ISIITA 2025

HYBRID MODE (Virtual & Physical)

International Symposium on Innovation in Information Technology and Application

PROGRAM

Taipei, Taiwan, Shih Chien University Taipei Campus

February 10 ~ 13, 2025

Organized by

International Society for Information Technology and Application (ISITA)
University of the Taipei, Taiwan
DU_The Research Institute for Special Education & Rehabilitation Science
(NRF-2022S1A5C2A07091326

WELCOME ADDRESS

Welcome to the 2025 International Symposium on Innovation in Information Technology and Application. A sincere welcome awaits all visitors.

As we entered the 21st century, the rapid growth of information technology has changed our lives more conveniently than we have ever speculated.

Recently in all fields of industry, heterogeneous technologies have converged with information technology resulting in a new paradigm, IT convergence, and people have been breaking the limit and finding other possibilities of IT research and development through converging with various industries and technologies.

The goal of this conference is to discover a new progressive technology by upgrading the previous technologies and to solve the technical problems that may have occurred in the process of converging technology in various fields of industry.

The International Symposium Innovation in Information Technology Application (ISIITA) 2025, the world's premier networking forum of leading researchers in the highly active fields of information technology application, will be held in Taiwan, Taipei. The ISIITA 2025 will include oral and poster sessions as well as tutorials given by experts in state-of-the-art topics.

IT experts, researchers, and practitioners from each field are invited to share ideas and research technologies; moreover, encouraged to cooperate with each other to overcome the confronted technical problems. As a result, this conference will become a place of knowledge where a variety of effects can be created.

We are proud to invite you to Taipei, Taiwan, which is a perfect setting for the Conference. We truly hope that you will have a technically rewarding experience as well as some memorable experiences in Taipei, Taiwan.

It is our hope that you're participating in ISIITA 2025 will be a rewarding experience and that you will get a chance to meet other colleagues working in the exciting area of industrial information systems. We are all looking forward to seeing you in Taipei, Taiwan.

A sincere welcome awaits all visitors at the conference.

Sang Hyuk LEE
General Chair
New Uzbekistan University, Uzbekistan

COMMITTEE

General Chair	Sang Hyuk LEE (New Uzbekistan University, Uzbekistan)
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Conference Secretaries	Hyung Gyu Lee (Duksung Women's University, Korea) Kyung-Ki Kim (Daegu University, Korea)

PROGRAM AT A GLANCE

Shih Chien University,
L Building (ADMINISTRATION & TEACHING BUILDING) 3F, Room L307, L310

Time	Event
Feb. 10 | 2025	
13:30~15:15	SIG Meeting I
15:15~15:35	Coffee Break
15:35~16:35	SIG Meeting II
Feb. 11 | 2025	
08:30~09:00	Registration
09:00~09:20	Opening Ceremony (Room: L310)
09:20~10:10	Keynote I (Room: L310)
10:10~10:30	Coffee Break
10:30~12:00	Session 1 (Room: L310)
12:00~13:00	Special Lunch Time (All together)
13:00~14:10	Session 2 (Posters & Capstone) **(Room: L310)**
14:10~14:30	Coffee Break
14:30~16:00	**(Room: L310)** Session 3 | Session 4 **(Room: L307)**
16:00~16:20	Coffee Break
16:20~17:50	**(Room: L307)** Session 5 | Session 6 **(Room: L310)**
Feb.12 | 2025	
09:00~10:30	Session 7 **(Room: L310)**
10:30~10:50	Coffee Break
10:50~12:20	**(Room: L310)** Session 8 | Session 9 (Video)
13:30~14:40	Special Meeting 1: AI Research Group Meeting*
	Special Meeting 2: Smart Factory Research Group Meeting*
15:00~16:00	Special Meeting 3: Energy Technology Research Group Meeting*
	Special Meeting 4: MIS Research Group Meeting*
Feb. 13 | 2025	
09:00~11:00	Interactive Networking
11:00~11:30	Committee Meeting
* Note that all special meetings are closed sessions and not open to general registrants.	

TECHNICAL PROGRAM

Feb. 10 | 2025	
Time	**Content**
13:30 ~	SIG Meeting I
15:15 ~	Coffee Break
15:35 ~	SIG Meeting II

Feb. 11 | 2025		
Time	**Content**	
08:30 ~	Registration	
09:00 ~	Opening Ceremony (General Chair, Shih Chien University)	
09:20 ~	Keynote I (Dr. Shang-Pin Ma, National Taiwan Ocean University) Chair: Miran Lee (Daegu Univ.)	
10:10 ~	Coffee Break	
10:30 ~	Session 1: Smart Technologies and Data-Driven Innovations (Room: L310) Chair: Miran Lee (Daegu Univ.)	
	1S-1 [015]	**Integrated Elevator Control System with OTS and Robotic Arm for Inter-Floor Transfer Robot** *Kyungmin Jung[1)] and Hyunki Lee[2*)]* *1) Department of Interdisciplinary Engineering, DGIST, 333 Techno jungang-daero, Daegu 42988, Korea* *2) Division of Intelligent Robotics, DGIST, 333 Techno jungang-daero, Daegu 42988, Korea*
	1S-2 [019]	**Understanding NFT Prices through Word Embeddings: A Case Study of BAYC** *Lee Geun-Cheol[1)], Hoon-Young Koo[2)], and Heejung Lee[3*)]* *1) College of Business Administration, Konkuk University, Seoul 05029, Korea* *2) School of Business, Chungnam National University, Daejeon 34134, Korea* *3) School of Interdisciplinary Industrial Studies, Hanyang University, Seoul 04763, Korea*
	1S-3 [021]	**Descriptive Analytics of Space Debris: Trends and Insights from Satellite Catalog Data** *P.C. Sridevi[1)] and T.Velmurugan[2*)]* *1) Research Scholar, PG and Research Department of Computer Science* *2) Associate Professor, PG and Research Department of Computer Science* *Dwaraka Doss Goverdhan Doss Vaishnav College, Chennai-600106, India*
	1S-4 [030]	**Predicting YouTube Views through an Integrated Approach of Automated Retraining and Thumbnail Visual Impact Analysis** *Tsolmon Narangerel[1)] and Yoosoo Oh [2*)]* *1) School of Computer and Information Engineering, Daegu University, 38455, Korea* *2) School of Computer and Information Engineering, Daegu University, 38455, Korea*
	1S-5 [034]	**Energy Optimization for University Buildings Timetable Scheduling Considering Thermal loading on HVAC**

		Dina Dahy[1)] , Adel Ahmed[2)] , M. Nayel[2)] , and Wael Ahmed[2)] *1) Assiut and New Valley Company for water and wastewater Assiut, Egypt* *2) Dept. of Electrical Engineering Faculty of Engineering, Assiut University, Assiut, Egypt*
	1S-6 [048]	**Comparative Analysis of Deep Learning Architectures for Meat Freshness Classification** *Fernando Quiroz, Jr. [1*)], Robert Roxas[2)], Edison Ralar [3)]* *1) School of Tech. and Computer Studies. Biliran Province State University, Philippines* *2) College of Science. University of the Philippines Cebu, Philippines* *3) School of Tech. and Computer Studies. Biliran Province State University, Philippines*
12:00 ~	Lunch	
13:00~	Session 2: Interactive Posters (Room: L310) Chairs: Hyung Gyu Lee (Duksung Women's Univ.) and Hyun Duk Kim (DGIST)	
	2S-1 [003]	**A Study on PI Gain Control Method for Real-Time Optimization of Current Response in MR Dampers** *Si-Uk Jung[1)] , Sung-Hyun Park[2)] , Byeong-Hwa Lee[2)] and Jae-Woo Jung[1*)]* *1) Dept. of Electronic Engineering, Daegu University, Gyeongsan 38453, South Korea* *2) Daegu-Gyeongbuk Division, Korea Automotive Technology Institute, Daegu 43011, South Korea*
	2S-2 [006]	**Remote Heart Rate Estimation using RGB-NIR Fusion** *Hyunduk Kim[1)] , Sang-Heon Lee[1)] , Myoung-Kyu Sohn[1)] , and Junkwang Kim[1)]* *1) Division of Automotive Technology, DGIST, Daegu, Republic of Korea*
	2S-3 [007]	**Low Power MUSIC Algorithm based MIMO Image FMCW Radar Techniques** *Bong-seok Kim[1)] , Jonghun Lee[2)] and Sangdong Kim[2*)]* *1) Division of Automotive Technology, DGIST, Daegu, South Korea* *2) Division of Automotive Technology and the Department of Interdisciplinary Engineering, DGIST, Daegu, South Korea*
	2S-4 [022]	**Design of a Malicious Email Analyzer with Rule-based Detection and Three-step Process** *Jieun Choi[1)] and Yongho Choi[2*)]* *1) Dept. of Police Administration, Daegu University, Gyeongsan-si, Gyeongsangbuk-do 38453, Republic of Korea* *2) Dept. of Computer & Information Engineering, Daegu University, Gyeongsan-si, Gyeongsangbuk-do 38453, Republic of Korea*
	2S-5 [044]	**Design of Upper/Lower System with Automatic Height Control for CNC Gas Cutting** *Jun-Yeop Lee[1)] , Thanh-Binh Nguyen[1)] , and Byeong-Soo Go[2)]* *1) Dept. of Electric Engineering, Changwon National University, Changwon, Republic of Korea* *2) Institute of Mechatronics, Changwon National University, Changwon, Republic of Korea*
	2S-6 [064]	**Improving Driving Control Accuracy of Autonomous Vehicles Based on CNNs** *Youjin Park[1)], Sojung Kim[1)], and Hyung Gyu Lee[1)]* *1) Dept of Software, Duksung Women's University, Seoul, Republic of Korea*
	2S-7 [001]	**Remote Configuration of ADR parameters for End-Devices Using the RFU Field in LoRaWAN Packets** *Won-jae Lee[1)] and Seand Seong-eun Yoo[1*)]* *1) Dept. of Artificial Intelligence, Daegu University, Gyeongsan-si, Gyeongsangbuk-do 38453, Korea*
	2S-8 [063]	**Posture Correction Device Based on Pressure Feedback for Scoliosis Improvement** *So Yeong Lee[1)], Chang-Yong Ko[2)] and Sung-Phil Heo[1*)]* *1) Gangneung-Wonju National University, Wonji-si, 26403, Korea* *2) Dept. of Research & Development, Refind Inc., Wonju 26354, Korea*

14:30~	Session 3: Machine Learning and Applications (Room: L310) Chair: Lee Hyungi (DGIST) and Moon Kean Kim (Oslo Metropolitan Univ.)	
	3S-1 [011]	**Factors Influencing the Transition to a New Learning Management System: Focusing on Collaboration with the International Atomic Energy Agency(IAEA)** *Hyeon-Jin Kim[1)] , Kyoung-Pyo Kim[2)] , and Ik Jeong[2*)]* *1) Nuclear Training and Education Center, Korea Atomic Energy Research Institute, Daejeon, Republic of Korea* *2) SMART Technology Development Division, Korea Atomic Energy Research Institute, Daejeon, Republic of Korea*
	3S-2 [016]	**Real-time Surgical Navigation Framework Using Integrated Machine Vision and Stereo Vision** *Mingang Jang[1)] and Hyunki Lee[2*)]* *1) Department of Interdisciplinary Engineering, DGIST, 333 Techno jungang-daero, Daegu 42988, Korea* *2) Division of Intelligent Robotics, DGIST, 333 Techno jungang-daero, Daegu 42988, Korea*
	3S-3 [027]	**Development of Artificial Intelligence-Predicted Multi-Antigen Fusion Vaccine and Immunological Characterization** *Ki Bum Ahn[1)] , Kyoung-Pyo Kim[2)] and Ho Seong Seo[1*)]* *1) Cyclotron Applied Research Section, Korea Atomic Energy Research Institute, Jeongeup 56212, Republic of Korea.* *2) SMART Technology Development Division, Korea Atomic Energy Research Institute, Daejeon 34057 Republic of Korea*
	3S-4 [035]	**Research Study on Forest Fire Prediction System Using KNN** *Dr.N.M Sangeetha[1)] , Sathya Seelan S.A[1)] , and Sanjay S[1)]* *1) Department of Computer Science (UG&PG) Dwaraka Doss Goverdhan Doss Vaishanav College, Chennai, TN, India*
	3S-5 [033]	**Review of Data Normalization Techniques for Building Energy Predictions** *Moon Keun Kim[1*)]* *1) Dept. of Built Environment, Oslo Metropolitan University, Oslo N-0130, Norway*
	3S-6 [036]	**Surveys on the Stylus Technologies for Capacitive-Type Touch Systems** *Jae-Sung An[1)]* *1) Sony Europe Design Center, Sony Semiconductor Solution, Norway*
14:30~	Session 4: Management Information (Room: L307) Chair: Min Ho Ryu (Dong-A Univ.)	
	4S-1 [005]	**The Impact of Generational Harmony on Retail Activation: Focused on Seoul** *GeonYul Shin[1)] , Min Ho Ryu[1)]* *1) Dept. of Management Information System, Dong-A University, 255 Gudeok-ro, Busan 49236, Korea*
	4S-2 [020]	**Passenger Demand Forecasting at Singapore's Changi Airport in Post Pandemic Era** *Lee Geun-Cheol[1)] , Heejung Lee[2)] and Hoon-Young Koo[3*)]* *1) College of Business Administration, Konkuk University, Seoul 05029, Korea* *2) School of Business, Chungnam National University, Daejeon 34134, Korea* *3) School of Interdisciplinary Industrial Studies, Hanyang University, Seoul 04763, Korea*
	4S-3 [060]	**GymViet: AI-Driven Fitness Assistance Platform** *Doan-Duc Pham[1)] , Van-Nhien Ho[1)] , Minh-Tuan Pham[1)] , Minh-Thi L. Pham[1)] , Quoc-Vi Dam[1)] , Duc-Man Nguyen[1)]* *1) International School of Duy Tan University, 550000, Da Nang, Vietnam.*

	4S-4 [061]	**Ve-Amor: AI enhance Dating Application** *Long-Phan Hoang[1)] , Bao-Gia Nguyen[1)] , Thanh-Mai Van[1)] , Khai-Nhat Nguyen[1)] , Trong-Thanh Nguyen[1)]* *1) International School, Duy Tan University, 550000, Da Nang, Vietnam.*
	4S-5 [062]	**DanaHub: A Smart Solution for Urban Traffic and Flood Management in Metropolitan Areas** *Phuoc-Tinh V. Le[1)] , Dinh-Hiep Tran[1)] , Viet-Minh Tran[1)] , Minh Phu-Nguyen[1)] , Duc-Man Nguyen[1)]* *1) International School, Duy Tan University, 550000, Da Nang, Vietnam.*
	4S-6 [025]	**Building the Future: Cloud Computing and IoT in Urban Development** *S. Sivaranjani[1)] and R. Anandhi[2)]* *1) Assistant Professor, PG Department of Information Technology and BCA, Dwaraka Doss Goverdhan Doss Vaishnav College, Chennai, India.* *2) Assistant Professor, PG and Research Department of Computer Applications (MCA), Dwaraka Doss Goverdhan Doss Vaishnav College, Chennai, India.*
16:00 ~	Session 5: AI and Data Technologies (Room: L307) Chair: T. Velmurugan (Dwaraka Doss Goverdhan Doss Vaishnav College) Hyung Gyu Lee (Duksung Women's Univ.)	
	5S-1 [008]	**Sentiment Analysis of Musical Instruments Customer Reviews Using Machine Learning Techniques with Novel Hybrid Approach** *T.Velmurugan[1)] and M. Archana[2)]* *1) PG & Research Department of Computer Science, 2PG Department of IT & BCA* *2) Dwaraka Doss Goverdhan Doss Vaishnav College, Chennai, India*
	5S-2 [009]	**Enhancing Mobile Data Security and Privacy: A Spotlight on Cloud Solutions** *K. Ramya[1)] , R. Anandhi[2)]* *1) PG Department of Information Technology and BCA, Dwaraka Doss Goverdhan Doss Vaishnav College, Chennai, India.* *2) PG and Research Department of Computer Applications (MCA), Dwaraka Doss Goverdhan Doss Vaishnav College, Chennai, India*
	5S-3 [010]	**Facial Expression Analysis for Emotion Detection Using Convolutional Neural Networks** *Vikas Jangra[1*)] and Sumeet Gill [1)]* *1) Department of Mathematics, M.D. University Rohtak, India*
	5S-4 [013]	**Hyperspectral Imaging-Based Tumor Segmentation Using K-Means Clustering and Morphological Analysis** *Diviya K and Radhakrishnan Palanikumar* *PG& Research Department of Computer Science, DonBosco College(Co-Ed), Guezou Nagar, YelagiriHills, Tamilnadu-635854. (Affiliated to Thiruvalluvar University),India*
	5S-5 [[018]	**Conspiracy of Shadows: a Story-Driven Game Design and Immersive Player Engagement** *Dr.Girija M S.[1)] , Keerthi S.[1)] , Harshini S V.[1)] , Rithuna V.[1)]* *1) Dept. of Computer Science and Design, R.M.K. Engineering College, Chennai, India.*
	5S-6 [046]	**The Price of Convenience: Empirical Runtime Study on Type Casting Across Programming Paradigms** *Ashton Curry[1)] , Rane Murphy[1)] , Ka Lok Man[2)] , Yuxuan Zhao[3)] , and Kamran Siddique[1)]* *1) Dept. of Computer Science and Engineering, University of Alaska Anchorage* *2) Department of Computing, School of Advanced Technology, Xi'an Jiaotong-Liverpool University* *3) School of AI and Advanced Computing, Xi'an Jiaotong-Liverpool University*

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16:00 ~	Session 6: Machine Learning (ROOM: L310) Chair: Sanghyuk Lee (New Uzbekistan University) and Jae-Woo Jung (Daegu Univ.)	
	6S-1 [041]	**Design of a Dynamic Simulation Platform for Verifying Unloading Automation Algorithms in Grab Type Ship Unloader** *Ga-Eun Jung[1)] , Jae-In Lee[1)] , and Seok-Ju Lee[2)] , and Chang-Uk Kim[3)]* *1) Dept. of Electrical Engineering, Changwon National University, Changwon 51140, Republic of Korea* *2) Industry-University Cooperation Foundation, Changwon National University, Changwon 51140, Republic of Korea* *3) R&D Center, S-Material Handling Co., Ltd., Changwon 51395, Republic of Korea*
	6S-2 [056]	**Machine Learning (ML) Approach Utilizing FTIR Spectroscopy Data for Accurate and Efficient Identification of Chemical Functional Groups** *Otabek Atabayev and Babaa Mouley Rashid* *Department of Chemical Engineering New Uzbekistan University*
	6S-3 [057]	**Granular Computing on Brain Signals using Fuzzy Logic and Pattern Recognition** *Rukhsora Toirova, Kurbon Abdukhakimov, Mukhiddin Abduazimov, Elmurod Erkinov, and Sanghyuk Lee* *Department of Computer Science New Uzbekistan University*
	6S-4 [058]	**Light-weight Visualization of Computational Fluid Dynamics** *Safoyev Shahboz, Dilnoza Seydametova, Dilnoza Raxmatullayeva, Komilakhon Nodirbekova, Adminaddinov, and Khumoyun* *Department of Computer Science New Uzbekistan University*
	6S-5 [054]	**Fine-tuning Large Language Models for Question Answering on API and Programming Documentation** *Dilnoza Saydametova, Shahboz Safoev, Dilnoza Raxmatullaeva, Komilakhon Nodirbekova, and Khumoyun Aminaddinov* *Department of Computer Science, New Uzbekistan University*
	6S-6 [055]	**From Simulation to Mitigation: Countering Deceptive and Deauthentication Threats** *Behzod Khakimov, Ozodbek Adkhamov and Siroddjin Juraev* *Department of Computer Science, New Uzbekistan University*
	6S-7 [042]	**Design of the Frequency-Dependent DC Line Models for Transient Simulation of MVDC Distribution Networks** *Nam-Gi Park[1)] , Jae-In Lee[2)] , Seok-Ju Lee[2)] , and Minh-Chau Dinh[2*)]* *1) Dept. of Electrical Engineering, Changwon National University, Changwon, Republic of Korea* *2) Institute of Mechatronics, Changwon National University, Changwon, Republic of Korea*

Feb. 12 | 2025		
Time	**Content**	
09:00~	Session 7: Data-Driven Models and Deep Learning Applications (Room: L310) Chair: Jonghun Lee (DGIST) and Sang Suh (East Texas A&M University)	
	7S-1 [002]	**Data-Driven Surrogate Model for Predicting 2D Assembly-wise Power Distribution Changes** *Jung-seok Kwon[1)], Tongkyu Park [1*)], Sung-kyun Zee [1)]* *1)Nuclear Computational Science Group, FNC Technology, Yongin-si, Gyeonggi-do, Korea*

	7S-2 [012]	**Vehicle Recognition and Speed Monitoring System using YOLOv9** *Sang Suh[1)] and Bilal Mushtaq[1)]* *1) Department of Computer Science, East Texas A&M University, U.S.A.*
	7S-3 [023]	**Understanding Foot Gesture Recognition Mechanisms Based on a Low-Cost Radar and Deep Learning Models for Human Detection** *Seungeon Song[1)], Bongseok Kim[1)], Sangdong Kim[1,2)], and Jonghun Lee[1,2*)]* *1) Division of Automotive Technology, Research Institute, DGIST, Dalseong-gun, Daegu, Korea* *2) Department of Interdisciplinary Engineering, Graduate School, DGIST, Dalseong-gun, Daegu, Korea*
	7S-4 [026]	**Ensemble Approach Towards Heuristic Features on Deep Learning Algorithms for Coronary Artery Disease Prediction and Drug Recommendations** *Sang Suh[1)] , Lakshmi Kiranmai Reddy Voggu[1)] , Venkata Sai Jaswanth Kumar Vellanki[1)] , Bhavya Muthineni[1)], Ravin Timalsina[1)]* *1) Department of Computer Science, East Texas A&M University, U.S.A.*
	7S-5 [038]	**Impact of Noise on GPR Signal Processing and Comparative Analysis of Denoising Filters** *Gyeongtaeg Yang[1)] , Seungeon Song[2)] , and Jonghun Lee[1*,2)]* *1) Dept. of Interdisciplinary Engineering, Graduate school, DGIST, Daegu, 42988, Korea* *2) Institute of Research, DGIST, Daegu, 42988, Korea*
	7S-6 [039]	**Analysis of the recent ICT curriculum of Trade schools in D City** *Seung Kwang Ryu[1)] , Jae Hyun Lee[2)] , and Jeong Tak Ryu [3*)]* *1) Graduate School of Smart Convergence Systems Engineering, Daegu University, Korea* *2) Department of Mechanical and Automotive Engineering, College of Engineering, Daegu University, Korea* *3) Department of Electronic Engineering, College of Information and Communication Engineering, Daegu University, Korea*
10:30~	Coffee Break	
10:50 ~	Session 8: AI-based system design (Room: L310) Chair: Yoosoo Oh (Daegu University)	
	8S-1 [014]	**Performance Improvement of Worker Detection Systems Through ROI-Based Image Post-Processing Filters** *Rock Hyun Choi[1)] and Hyunki Lee[1*)]* *1) Division of Intelligent Robotics, DGIST, Daegu, 42988, South Korea*
	8S-2 [028]	**LangChain and RAG-Based Q&A System for University Policies** *In-Hye Park[1)], Min-Jeong Kim[1)] and Kyung-Ae Cha[1)]* *1) Dept. of Artificial Intelligence, Daegu University, Gyeongsan 38453, Korea*
	8S-3 [029]	**AI Assistant System for Fault Ratio Analysis Using Traffic Accident Data** *Young-Jun Kim[1)] , In-Hye Park[1)] , Min-Jeong Kim[1)] and Kyung-Ae Cha* *1) Dept. of Artificial Intelligence, Daegu University, Gyeongsan-si, Korea*
	8S-4 [031]	**Airport Baggage Loading Based on Boarding Check-in Priority Using CNN-PPO** *YunSeo Choi[1)] and Yoosoo Oh [2,*)]* *1) School of AI, Daegu University, Daegu 38455, Korea* *2) School of Computer and Information Engineering, Daegu University, Daegu 38455, Korea*

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	8S-5 [032]	**Design of a Chatbot System that Provides Korean Legal Advice for Assault Victims** *Hyori Kim[1)] and Yoosoo Oh [2,*)]* *1) School of Computer and Information Engineering, Daegu University, Daegu, South Korea*
	8S-6 [067]	**Assessment of Pricing-Based Demand Response Programs and Their Impact on Demand-Side Management** *Mohammed Sayed[1)], Mohamed A.Abdellah[1)], Mohamed Abd Elazim Nayel[1)]* *1) Electrical Engineering, Assiut University, Assiut, 71511, Assiut, Egtpy.*
10:50 ~	Session 9: Intelligent Methods, and Innovations in Energy Management Chair: Jong Tak Ryu (Daegu Univ.)	
	9S-1 [017]	**A Comparative Study on Analyzing Neural Network Models for Detecting Network Anomalies Using a Tabular Dataset** *Kiko Onishi[1)] , Aryan Shah[1)] , and Donghwoon Kwon[1*)]* *1) Dept. of Computer Science and Engineering, North Central College, Naperville, IL 60540, USA*
	9S-2 [024]	**Development of an Efficient and Stable Numerical Scheme** *Seoungejae Lee[1)] and Yongho Choi[2*)]* *1) Dept. of IT Convergence Engineering, Daegu University, Gyeongsan-si, Gyeonsangbuk-do 38453, Korea* *2) Dept. of Computer & Information Engineering, Daegu University, Gyeongsan-si, Gyeonsangbuk-do 38453, Korea*
	9S-3 [043]	**Advanced Battery Management Method For Energy-Transportation Network** *Bharath.M[1)] and Gomathi.E[1)]* *1) Department of Petrochemical Technology, University College of Engineering- BIT Campus, Anna University, Trichy*
	9S-4 [040]	**Design of a System to Prevent Elopement Behavior for Students with Developmental Disabilities** *Woosoon Jung[1)] , KyoungOck Park[2)] , and Jeong Tak Ryu[3*)]* *1) Institute of Special Education & Rehabilitation Science, Daegu University, Gyeongsan-si, 38453, Korea* *2) Dept. of Elementary Special Education, Daegu University, Gyeongsan-si, 38453, Korea* *3) Dept. of Electronic and Electrical Engineering, Daegu University, Gyeongsan-si, 38453, Korea*
	9S-5 [037]	**Study on Current, Voltage, and Torque Measurement Systems for Quality Inspection of Induction Motors** *Seung Kwang Ryu[1)] , Byung Seop, Song[2)] , Jeong Tak Ryu[3*)]* *1) Graduate School of Smart Convergence Systems Engineering, Daegu University, Korea* *2) Department of Medical Rehabilitation, Daegu University, Korea* *3) Department of Electric Engineering, Daegu University, Gyeongsan 38453, Republic of Korea*
	9S-6 [047]	**Development of Simulated Neutron Signal Generation Algorithm for Small Modular Reactor** *Daeil Lee[1)], Joon-ku Lee[1)], Kwang-il Jeong[1)]and Hyeong-seok Eun[1)]* *1) Korea Atomic Energy Research Institute, Daejeon, 34057, Republic of Korea*
	Special Research Meetings (closed sessions) Chair: Hyung Gyu Lee (Duksung Women's Univ.)	
13:30 ~	Special Meeting 1: AI Research Group Meeting	
	Special Meeting 2: Smart Factory Research Group Meeting	

International Symposium on Innovation in Information Technology and Application

	Special Meeting 4: MIS Research Group Meeting

Feb. 13 | 2025	
Time	**Content**
09:00 ~	Interactive Network
11:00 ~	Committee Meeting
11:30 ~	Closing

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10:30 ~	Session 1: Smart Technologies and Data-Driven Innovations (Room: L310) Chair: Miran Lee (Daegu Univ.)	
	1S-1 [015]	**Integrated Elevator Control System with OTS and Robotic Arm for Inter-Floor Transfer Robot** *Kyungmin Jung[1)] and Hyunki Lee[2*)]* *1) Department of Interdisciplinary Engineering, DGIST, 333 Techno jungang-daero, Daegu 42988, Korea* *2) Division of Intelligent Robotics, DGIST, 333 Techno jungang-daero, Daegu 42988, Korea*
	1S-2 [019]	**Understanding NFT Prices through Word Embeddings: A Case Study of BAYC** *Lee Geun-Cheol[1)] , Hoon-Young Koo[2)] , and Heejung Lee[3*)]* *1) College of Business Administration, Konkuk University, Seoul 05029, Korea* *2) School of Business, Chungnam National University, Daejeon 34134, Korea* *3) School of Interdisciplinary Industrial Studies, Hanyang University, Seoul 04763, Korea*
	1S-3 [021]	**Descriptive Analytics of Space Debris: Trends and Insights from Satellite Catalog Data** *P.C. Sridevi[1)] and T.Velmurugan[2*)]* *1) Research Scholar, PG and Research Department of Computer Science* *2) Associate Professor, PG and Research Department of Computer Science* *Dwaraka Doss Goverdhan Doss Vaishnav College, Chennai-600106, India*
	1S-4 [030]	**Predicting YouTube Views through an Integrated Approach of Automated Retraining and Thumbnail Visual Impact Analysis** *Tsolmon Narangerel[1)] and Yoosoo Oh [2*)]* *1) School of Computer and Information Engineering, Daegu University, 38455, Korea* *2) School of Computer and Information Engineering, Daegu University, 38455, Korea*
	1S-5 [034]	**Energy Optimization for University Buildings Timetable Scheduling Considering Thermal loading on HVAC** *Dina Dahy[1)] , Adel Ahmed[2)] , M. Nayel[2)] , and Wael Ahmed[2)]* *1) Assiut and New Valley Company for water and wastewater Assiut, Egypt* *2) Dept. of Electrical Engineering Faculty of Engineering, Assiut University, Assiut, Egypt*
	1S-6 [048]	**Comparative Analysis of Deep Learning Architectures for Meat Freshness Classification** *Fernando Quiroz, Jr. [1*)], Robert Roxas[2)], Edison Ralar [3)]* *1) School of Tech. and Computer Studies. Biliran Province State University, Philippines* *2) College of Science. University of the Philippines Cebu, Philippines* *3) School of Tech. and Computer Studies. Biliran Province State University, Philippines*

Integrated elevator control system with OTS and robotic arm for inter-floor transfer robot

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Abstract: Currently, autonomous mobile robots are primarily constrained to operations on a single floor, which presents significant challenges for tasks requiring multi-floor navigation. Recent advancements in the field have stimulated research focused on robots that possess the capability to traverse between floors utilizing elevator systems. Nevertheless, the majority of inter-floor robotic systems depend on RGB-D cameras and sophisticated deep learning algorithms for the recognition of buttons, necessitating extensive image datasets and considerable computational resources. This investigation puts forth a novel Optical Tracking System (OTS)-based inter-floor robotic architecture to mitigate these challenges. The proposed framework consists of three fundamental components: the OTS, the button manipulation subsystem, and the robot navigation module. By employing predefined distance metrics between buttons, the system functions with minimal computational requirements while achieving a higher degree of accuracy in recognition compared to deep learning-centric approaches. This design guarantees a high level of reliability and diminishes maintenance expenditures. The suggested framework presents a pragmatic and economically viable solution for multi-floor robotic operations, yielding enhanced performance without necessitating substantial computational capabilities.

Keywords : Optical Tracking System, Autonomus moblie robot, Inter-floor moving robot

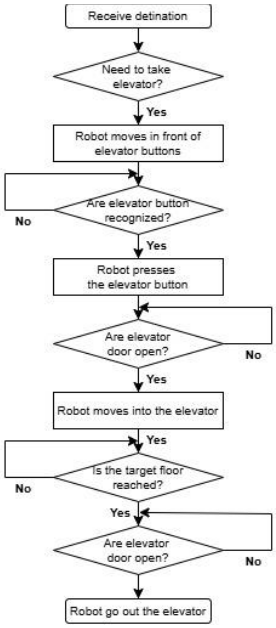

Fig. 1. A flowchart of proposal system

With the progression of autonomous robotic technology, mobile robots are progressively undertaking functions across diverse indoor settings such as healthcare facilities, dining establishments, and transportation hubs. Nonetheless, traditional systems have predominantly

been confined to ground-level or single-floor functionalities, thereby constraining their operational capabilities. Recently, scholarly inquiry has concentrated on inter-floor robots that adeptly utilize elevators for multi-level functionalities. These robots navigate autonomously by discerning elevator buttons and doors[1].

Conventional inter-floor robots employing RGB-D cameras analyze video or images utilizing deep learning frameworks to identify elevator buttons and doors[2][3]. However, this methodology necessitates substantial image datasets, considerable computational resources for real-time analysis, and accurate identification of all buttons, which presents formidable obstacles.

To mitigate these challenges, the present research introduces an Optical Tracking System (OTS)-based inter-floor robotic solution. The OTS-based architecture is segmented into three principal components: OTS System: Infrared cameras are deployed to identify elevator buttons. Each button is associated with predefined coordinates and is positioned within and outside the elevator. These coordinates encompass x, y, and z values, which facilitate the computation of relative distances. Button Manipulation System: The coordinates and distance metrics derived from the OTS system serve as input data for the robotic arm apparatus. These metrics enable the robotic arm to precisely locate and engage the appropriate button. Robot Navigation System: This component empowers the robot to traverse both inside and outside the elevator. Employing the Dynamic Window Approach (DWA) in ROS Navigation, the robot maneuvers through predefined coordinates in these areas. LiDAR technology is utilized to perceive the surrounding environment and any potential obstacles. Should the elevator doors be closed, the robot remains stationary in front of the elevator. Upon the opening of the doors, the robot proceeds to enter safely. Each component communicates through an internal communication system, thereby ensuring effective inter-floor transit via the elevator. LiDAR is also employed to validate the status of the elevator doors, enabling the robot to enter securely when they are ajar.

The proposed OTS-based inter-floor robotic system exemplifies precise and dependable recognition and manipulation of elevator buttons without dependence on deep learning frameworks that necessitate extensive training datasets. This system presents a pragmatic solution with diminished maintenance expenses while ensuring elevated reliability, rendering it a feasible approach for multi-floor robotic applications.

Acknowledgment

This research was supported by a grant of Korean ARPA-H Project through the Korea Health Industry Development Institute (KHIDI), funded by the Ministry of Health & Welfare, Republic of Korea (grant number : RS-2024-12345678)

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Understanding NFT Prices through Word Embeddings: A Case Study of BAYC

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Abstract: The explosive growth of Non-Fungible Tokens (NFTs) in recent years, especially profile picture (PFP) NFTs, has brought forward new challenges in valuation. Traditional valuation models, primarily used for fungible assets, struggle to capture the intrinsic and extrinsic factors that affect NFT pricing. In this study, we propose a novel methodology that utilizes word embedding techniques to evaluate the market value of NFTs, focusing on the Bored Ape Yacht Club (BAYC) collection.

Our research introduces a hedonic pricing model that quantifies the relationship between NFT traits and market value. Unlike the widely used one-hot encoding method for categorical traits, this study uses advanced natural language processing (NLP) techniques, including Word2Vec, FastText, and Term Frequency-Inverse Document Frequency (TF-IDF), to generate numerical representations of each NFT's unique traits. These traits, which include features such as background color, accessories, and facial expressions, play a crucial role in determining the value of an NFT, particularly in high-profile collections like BAYC.

The empirical analysis conducted on a dataset of 6,618 BAYC transactions from May 2021 to July 2023 demonstrates the efficacy of this approach. Comparative tests reveal that models incorporating TF-IDF embeddings outperform both the Word2Vec and FastText-based models, as well as traditional one-hot encoding methods. Specifically, the TF-IDF model achieved the highest adjusted R^2 and the lowest Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) values, indicating a superior fit to the data. The results suggest that word embedding techniques are better suited for capturing the nuanced relationships between an NFT's descriptive traits and its market price.

In addition to highlighting the success of TF-IDF in this context, the study also explores the potential for further enhancements in NFT valuation models. Future work could incorporate more advanced word embedding techniques, such as BERT or GPT-based models, to capture even deeper semantic relationships. Furthermore, extending the dataset to include other popular NFT collections could provide more generalized insights into NFT pricing dynamics.

In conclusion, this study contributes to the literature by demonstrating how word embedding techniques can improve the accuracy of NFT valuations, providing a more robust framework for collectors, investors, and creators in the fast-evolving digital asset space. Our findings also underline the importance of understanding the intrinsic traits that define the value of NFTs, offering new tools for navigating the speculative and volatile NFT market.

Keywords : Non-Fungible Tokens, Profile Picture, Bored Ape Yacht Club (BAYC), Word Embedding, Hedonic Pricing Models, TF-IDF, Word2Vec, FastText

Acknowledgment

This research was supported by the Ministry of Education of the Republic of Korea and the National Research Foundation of Korea (NFR-2023S1A5A2A0308344012).

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Biography

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Descriptive Analytics of Space Debris: Trends and Insights from Satellite Catalog Data

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Abstract: Space debris poses significant risks to active satellites, space exploration, and the long-term sustainability of orbital activities. This paper presents a comprehensive descriptive analysis of a publicly available dataset on space debris, sourced from Space-Track.org, encompassing over 14,000 objects recorded between October 4, 2021, and November 1, 2021. The analysis focuses on key parameters such as debris origin, temporal trends, and spatial distribution within Earth's orbit. Notable findings include the dominance of debris from major fragmentation events, such as the FENGYUN 1C and COSMOS 2251 incidents, and the concentration of debris in Low Earth Orbit (LEO). Temporal analysis reveals periods of heightened debris creation and highlights the rapid escalation of space congestion in recent years. By providing a detailed exploration of the dataset, this study offers valuable insights to policymakers, satellite operators, and researchers, underscoring the urgency of implementing effective space debris mitigation strategies. The work serves as a foundational resource for further exploration into predictive modeling, risk assessment, and sustainable space operations.

Key word: Space Debris, Space Debris Mitigation, Risk Assessment, Descriptive Analytics

Introduction

Space debris has emerged as a critical challenge for both satellite operations and the long-term sustainability of orbital activities. The presence of thousands of objects orbiting Earth, ranging from defunct satellites to fragments of destroyed spacecraft, poses a significant risk to active satellites and space exploration missions. With the increasing number of objects in orbit, the likelihood of collisions and the subsequent creation of more debris are rapidly growing [1]. This phenomenon threatens not only the operational lifespan of satellites but also the safety of astronauts and the viability of future space missions. In response to these growing concerns, understanding the dynamics of space debris and its impact on space activities has become imperative. This paper presents a comprehensive descriptive analysis of a publicly available dataset on space debris, sourced from Space-Track.org, covering over 14,000 objects tracked between October 4, 2021, and November 1, 2021. The dataset offers a unique opportunity to analyze the current state of space debris and its implications for the future of space exploration. The study delves into key parameters such as the origin of debris, the temporal trends in its accumulation, and its spatial distribution within Earth's orbit. By examining the origins of debris, the analysis identifies significant contributors to the growing debris environment, including major fragmentation events like the FENGYUN 1C and COSMOS 2251 incidents [2] [3]. These events have resulted in substantial debris fields, which now dominate Low Earth Orbit (LEO), the region of space where most satellite operations occur.

The temporal analysis within the dataset reveals distinct periods of increased debris creation, pointing to a worrying trend of escalating space congestion. This rapid increase in debris not only poses immediate risks to satellite operations but also threatens the long-term habitability of Earth's orbital environment. As the number of objects in LEO continues to rise [4], the potential for collisions and the generation of additional debris becomes more likely, creating a self-perpetuating cycle of orbital contamination. Through this detailed exploration of the dataset, this study highlights the urgent need for effective space debris mitigation strategies. It emphasizes the importance of coordinated efforts from policymakers, satellite operators, and space agencies to address the growing threat of space debris. The findings provide valuable insights into the scale and distribution of debris, offering a foundation for predictive modeling, risk assessment, and the development of sustainable space operations practices. This work serves as a crucial resource for ongoing research into space debris management and the future of space activities, advocating for a proactive approach to safeguard the space environment for future generations.

Related Work

The related work on space debris has focused on various aspects such as the assessment of collision risks, the evolution of debris in orbit, and mitigation strategies. Studies by [5] underscore the growing problem of debris and the potential for catastrophic collisions. Furthermore, recent advancements have utilized machine learning techniques for identifying and predicting debris-related risks [6], while organizations like the European Space Agency (ESA) have developed comprehensive guidelines to manage and reduce debris accumulation in space. This work done by li et al., [7] focuses on the increasing risk of collisions due to space debris in Earth’s orbit. The study emphasizes the need for effective space debris mitigation strategies and proposes collision risk assessments as part of the design process for spacecraft. This research by Liang et al., [8] examines the growth of space debris in Earth’s orbit and presents models to predict future debris population trends. It highlights how debris accumulation could lead to a critical "Kessler Syndrome" scenario.

The European Space Agency [9] provides a set of guidelines for debris mitigation that focuses on reducing debris generation from active missions and ensuring long-term sustainability in orbit. This study by giudici et al., [10] investigates the spatial distribution of debris in Low Earth Orbit (LEO) and highlights how orbital altitude and inclination affect debris concentration, offering insights into the design of space debris mitigation measures. These studies provide critical insights into the growing issue of space debris and underline the necessity for advanced monitoring, risk analysis, and mitigation techniques.

Methodology

The methodology adopted in this study comprised several critical steps to perform a detailed analysis of space debris:

Data Collection and Cleaning: The dataset, obtained from Kaggle [11], contains detailed records of over 14,000 space objects, including satellites and debris, tracked between October 4, 2021, and November 1, 2021. It includes key attributes such as the name of the object (OBJECT_NAME), the date the object was created (CREATION_DATE), and the center

responsible for tracking the object (CENTER_NAME). This data provides valuable insights into space debris origins, its creation timeline, and tracking methodologies.

Table 1: Sample Data

OBJECT_NAME	**CREATION_DATE**	**CENTER_NAME**
FENGYUN 1C	05-10-2021	USSPACECOM
COSMOS 2251	06-10-2021	USSPACECOM
IRIDIUM 33	10-10-2021	USSPACECOM
OBJECT-0079	12-10-2021	JAXA

Table 2: Data Description

Attribute	**Description**
OBJECT_NAME	Name of the object (satellite or debris) tracked by the center.
CREATION_DATE	The date when the object was created or first identified in the database.
CENTER_NAME	The name of the space agency or organization responsible for tracking the object.
OBJECT_ID	Unique identifier assigned to each object for precise tracking.
ORBIT_TYPE	Type of orbit the object is in (e.g., LEO, GEO).
OBJECT_STATUS	The current status of the object (e.g., active, inactive, debris).
DECAY_DATE	The date when the object was deorbited, if applicable.

Trend Analysis: A crucial part of the analysis focused on understanding the trends in space debris creation [12]. We explored the temporal distribution of debris, specifically focusing on how debris count changed over time. The CREATION_DATE field was leveraged to analyze debris generation over months and years. Data grouping by specific time intervals, such as days or months, allowed for identifying periods of increased debris activity, which might correspond to satellite breakups, launch activities, or other events. In the **data cleaning** step, converting CREATION_DATE to datetime ensures proper handling of date-related operations, while dropping rows with missing values eliminates invalid entries, though imputation could be

explored if significant data is lost. For **temporal analysis**, creating a Year_Month column allows for granular observations of monthly trends, and the bar chart visualizing debris creation over time provides clear insights. To improve, consider a line plot for smoother trend representation and verify chronological ordering of dates.

Spatial Analysis: Spatial distribution was analyzed by categorizing space debris based on its orbit type, such as Low Earth Orbit (LEO) and Geostationary Orbit (GEO). The variable OBJECT_TYPE was particularly useful in identifying the source of debris and determining the relative concentration of debris in different orbital zones. Visualization techniques like bar plots and count plots provided a clear representation of the frequency of debris objects in various orbit types. The **spatial analysis** Yuyan et al.,of debris by OBJECT_TYPE using a count plot highlights category distributions effectively. If OBJECT_TYPE contains numerous categories, grouping or focusing on the most frequent ones could enhance readability. Overall, the approach is sound and offers valuable insights, with minor adjustments to further refine the presentation.

Correlation and Statistical Analysis: To investigate relationships between key orbital parameters, a correlation matrix was computed for several numerical attributes, including MEAN_MOTION, ECCENTRICITY, INCLINATION, SEMIMAJOR_AXIS, APOAPSIS, and PERIAPSIS. This analysis aimed to determine how these orbital characteristics are interrelated and their influence on debris trajectory and risk factors. Statistical tests were performed to understand how different orbital attributes correlate with space debris creation and decay. For **orrelation matrices** to investigate relationships between orbital parameters such as **MEAN_MOTION**, **ECCENTRICITY**, **INCLINATION**, and others. Adding **statistical tests** like **hypothesis testing** and confidence intervals could validate the observed correlations and trends.

Risk Assessment and Proximity Analysis: A basic risk assessment was performed by examining the proximity between debris objects using their apogee (APOAPSIS) and perigee (PERIAPSIS). By calculating the difference between these values, this work generated a measure of how close debris objects are to each other in their orbits. This analysis is essential for understanding the risk of collision and predicting potential satellite threats. A histogram was created to display the distribution of proximity values, helping to identify potential high-risk regions. Creating a **histogram** for proximity values will help identify high-risk regions where debris objects might be too close to each other, increasing the risk of collisions. You might also want to explore **distance-based clustering** or **collision prediction models** for a more in-depth risk assessment.

Visualization Techniques: Several Python libraries, including **Pandas**, **Matplotlib**, **Seaborn**, and **NumPy**, were employed to manipulate and visualize the data. Count plots, line plots, histograms, and correlation heatmaps were used extensively to present the findings in a clear, digestible manner. These visualizations not only provided insight into the spatial and temporal distribution of debris but also helped to identify patterns, trends, and anomalies in the dataset. This methodology facilitated an in-depth understanding of the space debris landscape, providing insights into trends, risks, and spatial distribution. The data-driven approach established the foundation for more comprehensive studies and actionable recommendations for space debris mitigation and management.

Results and Discussion

The dataset provides detailed statistics on various orbital parameters of space debris objects. The description obtained by statistical analysis is given as fallows.

1. **Mean Motion**: The mean motion ranges from 0.05 to 16.4, with an average of approximately 12.46. This suggests a diverse set of orbital speeds, with most objects having moderate orbital velocities. The standard deviation of 4.51 indicates variability in the orbital speeds.
2. **Orbital Parameters**:
    - **Eccentricity** ranges from nearly circular orbits (0.000005) to highly elliptical orbits (0.897). Most debris objects have low eccentricity, indicating relatively circular orbits.
    - **Inclination** varies significantly, with values ranging from 0.001° to 144.6°. A mean inclination of 74.35° suggests a mix of polar and inclined orbits, common for many satellite launches and debris trajectories.
    - **Apogee and Perigee**: The range of apogee (5721 km) and perigee (2795 km) shows the variation in the altitude of debris objects. The largest apogee is much higher, reflecting objects in geostationary orbits or other high-altitude trajectories.
3. **Orbital Period**: The orbital period has a mean of 223.5 minutes, with a significant variation (446 minutes), indicating that debris objects are spread across different altitude ranges and orbital configurations.
4. **Debris Creation Dates**: The launch dates range from 1961 to 2021, with a peak in recent years (median launch year is 2002). This indicates a growing amount of debris due to increasing satellite launches over time.
5. **NORAD Catalog and Ephemeris Type**: The dataset includes data from the NORAD catalog, with IDs ranging from 26741 to 270288. This reflects a wide variety of debris objects with varying degrees of tracking and classification.

Overall, this dataset highlights the **diverse nature** of space debris in terms of orbital parameters, creation dates, and distribution. The presence of highly elliptical orbits, varying inclinations, and significant differences in apogee/perigee values points to complex dynamics within Earth's orbital environment. These insights are crucial for understanding the **risks** posed by space debris and the need for **mitigation** strategies.

Temporal Analysis of Space Debris Creation: The temporal analysis figure 1 of space debris creation, as visualized through a bar chart of debris creation over time, reveals several important trends. The data covers a span from October 4, 2021, to November 1, 2021, providing a snapshot of the space debris environment during this period. The analysis highlights that space debris creation is not evenly distributed across time, with certain months showing a marked increase in debris objects. The peak debris creation periods likely correlate with significant space events such as satellite breakups, launches, or other incidents leading to fragmentation. The year-month aggregation captures these trends effectively, though future analyses may benefit from a line plot to smooth out fluctuations and provide clearer insights into longer-term trends. And according to the figure 1 it is evident that the month November had over 8000 debris which quite the double amount of debris in October.

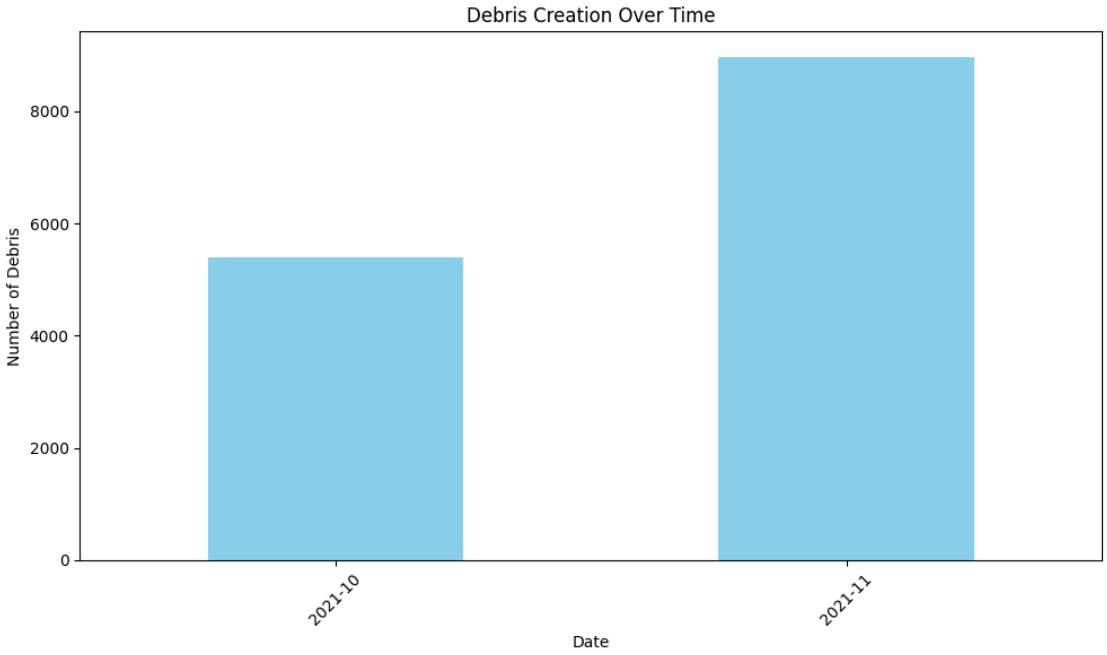

Figure 1: Debris created in space between October and November 2021

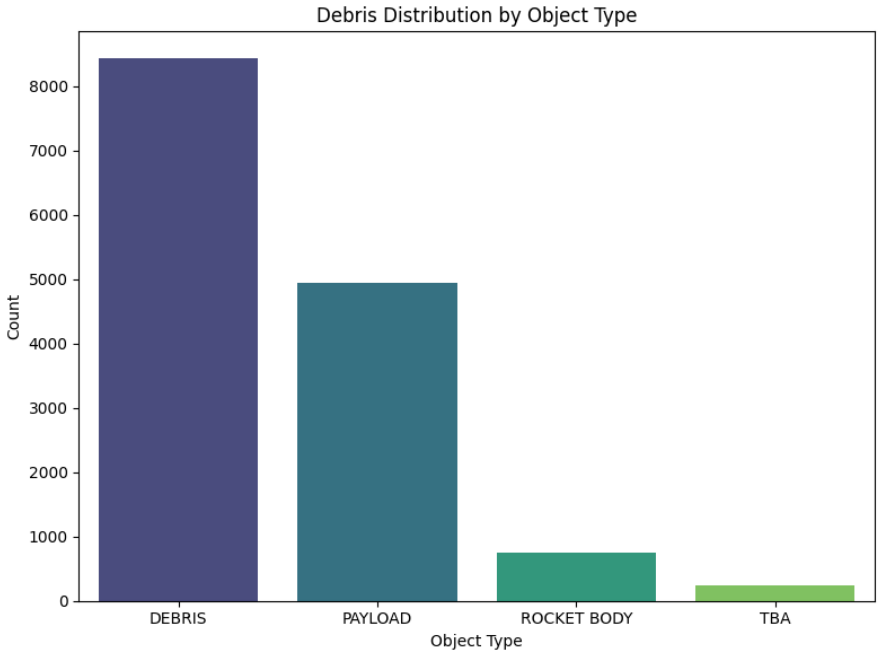

Figure 2: Debris distribution by object

Spatial Distribution of Space Debris by Object Type: The spatial distribution of debris, categorized by its OBJECT_TYPE figure 2, sheds light on the diversity of debris sources and their orbital characteristics. The count plot visualizes the relative frequency of debris objects

from various categories, such as defunct satellites, rocket stages, and other space debris. From this distribution, we can infer that certain object types contribute more significantly to the debris population than others. For instance, satellite fragmentation events and abandoned rocket stages appear to be major contributors to the debris in orbit. The concentration of debris in Low Earth Orbit (LEO) is particularly noteworthy, as this region is heavily trafficked by operational satellites, increasing the risk of collisions. The bar plot representation provides a clear visual of this spatial distribution, aiding in the identification of high-risk debris zones. A more refined analysis could focus on the most frequent object types to further understand the primary sources of debris in different orbital zones.

Correlation Between Key Orbital Parameters: The correlation analysis figure 3 of key orbital parameters such as MEAN_MOTION, ECCENTRICITY, INCLINATION, SEMIMAJOR_AXIS, APOAPSIS, and PERIAPSIS reveals several interesting insights into how orbital characteristics are interrelated. For instance, mean motion (the rate at which an object orbits Earth) shows a correlation with eccentricity and semimajor axis, which is expected because orbital objects with higher eccentricity typically experience faster orbital motions. The heatmap visualization of these correlations offers a quantitative perspective on how orbital characteristics might influence the behavior and risk associated with space debris. Understanding these relationships can aid in risk assessment, especially in predicting the likelihood of debris objects colliding with operational satellites based on their orbital parameters.

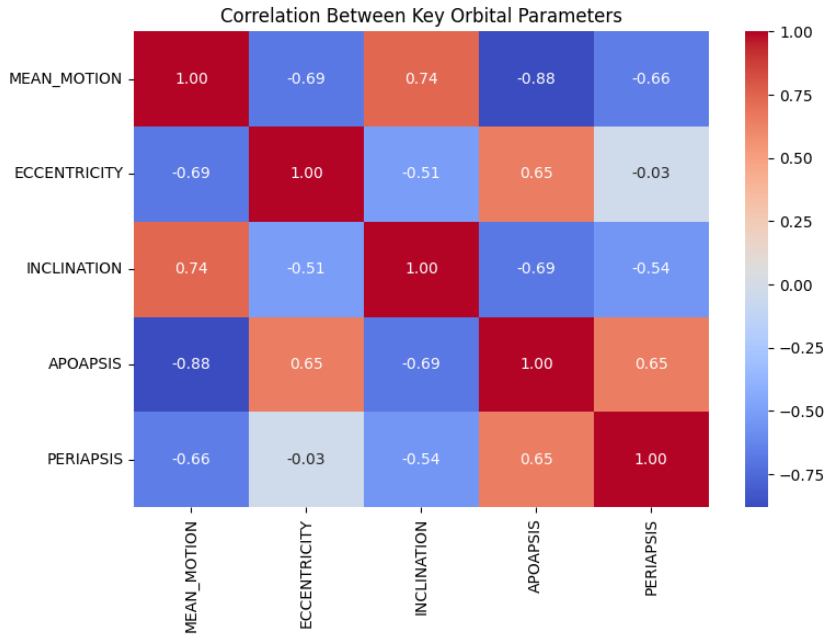

Figure 3: Correlation

Space Debris Proximity Distribution: The proximity analysis figure 5 focused on the distance between debris objects, using the APOAPSIS (apogee) and PERIAPSIS (perigee) values to calculate how close debris objects are to each other in their orbits. The histogram of proximity values shows the distribution of distances between debris objects. Notably, a significant portion of debris objects falls within a proximity range where collisions are more likely, highlighting areas where mitigation strategies need to be prioritized. Proximity analysis is crucial for collision risk assessment, and this analysis provides valuable insights into how densely packed debris is in certain orbital regions. Future analyses could refine this approach by calculating the probability of collision based on proximity, which would help inform satellite operators on potential threat levels.

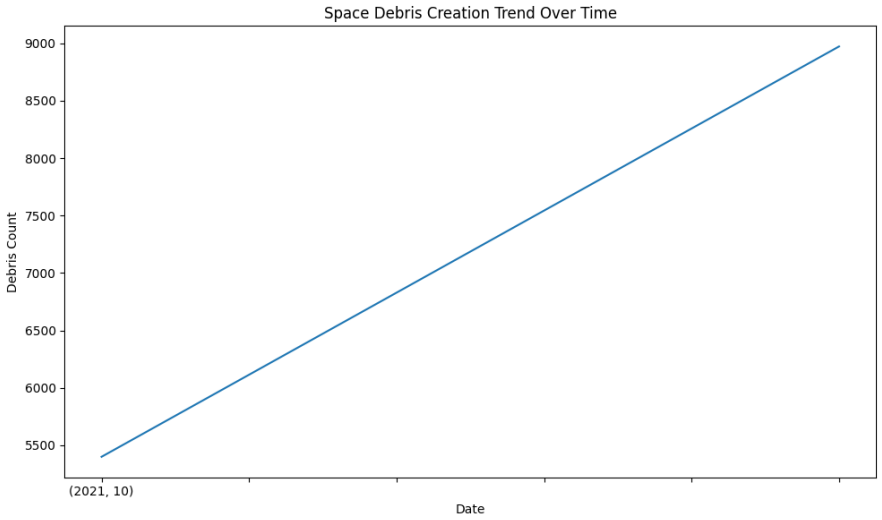

Figure 4: Debris Creation trend

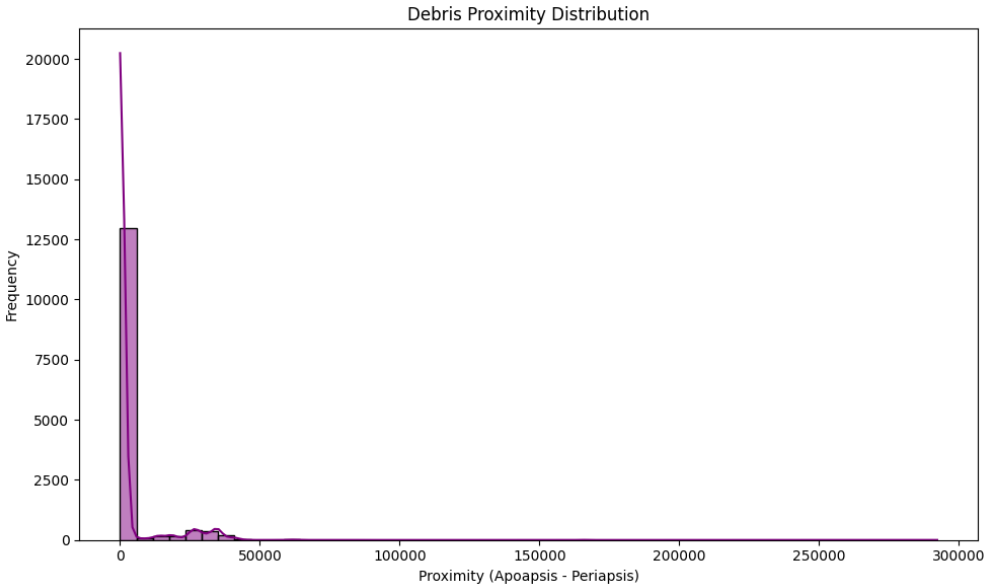

Figure 5: Debris proximity Distribution

Statistical and Predictive Analysis: While this analysis primarily focuses on descriptive statistics, the findings pave the way for further predictive modeling of space debris behavior. Machine learning techniques, such as decision trees or regression analysis, can be applied to predict the likelihood of debris creation or the probability of collisions, based on historical trends and the orbital characteristics of space objects. The correlation matrix and proximity analysis also form a solid foundation for building models that assess space debris risk and inform mitigation efforts.

Policy and Mitigation Strategies: Based on the findings, the study underscores the growing congestion in Low Earth Orbit (LEO) and the urgent need for effective space debris management strategies. The high frequency of debris creation during certain periods, as well as the risk of collisions in densely populated regions of space, emphasizes the importance of **international collaboration** and regulatory frameworks to manage and reduce space debris. Mitigation strategies, such as **debris removal technologies**, **end-of-life disposal plans**, and **collision avoidance systems**, need to be prioritized to ensure the sustainability of orbital operations. Additionally, the correlation and proximity analysis suggest that a more proactive approach to monitoring debris and implementing preventive measures, such as active debris removal or collision avoidance systems, could significantly reduce the long-term risks of space debris.

Conclusion

The analysis of space debris, based on the publicly available dataset from Space-Track.org, provides valuable insights into the temporal, spatial, and orbital characteristics of space debris, emphasizing the increasing risks posed by debris accumulation in Earth's orbit. The trends in debris creation, analyzed over time, show a steady rise, especially in low Earth orbit (LEO), which raises concerns about potential collisions with active satellites. Spatial distribution analysis indicates that LEO is the most densely populated zone, highlighting the need for effective debris mitigation strategies. By investigating key orbital parameters like eccentricity, inclination, and semi-major axis, the study establishes the relationships between these factors and their potential impact on collision risks. Proximity analysis of debris objects further identifies high-risk zones, where debris poses a significant threat to operational satellites. These insights can guide the development of better space debris management strategies, including collision avoidance measures and more effective tracking systems. Future work, particularly involving predictive modeling and statistical validation, will enhance our understanding of debris behavior and contribute to the development of more robust mitigation techniques to reduce the growing challenge of space debris.

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Predicting YouTube Views through an Integrated Approach of Automated Retraining and Thumbnail Visual Impact Analysis

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Abstract. We propose an integrated approach for predicting YouTube views through automated retraining and thumbnail visual impact analysis. This paper uses regression algorithms for improved accuracy, retraining them monthly with real-time data. Visual impacts are analyzed through dominant color extraction and text detection. Results are presented through an infographic dashboard to provide insights and improve content quality and popularity.

Keywords; YouTube View; Thumbnail; OCR; Infographic System; Machine Learning

1. Introduction

YouTube's rapid growth has increased competition among creators to reach larger audiences, with success relying on both creativity and views [1]. The YouTube algorithm recommends content with higher views to a wider audience, requiring creators to predict and enhance views effectively. However, predicting views is challenging for creators due to changing trends and factors. Therefore, we propose a system for predicting YouTube views that integrates automated retraining and thumbnail visual impact analysis. Recognizing thumbnails as the first visual element that highly influences viewer engagement, this study incorporates thumbnail metadata. We analyze thumbnails through dominant color extraction with K-means clustering [2] and text detection via Tesseract OCR [3]. The proposed system retrains monthly with real-time data from the YouTube Data API v3 [4], using machine learning regression algorithms (Linear Regression, Lasso, Ridge, Random Forest, Gradient Boosting, XGBoost) to select the best model. We propose an infographic dashboard that visualizes results, helping creators optimize strategies and boost engagement.

2. Proposed YouTube View Prediction System

In this paper, we collected 2,000 YouTube video data using the YouTube Data API v3. We were categorized into five groups (Music, Pets & Animals, Sports, People & Blogs, and Food Broadcast ('Mukbang' in Korean) with 400 samples each. We calculate the average activity for each channel by dividing uploaded videos by the active duration. The proposed system

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preprocesses title data to extract features such as title length and sentiment score using NLTK's word_tokenize [5]. Moreover, the proposed system analyzes thumbnails by extracting dominant colors using K-means clustering and detecting text using Tesseract OCR. The proposed system retrains regression algorithms every 30 days using the latest data to ensure the model adapts to changing trends and viewer preferences. After each training cycle, we compare the performance of each algorithm to determine the best model for view prediction. The proposed infographic dashboard is designed to present analysis results and predict outcomes through graphs and charts.

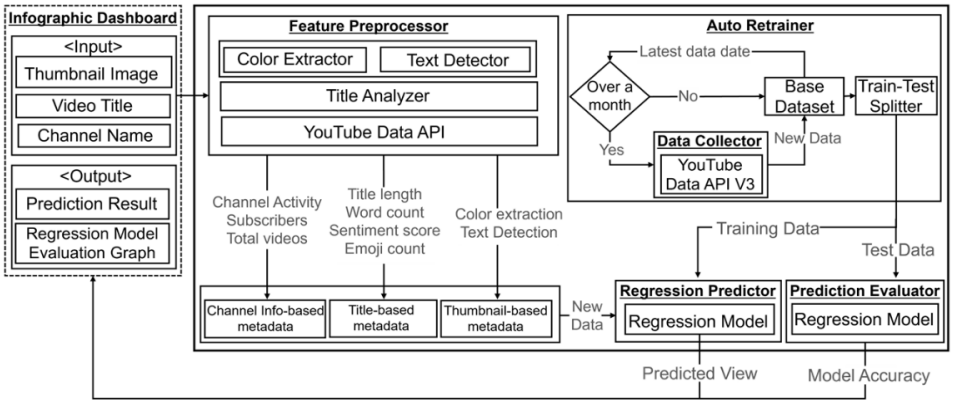
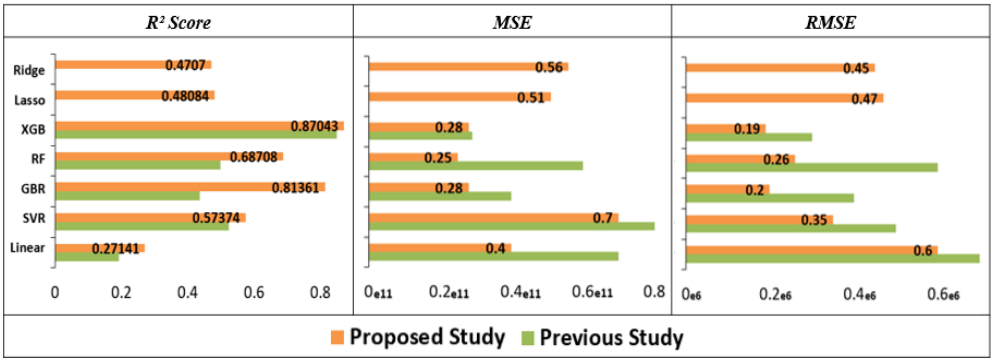


Fig 1. Diagram of an integrated approach for predicting YouTube views through automated retraining and thumbnail visual impact analysis

3. Experiment and Evaluation

To evaluate our system, we compared regression algorithms, including Linear Regression, Lasso, Ridge, Random Forest, Gradient Boosting, and XGBoost. In Table 1, we compared the accuracy of the previous study with the accuracy of the current proposed study. Our previous study used only channel info-based and title-based metadata, while the current study integrates thumbnail-based metadata. Experiment results show that the R^2 value has increased and the error has decreased compared to the previous study. The XGBoost regression model achieved the highest accuracy of 0.87043.

TABLE I. MODEL ACCURACY COMPARISON



4. Conclusion

In this study, we designed an integrated approach for predicting YouTube views through automated retraining and thumbnail visual impact analysis. The system retrains each cycle every 30 days, comparing six regression algorithms (Linear Regression, Lasso, Ridge, Random Forest, Gradient Boosting, and XGBoost) to select the best model for accurate prediction, ensuring adaptability to changing trends and viewer preferences. We extracted features such as channel activity, title length, dominant colors, and text presence as channel info-based, title-based, and thumbnail-based metadata. The infographic dashboard presents analysis results and predictions. In future research, we will focus on improving prediction accuracy and develop new methods to provide recommendations based on metadata such as thumbnails and titles.

Acknowledgment

This work was supported by the Ministry of Education of the Republic of Korea and the National Research Foundation of Korea (NRF-2022S1A5C2A07091326).

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Energy Optimization for University Buildings Timetable Scheduling Considering Thermal loading on HVAC

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Abstract: Higher education administrators must actively develop their management strategies to lower building energy usage, as it is challenging to get students to adopt energy-saving behaviors due to their limited responsibilities. The increasing number of students, the variety of teaching processes, the lack of adequate educational facilities in some areas, limited availability of classrooms, and the scheduling preferences of lecturers and students are essential factors that affect schedule management. Programming for preparing academic timetables has become particularly difficult in recent years. The goal of this paper is to use the academic timetable as an effective tool to improve electrical energy consumption and to align students' activities during their time in university buildings with energy efficiency. The goals of an optimum timetable can be achieved through three directions: human preferences, time slots, and space characteristics. This work uses a genetic algorithm to generate an optimum university schedule that considers building energy efficiency. The suggested technique simulates the schedule of a university teaching building in the Electrical Engineering Department at Assiut University, Assiut, Egypt, for the academic year 2023/2024. The optimized timetable shows a reduction in energy consumption of teaching spaces by approximately 20.6%.

Keywords : University course timetable; building energy efficiency; Genetic algorithm

I. Introduction:

A university building uses 1.5 times more energy per unit area compared to other public structures [1]. Most of the energy consumption and carbon emissions in university buildings are attributed to teaching facilities, where instructors and students frequently reside for extended periods [2] administrators must enforce the use of management-based solutions. A classroom's energy usage may fluctuate over time due to variations in indoor and outdoor climates [3]. Additionally, classrooms of different sizes consume varying amounts of energy. By optimizing the course schedule, the energy consumption of a teaching building can be effectively managed. Furthermore, scheduling classes in rooms that match the student population and classroom capacity can lead to energy savings of about 4.0% [4]. Calculation of energy consumption in classrooms and laboratories based on rating of loads and operation hours due to non-optimized table.

II. Methodology:

. **OPTIMUM TIMETABLE PARAMETERS:**

A. Classrooms Energy Consumption

Classrooms at electrical department, Assiut university can divide into three partitions: small classrooms, large classrooms, and laboratories. The electrical loads are led, and florescent lamps, fans, air conditioning, LCD monitors, and projectors. Calculation of energy consumption is based on bottom-up surveys of energy-consuming devices and rating hours due to courses timetable schedules. It depends on summation of power rating for all devices at classroom and multiply with operating time which is extracted from timetable schedule. The total amount of energy consumed in a classroom can be calculated by (1).

$$E(c) = \sum_{m=1}^{n} (P_{cm} * t_{cm}) \quad (1)$$

Course Timetable Constraints

This research aims to reduce energy consumption by reallocating students in classrooms based on fitness function. The fitness function of course timetabling is to minimize energy use in classrooms, while satisfying hard constraints and soft constraints

Hard constraints:

- A teacher is assigned to teach only one course at a time.
- A class is scheduled for no more than one course at any given time.
- A classroom is allocated for only one course at a time.
- The number of seats in a classroom must be at least equal to the number of students enrolled in the course.
- Each course must meet its required frequency of sessions per week

Soft constraints can be represented as the following:

- Reducing the distance between classroom locations to save time and effort for students and staff.
- Ensuring no individual remains in the classroom for an hour continuously after completing a lecture.
- Minimizing the number of empty seats in classrooms to optimize space usage.

Fitness Function: The fitness function of course timetabling is to minimize energy use in classrooms, while satisfying hard constraints and soft constraints

- Minimizing energy consumption by optimizing the allocation of classrooms and scheduling times.
- Maximizing scheduling preferences by ensuring that courses are scheduled on the preferred days, sessions, and hours whenever possible.
- Assigning courses to the largest possible classrooms to accommodate the maximum number of students comfortably.
- Enhancing student comfort by considering factors such as suitable classroom sizes, proper ventilation, and convenient scheduling.

III. Results and Discussions:

The optimization approach is flexible and can be adapted to different universities or contexts with varying energy needs. Adjusting input parameters allows application in diverse, institutions, The result of the proposed algorithm is optimized electric department building timetable schedule. Daily energy consumption is calculated based on bottom-up surveys of energy-consuming and optimized timetable schedule by GA. The results are presented by Fig. 1.The percentage reduction in energy consumption is calculated by (12). The results show that percentage reduction is 20.6% through the semester studied.

$$\text{Percentage Reduction} = \frac{\textbf{energy cons.before optimization} - \textbf{energy cons. after optimization}}{\textbf{Total energy cons. before optimization}} * \mathbf{100} \quad (2)$$

IV. Conclusion:

The proposed algorithm is developed using a genetic algorithm to create an optimized academic electric department building ,timetable schedule that achieves hard and soft constraint leading to minimizing energy consumption. *A genetic algorithm was* used to optimize the lecture schedule for the Electrical Engineering Department at Assiut University, resulting in a 20.6% reduction in energy consumption compared to the non-optimized schedule.

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Fig. 1 Daily Energy Consumption Based on Non-Optimized and Optimized Timetable

Comparative Analysis of Deep Learning Architectures for Meat Freshness Classification

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Abstract. This research presents a comparative analysis of various deep learning architectures for the classification of meat freshness and address a critical issue in the Philippine meat market where consumers often struggle to assess meat quality accurately. The study evaluates six (6) prominent convolutional neural network (CNN) architectures: LeNet, AlexNet, VGGNet, GoogleNet, ResNet, and DenseNet, using a manually built dataset, categorized into fresh and non-fresh meat images. Each model was trained and evaluated based on accuracy, loss, and training efficiency, with a focus on practical applicability in local markets. Results indicate that LeNet achieved the highest validation accuracy (76.07%) and training efficiency, requiring only 8 epochs and 849 seconds for training. In contrast, more complex models like VGGNet and DenseNet exhibited significantly longer training times and lower accuracy, raising concerns about their practicality for real-time freshness detection.

Keywords; computer vision, deep learning, meat freshness, neural network

1. Introduction

The meat market in the Philippines is a critical component of the country's economy, providing essential protein sources for millions of Filipinos. According to the Philippine Statistics Authority (PSA), the livestock and poultry sector produced 230.11 and 798.11 metric tons, respectively in the third quarter of 2024. In addition, pork is one of the most consumed meat products with 403,000 metric tons consumed per capita. Biliran Island, known for its agricultural activities, has a growing meat industry that supports local livelihoods and contributes to food security. In its 2016 report, PSA recorded 6.735 kilograms per capita consumption in the province. Despite the abundance of meat resources, ensuring the freshness and quality of meat products presents a significant challenge for consumers in Biliran Island. Many consumers lack the knowledge and tools to accurately assess meat freshness, often relying on visual cues that can be misleading. Additionally, limited access to advanced preservation technologies and inadequate cold chain logistics worsens the problem and may lead to a higher likelihood of purchasing spoiled or subpar meat. This not only compromises consumer health but also diminishes trust in local markets and affects purchasing decisions and overall satisfaction with meat products. This research aims to address these challenges by exploring the application of transfer learning techniques in developing a practical solution for meat freshness detection and contribute to improved consumer safety and market sustainability.

2. Review of Literature

Advancements of technology have led to development of various methods for assessing meat freshness, ranging from traditional sensory evaluation to advanced technological approaches. A review on different approaches in meat freshness detection highlighted the use of electrochemical, electronic nose and gas sensors, and optical biosensors [1], which are costly to purchase. Other studies have explored the use of advanced sensors, such electrochemistry sensors [2], fluorescence screening [3] and imaging technology [4].

In recent years, studies have used computer vision techniques for a low cost detection of meat freshness [5], [6], [7]. A study employed colorimetric sensor to tracks CO_2 levels increase with bacterial population and analyze the grey scale from the RGB space color [8]. The use of genetic algorithm for feature extraction and artificial neural network for prediction of chicken meat freshness were also experimented and gained promising results [9].

Despite these current solutions, many of these methods require specialized equipment and expertise, which are not readily available in many local markets. Additionally, while some studies have explored the integration of computer vision techniques for meat freshness detection, there remains a significant gap in the literature regarding their practical application since computer vision tasks require large amount of data and high computing resources.

At present, there are six (6) widely-used deep learning architectures for computer vision primarily based on convolutional neural network (CNN). LeNet was one of the first convolutional neural networks designed for handwritten digit recognition consisting of seven layers with convolutional and subsampling layers [10]. Following this, AlexNet won the ImageNet competition and popularized deep learning in computer vision with its eight-layer architecture, use of ReLU activation functions, and dropout for regularization [11]. VGGNet is known for its simplicity and depth, employing small 3x3 convolutional filters stacked to create deeper networks which has influenced many subsequent models by emphasizing the importance of depth in improving performance [12]. In 2014, GoogLeNet introduced the inception module, allowing for multi-scale feature extraction within the same layer, which improved the model's ability to learn complex patterns while reducing the number of parameters [13]. ResNet further advanced the field by introducing residual connections and by enabling the training of very deep networks without the vanishing gradient problem, thus setting new benchmarks in image classification [14].DenseNet built upon the concept of residual connections by connecting each layer to every other layer, promoting feature reuse and improving gradient flow [15]. This research aims to apply the different deep learning architectures for the classification of meat freshness through comparative analysis of their performances.

3. Methodology

A. Dataset

The dataset was manually gathered from a local market . The images were categorized into subdirectories (fresh and non-fresh), with each subdirectory representing a different class for binary classification, as shown in Figure 1.

Figure 1. Sample meat images from the initial dataset. Left image: fresh; Right image: non-fresh.

A data augmentation technique was used and configured to perform several transformations on the images, including normalization of pixel values by rescaling them to the range [0, 1]. Additionally, 20% of the dataset was allocated for validation to ensure that the model's performance could be evaluated on unseen data. The augmentation techniques included random rotations (up to 20 degrees), width and height shifts (up to 20% of the total width and height), shear transformations, zooming, and horizontal flipping. The training and validation sets were then loaded and automatically labels the images based on their respective subdirectory names and resizes them to a target size of 150x150 pixels.

B. Model Training and Evaluation

Each of the deep learning architecture was implemented using *Tensorflow* and *Keras*, and was compiled using *Adam* optimizer, which is known for its efficiency in training deep learning models [16]. The loss function used was binary cross-entropy, suitable for binary classification problems, and the model's performance was monitored using accuracy as a metric.

To prevent overfitting, early stopping callbacks were configured to monitor the validation loss, with a patience of 10 epochs, meaning that training would stop if the validation loss did not improve for 10 consecutive epochs. This approach helps to retain the best model weights and avoid overfitting to the training data. Additionally, model checkpoint was used to save the best-performing model based on validation loss. *TensorBoard* was also setup to visualize training progress, which aids in monitoring metrics such as loss and accuracy over time.

The model was trained with the training and validation data provided with a maximum of 100 epochs. After training, each model was evaluated on the validation dataset, using the validation loss and accuracy. Computed as well the *F1* score to assess the models' classification performance and constructed a confusion matrix to visualize the model's performance across the different classes.

The LeNet architecture was configured starting with an input layer designed to accept *RGB* images of size 150x150 pixels. It features three convolutional layers, comprising 32, 64, and 128 filters, respectively, each utilizing a 3x3 kernel and *ReLU* activation function to facilitate feature extraction. Each convolutional layer is followed by a max pooling layer with a 2x2 pooling size, which serves to down sample the feature maps, thereby reducing spatial dimensions while preserving critical information. After the convolutional and pooling operations, the output is flattened into a one-dimensional vector, which is then processed by a fully connected layer containing 128 units and employing *ReLU* activation. The architecture concludes with a final dense layer featuring a single unit and a sigmoid activation function, which outputs probabilities for binary classification.

AlexNet is designed to accept input images of size 150x150 pixels with three color channels (RGB). The architecture begins with the first convolutional layer, which employs 96 filters of size 11x11 and a stride of 4 to capture large features from the input images while significantly reducing the spatial dimensions. This is followed by a max pooling layer with a pool size of 3x3 and a stride of 2, which further down-samples the feature maps. The second convolutional layer consists of 256 filters of size 5x5, utilizing 'same' padding to maintain the spatial dimensions, followed by another max pooling layer. Subsequent layers include two convolutional layers with 384 filters of size 3x3, both using same padding to allow the model to learn more complex features. The fifth convolutional layer, which has 256 filters, is again followed by a max pooling layer. After the convolutional and pooling operations, the output is flattened into a one-dimensional vector, which is then processed through three fully connected layers. The first two fully connected layers each contain 4096 units and employ ReLU activation, with dropout layers added to mitigate overfitting by randomly setting a fraction of the input units to zero during training. The final output layer consists of a single unit with a sigmoid activation function.

VGGNet accepts input images of size 150x150 pixels with three color channels (RGB) and utilized a sigmoid activation function in the output layer. The architecture is organized into five distinct blocks, each comprising convolutional layers followed by max pooling layers. In Block 1**,** the model begins with two convolutional layers, each with 64 filters of size 3x3 and ReLU activation, both using same padding to preserve spatial dimensions. This is followed by a max pooling layer with a pool size of 2x2 and a stride of 2, which reduces the spatial dimensions of the feature maps. Block 2 follows a similar structure, with two convolutional layers of 128 filters, again using 3x3 kernels and ReLU activation, followed by another max pooling layer. Block 3 consists of three convolutional layers, each with 256 filters, allowing the model to learn more complex features. This is followed by a max pooling layer to down sample the output. Block 4 and Block 5 mirror this structure, with three convolutional layers of 512 filters in each block. Each convolutional layer employs ReLU activation and same padding. After the convolutional and pooling operations, the output is flattened into a one-dimensional vector, which is then processed through three fully connected layers. The first two fully connected layers each contain 4096 units and utilize ReLU activation, allowing for complex decision-making based on the learned features. The final output layer consists of a single unit with a sigmoid activation function, suitable for binary classification tasks.

GoogleNet, also known as Inception V1, s configured for binary classification tasks, accepting input images of size 150x150 pixels with three color channels (RGB) and used a sigmoid activation function in the output layer, as shown in Figure 5.. The architecture begins with an initial convolutional layer that employs 64 filters with a 7x7 kernel size and a stride of 2, followed by a max pooling layer to reduce spatial dimensions. This is succeeded by another convolutional layer with 192 filters and a subsequent max pooling layer. The core of the GoogleNet architecture consists of multiple inception modules, which allow the model to capture multi-scale features by applying different convolutional filter sizes in parallel. Each inception module includes a combination of 1x1, 3x3, and 5x5 convolutions, as well as a max pooling operation, all of which are concatenated along the channel dimension to form a rich feature representation. The model incorporates several inception modules, each with varying filter configurations to learn complex patterns and features from the input images. After processing through the inception modules, the output is passed through a global average pooling layer, which reduces the spatial dimensions to a single value per feature map,

effectively summarizing the learned features. Finally, the output is fed into a fully connected layer with a single unit and a sigmoid activation function, suitable for binary classification tasks.

ResNet is designed to accepting input images of size 150x150 pixels with three color channels (RGB). The architecture begins with an initial convolutional layer that employs 64 filters with a 7x7 kernel size and a stride of 2, followed by batch normalization and ReLU activation to enhance training stability and introduce non-linearity. This is followed by a max pooling layer to reduce the spatial dimensions of the feature maps. The core of the ResNet architecture consists of multiple residual blocks, each designed to learn residual mappings rather than the original unreferenced mappings. Each residual block includes two convolutional layers, each followed by batch normalization and ReLU activation. The input to the block (the shortcut connection) is added to the output of the second convolutional layer to allow gradients flow more easily during backpropagation and mitigating the vanishing gradient problem. The model features a series of residual blocks organized into four layers, with 3, 4, 6, and 3 blocks in each layer, respectively. After each set of residual blocks, a max pooling layer is applied to further down sample the feature maps. This structure enables the network to learn increasingly complex features while maintaining a manageable number of parameters. After processing through the residual blocks, the output is passed through a global average pooling layer, which reduces the spatial dimensions to a single value per feature map, effectively summarizing the learned features. Finally, the output is fed into a fully connected layer with a single unit and a sigmoid activation function, suitable for binary classification tasks.

DenseNet is designed to accept input images of size 150x150 pixels with three color channels (RGB) and utilizing a sigmoid activation function in the output layer. The architecture begins with an initial convolutional layer that employs 64 filters with a 7x7 kernel size and a stride of 2, followed by batch normalization and ReLU activation to enhance training stability. This is followed by a max pooling layer to reduce the spatial dimensions of the feature maps. The core of the DenseNet architecture consists of multiple dense blocks, where each block contains a specified number of layers. Within each dense block, a series of operations are performed: a 1x1 convolution (bottleneck layer) is applied to reduce dimensionality, followed by a 3x3 convolution to extract features. The output of each convolutional layer is concatenated with the input of the block, allowing for the accumulation of features from all preceding layers. After each dense block, a transition layer is applied (except after the last block), which consists of a 1x1 convolution to reduce the number of feature maps, followed by average pooling to down sample the feature maps. This transition helps to control the model's complexity and reduce the spatial dimensions while maintaining important features. The architecture allows for a high degree of feature reuse, as each layer receives input from all preceding layers, which mitigates the vanishing gradient problem and enhances gradient flow during training. After processing through the dense blocks and transition layers, the output is passed through a global average pooling layer, which reduces the spatial dimensions to a single value per feature map, effectively summarizing the learned features. Finally, the output is fed into a fully connected layer with a single unit and a sigmoid activation function.

4. Results and Discussion

As shown in Table 1, among the models evaluated, LeNet emerged as the most effective model in terms of training accuracy (91.76%) and validation accuracy (76.07%), which indicates its capability to generalize well to unseen data. However, its validation loss of 51.62% suggests that while it performs well, there is still room for improvement, particularly in reducing overfitting. The standard deviation of 20.40 in training accuracy indicates a moderate level of variability, suggesting that while LeNet is generally reliable, its performance may fluctuate depending on the specific training samples used. The variance of 416.02 further emphasizes this variability, highlighting the need for careful selection of training data to ensure consistent performances

Table 1. Accuracy and loss results.

Deep Learning Model	Training Accuracy	Validation Accuracy	Training Loss	Validation Loss
LeNet	91.76%	76.07%	19.94%	51.62%
AlexNet	51.34%	50.55%	69.33%	69.31%
VGGNet	47.32%	50.74%	69.33%	69.31
GoogleNet	84.29%	67.83%	39.13%	61.18%
ResNet	95.53%	72.98%	11.77%	61.78%
DenseNet	95.57%	74.08%	11.49%	66.14%
SD (σ)	**20.40**	**10.71**	**24.74**	**6.10**
Variance (σ^2)	**416.02**	**114.66**	**612.20**	**37.25**

Moreover, LeNet stands out as the most efficient model, requiring only 8 optimal epochs and a total training time of 849 seconds, with an average training time of 47.16 seconds per epoch, as shown in Table 2. This efficiency makes LeNet particularly appealing for applications where quick training and inference are essential, such as real-time monitoring of meat freshness. The low training time combined with relatively high accuracy suggests that LeNet is well-suited for this specific task, allowing for rapid deployment in practical scenarios.

Table 2. Accuracy and loss results.

Deep Learning Model	Optimal Epoch	Total Training Time (s)	Average Training Time (s)
LeNet	8	849	47.16
AlexNet	19	1546	53.31
VGGNet	3	8552	657.85
GoogleNet	7	1201	70.65
ResNet	10	2175	108.75
DenseNet	12	55773	2535.14
SD (σ)	**4.95**	**19891.96**	**901.06**
Variance (σ^2)	**24.47**	**395690000**	**811909.89**

In contrast, AlexNet, while requiring more epochs (19) and a total training time of 1,546 seconds, still maintains a reasonable average training time of 53.31 seconds per epoch. However, its performance metrics were significantly lower than those of LeNet, indicating that the additional training time did not translate into improved accuracy for this specific

application. This raises questions about the efficiency of using more complex architectures when simpler models can achieve comparable or superior results. VGGNet, despite converging in just 3 epochs, exhibited an extraordinarily high total training time of 8,552 seconds and an average training time of 657.85 seconds per epoch. This inefficiency highlights a significant drawback of VGGNet, as the extensive computational resources required may limit its practicality in real-world applications, especially when faster alternatives like LeNet are available. The long training time, coupled with its lower accuracy, suggests that VGGNet may not be the best choice for meat freshness classification.

GoogleNet required 7 epochs and a total training time of 1,201 seconds, with an average training time of 70.65 seconds per epoch. While its training time is more manageable than that of VGGNet, it still reflects a trade-off between complexity and performance. The results indicate that GoogleNet may offer some advantages in feature extraction but at the cost of increased training time. ResNet and DenseNet, while achieving high training accuracies, required significantly more training time, with ResNet taking 2,175 seconds and DenseNet an astonishing 55,773 seconds. The average training times of 108.75 seconds and 2,535.14 seconds per epoch, respectively, highlight the computational intensity of these architectures. The extensive training times may pose challenges for practical implementation, particularly in environments where rapid decision-making is crucial. The standard deviation (SD) and variance of the training times further emphasize the variability in the efficiency of these models. The high SD of 19,891.96 seconds and variance of 395,690,000 indicate that while some models are efficient, others, particularly DenseNet, exhibit extreme variability in training time, which could complicate resource planning and deployment strategies.

5. Conclusion and Recommendation

This comparative analysis of deep learning architectures for meat freshness classification shows the effectiveness of simpler models, particularly LeNet, in achieving high accuracy with significantly reduced training times. The findings suggest that while more complex architectures like ResNet and DenseNet may offer superior performance in certain contexts, their extensive computational requirements limit their practicality for real-time applications. Therefore, it is recommended to consider adopting LeNet or similar lightweight models for meat freshness detection systems. Further research should explore the integration of these models with mobile applications or low-cost imaging devices to empower consumers with accessible tools for assessing meat quality, ultimately enhancing food safety and consumer confidence in local meat products.

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13:00~	Session 2: Interactive Posters (Room: L310) Chairs: Hyung Gyu Lee (Duksung Women's Univ.) and Hyun Duk Kim (DGIST)	
	2S-1 [003]	**A Study on PI Gain Control Method for Real-Time Optimization of Current Response in MR Dampers** *Si-Uk Jung[1)] , Sung-Hyun Park[2)] , Byeong-Hwa Lee[2)] and Jae-Woo Jung[1*)]* *1) Dept. of Electronic Engineering, Daegu University, Gyeongsan 38453, South Korea* *2) Daegu-Gyeongbuk Division, Korea Automotive Technology Institute, Daegu 43011, South Korea*
	2S-2 [006]	**Remote Heart Rate Estimation using RGB-NIR Fusion** *Hyunduk Kim[1)] , Sang-Heon Lee[1)] , Myoung-Kyu Sohn[1)] , and Junkwang Kim[1)]* *1) Division of Automotive Technology, DGIST, Daegu, Republic of Korea*
	2S-3 [007]	**Low Power MUSIC Algorithm based MIMO Image FMCW Radar Techniques** *Bong-seok Kim[1)] , Jonghun Lee[2)] and Sangdong Kim[2*)]* *1) Division of Automotive Technology, DGIST, Daegu, South Korea* *2) Division of Automotive Technology and the Department of Interdisciplinary Engineering, DGIST, Daegu, South Korea*
	2S-4 [022]	**Design of a Malicious Email Analyzer with Rule-based Detection and Three-step Process** *Jieun Choi[1)] and Yongho Choi[2*)]* *1) Dept. of Police Administration, Daegu University, Gyeongsan-si, Gyeongsangbuk-do 38453, Republic of Korea* *2) Dept. of Computer & Information Engineering, Daegu University, Gyeongsan-si, Gyeongsangbuk-do 38453, Republic of Korea*
	2S-5 [044]	**Design of Upper/Lower System with Automatic Height Control for CNC Gas Cutting** *Jun-Yeop Lee[1)] , Thanh-Binh Nguyen[1)] , and Byeong-Soo Go[2)]* *1) Dept. of Electric Engineering, Changwon National University, Changwon, Republic of Korea* *2) Institute of Mechatronics, Changwon National University, Changwon, Republic of Korea*
	2S-6 [064]	**Improving Driving Control Accuracy of Autonomous Vehicles Based on CNNs** *Youjin Park[1)], Sojung Kim[1)], and Hyung Gyu Lee[1)]* *1) Dept of Software, Duksung Women's University, Seoul, Republic of Korea*
	2S-7 [001]	**Remote Configuration of ADR parameters for End-Devices Using the RFU Field in LoRaWAN Packets** *Won-jae Lee[1)] and Seand Seong-eun Yoo[1*)]* *1) Dept. of Artificial Intelligence, Daegu University, Gyeongsan-si, Gyeongsangbuk-do 38453, Korea*
	2S-8 [063]	**Posture Correction Device Based on Pressure Feedback for Scoliosis Improvement** *So Yeong Lee[1)], Chang-Yong Ko[2)] and Sung-Phil Heo[1*)]* *1) Gangneung-Wonju National University, Wonji-si, 26403, Korea* *2) Dept. of Research & Development, Refind Inc., Wonju 26354, Korea*

A Study on PI Gain Control Method for Real-Time Optimization of Current Response in MR Dampers

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Abstract: Magnetorheological (MR) dampers adjust damping characteristics in real-time by controlling the viscosity of MR fluid through magnetic fields. MR dampers are widely used in high-performance and autonomous vehicles for their ability to improve ride comfort and vehicle stability [1]. Fig. 1 illustrates the conceptual configuration of the MR damper control system. The acceleration sensors measure vehicle dynamics and send signals to the MR controller, which processes the data and adjusts the current output to the MR damper. This flow enables real-time adjustment of the damping force based on vehicle acceleration. The power supply supports the operation, while monitoring equipment is included for evaluating system performance during testing. However, conventional fixed-gain control methods often exhibit limitations such as slow current response, overshoot, and inadequate adaptability to varying current amplitudes and frequencies [2]. These challenges become more pronounced in low-current regions where achieving both fast rising times and minimal overshoot is critical.

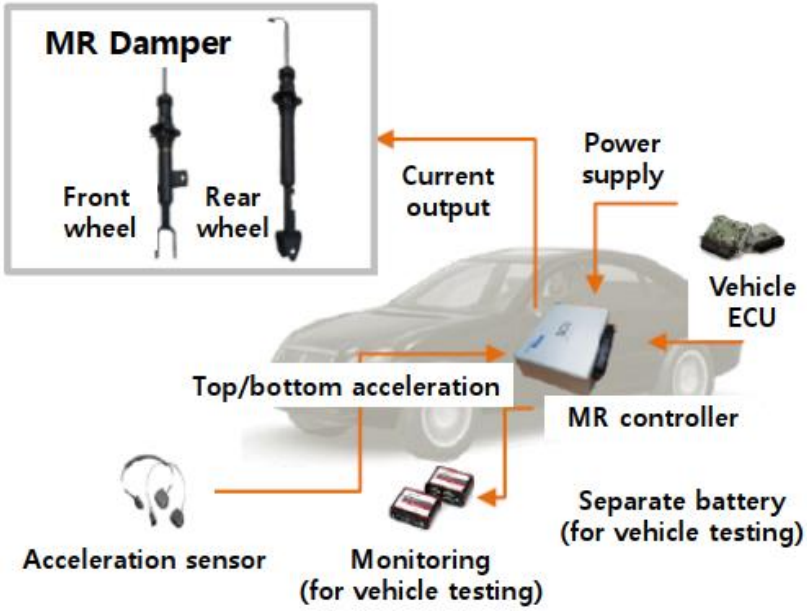

Fig. 1. Configuration of the MR Damper Control System

This study proposes a PI Gain tuning method that dynamically adapts to MR dampers' inductive properties. Inductance variations were analyzed via finite element analysis (FEA) in DC and AC regions, accounting for magnetic saturation and eddy current effects [3]. The resulting inductance data, structured into a Look-up Table, enabled a one-dimensional gain scheduling method that replaced FFT-based analysis, reducing computational load on microcontroller units (MCUs) while enhancing efficiency and stability [2]. Unlike conventional gain tuning methods, the proposed approach leverages the inductance profile of the MR damper to achieve real-time adaptability without compromising computational efficiency.

The control algorithm, developed in MATLAB Simulink and implemented through automatic code generation, achieved a rising time reduction of up to 2.21 ms and a 45.5% decrease in overshoot in simulations, outperforming fixed-gain methods. The method also ensured robust performance across varied current amplitudes and frequencies, demonstrating adaptability and reliability. In particular, low-current regions benefited from significant improvements in response times and overshoot, highlighting the method's potential for practical applications in automotive systems requiring precise control under varying conditions. Fig. 2 shows the implementation flow of the control system for MR dampers, highlighting the key steps from Simulink-based code generation to dynamic PI gain adjustment and its interaction with the MR damper model.

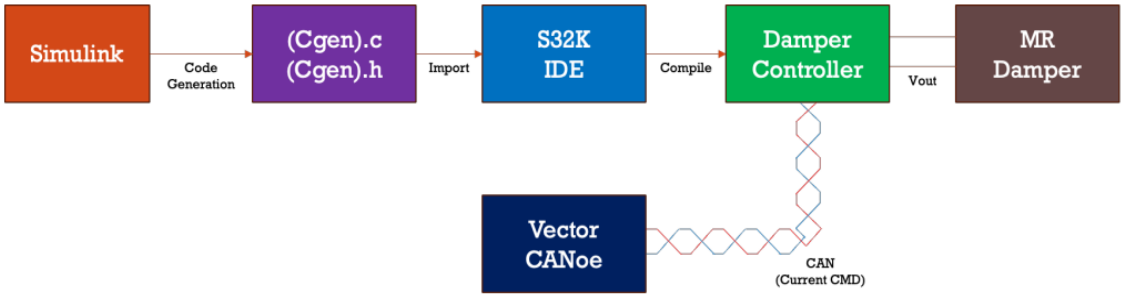

Fig. 2. Implementation Flow of the MR Damper Control System

This study demonstrates that the proposed PI Gain tuning method effectively addresses fixed-gain limitations, improving real-time control reliability and efficiency in MR damper systems. By dynamically adapting to varying current amplitudes and frequencies, it achieves precise control and robust performance under diverse operating conditions. Furthermore, its simplified computational requirements make it well-suited for real-time applications in high-performance and autonomous vehicles. Future work will focus on experimental validation in vehicle environments and optimization for autonomous suspension systems to ensure reliable performance in practical applications.

Keywords : MR Damper, Inductance, Eddy current, PI Gain Tuning

Acknowledgment

This research was supported by Daegu University. We thank our colleagues from the Korea Automotive Technology Institute, who provided valuable insight and expertise that greatly assisted the research, although they may not agree with all the interpretations and conclusions of this paper.

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Remote Heart Rate Estimation using RGB-NIR Fusion

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Abstract: Remote photoplethysmography (rPPG) has emerged as a promising method for contactless heart rate estimation using video sequences. In this study, we propose CrossSTSPhys, which incorporates a cross-attention mechanism between dual streams of video inputs: the original RGB stream and the NIR stream. This dual-path structure enhances the network's ability to exploit complementary features from the two input modalities. The CrossSTSPhys architecture adopts Spatial-Temporal SwiftFormer blocks and integrates cross-attention layers at multiple hierarchical levels to exchange and refine information across the two streams. Experimental results show that CrossSTSPhys achieves superior heart rate estimation accuracy on benchmark datasets, outperforming the baseline STSPhys model and existing state-of-the-art methods.

Keywords : remote heart rate estimation, RGB-NIR fusion, visual trasnformer

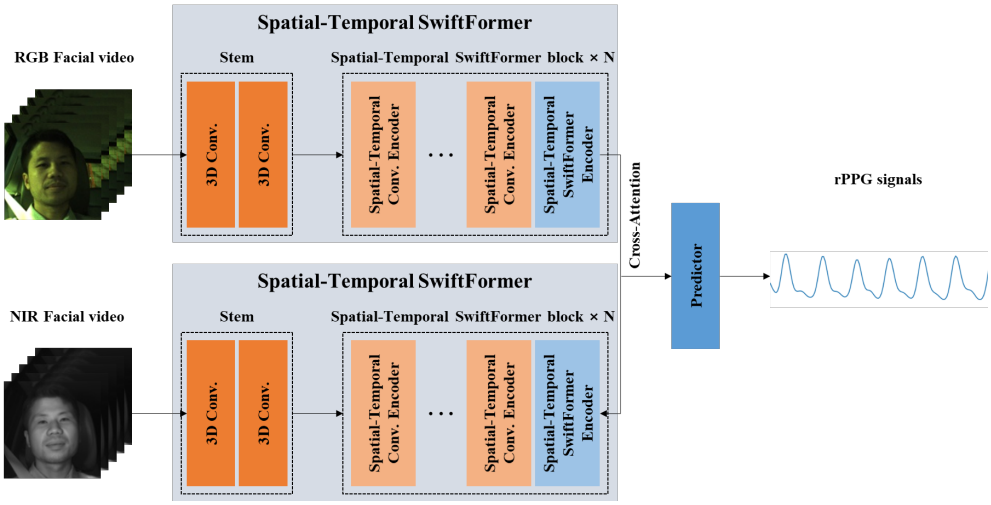

Fig. 1. Overview of the proposed CrossSTSPhys architure.

The CrossSTSPhys framework builds upon the STSPhys model, extending its capabilities by introducing a dual-stream architecture. The model processes two video streams in parallel: the RGB stream and the NIR stream, extracted by converting the original RGB frames into NIR frames. Each stream is fed into a Spatial-Temporal SwiftFormer backbone, composed of a series of SwiftFormer blocks designed to capture spatial and temporal features simultaneously. To enable effective feature integration between the two streams, cross-attention mechanisms are applied at multiple hierarchical levels of the SwiftFormer blocks. Specifically, feature maps from the RGB and NIR streams are used as query, key, and value inputs in the cross-attention layers, enabling mutual refinement of spatial-temporal features. This design allows the model to exploit complementary characteristics of the two input modalities, improving its robustness to noise and artifacts. Following the feature extraction and integration stages, the outputs from both streams are concatenated and fed into a shared predictor module to estimate the heart rate signal. The predictor comprises fully connected layers and a temporal smoothing module to ensure stable and accurate.

Acknowledgment

This work was supported by the DGIST R&D Program of the Ministry of Science and ICT (25-IT-02).

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Biography

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Low Power MUSIC Algorithm based MIMO Image FMCW Radar Techniques

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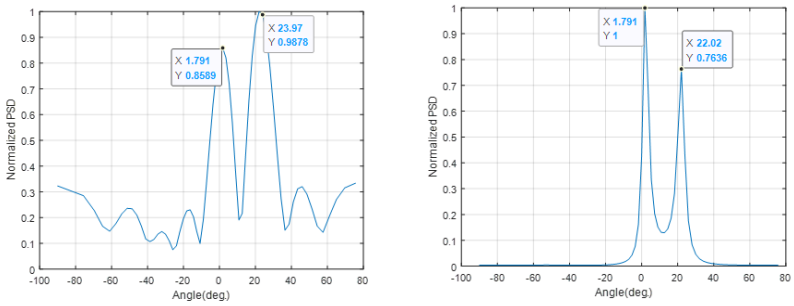
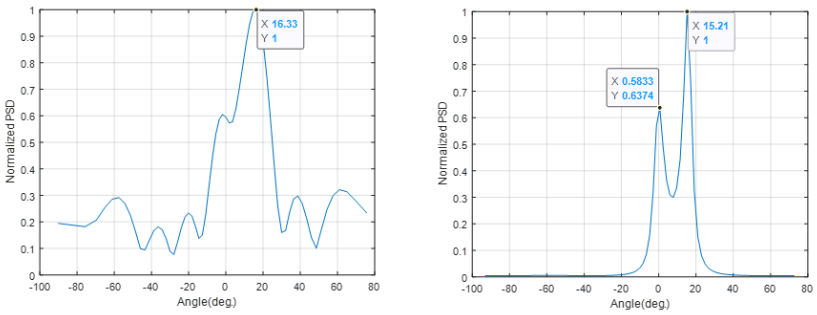
Abstract: This paper proposes a low-power imaging technique for frequency-modulated continuous-wave (FMCW) radar, with the Multiple Signal Classification (MUSIC) algorithm in conjunction with a multiple-input multiple-output (MIMO) configuration. FMCW radar is widely used due to its robustness in severe weather conditions and low system complexity. However, limitations of resolution make it difficult to apply imaging applications. To solve this problem, the proposed method integrates the low-complexity based MUSIC algorithm with MIMO FMCW radar to significantly enhance angular resolution for high-quality imaging. The proposed FMCW radar technology satisfies low power characteristics and can be applied to the real-time system. To validate the proposed approach, experiments were conducted in an indoor environment using an FMCW radar module. The results demonstrate the effectiveness of the proposed method, highlighting its potential for advanced imaging applications with low power consumption.

Keywords : low-power, FMCW, imaging, radar, MIMO, MUSIC



(a) conventional (b) proposed

Fig. 1. Angular interval image result : 16 degree



(a) conventional (b) proposed

Fig. 2. Angular interval image result : 10 degree

Recently, radar [1-2] is widely used as a sensor for detecting, tracking, and recognizing targets in aviation, surveillance, and autonomous vehicle-based applications. In defense application, many studies have been conducted to image radar results with the Synthetic Aperture Radar (SAR) technique beyond detection. However, this SAR technique was difficult to use in civil applications because it was necessary for the target to obtain good performance radar image results. As an alternative, better performance imaging radar research was being conducted using the MIMO (Multi-Input Multiple Output) FMCW architecture [3]. MIMO-FMCW radar has the advantage of having a smaller antenna size than phased array imaging radar. However, since the MIMO FMCW radar system is affected by the number of transmitting and receiving antennas, a limitation still exists to improving the angular resolution to obtain imaging radar results.

To solve this problem, we propose a super-resolution-based MIMO-FMCW imaging radar technique. In particular, MIMO-FMCW radar technology based on the low-power, super-resolution MUSIC algorithm is required for real-time processing. Only the target signal of interest among the distance FFT result data is subjected to angle processing, and this angle data is applied with MUSIC to solve the problem of low-power issues while having high angular resolution.

Acknowledgment

This work was supported in part by DGIST R&D Program of the Ministry of Science, ICT and Future Planning of Korea under Grant 24-IT-01 and 24-DPIC-04; and in part by the Basic Science Research Program through the National Research Foundation (NRF) of South Korea funded by the Ministry of Education under Grant 2022R1F1A1063386. (Corresponding author: Sangdong Kim).

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Design of a Malicious Email Analyzer with rule-based detection and three-step process

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Abstract: This research discusses the necessity of developing a malicious email analyzer and presents a program for classifying malicious emails, which was developed based on prior research [1–4]. The program was designed with a strong emphasis on simplicity and intuitive results to ensure consistent user engagement. We anticipate that this program will contribute to minimizing email-related damage experienced by the general public. The program processes received emails by accepting EML files as input and performing a three-step analysis: EML header analysis, link analysis, and attachment analysis. For the header analysis phase, we implemented a rule-based detection process by comparing and analyzing email header fields, referencing existing research on malicious email analysis [1–3]. In the subsequent steps—link and attachment analysis—the program extracts links and attachments from EML files, compares them with known malicious URLs, and incorporates AI-based analytical processes. During the development of the EML header analysis component, a challenge was identified with global corporations like Gmail, whose domain-derived IPs are highly variable. This variability caused incorrect classifications, as emails from such corporations were flagged as malicious due to differing country codes. To address this issue, we implemented a whitelist-based approach to handle exceptions involving global corporations. However, addressing the dynamic IP allocation of such entities remains a challenge for future iterations of this analyzer.

Keywords : Intuitive program, EML file, Header analysis, Rule-Based detectection, Link analysis, Attachments analysis, API

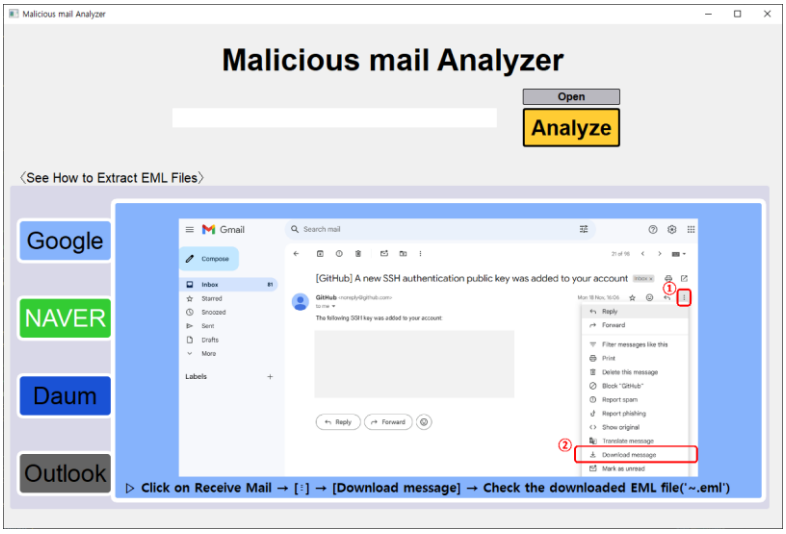
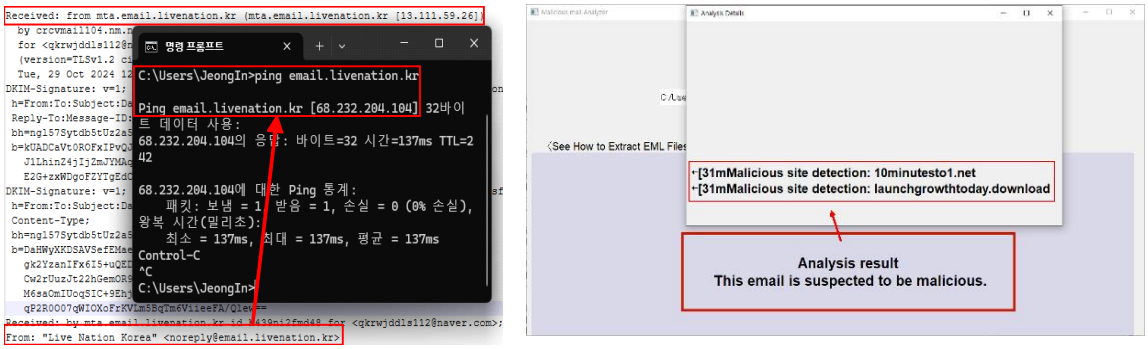


Fig. 1. Program execution screen



(a) (b)

Fig. 2. (a) Header analysis process, (b) analysis results screen

Acknowledgment

This research was supported by Basic Science Research Program through the National Research Foundation of Korea(NRF) funded by the Ministry of Education(2022R1I1A3072824).

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Design of Upper/Lower System with Automatic Height Control for CNC Gas Cutting

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Abstract: CNC gas cutting machines are essential equipment in the heavy industry sector, widely used for precision cutting and high productivity in processing thick steel plates (8-300mm). These machines operate based on a CNC gantry structure, enabling movement along the X-axis (longitudinal) and Y-axis (transverse) to perform cutting operations. The quality of the cutting process heavily depends on flame control, maintaining the gap between the torch and the workpiece, and cutting speed. However, maintaining a consistent gap is challenging during large steel plate operations, often requiring manual adjustment by the operator [1].

Although automatic height control and ignition systems have been developed, they face limitations such as torch interference, system instability, and frequent maintenance or replacement, resulting in continued reliance on manual operation in most workplaces. To address these challenges and achieve complete automation of the gas cutting process, the development of a high-performance system that integrates automatic height control and automatic ignition functionality is critical. Such a system can enhance cutting quality, improve operational efficiency, and ensure greater safety for operators [2].

This paper proposes the design and implementation of an automatic height control system for CNC gas cutting machines. A ring-shaped capacitive sensor is employed to ensure precise and consistent height control, while an STM32 microcontroller is utilized for processing sensor signals and managing the control system. To validate the reliability of the designed system, finite element analysis (FEA) was conducted, followed by experimental verification to demonstrate its performance.

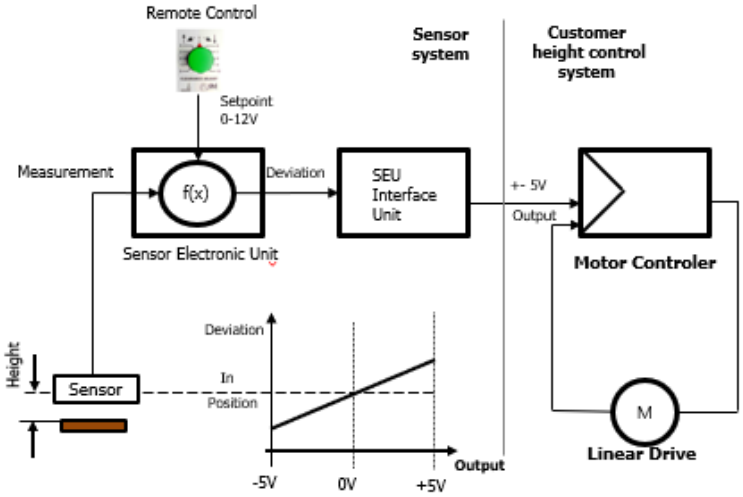

Fig. 1. Capacitive sensor diagram for automatic height adjustment system

Keywords : Automatic torch height control; Automatic Ignition; Gas cutting torch; Up&Down System; All-in-one

Acknowledgment

This work was supported by the Technology Innovation Program(or Industrial Strategic Technology Development Program)(RS-2024-00469034, Devenopment of cryogenic flexible hoses and Connector for ships) funded By the Ministry of Trade Industry & Energy(MOTIE, Korea)

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Improving Driving Control Accuracy of Autonomous Vehicles Based on CNNs

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Abstract: Deep learning models utilizing CNNs (Convolutional Neural Networks) exhibit superior performance in computer vision applications when trained in a specific environment. This study aims to enhance the driving control accuracy of autonomous vehicles in a simulated environment using a trained CNN model. Experiments were conducted with datasets classified into 4, 6, and 8 classes to analyze the effect of class granularity on control accuracy. The results demonstrated that increasing the number of classes improved recognition accuracy, confirming that class granularity contributes to the control precision of CNN-based autonomous driving models.

Keywords : Autonomous driving, Artificial intelligence, Deep learning, CNN, Steering control

1. Introduction

Autonomous vehicles operate without continuous human intervention, utilizing AI, sensors, cameras, radar, and GPS [1]. Lane detection, a key task in autonomous driving, is often performed using OpenCV-based edge detection like Canny [2]. However, filtering-based methods are sensitive to environmental variations, affecting robustness [3]. In contrast, deep learning models, particularly CNNs, offer superior performance in image recognition and video analysis, ensuring greater reliability in trained environments [4].

2. CNN Model Design for Autonomous Driving

2.1 Simulated Environment Setup

A Raspberry Pi-based model car was implemented for autonomous driving simulation, as shown in Fig. 1. The model car consists of a Raspberry Pi 3 mainboard, a camera, a battery, and a motor. A custom-built track was created to collect training data.

Fig. 1. Raspberry Pi-based model car

2.2 CNN Model Architecture

The CNN model in this study comprises five convolutional and fully connected layers in Fig. 2. Each convolutional layer utilizes ELU activation and batch normalization to enhance learning and mitigate overfitting. A 0.5 dropout rate after the final convolutional layer improves generalization [5]. Flattened features pass through fully connected layers for classification into 4, 6 or 8 categories.

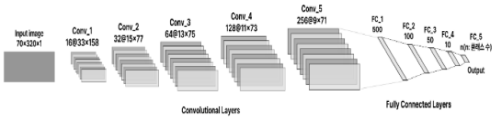

Fig. 2. CNN Model Architecture

2.3 Data Collection and Preprocessing

The training data was collected by manually controlling the model car on a designated track. The overall preprocessing pipeline is illustrated in Fig. 3, while the processed dataset categorized into different steering control classes is shown in Fig. 4.

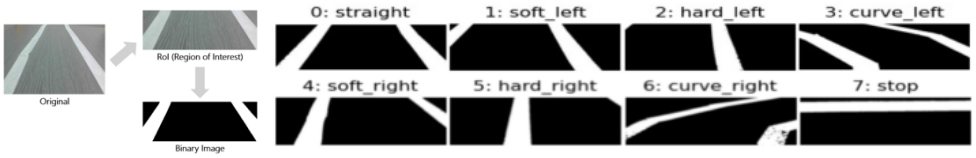

Fig. 3 and Fig. 4.Image preprocessing pipeline (left) and preprocessed 8-class example (right)

Video frames were captured every five frames, and the region of interest (RoI) was set to the bottom third of each image before binarization was applied. The classification criteria for 4, 6, and 8 classes are summarized in Table 1, where the steering control categories are subdivided into finer angles.

Table 1.Class Composition

controll	Class Classification		
	4	6	8
Straight	Straight	Straight	Straight
Left	Left	Soft Left	Soft
		Hard Left	Hard Left
			Curve Left
Right	Right	Soft Right	Soft Right
		Hard Right	Hard Right
			Curve Right
Stop	Stop	Stop	Stop

3. Experimental Results

3.1 Experimental Setup

The CNN model was trained and evaluated using the PyTorch framework. The same model and parameters were applied regardless of class count. The dataset distribution for training and evaluation is summarized in Table 2.

Table 2. Dataset Distribution

Class	Train Data	Test Data
straight	3,006	92
soft_left	409	199
hard_left	426	286
curve_left	2,646	160
soft_right	497	172
hard_right	777	198
curve_right	1,826	138
stop	1,100	146
Total	10,687	1,391

3.2 Performance Evaluation

The impact of class granularity on control accuracy was analyzed by subdividing the four standard control commands (straight, left, right, stop). Table 3 presents the overall model accuracy for different class counts.

Table 3. Model Accuracy with Different Class Granularity

Number of Classes	Accuracy
4	96.66
6	97.70
8	98.78

The highest accuracy of 98.78% was achieved with 8 classes. The confusion matrices for 4, 6, and 8 classes are shown in Fig. 5.

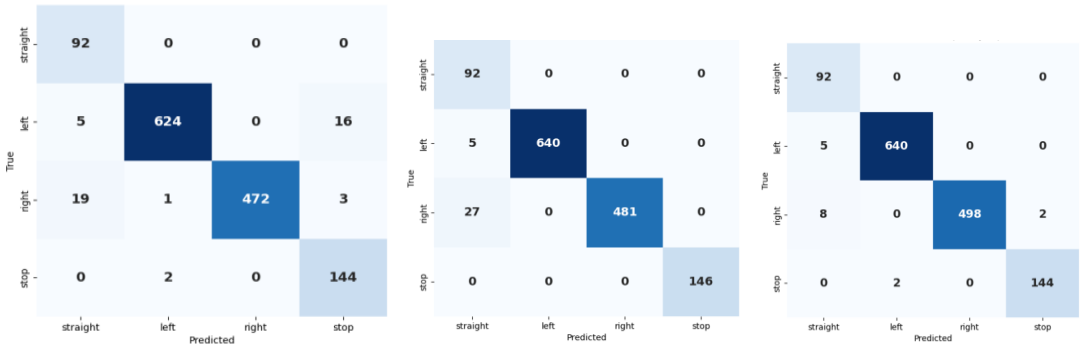

Fig. 5. Confusion matrices for different class granularity: (a) 4-class, (b) 6-class, and (c) 8-class

Fig. 5(a) demonstrates occasional misclassification between left and right classes. Fig. 5(b) shows improved accuracy by distinguishing between soft and hard turns. Fig. 5(c) with the highest accuracy, highlights the effectiveness of class granularity in refining steering control precision. These findings confirm that subdividing control commands enhances the accuracy of CNN-based autonomous driving models.

4. Conclusion and Future Work

This study examined the impact of class granularity on CNN-based autonomous driving by subdividing four primary control commands into six and eight classes. Results show that increasing class granularity enhances control accuracy, with a peak accuracy of 98.78% at eight classes. This suggests that finer granularity improves autonomous driving precision in complex environments. Future work will focus on optimizing real-time performance for practical deployment.

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Remote Configuration of ADR parameters for End-Devices Using the RFU Field in LoRaWAN Packets

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Abstract: The rapid growth of Internet of Things (IoT) devices has highlighted the need for low-power wireless communication protocols, with LoRaWAN serving as a key protocol for long-range, low-power communication. This paper proposes a method for dynamically adjusting LoRaWAN's Adaptive Data Rate (ADR) parameters in response to network environment changes, such as End-Device mobility or obstacles. Existing LR+ADR algorithm rely on predefined and fixed thresholds, requiring reprogramming, such as a firmware update, for adjustments. To address this limitation, the study leverages the Reserved for Future Use (RFU) field in LoRaWAN packets to enable a remote parameter update. The proposed approach supports lightweight, header-based control, minimizing data packet size and reducing the possibility of system malfunctions. Future research could explore RFU field expansion and higher-layer integration for enhanced flexibility and scalability.

Keywords : LoRaWAN, ADR, Adaptive Data Rate, RFU, Reserved for Future Use, Dynamic Parameter Adjustment

Introduction: The increasing number of Internet of Things (IoT) devices has highlighted the importance of low-power wireless communication protocols. LoRaWAN (Long Range Wide Area Network) has emerged as a representative protocol supporting long-range, low-power communication, widely used in various IoT applications. A LoRaWAN network consists of three primary components: End-Devices, Gateways, and Network Servers, functioning as devices, relays, and network control systems, respectively. LoRaWAN features an Adaptive Data Rate (ADR) system that dynamically optimizes data transmission settings using various algorithms. In mobile environments or when network conditions change—such as when End-Devices move or obstacles arise between End-Devices and Gateways—algorithms like LR+ADR (Linear Regression + ADR)[1] and FCR-ADR (Fast Connection Recovery-ADR)[2] are employed, relying on fixed thresholds, which can limit adaptability in dynamic scenarios. The challenge lies in the fact that most ADR algorithms are embedded within the firmware of End-Devices, making physical access necessary for adjustments when remote firmware updating mechanisms are unavailable. This limitation leads to significant maintenance and scalability issues. To address this, this paper proposes a method for remotely controlling ADR parameters using the Reserved for Future Use (RFU) field in LoRaWAN packets.

Methodology: Like other network protocols, LoRaWAN packets are composed of multiple layers as shown in Fig. 1, with specific areas reserved as RFU (Reserved for Future Use) to ensure upward compatibility and octet alignment[3]. This study utilizes the 0.5-byte RFU field in the Frame Control Octet (FCtrl), containing ADR-related bit fields. Although other RFU fields exist, they are typically located in higher-layer headers, making access challenging. Therefore, the RFU field in the FCtrl was selected for direct control by ADR algorithms.

The proposed mechanism operates as follows: The network server sends specific control commands to End-Devices via downlink packets. Example commands include:

- Profile Selection: Combining fixed parameter profiles used by specific ADR algorithms and selecting the appropriate profile based on network conditions.
- ADR Algorithm Switching: Equipping End-Devices with multiple ADR algorithms and

switching between them as needed based on environmental changes.

Through uplink packets, the End-Device responds with the results of executing commands received from the Network Server. The response information is structured as follows:

- When the command is successfully executed: The End-Device retransmits the command information sent by the Network Server, confirming successful delivery.
- When the command execution fails: The response includes details about the task type and error information.

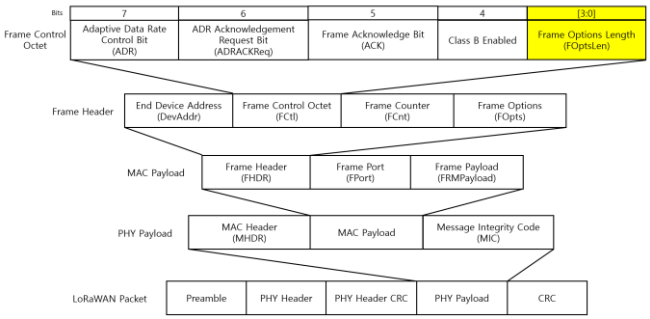

Fig. 1. LoRaWAN packet structure

Results: The proposed RFU-based ADR control method has the following advantages and limitations:

Advantages:

- Header-Based Control: ADR algorithms can be controlled through header access, reducing the risk of malfunction compared to payload-based access.
- Lightweight Message Processing: Efficient control without increasing the data packet size.

Limitations:

- Limited Size: The 0.5-byte RFU field restricts the amount of data that can be processed.
- RFU Collision Risk: If the RFU field becomes officially assigned, the proposed method will no longer be applicable.

Conclusion: This paper proposes a method for remotely controlling End-Device ADR parameters using the RFU field in LoRaWAN packets. However, the limited size of the RFU field permits only mode switching, making it challenging to convey even simple values. Additionally, future protocol updates could assign the field, posing a potential conflict risk.

Future research should explore alternative RFU fields and consider integrating payload-based and higher-layer control mechanisms to develop a more flexible and robust control system.

Acknowledgment

This research was supported by Basic Science Research program through the National Research Foundation of Korea (NRF) funded by the Ministry of Science and ICT (No. 2020R1F1A1048179)

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Posture Correction Device Based on Pressure Feedback for Scoliosis Improvement

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Abstract: Modern people are increasingly complaining of back pain due to inappropriate posture, increased stress, and lack of exercise due to biased lifestyle habits. This back pain is caused by scoliosis and affects a wide range of ages, from students in their growing years to adults. In particular, spinal deformation caused by incorrect posture management during the growing years progresses to abnormal spinal deformation, which not only causes an unsightly appearance but also causes inflexibility in physical activities accompanied by pain and stiffness, which can cause many obstacles in proper daily life. Most patients with scoliosis in 85% to 90% of them cannot find the cause of their occurrence, and these cases are collectively referred to as idiopathic scoliosis. Scoliosis is a symptom in which the spine is deformed three-dimensionally. It mainly occurs in childhood and adolescence and cannot be completely cured with medication or treatment devices, but instead requires lifelong management. Therefore, in this paper, we described the design of body pressure-based digital healthcare technology and manual and active posture correction devices that allow spinal scoliosis patients to manage themselves.

Keywords : Scoliosis, Posture Correction, Body Pressure Feedback

Scoliosis can be defined as a three-dimensional deformation in which the spine is laterally curved or disoriented from the axis of the anatomical midline, accompanied by rotation of the vertebrae, and the normal curvature is lost on the sagittal plane.

Idiopathic scoliosis is the most common form of scoliosis, accounting for 85% of all scoliosis, and its cause is still unknown. However, the increasing number of young people with mental stress from studying, the high level of industrialization, and the long-term use of computers, which lead to prolonged inappropriate postures, and the lack of exercise and health education are further increasing the incidence of scoliosis in young people.

The limitations of existing assistive devices are clear. First, it does not fit the user's body type, so excessive pressure is applied to a specific area, causing pain and discomfort. Second, it is difficult for the user to check the correction effect in real time because there is no feedback function for posture correction. Finally, since such a device can be applied only in a specific posture, it is difficult to continuously correct it during daily life.

In order to solve these problems, a new corrective device that combines a body pressure-based feedback system and digital healthcare technology is needed. This technology enables personalized management for patients and can overcome the limitations of existing treatment methods.

Therefore, in this paper, a scoliosis posture correction device based on body pressure feedback was described for the design.

- Position fixing with modified spine correction and upper body side and rotation correction
- Body adaptive pad adjustable to personal body type
- Pneumatic based body pressure feedback system with continuous monitoring of posture

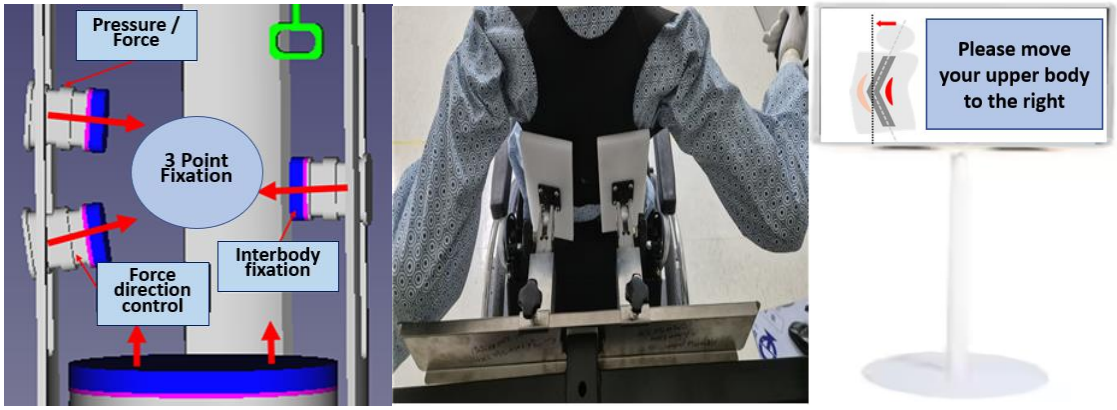

Fig. 1. Body pressure feedback-based scoliosis posture correction device

The active pressure feedback-based scoliosis posture correction device overcomes the limitations of existing correction devices and provides an active solution that allows patients to correct their posture on their own. Such devices can contribute to improving the quality of life of patients with scoliosis and increasing the efficiency of posture correction.

Acknowledgment

This paper was supported by Korea Institute for Advancement of Technology(KIAT) grant funded by the Korea Government(MOTIE) (P0011930, The Establishment Project of Industry-University Fusion District)

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Biography

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14:30~	Session 3: Machine Learning and Applications (Room: L310) Chair: Lee Hyungi (DGIST) and Moon Kean Kim (Oslo Metropolitan Univ.)	
	3S-1 [011]	**Factors Influencing the Transition to a New Learning Management System: Focusing on Collaboration with the International Atomic Energy Agency(IAEA)** *Hyeon-Jin Kim[1)] , Kyoung-Pyo Kim[2)] , and Ik Jeong[2*)]* *1) Nuclear Training and Education Center, Korea Atomic Energy Research Institute, Daejeon, Republic of Korea* *2) SMART Technology Development Division, Korea Atomic Energy Research Institute, Daejeon, Republic of Korea*
	3S-2 [016]	**Real-time Surgical Navigation Framework Using Integrated Machine Vision and Stereo Vision** *Mingang Jang[1)] and Hyunki Lee[2*)]* *1) Department of Interdisciplinary Engineering, DGIST, 333 Techno jungang-daero, Daegu 42988, Korea* *2) Division of Intelligent Robotics, DGIST, 333 Techno jungang-daero, Daegu 42988, Korea*
	3S-3 [027]	**Development of Artificial Intelligence-Predicted Multi-Antigen Fusion Vaccine and Immunological Characterization** *Ki Bum Ahn[1)] , Kyoung-Pyo Kim[2)] and Ho Seong Seo[1*)]* *1) Cyclotron Applied Research Section, Korea Atomic Energy Research Institute, Jeongeup 56212, Republic of Korea.* *2) SMART Technology Development Division, Korea Atomic Energy Research Institute, Daejeon 34057 Republic of Korea*
	3S-4 [035]	**Research Study on Forest Fire Prediction System Using KNN** *Dr.N.M Sangeetha[1)] , Sathya Seelan S.A[1)] , and Sanjay S[1)]* *1) Department of Computer Science (UG&PG) Dwaraka Doss Goverdhan Doss Vaishanav College, Chennai, TN, India*
	3S-5 [033]	**Review of Data Normalization Techniques for Building Energy Predictions** *Moon Keun Kim[1*)]* *1) Dept. of Built Environment, Oslo Metropolitan University, Oslo N-0130, Norway*
	3S-6 [036]	**Surveys on the Stylus Technologies for Capacitive-Type Touch Systems** *Jae-Sung An[1)]* *1) Sony Europe Design Center, Sony Semiconductor Solution, Norway*

Factors Influencing the Transition to a New Learning Management System: Focusing on Collaboration with the International Atomic Energy Agency (IAEA)

Hyeon-Jin Kim[1)], Kyoung-Pyo Kim[2)], Ik Jeong [3,)]*

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[3)] Nuclear Training and Education Center, Korea Atomic Energy Research Institute, Daejeon, Republic of Korea

Abstract. Analyzing 'what will be learned' constitutes the initial phase of the Systematic Approach to Training (SAT) method. In this context, it is essential to discuss the Learning Management System (LMS), which supports and controls the learning process, in order to effectively specify learning objectives. Setting up an LMS is a crucial first step for successful teaching and learning within virtual environments, enabling teachers and students to actively participate in the learning process. This study, emphasizing cooperative development of an LMS to enhance e-learning, clarify factors influencing the transition to a new LMS. The focus lies on the collaborative project undertaken by the Korea Atomic Energy Research Institute (KAERI) and the International Atomic Energy Agency (IAEA) since late 2010. The study identifies key variables influencing this transition and its outcomes. By examining the conversion of LMSs, considering both contextual and personal factors, this study aims to comprehend these elements comprehensively. This was achieved through focused stakeholder interviews and a review of literature on the development and results of the e-learning project. The findings showed five crucial factors is emerged: 'scalability', 'cost-effectiveness', 'integration with existing systems', 'support for diverse learning formats', and 'enhanced collaboration and communication'. Consequently, successful e-learning implementation necessitates a diverse strategy for creating an LMS.

Keywords; Systematic Approach to Training (SAT); Learning Management Systems (LMS); e-learning; International Atomic Energy Agency (IAEA); collaborative development

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Received:; Accepted:; Published:

1. Introduction

The COVID-19 pandemic has had a profound impact on adult workplaces globally, introducing an era characterized by non-face-to-face interactions and the widespread use of collaboration tools. This shift extends beyond work environments; educational institutions have also transitioned toward non-face-to-face education methods, utilizing video conferencing software for e-learning. Concurrently, platform companies such as Amazon, Google, Facebook [now Meta], and Apple have experienced significant growth in both their business influence and market share.

Technological advancements driven by the pandemic have led to the emergence of new business models centered on 'Innovative Technology,' 'Broad Ecosystems,' 'Global Influence,' and 'Data-Centric.' These companies have developed technologies related to Learning Management Systems (LMS), facilitating a shift from self-hosted systems to cloud-based solutions. For instance, Amazon leverages its AWS platform to provide customized LMS solutions using services like S3 and EC2. Google Classroom serves as a free LMS for educational institutions, enhancing collaboration between teachers and students through task management, communication, and resource sharing. Facebook [now Meta] Workplace Platform supports education and collaboration by fostering user interaction via community features. Apple integrates educational apps into its tools like School Manager to provide personalized learning experiences on iPad and Mac-based platforms.

In parallel, the Korea Atomic Energy Research Institute (KAERI) has collaborated with the International Atomic Energy Agency (IAEA) since the early 2000s to establish an LMS and implement e-learning. This effort involved transitioning from self-hosting to cloud-based systems, aligning with the IAEA CLP4NET platform. Furthermore, KAERI has utilized cloud-based LMS solutions provided by global platform companies, such as Google Classroom.

This study aims to examine the factors influencing the transition to a new LMS, focusing on collaboration with the IAEA. It seeks to clarify the impact of these technological advancements on adult education in nuclear energy and derive insights from the experiences of KAERI and other global brands. To achieve this purpose, this study will conduct Focus Group Interviews (FGIs) with key stakeholders involved in this transformation, along with examining the current status of LMS construction implemented by IAEA through collaboration with KAERI: Switching from self-hosted to cloud-based LMS. This qualitative approach will allow us to delve deeper into personal and contextual factors influencing decision-making processes related to LMS adoption and implementation.

2. Review of Literature

Although there are numerous reasons to migrate to an LMS, numerous studies have identified the following crucial elements.

A. Scalability

Scalability is a critical factor to consider when selecting a LMS, as it indicates the platform ability to manage future increases in users, materials, and features. The capacity of an LMS to accommodate growing workloads, such as more instructors, students, courses, or interactive elements, without compromising stability, speed, or performance is defined as scalability [1].

B. Cost-effectiveness

Cost-effectiveness is a critical consideration when selecting a LMS, since it evaluates whether the platform's costs align reasonably with its value. When assessing cost-effectiveness, both upfront and recurring expenses such as software licensing, implementation, customization, training, and ongoing maintenance are taken into account [2].

C. Flexibility and Accessibility

When choosing a LMS, 'flexibility and accessibility' are important considerations that have a big impact on how well instruction is delivered. The term 'flexibility' describes the LMS capacity to support different pedagogical approaches, course formats, and learning styles, enabling teachers to modify assessments and content to suit a range of student demands [3].

D. Improved Tracking and Reporting

'Improved Tracking and Reporting' is a key consideration when selecting a LMS, as it significantly enhances the management of learning processes and outcomes. This aspect refers to the system's ability to efficiently track student development, engagement, and performance. Enhanced tracking enables teachers to collect data in real-time, including assessment results, time spent on assignments, and course completion rates [4].

E. User Engagement and Interactivity

'User Engagement and Interactivity' are significant considerations when selecting a LMS, as they have a substantial impact on the effectiveness of online learning experiences. Interactivity refers to the system ability to support dynamic interactions between students, educators, and content, while user engagement is the extent to which students actively participate in the educational process [5].

F. Integration with Existing Systems

When selecting a LMS, 'Integration with Existing Systems' is a crucial element that significantly impacts how well an institution's educational technology ecosystem functions. According to [4], this integration involves the LMS ability to seamlessly interface with other programs and systems currently in use, including Content Management Systems (CMS), Student Information Systems (SIS), and other teaching resources. Efficient integration, as noted by [6], reduces the need for redundant data entry, streamlines administrative procedures, and enhances the user experience for both educators and students.

G. Support for Diverse Learning Formats

'Support for Diverse Learning Formats' is a critical consideration when selecting a LMS, since it enhances the flexibility and efficiency of instruction. This concept pertains to the LMS ability to support various teaching strategies and content types, such as competency-based education, blended learning, synchronous learning, and asynchronous learning [7].

H. Enhanced Collaboration and Communication

'Enhanced Collaboration and Communications' is a crucial component that significantly impacts the learning process when selecting a LMS. To foster a collaborative learning environment, this concept involves the LMS ability to facilitate meaningful interactions between students, educators, and course materials [8]

3. Methodology

A. Data Collection

This study aims to elucidate the effects of influencing the transition to a new LMS, with a particular focus on the collaborative effort between the KAERI and the IAEA in enhancing e-learning, which they have been working together on since late 2010. Six experts from the fields of e-learning and Human Resource Development (HRD) participated in this study. Due to the small number of participants, the methodology was more qualitative than quantitative.

B. Measures

From November 2nd to November 6th, an interviewer conducted a series of one-day interviews with each expert involved in this study. The central question posed during these sessions was: "What are the factors influencing the transition to a new LMS, particularly for the e-learning initiative that KAERI and IAEA have collaborated on since late 2010?" Additionally, the interviewer provided information about the combined project involving e-learning and LMS. In the first round of interviews, eight key elements were identified.

The second set of interviews took place three weeks later, from November 25th to November 28th, with only one interviewer per day. Each participant was again asked: "What are the main factors influencing the transition to a new LMS?" Through these discussions, five crucial factors emerged: 'Scalability', 'Cost-effectiveness', 'Integration with Existing Systems', 'Support for Diverse Learning Formats', and 'Enhanced Collaboration and Communication'.

C. Analysis

Firstly, this study identified five latent elements critical for transitioning to a new LMS. Secondly, each interviewee concurrently assessed these five factors using a five-point Likert-

type scale: 1 = not important, 2 = somewhat important, 3 = quite important, 4 = quite a lot important, and 5 = a great amount important. Thirdly, the content validity of the questions was conducted. This involved examining the Content Validity Ratio (CVR). The minimum CVR value is determined by the number of panelists; if the CVR value exceeds this threshold, the question is deemed to have content validity. Below is a table detailing the minimum CVR values.

TABLE I. MINUMUM VALUES OF THE NUMBER OF PANELISTS ON CONTENT VALIDITY RATIO

Number of Panelists	Minimum Value
5	.99
6	.99
7	.99
8	.75
9	.78
10	.62
11	.59
12	.56
13	.54
14	.51
15	.49
20	.42
25	.37
30	.33
35	.31
40	.29

4. Result and Discussion

The respondents perceived the five factor as “quite a lot important” or “a great amount important” ($M > 4.0$). The highest mean was for “support for diverse learning formats” ($M = 4.83$), and the lowest means was for “scalability” ($M = 4.17$). All other means was between the two ($4.17 < M_{\text{cost-effectiveness}}$, $M_{\text{integration with existing systems}}$ and $M_{\text{enhanced collaboration and communication}} < 4.83$). However, the mean of other factors except the five factor was below four ($M_{\text{Flexibility and Accessibility}}$ and $M_{\text{Improved Tracking and Reporting}}$, and $M_{\text{User Engagement and Interactivity}} < 4.0$). The table 2 showed the detail scores by the six experts.

TABLE II. SCORE RESULTS BY EXEPERTS

	F_1[a]	F_2[b]	F_3[c]	F_4[d]	F_5[e]
E_1	4	4	4	5	4
E_2	4	5	5	5	5
E_3	4	4	4	5	4
E_4	4	5	5	5	4
E_5	4	4	4	5	4

E_6	5	5	4	4	5
Average	4.17	4.50	4.33	4.83	4.33

a. scalability, b: cost-effectiveness, c: integration with existing systems, d: support for diverse learning formats, e: enhanced collaboration and communication

5. Conclusion

The conclusion of this study is as follows: Firstly, compared to self-hosted Learning Management Systems (LMS), cloud-based LMS offers significant cost savings for public institutions. The cloud-based option becomes more economical for government organizations seeking efficient use of their limited resources. Secondly, when choosing an LMS for public institutions, support for various learning modalities is essential in meeting the unique demands of students. Accommodating diverse learning formats can improve educational efficacy and accessibility, making it crucial for public institutions. Thirdly, when selecting an LMS in collaboration with global enterprises, cost reduction is a critical consideration. Reducing expenses during the selection process directly contributes to the sustainability and scope of international educational projects.

Despite these significant findings, this study has several limitations: Firstly, the lack of adequate expert participants limited the diversity of insights and reduced the generalizability of findings, thereby limiting the validity and reliability of this study. Secondly, the study's trustworthiness was constrained by its exclusive focus on a single project.

Acknowledgment

This study is based on revising the article presented in a journal called as ‘Edelweiss Applied Science and Technology’. I would like to express my sincere gratitude to my corresponding author for their guidance and invaluable feedback, which greatly enhanced the quality of this paper. I also thank the other co-author for their insightful discussions and support throughout the process. Finally, I am grateful to my family and friends for their encouragement and patience.

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Real-time Surgical Navigation Framework Using Integrated Machine Vision and Stereo Vision

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Abstract: This study presents a novel surgical navigation system integrating stereo endoscopic imaging with CT data for real-time organ visualization and lesion tracking. The system combines CT-based 3D reconstruction, U-Net depth estimation, and attention-based lesion tracking to provide accurate surgical guidance without additional hardware. Our approach enables continuous organ localization during minimally invasive procedures, addressing challenges of tissue deformation and lighting variations, while aiming to enhance surgical precision and improve patient outcomes.

Keywords : Surgical navigation, Stereo endoscopy, Medical image, Lesion tracking

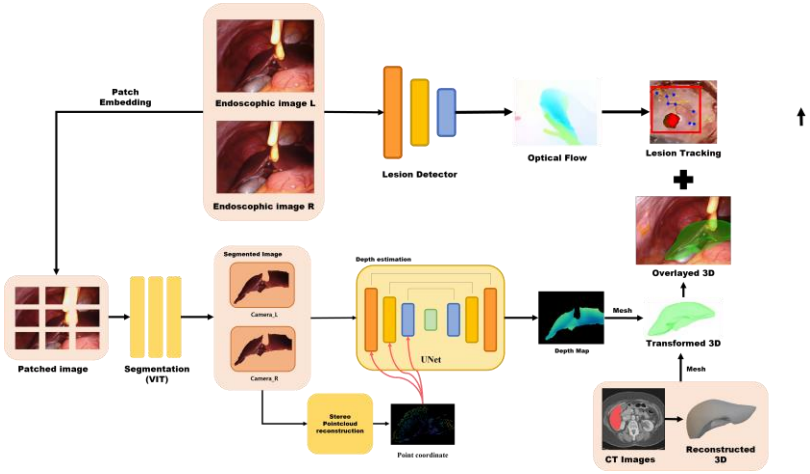

Fig. 1. Suggested model architecture for surgical navigation frameworks

The expected size, shape, and location of the tumor is often different in the actual surgery. Tumors are often located near organs and buried in normal tissue. If surgical navigation can provide accurate and objective tumor localization, it can reduce overall surgical time in complex anatomical areas and increase surgical reliability. In this research, Real-time localization and visualization of surgical tools is essential for performing precise surgeries. Existing marker-based systems require additional hardware and are limited in real-world clinical environments.[1] To overcome these limitations, a new approach integrating stereo vision and machine learning is required. In this study, we aim to develop virtual and augmented reality surgical navigation that can visualize patient organs and lesions in a three-dimensional model through stereo endoscopic imaging and patient CT matching, and respond to organ changes during surgery.

Fig. 1. shows the architecture of the model for overlaying the three-dimensional model with images of patient organs obtained from stereo endoscopic images and CT and tracking lesions. In the endoscopic image, the organ is partially occluded, making it difficult to determine its complete shape. We first convert CT images from multiple angles into three-dimensional nifti images. The target organ is then segmented to obtain the original 3D model of the organ. Since the obtained 3D model does not reflect real-time organ deformation during surgery, we use the

depth estimation module based on U-net[2] to obtain depth maps from endoscopic images and transform the original 3D model. To identify patient organs in endoscopic images, we use a VIT[3] based module to segment patient organs. Endoscopic surgical images have many lighting changes, bleeding, smoke, and uniform tissue surfaces, which make general depth estimation difficult[4]. In this study, we propose a new method to estimate the depth by first estimating the point cloud through relatively reliable feature point matching and taking it as a conditions.

To track the lesion, we first use an Attention-based object detection module[5,6] to detect the location of the lesion. In a surgical environment, it is difficult to apply object tracking methods to lesions due to their small size, occlusion, and changing light intensity. Therefore, we extract feature points around the lesion, track the feature points with optical flow, and track the location of the lesion using a transformation matrix.

Through this method, we aim to check the position of surgical organs in real time without relying on optical trackers or magnetic sensors. This can effectively localize the patient's organs in a surgical environment where medical device invasion must be minimized, helping to improve surgical outcomes and patient health through minimal resection.

This work was supported by the DGIST R&D Program of the Ministry of Science and ICT (24-IT-02)

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Development of Artificial Intelligence-Predicted Multi-Antigen Fusion Vaccine and Immunological Characterization

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Abstract: *Streptococcus* suis is a Gram-positive opportunistic pathogen that causes zoonotic infections. The high prevalence of antibiotic-resistant *S. suis* strains and the existence of 35 diverse serotypes pose significant challenges to controlling infections, resulting in substantial economic losses in the swine industry and severe infections in humans. While vaccination is considered an effective means of infection control, no licensed vaccines for *S. suis* are currently available. To address this, we aimed to develop a multi-antigen fusion vaccine to effectively control *S. suis* infections and investigated the resulting immune responses. Using AI-based protein prediction tools such as AlphaFold, Protein-Sol, and the Immune Epitope Database (IEDB), we designed and constructed ATOMSSUIS$_{penta}$, a multi-antigen fusion vaccine comprising conserved antigens of *S. suis*: HP0197, Fnb, Sao, C5a peptidase, and Suilysin. Subcutaneous immunization of ATOMSSUIS$_{penta}$ in mice significantly increased serum IgG, IgG2a, and IgG1 antibody responses specific to *S. suis* serotype 2, HP0197, Fnb, Sao, C5a, and Suilysin. The vaccine elicited strong cellular immunity, characterized by Th1/Th17-skewed responses and activation of cytotoxic T cells. Notably, ATOMSSUIS$_{penta}$ vaccination increased the proportion of multifunctional $CD4^+$ and $CD8^+$ T cells. Furthermore, ATOMSSUIS$_{penta}$ provided robust protection against *S. suis* serotypes 2, 4, and 9, as demonstrated by histopathological analysis, which revealed significant reductions in meningitis and pneumonia caused by *S. suis* infection. In conclusion, ATOMSSUIS$_{penta}$ represents a promising broad-spectrum *S. suis* vaccine with robust humoral and cellular immune responses. The design strategy of this multi-antigen fusion subunit vaccine offers a promising platform technology for developing more effective vaccines against a wide range of pathogens.

Keywords : *Streptococcus suis*, vaccine, AI, multi-antigen fusion, cellular immunity, humoral immunity

RESEARCH STUDY ON FOREST FIRE PREDICTION SYSTEM USING KNN

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Abstract: Forest fires are one of the most disastrous natural calamities causing significant harm to human life and property. Early detection of wildfires is important to prevent their spread and minimize their damage. Wildfire research is an important environmental and scientific issue, especially in wildfire-prone regions such as South Carolina (SC). Machine Learning techniques offer an opportunity to improve wildfire prevention despite the limited research on forest fires. This application of machine learning techniques presents an opportunity to enhance forest fire prevention and control efforts. In this paper, we present a comparative study of four popular ML methods tree, random forest, k-nearest neighbors (KNN), and support vector machine (SVM)- for forest fire detection.

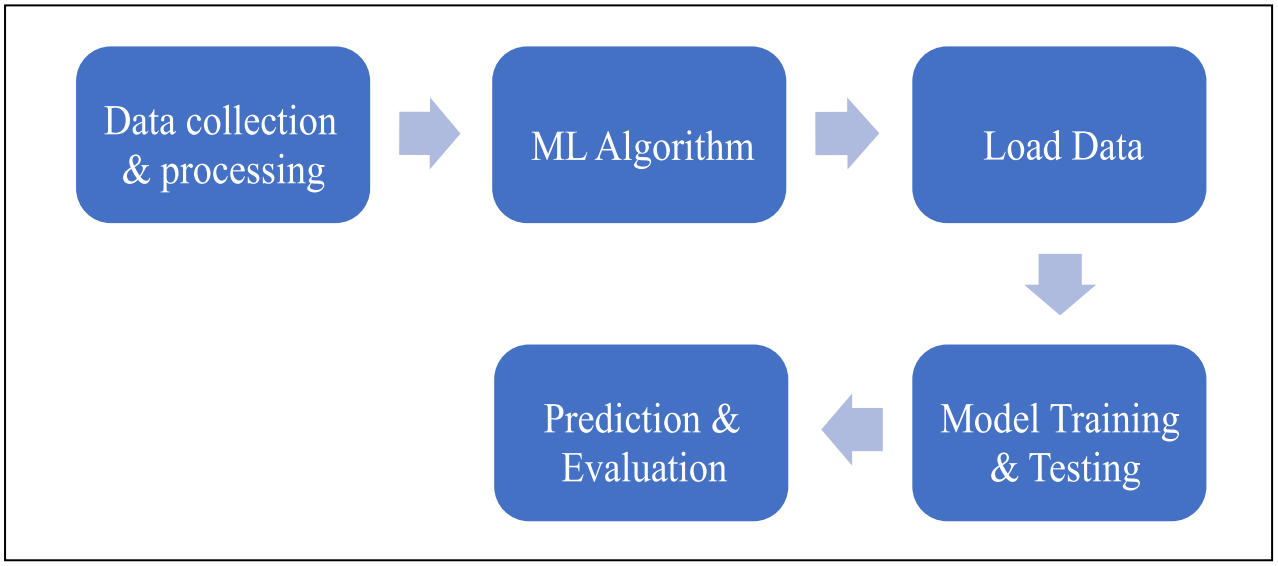
Keywords: Forest Fires, Machine Learning

1. Introduction

Forest fires pose significant threats to ecosystems, human health, and economies, with their frequency and severity increasing due to climate change and human activity. Accurately predicting these fires minimizes damage and enhances emergency response efforts. Recent advancements in machine learning (ML) offer promising solutions for forest fire prediction by leveraging large datasets that include environmental factors such as weather conditions, vegetation types, and historical fire incidents. This paper explores using ML algorithms to develop predictive models for forest fires, aiming to identify key risk factors and improve decision-making in fire prevention and management.[1]

This research seeks to enhance the ability to forecast and mitigate the impact of forest fires in vulnerable regions by integrating data-driven approaches [9].

2. Methodology



2.1 Data Collection

Data collection involves gathering key information such as weather data (temperature, humidity, wind speed), historical fire data (locations and times of past fires), satellite imagery, and terrain information (elevation and slope). This data forms the foundation for the model to identify patterns that influence fire occurrence and behavior [4].

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2.3 Machine Learning Algorithm

The ML algorithm is crucial in learning patterns from the processed data to predict fire risks.Algorithms like Random Forest,Support Vector Machines (SVM),and Neural Networks analyze features such as weather conditions, vegetation type, and historical fire data to identify high-risk areas[5]. The selected algorithm helps classify or forecast fire occurrences based on real- time inputs.

2.4 Model Training

Model training in a forest fire prediction system involves feeding historical data to the machine learning algorithm to learn patterns related to fire risks. The model adjusts its parameters through techniques like cross-validation to improve accuracy and avoid overfitting. This process enables

the model to generalize and make reliable predictions on new data[12][5].

2.5 Model Testing

Model testing in a forest fire prediction system involves evaluating the trained model on a separate test dataset that it has not seen before. This helps assess the model's accuracy and performance in predicting fire risks on new, unseen data. The results are measured using metrics like precision, recall, and F1-score to determine the model's effectiveness

2.6 Prediction and Evaluation

Prediction and evaluation in a forest fire prediction system involve using the trained model to predict fire risks based on real-time data. The model's predictions are then compared with actual outcomes to assess its accuracy and reliability. Evaluation metrics like accuracy, precision, recall, and F1- score help determine the model's performance and areas for improvement[6][8].

3. Workflow For a Forest Fire Prediction Model

A simple example of how a machine learning model for predicting forest fires might be implemented using Python. The program makes use of the RandomForestClassifier to predict whether a fire will occur based on environmental features[3][6].

STEP 1: Import the necessary libraries

```
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import accuracy_score, classification_report
```

•pandas: Used to handle data manipulation tasks, such as loading datasets and manipulating DataFrames.

•train_test_split:This helps to split the dataset into two parts: one for training the model and the other for testing it.

•RandomForestClassifier: This is used for classification tasks. It builds multiple decision trees and combines their results.

STEP 2: Load Data

```
data = pd.read_csv('forest_fire_data.csv')
```

•data:This line loads the dataset from a CSV file (forest_fire_data.csv). The dataset contains information about various environmental features (e.g., temperature, humidity) and the target variable (whether a forest fire occurred, labeled as 1 for fire and 0 for no fire).

STEP 3: Data Preprocessing

```
X = data.drop('target', axis=1)  # Features
y = data['target']  # Target variable
```

•X: These are the independent variables (the factors that influence the fire occurrence).

•Y: This is the target variable representing the dependent variable, which is the outcome (fire or no fire). It is assigned the values from the 'target' column in the dataset.

STEP 4: Split data into training and testing sets

•X_train and y_train are the features and target variables for training the model.

•X_test and y_test are the features and target variables for testing the model after it has been trained.

STEP 5: Train random forest model

```
model = RandomForestClassifier(n_estimators=100, random_state=42)
model.fit(X_train, y_train)
```

•RandomForestClassifier:Random Forest is an ensemble learning algorithm that uses multiple decision trees to make predictions, improving accuracy and reducing overfitting

•model.fit(X_train, y_train):This step trains the model using the training data. The model learns the relationship between the input features (X_train) and the output target (y_train).

STEP 6: Make Predictions

```
y_pred = model.predict(X_test)
```

•model.predict(X_test):After training, the model is used to make predictions on the test set(X_test). The predicted values are stored in y_pred. These predictions represent whether the model predicts a fire (1) or no fire (0) based on the input features.

STEP 7: Evaluate Model

```
print("Accuracy:", accuracy_score(y_test, y_pred))
print("Classification Report:\n", classification_report(y_test, y_pred))
```

•accuracy_score(y_test, y_pred):This calculates the accuracy of the model by comparing the predicted values (y_pred) with the actual values from the test set (y_test). Accuracy is the percentage of correct predictions made by the model.

•classification_report(y_test, y_pred):This generates a detailed classification report, which includes precisions and recall.

Using the above algorithm, we can predict whether a forest fire will occur by collecting and processing the data.

4. Challenges and Limitations

•Gathering comprehensive datasets, especially in remote forested areas, can be difficult. Incomplete or missing data can reduce the accuracy of predictions [11].

•Models trained on data from one region may not perform well in other areas due to different climates, vegetation, or geographical conditions. This imbalanced nature of the data can result in the model failing to predict fires that occur, which is critical for public safety [2].

•Many machine learning models, such as deep learning and ensemble methods, lack interpretability, which makes it difficult for forest rangers, and authorities to trust and act on the predictions[10].

5. CONCLUSION

In conclusion, the use of machine learning for forest fire prediction offers a promising approach to enhancing early warning systems and improving fire management. ML models can provide valuable insights into fire risk by analyzing various environmental factors such as weather

conditions, vegetation, and historical fire data. However, challenges like data quality, regional specificity, and model interpretability must be addressed to improve the reliability of predictions. Additionally, integrating real-time data and overcoming class imbalances in datasets will further enhance model performance. Despite these obstacles, ML-based prediction systems have the potential to significantly reduce the impact of wildfires. Future advancements in data collection, model adaptation, and computational power will strengthen these systems. Ultimately, ML holds the key to more proactive and efficient forest fire management.

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Review of Data Normalization Techniques for Building Energy Predictions

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Abstract: Data normalization approaches are an essential pre-processing method that adjusts or transforms data to guarantee equitable contributions from all features, hence preventing the predominance of features with greater magnitudes [1]. This procedure enhances the performance and convergence of machine learning algorithms by standardizing feature scales and distributions, hence improving model correctness and efficacy [2]. This paper newly overviews and indicates the execution applying typical normalization techniques—Minimum-Maximum (Min-Max), Mean value normalization, Z-score normalization, and Gaussian techniques—intended to optimize input dataset for Artificial Neural Network (ANN) algorithms and strengthen built environmental energy usage expectation [3,4]. Each strategy targets particular data attributes to improve ANN efficacy.

This research investigates how data normalization affects the accuracy of electricity use predictions in buildings and compares the performance of four ANN models: Long Short-Term Memory Networks (LSTM), Levenberg-Marquardt Backpropagation (LMBP), Recurrent Neural Networks (RNN), and General Regression Neural Networks (GRNN). The work presents four normalization methods using experimental datasets. The findings indicate that the LSTM model utilizing Min-Max Scaling attained the highest accuracy. The recurrent algorithms with Gaussian techniques and the LMBP approach with Z-score method illustrates powerful appliance, illustrating small differences between the algorithms used [3,4]. The GRNN methodology, engaging raw dataset, demonstrated better outcomes than normalized alternatives. The results emphasize the critical functionality of normalization methodology on boosting the capability and output quality of using ANNs in built environment energy estimation, stressing the value of selecting optimized normalization techniques.

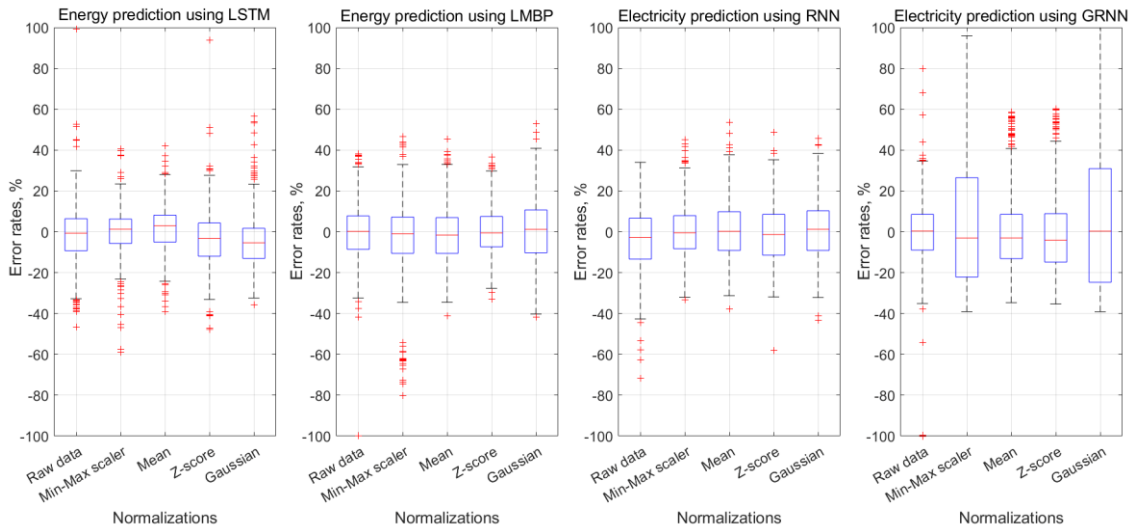

Fig. 1. Evaluation of performance of the four ANN models using four data normalization methods [4]

(1line spacing)

Data normalization markedly impacted the predictive efficacy of diverse ANN models, with its success differing according to the algorithm and dataset employed. In Fig.1, the results underscore the necessity of choosing appropriate normalizing techniques customized for particular applications, balancing enhanced efficiency with computational complexity. The proposed ANN models and normalization methods function as efficient tools for predicting long-term energy consumption in buildings, providing insights into building performance and the effectiveness of different procedures for certain systems and data types. Further study can improve prediction precision by integrating supplementary input elements and optimizing combinations of ANN models with detailed normalizing techniques. This research illustrates a comprehensive examination of the critical points of data normalization methodology in estimating electricity usage and establishes the ground works for improving environmental energy forecasting techniques.

Keywords : data normalization ; artificial neural networks ; building energy prediction

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Surveys on the Stylus Technologies for Capacitive-Type Touch Systems

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Abstract:
In this paper, the surveys on the stylus technologies for capacitive-type touch systems (CTSs) are presented. The stylus technologies are classified into the passive and active stylus depending on the battery integration. To explain two types of the stylus, the architecture of CTS with the stylus is firstly explained. Afterward, the operation principles of the passive, which have a capacitive-type (C-type), an electromagnetic resonance type, and an electrically coupled resonance type, and a C-type active type styli are described.

Author Keywords : Active stylus; capacitive-type passive stylus; electromagnetic resonance (EMR) type passive stylus; electrically coupled resonance (ECR) type passive stylus

I.Introduction

The capacitive-type touch systems (CTSs) are widely used in various applications such as a mobile phones, a tablet PCs, an automotives, and an interactive whiteboards due to their durability, high sensitivity, and multi-touch capability (1-3). Especially, the more a high-end CTSs are needed in these applications, the more the stylus in the CTS is demanded to express the various expressions with high sensitivity (1-13). As shown in Table 1, the stylus can be classified into the passive and active stylus without and with the battery integration, respectively (3). Among the several types of passive styli, the capacitive type (C-type) is dominantly used with the CTS because of its small thickness and weight, and the low fabrication cost, but it can express the only coordinate of stylus with a low sensitivity. The electromagnetic resonance (EMR) type (3,6-7) stylus can express the pressure and tilt angle with a high resolution and sensitivity, but it under the display panel, which increases the power consumption, fabrication cost, weight, and thickness of the CTS. The electrically coupled resonance (ECR) type stylus can express the pressure without an additional sensor, but it can represent only a pressure expression with a low resolution (8-9). The C-type active stylus (10-13) can represent the various expressions such as the pressure and tilt angle with a high resolution, but it needs a high thickness, high power consumption, and fabrication cost of the stylus because of the additional circuit and battery. This paper presents the surveys of stylus technologies for the CTSs. Section 2 explains the architecture of the CTS with stylus. Sections 3 and 4 describe the passive and active stlyi, respectively. Finally, the conclusion is given in Sections 5.

2. Architecture of CTS with Stylus

Fig. 1 shows the architecture of the CTS, which includes the touch sensor, analog front-end IC (AFE IC), and digital processor, with the stylus,. When the AFE IC sends the excitation signal (V_{EXT}) to the touch sensor, V_{EXT} is converted into the charge signal (Q_S) due to the capacitance between transmitter (TX) and receive (RX) electrodes. At the same time, the stylus changes the amplitude of QS through the capacitances between stylus, and TX and RX electrodes ($C_{STY,\ TX}$ and $C_{STY,\ RX}$). The AFE IC digitizes the Qs and transfers the digital data to the digital processor. The digital processor extracts the digital data to the touch data, and transfers it to the host PC. The host PC then calculates the touch coordinate and sends it to the display panel to show the various expressions of the stylus. According to the types of stylus, the multiplexer can be used to change the sensing direction (3,8-13).

Table 1.Types of stylus.

Types	C-type passive stylus	EMR-type passive stylus	ECR-type passive stylus	C-type active stylus
Battery	No	No	No	Yes
Form factor of stylus	Thin and light	Thin and light	Thin and light	Thick
Additional sensor	No	Yes or No	No	No

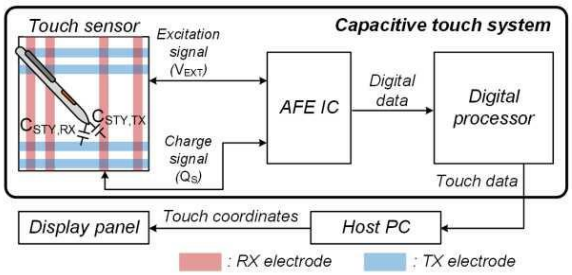


Figure 2. Conceptual diagram of C-type passive stylus.

3. Passive-type stylus

3.1 Capacitive Type (C-type)

The C-type passive stylus has been widely used in the CTS because of its small thickness and weight, and the low fabrication cost (3). Figure 2 shows the conceptual diagram of the C-type passive stylus. When the stylus moves from point A or C (between two RX electrodes) to point B or D (on the RX electrode), respectively, the capacitance variation increases because the C-type passive stylus changes more amplitude of Q_S. In addition, when the stylus tip is enlarged, it also changes more the amplitude of Q_S between the stylus tip and touch sensor, resulting in an increase in the capacitance variation. Thus, the C-type passive stylus depends on the thickness of the tip and electrode pitch of touch sensor. When the tip thickness is decreased, it absorbs less Q_S from the touch sensor, resulting in a small capacitance variation, and thereby it is hard to detect the stylus coordinate. Therefore, to maximize the capacitance variation of touch sensor, a large thickness tip is conventionally used for the C-type passive stylus (4-5).

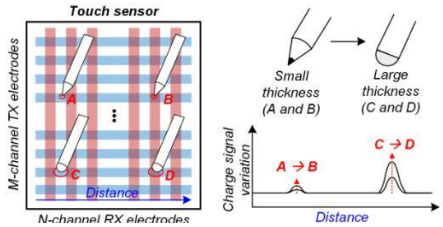


Figure 2. Conceptual diagram of C-type passive stylus.

3.2 Electromagnetic Resonance (EMR) Type

For various expressions such as the pressure and tilt angle, the EMR-type passive stylus has been adopted for mobile devices (6-7). Figure 3 shows the conceptual diagram of the EMR-type passive stylus and its sensing system. The sensing system consists of the EMR sensor with magnetic coils, EMR switch, and EMR excitation and readout circuits. In the EMR-type passive stylus, the equivalent circuit can be drawn using the tank inductor (L_{TANK}), tank capacitor (C_{TANK}), and pressure-sensitive capacitor ($C_{PRESSURE}$), button capacitor (C_{BOTTON}), and button switch. When the EMR excitation circuit is connected with the EMR sensor through the switch, the stylus absorbs the magnetic field, which is generated from the magnetic coils in the EMR sensor, through the L_{TANK} and combination of capacitors (C_{TANK}+$C_{PRESSURE}$+C_{BUTTON}). According to the pressure of stylus and button, the value of the combination of capacitors are changed because the values of $C_{PRESSURE}$ and C_{BUTTON} is adjusted, respectively. After then, the stylus converts the magnetic field to a radio frequency (RF) signal and sends the RF signal back to the EMR sensor as a stylus signal (V_{STY}) having different V_{STY} frequency (f_{STY}) according to the pressure and button as an Equation 1.

$$f_{STY} = \frac{1}{2\pi\sqrt{L_{TANK} \times (C_{TANK} + C_{PRESSURE} + C_{BUTTON})}} \quad (1)$$

In addition, to extract the coordinate of stylus efficiently and accurately, the two-step sensing method is used. During the first step sensing period, the coordinate of stylus is roughly determined. When the coordinate of stylus is detected, the coordinate is accurately extracted by driving the additional magnetic field and sensing V_{STY} during the second step sensing period. The EMR-type stylus can express the pressure and tilt angle with a narrow tip, but it needs the additional EMR sensor, which needs higher power consumption, thickness, and fabrication cost. In addition, the sensitivity of the EMR stylus depends on the magnetic coil's density and uniformity in the EMR sensor. Therefore, the magnetic coils is necessary to place with even and dense in all EMR sensor area.

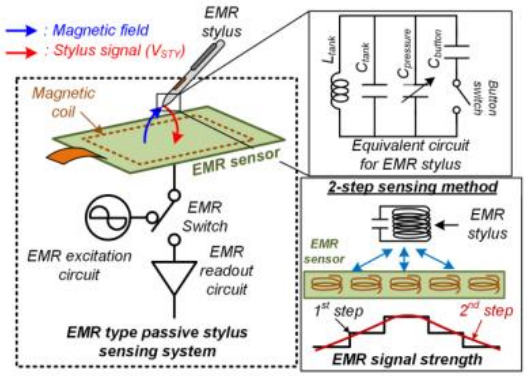


Figure 3. Conceptual diagram of an EMR-type passive stylus and sensing system.

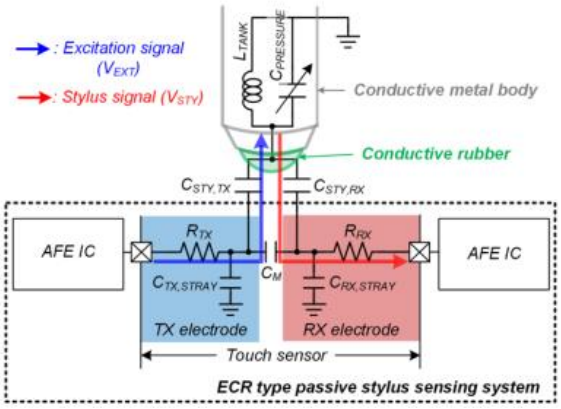


Figure 4. Conceptual diagram of an ECR-type passive stylus and sesing system.

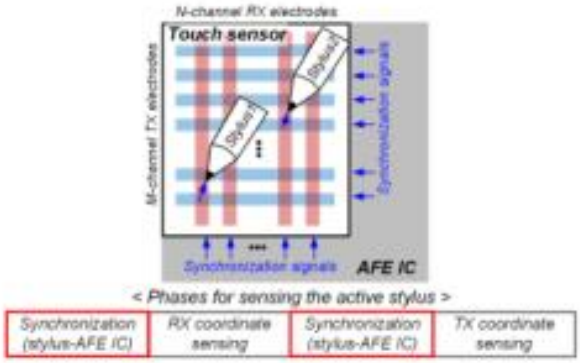
3.3 Electrically Coupled Resonance (ECR) Type

To express the pressure without the additional sensor, the ECR-type passive stylus was introduced (8-9). Figure 4 shows the conceptual diagram of the ECR-type passive stylus and sensing system. The ECR-type passive stylus consists of the conductive rubber and the conductive metal body including L_{TANK} and CPRESSURE. When the AFE IC sends the V_{EXT} to the touch sensor, the stylus absorbs the V_{EXT} through the $C_{STY,TX}$. It then converts the absorbed V_{EXT} to the resonance signal and transmits the resonance signal to the touch sensor as a V_{STY} with a frequency of an Equation 2.

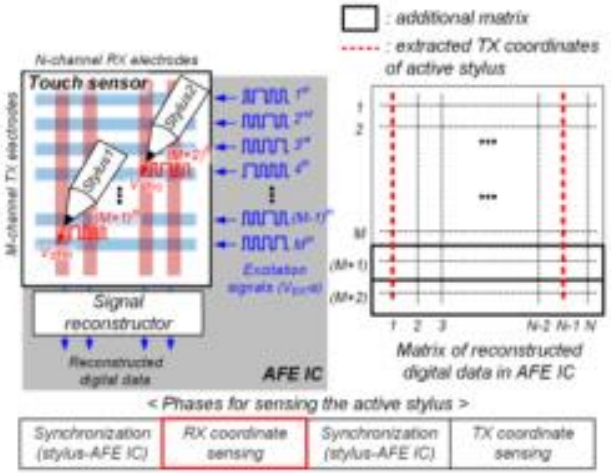
$$f_{STY} \models \frac{1}{2\pi\sqrt{L_{TANK} \times C_{PRESSURE}}} \quad (2)$$

The AFE IC senses the V_{STY} through the $C_{STY,RX}$. The pressure of the ECR-type passive stylus can be expressed using

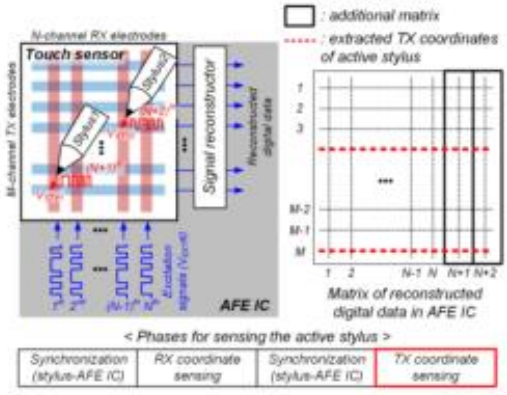
a different frequency of V_{STY} by changing the $C_{PRESSURE}$ as described in Equation 2. The ECR-type passive stylus does not need an additional sensor, thus it achieves a low power consumption and fabrication cost, and small thickness of the CTS. However, because the values of $C_{STY,TX}$ and $C_{STY,RX}$ are small due to the small tip, the ECR-type passive stylus cannot absorb the enough V_{EXT} through the touch sensor, and thus it has a low sensitivity. Moreover, the ECR-type passive stylus can express the pressure only.



(a)



(b)



(c)

Figure 5. Conceptual diagram of active stylus and sensing system: (a) synchronization phases, (b) RX coordinate sensing phase, and (c) TX coordinate sensing phase. coordinate sensing phase.

4. C-type Active-type Stylus

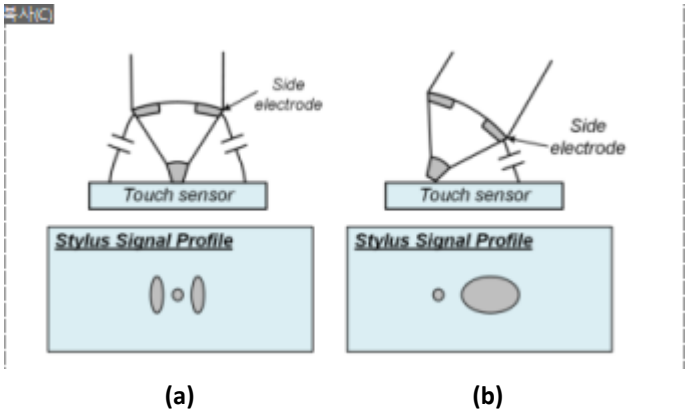


Figure 6. Principle of the tilt expression of the active stylus: (a) without and (b) with the tilt angle.

To express the pressure and hovering with high sensitivity, the active stylus was firstly adopted in the CTS with the parallel driving method (PDM) (10). As shown in Figure 5(a), to synchronize the timing between the active stylus and AFE IC, the active stylus absorbs the synchronization signals from the AFE IC before the RX and TX coordinate sensing phases. Figure 5(b) shows the RX coordinate sensing phase. The two active styli send the two V_{STY}s (V_{STY1} and V_{STY2}) to the touch sensor. At the same time, the AFE IC emits the V_{EXT}s to M-channel TX electrodes in parallel. When the AFE IC receives the V_{STY1}, V_{STY2}, and M- V_{EXT}s, it generates the N×(M+2) matrix digital data, and reconstructs this matrix to digital data through the signal reconstructor. Then, the AFE IC extracts the RX coordinates of the two active styli. Figure 5(c) shows the TX coordinate sensing phase. After the second synchronization phase, the sensing direction of AFE IC is changed from RX electrode to TX electrode. When the two styli and AFE IC send V_{STY1} and V_{STY2}, and N- V_{EXT}s to the touch sensor, respectively, the AFE IC sense these signals and reconstruct them as the (N+2)×M matrix digital data using the signal reconstructor. Finally, the AFE IC extracts the RX and TX coordinates of the two active styli.

Figure 6 shows the principle of the tilt expression of the active stylus. To express the tilt angle, the side electrodes are added at the side of stylus (11). Due to the side electrodes, the AFE can detects the capacitance variation between side electrodes and touch sensor. Without the tilt angle, three profiles of V_{STY} can be extracted in the CTS as shown in Fig. 6(a) because of two side electrodes and tip. With the tilt angle, the two profiles of V_{STY} are extracted in the CTS along with the direction of the tilt. According to the capacitance profiles and their dimensions, the CTS can extract the tilt angle of active stylus. Although the active stylus can express the pressure, tilt, and hover height with high sensitivity, the additional synchronization phases are needed for synchronizing between stylus and AFE IC.

To remove the synchronization phases, the CTS and active stylus adopt the multiple-frequency driving method (12-13). Figure 7 shows the conceptual diagrams of the CTS with the active stylus and operational principle. As shown in Figure 7(a), the MCU allocates the frequencies of f_1-f_M (frequency of V_{EXT}s) and f_{S1}-f_{S3}, f_P, and f_E (f_{S1}: coordinate, f_{S2}: pressure, f_{S3}: tilt angle, f_P: palm rejection, and f_E: eraser) in the low noise region for the high sensitivity, and sends them to the AFE IC and active stylus, respectively, without synchronization phases. When the active stylus senses the pressure and tilt angle, it changes the f_{S2} and f_{S3} to $f_{S2}+\Delta f_{S2}$ and $f_{S3}+\Delta f_{S3}$, respectively, and sends the V_{STY} having f_{S1}-f_{S3} to the touch sensor. To realize the palm rejection, the active stylus sends the V_{PALM} with f_P to the touch sensor through the side electrode and human body (13). In addition, to perform the erase operation, the active stylus sends a V_{ERASE} having f_E to the touch sensor via the conductive eraser (13). As shown in Figure 7(b), when the AFE IC senses the frequencies of Δf_{S2} and Δf_{S3}, the MCU can extract the pressure and tilt angle of the active stylus. In addition, when the AFE IC senses the frequencies of f_P and f_E, the MCU identifies the presence of palm and eraser, respectively (13). Therefore, the active stylus can express the pressure, tilt angle, and eraser without the synchronization phases (12-13). Although the active stylus can express the pressure, hovering height, and tilt angle with a high sensitivity, it has a high thickness, high power consumption, and high fabrication cost because of the additional circuit and battery in the active stylus.

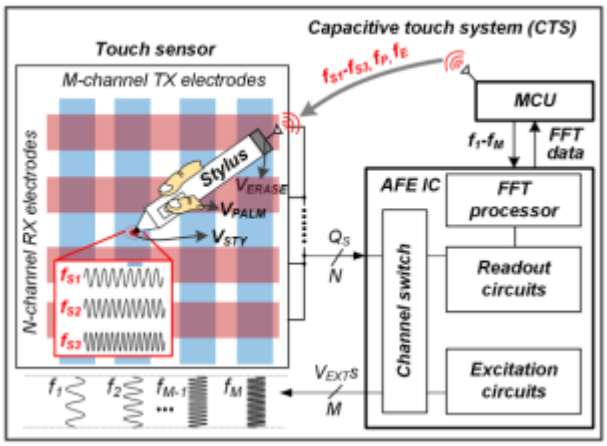


Figure 7. Conceptual diagram of (a) the CTS and active stylus using the MFDM, and (b) its operational principle.

5. Conclusions

This paper presents the survey of stylus technologies for the CTSs. The stylus technologies are classified into passive and active styli depending on the battery integration. To explain two types of styli, the architecture of CTS was firstly explained. After then, the operation principles of passive, which has the C-, EMR-, and ECR-types, and the C-type active stylus are described for the CTSs with the operational principles, advantages, and disadvantages. The passive stylus should be researched more to achieve high sensitivity with the thin and light, and low fabrication cost. The active stylus should be researched to have small thickness and weight with having a various expressions.

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14:30~	Session 4: Management Information (Room: L307) Chair: Min Ho Ryu (Dong-A Univ.)	
	4S-1 [005]	**The Impact of Generational Harmony on Retail Activation: Focused on Seoul** *GeonYul Shin[1)] , Min Ho Ryu[1)]* *1) Dept. of Management Information System, Dong-A University, 255 Gudeok-ro, Busan 49236, Korea*
	4S-2 [020]	**Passenger Demand Forecasting at Singapore's Changi Airport in Post Pandemic Era** *Lee Geun-Cheol[1)] , Heejung Lee[2)] and Hoon-Young Koo[3*)]* *1) College of Business Administration, Konkuk University, Seoul 05029, Korea* *2) School of Business, Chungnam National University, Daejeon 34134, Korea* *3) School of Interdisciplinary Industrial Studies, Hanyang University, Seoul 04763, Korea*
	4S-3 [060]	**GymViet: AI-Driven Fitness Assistance Platform** *Doan-Duc Pham[1)] , Van-Nhien Ho[1)] , Minh-Tuan Pham[1)] , Minh-Thi L. Pham[1)] , Quoc-Vi Dam[1)] , Duc-Man Nguyen[1)]* *1) International School of Duy Tan University, 550000, Da Nang, Vietnam.*
	4S-4 [061]	**Ve-Amor: AI enhance Dating Application** *Long-Phan Hoang[1)] , Bao-Gia Nguyen[1)] , Thanh-Mai Van[1)] , Khai-Nhat Nguyen[1)] , Trong-Thanh Nguyen[1)]* *1) International School, Duy Tan University, 550000, Da Nang, Vietnam.*
	4S-5 [062]	**DanaHub: A Smart Solution for Urban Traffic and Flood Management in Metropolitan Areas** *Phuoc-Tinh V. Le[1)] , Dinh-Hiep Tran[1)] , Viet-Minh Tran[1)] , Minh Phu-Nguyen[1)] , Duc-Man Nguyen[1)]* *1) International School, Duy Tan University, 550000, Da Nang, Vietnam.*
	4S-6 [025]	**Building the Future: Cloud Computing and IoT in Urban Development** *S. Sivaranjani[1)] and R. Anandhi[2)]* *1) Assistant Professor, PG Department of Information Technology and BCA, Dwaraka Doss Goverdhan Doss Vaishnav College, Chennai, India.* *2) Assistant Professor, PG and Research Department of Computer Applications (MCA), Dwaraka Doss Goverdhan Doss Vaishnav College, Chennai, India.*

The Impact of Generational Harmony on Retail Activation: Focused on Seoul

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Abstract: The current aging population is exacerbating conflicts over intergenerational resource allocation and welfare benefits (Ronald et al., 2011; Shuster, 2016). This conflict leads to gerontophobia, which may pose challenges to future policy implementation (Shin & Choi, 2020). In this situation, intergenerational harmony emerges as an essential element and plays an important role in building a harmonious society (VanderVen & Schneider-Munoz, 2012). With the growing purchasing power of older adults (Dorie et al., 2017), generational harmony is increasingly significant in economic and commercial contexts. This study aims to empirically analyze the impact of generational harmony on retail activation.

This study calculates the harmony rate based on the floating population by generation in the major commercial districts of Seoul. Afterwards, the impact of the harmony rate on the commercial activation index is analyzed through multiple linear regression analysis. In addition, the positive impact of the ratio of specific generations on commercial activation is examined. For the analysis, the estimated sales, number of stores, floating population by time zone and age were used from the 'Seoul City Commercial District Analysis Service' data operated by Seoul Open Data Plaza.

The expected effect of this study is to clarify the influence of intergenerational harmony on commercial activation in an aging society. It helps policy makers understand the positive influence of intergenerational harmony on commercial activation. In addition, it aims to provide useful data for policy making based on this.

Keywords : Generational Harmony, Retail Activation, Aging Population

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Biography

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Air Passenger Demand Forecasting at Singapore's Changi Airport in Post Pandemic Era

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Abstract: The COVID-19 pandemic caused unprecedented disruptions in air travel, creating challenges for accurately forecasting passenger demand. As air travel gradually recovers, reliable short-term forecasting is essential for operational efficiency at major hubs like Singapore's Changi Airport. This study focuses on developing a SARIMAX (Seasonal AutoRegressive Integrated Moving Average with eXogenous variables) model that incorporates external factors, such as international visitor numbers, to improve the accuracy of air passenger demand forecasts.

This study uses monthly air passenger data from 2010 to 2022 and the number of international visitors to Singapore as the exogenous variable. A SARIMAX model was selected to capture both seasonal patterns and the external impact of tourism on air travel demand. The model's performance was evaluated against other forecasting methods, including SARIMA, exponential smoothing (SES, DES, TES), and advanced machine learning models like LSTM and Prophet. The stationarity of the data was confirmed through differencing and the Augmented Dickey-Fuller (ADF) test. The SARIMAX model outperformed other models with a MAPE of 3.94%, significantly lower than SARIMA's 16.24%. The inclusion of international visitor data as an exogenous variable greatly improved accuracy compared to traditional methods. The results emphasize the importance of external factors in forecasting, particularly in unpredictable, post-pandemic travel scenarios.

The key finding is that incorporating exogenous variables like international visitor numbers enhances the forecasting accuracy of air passenger demand, as evidenced by the superior performance of the SARIMAX model. This model effectively addresses the volatility introduced by the pandemic, where traditional models fall short in capturing sudden shifts in demand. The results highlight the strong relationship between tourism and air travel, making external factors vital in forecasting models during volatile periods. This study demonstrates the effectiveness of the SARIMAX model for short-term air passenger forecasting at Changi Airport, outperforming other models due to the inclusion of external variables. The findings are valuable for airport management and policymakers aiming to optimize resource allocation and operational efficiency in a post-pandemic world. Future research could extend this approach to other airports and incorporate additional external factors, enhancing the predictive power of demand forecasting models.

Keywords : Air Passenger Demand Forecasting, SARIMAX, Time Series Analysis, Exogenous Variables, Post-Pandemic Air Travel, Singapore Changi Airport, Machine Learning

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Biography

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GymViet: AI-Driven Fitness Assistance Platform

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Abstract: In the digital age, the demand for personalized health and fitness solutions continues to grow, driven by individuals' desire for effective ways to maintain a healthy lifestyle. This paper presents "GymViet," an AI-driven fitness assistance platform designed to provide tailored workout and nutrition plans, leveraging advanced machine learning models and interactive chatbot technology. GymViet integrates Random Forest models for robust personalization, real-time AI chatbot support powered by Google's Gemini API, and scalable microservices architecture. By combining diverse data sources, including user demographics, exercise databases, and nutrition information, the platform ensures accurate and adaptive recommendations. This research highlights the development process, from data preprocessing and model training to frontend and backend system integration. Evaluation results demonstrate GymViet's potential to revolutionize personal fitness by delivering user-centric solutions that enhance motivation, engagement, and outcomes. The findings underline the transformative role of AI in promoting healthier lifestyles through innovative technology.

Keywords: AI-powered fitness assistance, Personalized workout plans, Nutrition planning, Machine learning in fitness, Random Forest models, Real-time AI chatbot, AI in health promotion, Smart fitness solutions

Ve-Amor: AI enhance Dating Application

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Abstract: In today's era of digital connections, ensuring authenticity and building trust in relationships has become a significant challenge. Ve-Amor is an AI-enhanced dating application designed to address these issues through advanced profile authentication features. By utilizing facial recognition technology, the platform ensures the credibility of user profiles. Real-time interaction capabilities, such as location-based services and customizable subscription packages, enhance user engagement and convenience.

The system prioritizes secure verification and privacy, fostering a reliable environment for users to form meaningful relationships. Tailored match recommendations based on user preferences and interests further improve the overall experience. By integrating cutting-edge AI with robust authentication processes, Ve-Amor establishes a trustworthy and interactive platform for individuals seeking genuine connections, from dating to long-term commitments.

Keywords: Facial recognition, Profile authentication, Real-time interaction, User privacy, Ve-Amor

DanaHub: A Smart Solution for Urban Traffic and Flood Management in Metropolitan Areas

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Abstract
Urban areas face increasing challenges with traffic congestion and environmental issues, particularly in rapidly developing cities like Da Nang, Vietnam. The DanaHub system is designed as an innovative solution to address these problems by integrating real-time data analysis, advanced algorithms, and user feedback to optimize urban mobility and safety. Leveraging technologies such as YOLO for traffic detection, Express.js and MongoDB for server infrastructure, and Flutter for cross-platform accessibility, DanaHub provides functionalities including real-time traffic monitoring, weather updates, route optimization, and incident reporting. The system also incorporates external data from CCTV, map services, and weather APIs to ensure accuracy and reliability. With a scalable architecture and user-centric design, DanaHub offers a practical approach to improving the quality of life in metropolitan areas, addressing urban challenges, and serving as a model for smart city solutions worldwide.

Keywords: Smart City Solutions, Traffic Management, Urban Flood Management, Real-Time Data Analysis. DanaHub

Building the Future: Cloud Computing and IoT in Urban Development

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Abstract: This paper examines the evolution of organized urban areas into dynamic, interconnected regions driven by the integration of advanced digital and physical systems and explores the transformative role of cloud-based insights derived from integrated systems in strategic decision-making, effectively converting indirect resources—such as revenues, physical assets, and infrastructure—into tangible, measurable benefits. These benefits encompass enhanced economic productivity, efficient resource management, and improved quality of life for residents. These systems harness the power of cloud computing and Internet of Things (IoT) technologies to convert traditional urban infrastructure into smarter, more efficient ecosystems. By collecting, processing, and analyzing real-time data, urban areas can optimize resources, enhance services, and address the multifaceted challenges of urban living. The study underscores the importance of IoT-enabled sensors and devices in gathering data from diverse sources, including individuals, public systems, and residential units. Furthermore, it highlights the role of community cloud resources provided by cloud service providers in fostering IoT environments, enabling seamless integration of IoT data into electronic systems through third-party applications.

Keywords: Internet of Things (IoT), Urban Conglomerates, Cloud Computing, Smart Cities, Information sharing.

I.INTRODUCTION

Obscure computing is the subsequent stage in the progression of internet base computing, and it allows in the sequential skill capability to be second offer as a repair. As an elegant strategy for moving exterior of the obscure communications setting, the Internet of Things container adds to competence, routine, and throughput [1]. Elegant city are housing regions that build methodical labors to perceive for themselves the fresh position of minutes and announcement technology, accomplish ecological sustainability, built-up structure influence, better physical condition, information maturity, and system ambitious progression [2].

II. LITERATURE REVIEW

Cloud computing is the subsequent stage in the enlargement of internet-based computing, allowing for the release of in sequence and message knowledge capital through a system. In cloud communications, the Internet of Things canister benefit from greater than before competence, presentation, and load. The appearance of blur computer has supported the way of growth and distribution and manufacturing electronic commerce packaging [3]. Therefore, Internet of Things plus blur are at the present extremely shut to prospect internet skills that are well-matched with Internet of Things organization [4]. The Internet of Things is above all troubled with challenges that arise in an active and communal atmosphere. Internet of Things is an extensive group that comprise of an assortment of adaptable and extraordinary campaigns with inadequate storage space, supremacy goods and concert capability [5]. These constraints create an obstruction and impedance to the expansion of Internet of possessions system, and consist of multifarious issues such as compatibility, competence, filled functionality, and ease of use [6]. One of the majority talented methods that might be joining with Internet of Things to conquer such limits is cloud computing. The blur provides shared capital (system, storage space, computer, and software) illustrious by ubiquity, near to the ground price, and artistic individuality. This document describes the on-hand communiqué, dispensation, and storage space claim on a cloud- based Internet of Things raised area for stylish city [7]. This raised area can use cloud possessions and armed forces to congregate, shift, evaluate, progression, and hoard statistics [8]. It could also utilize unclear

property and fortified forces to pull together, convey, rummage around, evaluate, and hoard data generated by multifarious scenarios. The dim base Internet of Things policy to expand applications [9]. From manufacturing systems to crisis deliveries, community transport, civic security, city lighting, and additional city application, the Internet of Things has completed its method into each profitable and community division plan [10]. City is flattering connected as the Internet of Things advances let them to get better communications fitting competence and the dependability and receptiveness of urgent situation armed forces [11]. In the pending years, researchers are thrilled to travel around novel ideas for neat city employ Internet of Things key [12]. Processor capability, all possible communications classification, selling process, and supplementary stable wealth can all be allied via make unclear compute [13]. The intensification of dim computer makes it easier to increase stretchy production model, such as allow involvement to use property when their commerce grow. different organization that gives customary web-based armed forces (e.g., mesh hosting), cloud computing allows for instant access to blur release with not a drawn-out provisioning development [14]. All provisioning and pulling out of belongings in make unclear computers can be repetitive for the foreseeable future [15]. API allows users to admit and make unclear, unarmed and consent for application which reserve minutes to speak in the cloud. Invoice and evaluate provider are worn in compensation system, given that the prop up compulsory to use the mark help and to make expenditure in go forward [16]. Check and assess the recital of cloud compute communications, in adding together to the included scheme of bodily compute and its technique, provides some transporter organization surroundings to check and assess presentation [17]. Internet of things will also locate additionally in repair completion and sensor gaining are in the blur so that armed forces and sensors are accessible in real-time. Internet of Things and blur addition can transport sensory and WSN to obscure [18]. This prevalent communication is one of the first innovation (broadly used for emission uncovering and emission maps through shaking in Japan). patrons that longing to keep Internet of Things correspondence in the obscure can disburse as they go with these municipals make unclear provider [19].

Authors	Reference	Year	Title-Explanation
Khan-et al.	[1]	2014.	Towards cloud-based tidy city, statistics safekeeping, and solitude organization
Khan-et al.	[2]	2012.	A cloud-based design for national military in stylish city
Suciu-et al.	[3]	2013.	Stylish city builds on flexible cloud compute and safe Internet of clothes
Roy-Sarddar	[4]	2016.	The position of blur of belongings in elegant city
Silva-et al.	[5]	2018.	Towards sustainable elegant city: An appraisal of trend, architectures, mechanism, and unlock challenge in smart city
Chai-et al.	[6]	2021.	Position of BIC (large information Internet of Things, and blur) for elegant city
Rubi-et al.	[7]	2021.	An Internet of Things -base stage for surroundings data distribution in elegant city
Kaur-et al.	[8]	2016.	Structure elegant cities application using Internet of belongings and cloud. Based architectures
Saleem-et al.	[9]	2020.	Structure elegant city application base on Internet of belongings technology: An appraisal
Dlodlo-et al.	[10]	2016.	Internet of belongings technology in elegant city
Hyman-et al.	[11]	2019.	Safe wheel for elegant city, application in clever transportation system and elegant building
Curry-et al.	[12]	2016.	Neat cities–enable armed forces and applications
Gonzalez-Zamar –et al.	[13]	2020.	Applications of Internet of Things which has an idea about smart cities in selling process
aravanan, K-et al.	[14]	2019.	Internet of equipment knowledge applications based tidy cities: do research oral exam
] Shamsir, S-et al.	[15]	2017.	Explores about architecture of networks related to Big Data Analytics for smart cities
Saha, H.N-et al.	[16]	2017.	Provides various solutions for smart cities with an idea of compensation system
Song, H, -et al.	[17]	2017.	Identified with various principles and applications for wide knowledge on smart cities.

Table 1. Summary of Related Survey

Table1 shows the cloud-based computing applications related journal articles from various years starting from 2012 to 2020. Description specified about the various applications involved in these journal articles and about the architecture, stages and various other manipulations.

III.INTERNET OF THINGS AND CLARIFY DIVERGENCE

The Internet of Things (IoT) refers to the network of physical devices ranging from everyday objects to sophisticated machines that are embedded with sensors, software, and other technologies to collect and exchange data over the internet. This concept enables these objects to communicate with each other, making them "smart" and capable of automating processes, enhancing efficiency, and providing real-time insights [20]. As Internet of Things request make large amount information and comprise manifold computational adjoins (e.g., real-time dispensation and analytics process), addition with blur computing communications be able to be cost economy. think of the next situation as an outstanding instance. In a little to medium-sized venture, that manufacture a control manage piece of equipment used in neat home and building, their ambition for growth

may be objectionably and luxuriously achieve by dispersion produce facts in the darken [21]. As tiny and medium-sized enterprises gain more all-embracing patrons and better visibility for their invention, they possibly will gather and use a rising quantity of facts. Also, cloud addition enables to protect and grip mammoth data sets gathered from a few sources [22]. The following Fig.1 describes the working of Internet of Things through devices of personal computer, laptop, mobile phone, tablet and smart watches in communication, services, tools and intelligence [23]. While transmitting the data from application layer to presentation layer, there are critical issues which are non-adaptive in nature. To enhance the transmission between the layers, a possible outcome of frame was designed with an IoT application with real time study [24].

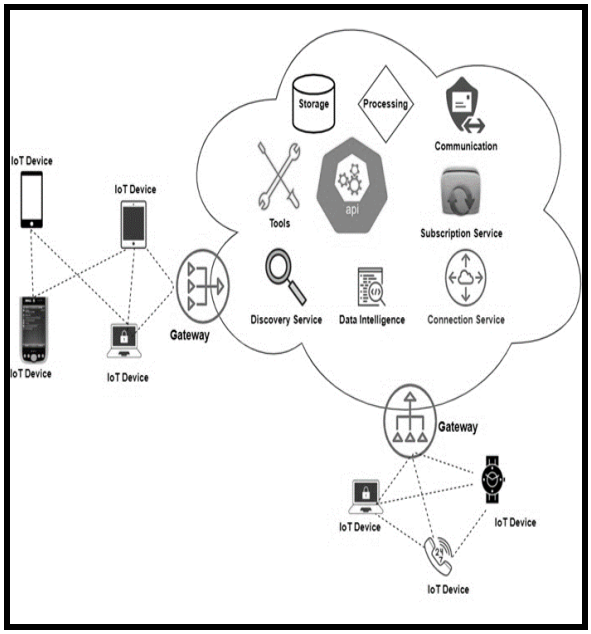

Fig 1. Connectivity among IoT Devices

This review paper has seven major challenges with the implementation of IESCs which has been addressed for future studies, including energy consumption and environmental issues, data analysis, issues of privacy and interoperability, scalability and adaptability with incorporation of IoT systems for the future development plans of smart cities. [25]. As technology evolves, smart cities will become increasingly adaptive, autonomous, and resilient. Emerging innovations like quantum computing, advanced robotics, and biosensors will further enhance urban living. The convergence of these technologies will lead to hyper-connected urban spaces where real-time data drives continuous improvement, creating cities that are not just smart, but also sustainable and inclusive for generations to come. In Fig.2, application involved in elegant cities in various places and things which are specified namely Aerospace, Hospital, Home, Micro-oven, Washing Machine, smart watches, smart cities, laptops, personal, computer, meetings, car navigations, truck navigation, fridge and smart navigation cities [26].

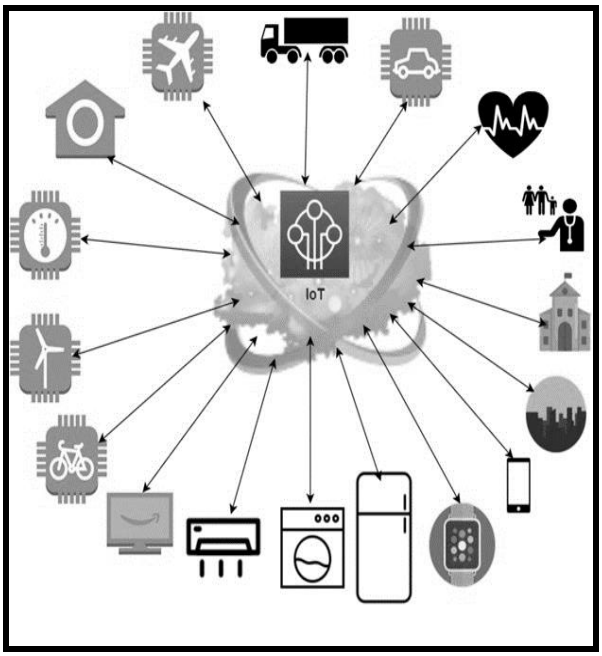

Fig 2. IoT Applications

IV.ELEGANT CAPITAL APPLICATIONS

Elegant Capital Applications refers to the strategic and thoughtful deployment of financial resources in ways that yield optimal value, often while minimizing risks and maximizing long-term returns. The idea of "elegance" in capital applications suggests a refined, sophisticated, and well-thought-out approach to investing, managing, and utilizing resources. Enables the vendor resources to overcome the difficulties which has been faced by the people. Substantial development should be made in terms of smart cities. For the interoperability of the people towards development, major facilities should be provided for that purpose. A greater number of surveys were taken on state of art solutions [27]. This study paper is all about deploying financial resources to achieve not only high returns but also positive impacts, sustainability, and long-term success. Whether in startups, impact investing, or corporate strategies, the core principle is to apply capital where it can generate value efficiently and responsibly.

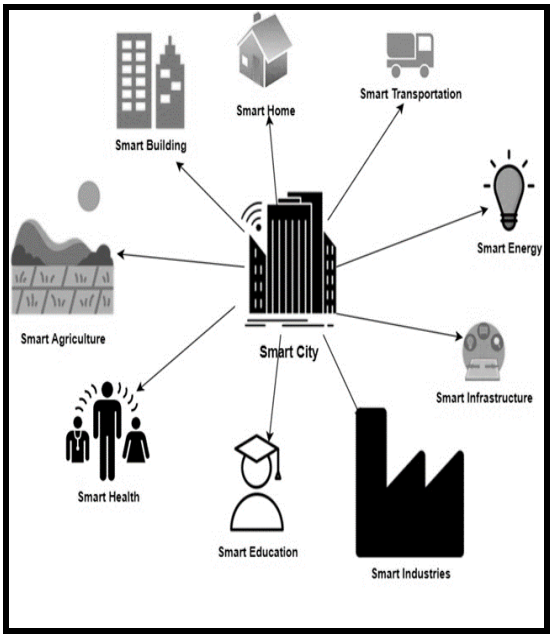

Fig 3. IoT Applications in a Smart City

In Fig.3, how the elegant cities would communicate, plan their infrastructure, minimize energy, concentrate on health of an individual, education in terms of transportation, building home and industries are shown.

4.1 Illumination System in Elegant City

Elegant cities would glow with single enhancement source and with the majority ever-present while application belongings to Internet got increased with more than a few administrations. At present it relies on the Internet of Things to put aside the terms of money and authority [28]. The scheme includes a rough Digit router group of students, which provides connectivity and verification for transfer frequent machine nodes to a tidy rod. The tidy lighting can be second-hand for a series of everyday jobs, as follows:

- Wheel for illumination
- Cameras for scrutiny
- Accepted perception
- Electronic billboards
- Thrilling automobile charging stations
- Way into wireless equipment

The implementation of the Internet of Things in modern residences renders the monitoring and maintenance of street lighting both efficient and cost-effective. By outfitting streetlights with sensors and integrating them into a centralized dimming management system, illumination can be optimized in real-time [29].

4.2 Haulage

Haulage refers to the integration of IoT technologies in the transportation and logistics industry to improve efficiency, visibility, and decision-making. Haulage communications is an additional fast increasing constituent of elegant metropolis application. transport business and elegant city place to gain significantly in charge investments, safety, route organization, and higher traveler skill [30]. The motor vehicle trail system and a wireless correlation are amid the motors and the intelligence transmit midpoint. This increase concern as regards the changeover from the obtainable analog system to IP-based voice-to-voice message,

- The group of contented fares and mobile phone ticketing shape wall firewall, IPSec VPN, community segregation, and confirmation,
- middle communiqué and traveler forbidden,
- Through online repair, we can path and uphold our groups and plans counting throng update and means of transportation monitor—these enhancement aid transport employees, couriers, and passenger in feeling safer in their message and growth.

The exercise of Internet of Things in stylish house makes road light continuation and supervision impractical and money-making the illumination can be in time by equipping streetlights with sensors and involving them to a dim managing tune-up. well-dressed light system inspect light, populace, and means of transportation group, then put together it with old and background information (e.g., sole function, community release scheme, occasion and year, etc.) and examine it to enhance the illumination schedule. When pedestrians irritated a street, the illumination approximately the journey might exist turned on, at what time a means of transportation is about to reach your destination at the means of transportation stop, the streetlights could be brightened, plus so on.

V.CONCLUSION

Cloud-based technologies enable accurate sequencing of access, analysis, and control, empowering experts, businesses, and nations to formulate smarter policies that enhance the quality of life for citizens. Community engagement within modern urban environments, facilitated by mobile devices, connected vehicles, and smart homes, plays a pivotal role in this transformation. By linking campaigns and data to a city's physical systems and infrastructure, operational costs can be reduced, and efficiency significantly improved. Through the Internet of Things (IoT), cities can optimize resource distribution, accelerate waste collection, reduce accidents, and mitigate pollution, paving the way for more sustainable and livable urban spaces. This paper explores and discusses the blur base Internet of Things request and their role in elegant city. It also enclosed Internet of belongings and cloud meeting, cloud-based Internet of Things answer, and cloud-based Internet of Things request for elegant city. More applications can be exposed, and their significance in near cities for potential explore.

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16:00 ~	Session 5: AI and Data Technologies (Room: L307) Chair: T. Velmurugan (Dwaraka Doss Goverdhan Doss Vaishnav College) Hyung Gyu Lee (Duksung Women's Univ.)	
	5S-1 [008]	**Sentiment Analysis of Musical Instruments Customer Reviews Using Machine Learning Techniques with Novel Hybrid Approach** *T.Velmurugan[1)] and M. Archana[2)]* *1) PG & Research Department of Computer Science, 2PG Department of IT & BCA* *2) Dwaraka Doss Goverdhan Doss Vaishnav College, Chennai, India*
	5S-2 [009]	**Enhancing Mobile Data Security and Privacy: A Spotlight on Cloud Solutions** *K. Ramya[1)] , R. Anandhi[2)]* *1) PG Department of Information Technology and BCA, Dwaraka Doss Goverdhan Doss Vaishnav College, Chennai, India.* *2) PG and Research Department of Computer Applications (MCA), Dwaraka Doss Goverdhan Doss Vaishnav College, Chennai, India*
	5S-3 [010]	**Facial Expression Analysis for Emotion Detection Using Convolutional Neural Networks** *Vikas Jangra[1*)] and Sumeet Gill [1)]* *1) Department of Mathematics, M.D. University Rohtak, India*
	5S-4 [013]	**Hyperspectral Imaging-Based Tumor Segmentation Using K-Means Clustering and Morphological Analysis** *Diviya K and Radhakrishnan Palanikumar* *PG& Research Department of Computer Science, DonBosco College(Co-Ed), Guezou Nagar, YelagiriHills, Tamilnadu-635854. (Affiliated to Thiruvalluvar University),India*
	5S-5 [[018]	**Conspiracy of Shadows: a Story-Driven Game Design and Immersive Player Engagement** *Dr.Girija M S.[1)] , Keerthi S.[1)] , Harshini S V.[1)] , Rithuna V.[1)]* *1) Dept. of Computer Science and Design, R.M.K. Engineering College, Chennai, India.*
	5S-6 [046]	**The Price of Convenience: Empirical Runtime Study on Type Casting Across Programming Paradigms** *Ashton Curry[1)] , Rane Murphy[1)] , Ka Lok Man[2)] , Yuxuan Zhao[3)] , and Kamran Siddique[1)]* *1) Dept. of Computer Science and Engineering, University of Alaska Anchorage* *2) Department of Computing, School of Advanced Technology, Xi'an Jiaotong-Liverpool University* *3) School of AI and Advanced Computing, Xi'an Jiaotong-Liverpool University*

Sentiment Analysis of Musical Instruments Customer Reviews Using Machine Learning Techniques with Novel Hybrid Approach

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Abstract: Nowadays the Customer reviews are becoming more and more important to businesses in the market because they have a significant impact on consumer behavior and marketing strategy. Purchase decisions can be greatly influenced by the insightful information provided by customer reviews regarding product performance and customer satisfaction. As a result, companies leverage various techniques to analyze and interpret these reviews. A branch of Natural Language Processing (NLP) called sentiment analysis is essential to comprehending the feelings conveyed in consumer reviews. By automating the classification of sentiments such as positive, negative, or neutral, businesses can gain a deeper understanding of customer opinions and enhance their marketing efforts. Customer reviews of a variety of musical products make up the musical instruments customer reviews dataset, which was obtained from Kaggle. Several conventional preprocessing techniques, such as lowercase conversion, stopword removal, stemming, punctuation and symbol removal, and lemmatization, were used to get the data ready for sentiment analysis. Following cleaning, the data was converted to numerical form and divided into two sets: 80% for training and 20% for testing. The sentiments were then divided into positive, negative, and neutral categories using a number of well-known machine learning algorithms, such as Naive Bayes, Support Vector Machine (SVM), Random Forest, and Decision Tree and NSRD (Naïve + Support Vector Machine + Random Forest + Decision Tree) proposed algorithm. Accuracy, precision, recall, and F1-score metrics were used to assess these models' performance, offering a thorough examination of their efficacy in sentiment classification.

Keywords: Natural Language Processing, Naïve Bayes Algorithm, Random Forest Algorithm, Support Vector Machine, Decision Tree Algorithm, NSRD (hybrid algorithm).

1. Introduction

A subfield of Artificial Intelligence (AI) called Natural Language Processing (NLP) is concerned with how computers and human language interact. It makes it possible for machines to meaningfully and practically comprehend, interpret, and produce human language. One important use of NLP is sentiment analysis, which identifies the emotional tone of a text and classifies it into sentiments like positive, negative, or neutral. Sentiment analysis has become a vital tool for companies looking to obtain a competitive edge due to the growing amount of user-generated content, particularly in the form of customer reviews. When it comes to musical instruments, knowing consumer sentiment can yield insightful information about the usability, quality, and general satisfaction of the product. Businesses can quickly evaluate enormous volumes of reviews and obtain actionable insights by automating the sentiment analysis process, which would otherwise require a significant investment of time and resources to extract manually.

Businesses can better understand customer opinions and make data-driven decisions by using sentiment analysis in the context of customer reviews.

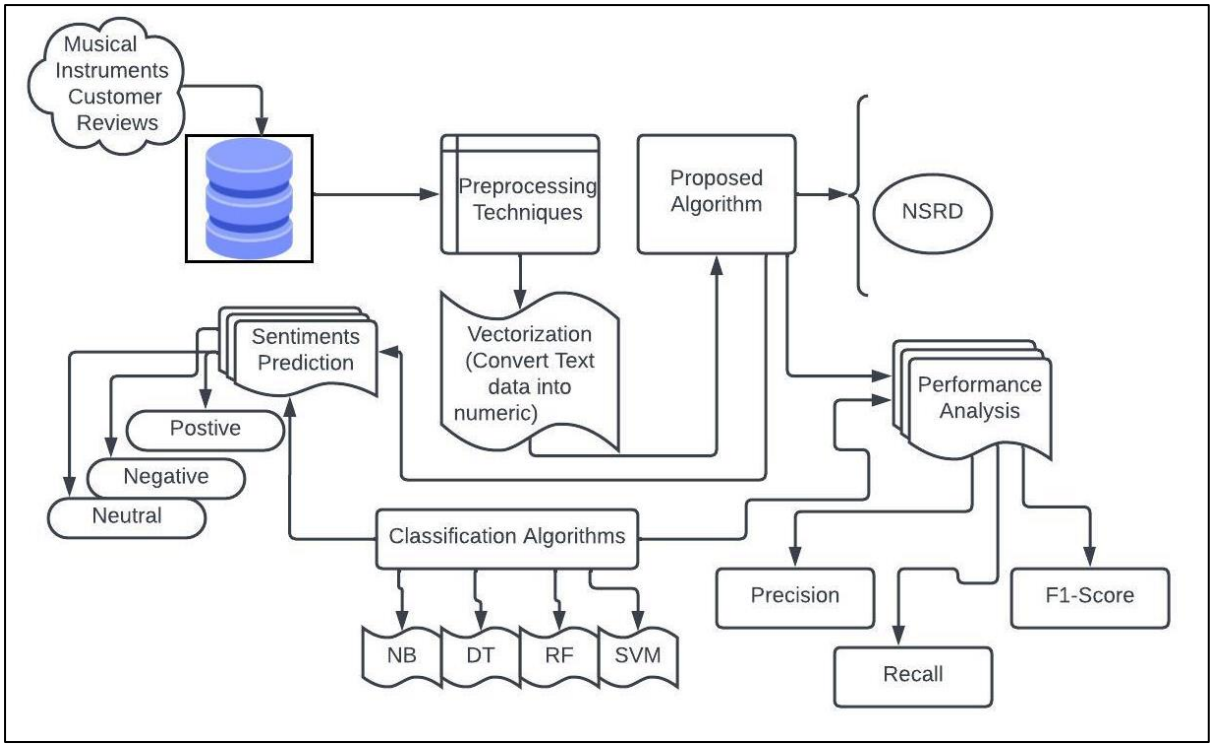

Figure 1: Architecture of Research work

A rich source of feedback, customer reviews offers important insights into customer satisfaction and product performance. However, to make sure the text is clear and appropriate for analysis, the raw text data from reviews needs to undergo a thorough preprocessing process that includes lowercase conversion, stopword removal, stemming, lemmatization, and punctuation and symbol removal. Figure 1 shows that the several machine learning algorithms, including Naive Bayes, Support Vector Machine (SVM), Random Forest, and Decision Tree and hybrid algorithm of NSRD are used to accurately classify sentiments after the data has been preprocessed. Through performance metrics like accuracy, precision, recall, and F1-score, these algorithms aid in assessing the efficacy of sentiment classification. This research investigates the application of these methods to evaluate musical instrument reviews from consumers, providing insightful information about the sentiment of both the product and the consumer.

The structure of this research is as follows: Chapter 2 provides a review of the related literature, Chapter 3 offers a detailed description of the dataset, Chapter 4 outlines the materials and methods employed, Chapter 5 presents the experimental results, and Chapter 6 concludes the study with key findings and insights.

2. Review of Literature

The literature review examines current research on sentiment analysis and natural language processing (NLP), emphasizing how these fields are used to analyze customer feedback in a variety of fields. Along with developments in hybrid approaches, it looks at the application of conventional machine learning algorithms such as Naive Bayes, SVM, Random Forest, and Decision Tree. There is also discussion of studies that concentrate on preprocessing methods like punctuation removal, lemmatization, and stemming. The basis for determining research gaps and developing innovative techniques for sentiment analysis in customer reviews is provided by this review.

A research paper carried out by Loukili et al. [1] states that the effectiveness of artificial intelligence techniques, such as Machine Learning and Natural Language Processing, in

evaluating various algorithms, including KNN, Random Forest, Logistic Regression, and CatBoost Classifier. Their findings indicate that Logistic Regression achieved the highest accuracy, scoring 90% (0.900). Another research work done by Mujawar et al. [2] explored sentiment analysis techniques applied to user reviews of wireless earphones from the Indonesian online retailer Tokopedia. Their research concluded that the Naïve Bayes classifier outperformed other methods across several evaluation metrics, making it the most effective approach overall.

A research work titled **as** "A Combined Approach of Sentiment Analysis Using Machine Learning Techniques" done by Gupta et al. [3], in which that the Random Forest classifier emerged as the most effective model with the accuracy exceeding 78% among those evaluated and proved to be the most practical for sentiment analysis in this work. Another research carried out by Elangovan Durai, and Varatharaj Subedha [4] utilized the Deep Belief Network (DBN) for sentiment classification in their proposed methodology. Their APGWO-DLSA technique was identified as the most efficient approach, achieving peak accuracy rates of 94.77% on the Cell Phones and Accessories (CPAA) dataset and 85.31% on the Amazon Products (AP) dataset following rigorous testing.

A research paper done by Tabany, Myasar, and Meriem Gueffal [5], in which that the SVM model initially achieved 70% accuracy, outperforming Naive Bayes, Logistic Regression and Random Forest classifiers. The performance of the SVM model was significantly improved through hyperparameter optimization, ultimately attaining 93% accuracy in sentiment analysis.

The literature review offers a thorough grasp of the body of research, stressing the advantages and disadvantages of the different sentiment analysis and natural language processing techniques. It finds gaps in the existing research while highlighting efficient approaches like preprocessing methods and machine learning algorithms.

3. Description of Dataset

The musical instruments customer reviews dataset, gathered from the Kaggle repository, contains 10,235 entries with 9 attributes shown in figure 2. For sentiment analysis, the reviewText column is preprocessed and used to extract insights into customer sentiments.

reviewerID: Unique identifier for the reviewer.
asin: Amazon Standard Identification Number, a unique identifier for the product.
reviewerName: Name of the reviewer.
helpful: The number of helpful votes received for the review.
reviewText: The text of the review written by the customer. This column is selected for sentiment analysis.
overall: The overall rating given by the reviewer, typically on a scale from 1 to 5.
summary: A brief summary or title of the review.
unixReviewTime: The timestamp of when the review was submitted, in Unix format.
reviewTime: The date and time when the review was submitted.

reviewerID	asin	reviewerName	helpful	reviewText	overall	summary	unixReviewTime	reviewTime
A2IBPI20UZIR0U	1384719342	cassandra tu "Yeah, well, that's just like, u...	[0, 0]	Not much to write about here, but it does exactly what it's supposed to. filters out the pop sounds. now my recordings are much more crisp. it is one of the lowest prices pop filters on amazon so might as well buy it, they honestly work the same despite their pricing,	5	good	1393545600	02 28, 2014
A14VAT5EAX3D9S	1384719342	Jake	[13, 14]	The product does exactly as it should and is quite affordable.I did not realized it was double screened until it arrived, so it was even better than I had expected.As an added bonus, one of the screens carries a small hint of the smell of an old grape candy I used to buy, so for reminiscent's sake, I cannot stop putting the pop filter next to my nose and smelling it after recording. :DIf you needed a pop filter, this will work just as well as the expensive ones, and it may even come with a pleasing aroma like mine did!Buy this product! :]	5	Jake	1363392000	03 16, 2013
A195EZSQDW3E21	1384719342	Rick Bennette "Rick Bennette"	[1, 1]	The primary job of this device is to block the breath that would otherwise produce a popping sound, while allowing your voice to pass through with no noticeable reduction of volume or high frequencies. The double cloth filter blocks the pops and lets the voice through with no coloration. The metal clamp mount attaches to the mike stand secure enough to keep it attached. The goose neck needs a little coaxing to stay where you put it.	5	It Does The Job Well	1377648000	08 28, 2013
A2C00NNG1ZQQG2	1384719342	RustyBill "Sunday Rocker"	[0, 0]	Nice windscreen protects my MXL mic and prevents pops. Only thing is that the gooseneck is only marginally able to hold the screen in position and requires careful positioning of the clamp to avoid sagging.	5	GOOD WINDSCREEN FOR THE MONEY	1392336000	02 14, 2014
A94QU4C90B1AX	1384719342	SEAN MASLANKA	[0, 0]	This pop filter is great. It looks and performs like a studio filter. If you're recording vocals this will eliminate the pops that gets recorded when you sing.	5	No more pops when I record my vocals.	1392940800	02 21, 2014

Figure 2: Sample dataset of Musical Instruments Reviews

4. Materials and Methods

The research materials and methodologies include and preprocessing methods numerical format such as vectorization. To categorize sentiments and forecast accuracy, machine learning algorithms such as Random Forest (RF), Decision Tree (DT), Support Vector Machine (SVM), and Naive Bayes (NB) are used. Furthermore, NSRD (Naive SVM Random Decision), a hybrid approach, is presented to improve performance by fusing the advantages of several algorithms to forecast polarity and accuracy.

4.1 Pre-processing Methods

The pre-processing of the musical instruments customer reviews dataset involves several key steps to clean and prepare the text for sentiment analysis shown in figure 3. First, the text is converted to lowercase to ensure uniformity, eliminating discrepancies between capitalized and lowercase words. Stop-word removal follows, eliminating common words like "and," "the," and "is," which do not add significant meaning to the analysis.

Stemming and lemmatization are applied to reduce words to their root forms, with stemming focusing on removing prefixes and suffixes, while lemmatization ensures words are reduced to their correct base form based on context[6][7]. Tokenization then splits the text into individual words or tokens, which helps in breaking down the data for further processing. Finally, the cleaned text is transformed into numerical data using count vectorization, where the frequency of each word is represented as a feature vector, making the dataset suitable for machine learning models.

4.1.1 Lowercase Conversion

At this point, the text in every review has been converted to lowercase. By helping to standardize the text and making sure that terms like "Excellent" and "excellent" are treated as the same term by the analysis, it reduces variability and improves consistency in text processing.

$$T_{lower} = F_{lower}\ (T_{original}) \qquad (1)$$

$T_{original}$: The set of original tokens (words) in the text.

F_{lower} : The lowercase conversion function that transforms each token to its lowercase equivalent.

T_{lower}: The resulting set of tokens with all characters in lowercase.

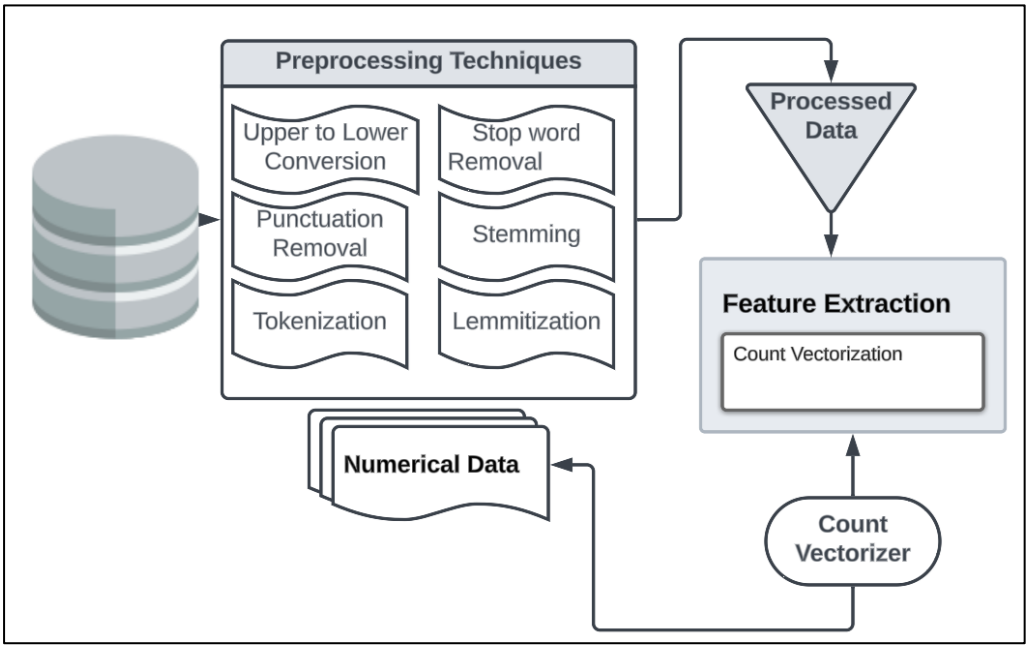

Figure 3: Workflow of Preprocessing Techniques

4.1.2 Stopwords Removal: Since stopwords don't substantially contribute to sentiment analysis, they are usually removed from texts[8]. These words include "and," "the," and "is." By reducing noise in the data, removing these stopwords enables the model to focus on more important terms.

$$T_{clean} = T_{original} - S \text{……..……..…….(2)}$$

$T_{original}$: The set of all tokens (words) in the original text.
T_{clean} : The set of predefined stopwords.

4.1.3 Tokenization: Tokenization produces distinct words, or tokens, within the text[9]. This step is crucial for breaking down the continuous text into discrete units that can be analyzed or utilized as input for machine learning models.

$$T = f(S) \text{ ……..……..…….(3)}$$

S : The input text; f is the function that splits the input text into individual components (words, phrases, or sentences) based on a delimiter such as spaces, punctuation, or custom rules. T - The output set or sequence of tokens (words or components).

4.1.4 Stemming: The base or root form of a stemmed word is derived [10][11]. For example, "working" might be stemmed to "work." This method can assist the model in more efficiently identifying and analyzing related terms by fusing different word forms into a single representation.

$$T_{Stemmed} = f_{stem}(T_{original}) \text{ ……..…….(4)}$$

($T_{original}$)- The set of original tokens (words) extracted from the text. f_{stem}- The stemming function that reduces each token to its root or base form by applying linguistic rules or truncation. $T_{Stemmed}$ -The resulting set of stemmed tokens.

4.1.5 Lemmatization: Lemmatization more accurately reduces words to their base or root form than stemming because it considers the word's context and meaning [12][13]. Words like "better" would be lemmatized to "good." This method provides more accurate text normalization, which improves text analysis and sentiment prediction.

$$T_{lemma} = f_{lemma}(T_{original}, C) \quad \text{.....(5)}$$

$T_{original}$: The set of original tokens (words) in the text.

f_{lemma}: The lemmatization function that maps each token to its base or dictionary form (lemma).

C: The context or part of speech (POS) of each token, which guides the lemmatization process.

T_{lemma}: The resulting set of tokens after applying lemmatization.

4.2 Machine Learning Algorithms

Several machine learning algorithms are used in this research to categorize and examine the sentiment contained in the dataset. Support Vector Machines (SVM) is excellent at handling high-dimensional data, while Naive Bayes (NB) is used because of its ease of use and probabilistic methodology[14][15]. Strong ensemble and tree-based classification capabilities are offered by Random Forest (RF) and Decision Tree (DT). Furthermore, NSRD (Naive Bayes, SVM, Random Forest, and Decision Tree) is a hybrid algorithm that combines the advantages of these techniques to improve accuracy and performance.

4.2.1 Naïve Bayes Algorithm

Based on Bayes' Theorem, the probabilistic machine learning algorithm Naive Bayes assumes feature independence [16][17]. It is easy to use, effective, and especially suitable for tasks involving text classification, such as sentiment analysis. Given the input data, the algorithm determines the probability of each class and chooses the one with the highest probability. It is a popular option for text mining and natural language processing because, in spite of its "naive" independence assumption, it works well in situations involving high-dimensional data.

4.2.2 Support Vector Machine

A popular supervised machine learning algorithm for classification and regression problems is the Support Vector Machine (SVM)[18]. It operates by locating the best hyperplane in a high-dimensional space that maximally divides data points of various classes. SVM is robust against overfitting, especially when there are fewer data points, and is especially good at handling high-dimensional data. For sentiment analysis and other text classification tasks, SVM is a flexible and dependable option because it can model intricate, non-linear relationships using kernel functions.

4.2.3 Decision Tree Algorithm

A supervised machine learning algorithm for classification and regression applications is called a decision tree. It creates a tree-like structure with decision nodes and leaf nodes by recursively dividing the dataset into subsets according to feature values [19]. While leaf nodes stand for class labels or results, each decision node represents a feature test. Decision trees are a popular option for tasks requiring explain ability because they are simple to comprehend, interpret, and visualize. They may, however, be susceptible to overfitting, which can be lessened by employing strategies like ensemble methods or pruning.

4.2.4 Random Forest

In order to increase accuracy and decrease overfitting, the Random Forest ensemble learning algorithm constructs several decision trees and aggregates their predictions [20]. To ensure diversity among the trees, it selects features at random at each split and trains each tree on a random subset of the data. A majority vote from all trees is used for classification, or the outputs are averaged for regression, to arrive at the final prediction. Random Forest is a dependable option for classification and regression tasks because it is resilient, manages big datasets well, and works well in situations with noisy or missing data.

4.2.5 NSRD (A hybrid method)

The strengths of four well-known machine learning algorithms—Naive Bayes (NB), Support Vector Machine (SVM), Random Forest (RF), and Decision Tree (DT)—are combined in NSRD, a hybrid algorithm. Through the integration of these disparate models, NSRD makes use of the interpretability of Decision Trees, the ensemble strength of Random Forest, the boundary optimization potential of SVM, and the probabilistic nature of Naive Bayes. This hybrid method increases prediction robustness, decreases overfitting, and improves classification accuracy. The combination makes NSRD an effective tool for tasks like text classification and sentiment analysis by enabling better handling of various data types and intricate patterns.

5. Results and Discussion

Metrics like accuracy, precision, recall, and F1-score are used in the results and discussion section to compare the performance of several machine learning algorithms, such as Naive Bayes, Support Vector Machine, Random Forest, Decision Tree, and the hybrid NSRD method. The hybrid NSRD algorithm performs better than the individual models, demonstrating increased robustness and classification accuracy. The advantages and disadvantages of each model are examined in relation to how well-suited they are for the given dataset and task. Furthermore, explanations of the performance variations are given, elucidating the ways in which feature selection, preprocessing, and algorithm selection affect the outcomes. The results show that a hybrid model that combines several algorithms performs better on text classification and sentiment analysis tasks.

Figure 4 shows the consistency of all text was standardized after lowercase conversion. Lemmatization and stemming efficiently handled morphological variances by reducing words to their root forms. Tokenization allowed for in-depth analysis by breaking the review text down into individual words. By removing non-informative words like "and," "the," and "is," stopword removal improved the clarity of the dataset. After completing these preprocessing steps, the dataset was cleaned and prepared for sentiment analysis and numerical representation. The frequency of particular words in a dataset pertaining to reviews of musical instruments is highlighted in the table 1 and figure 5. Due to its prominence in the dataset, the word "7049" appears the most, followed by "Guitar" with 6,353 occurrences. Additionally, words like "Sound" (5,027) and "One" (4,753) are used a lot, which indicates how important they are in the context of the reviews. "Great" (4,127) and "Good" (3,819) are examples of positive descriptors that indicate a trend toward positive sentiments. Furthermore, words like "String" (3,660) and "Work" (3,430) draw attention to technical details, whereas "Get" (3,412) may stand for actions or results. Figure 6 offers insightful information about recurring themes and emotions in the dataset.

```
                                                reviewText  \
Not much to write about here, but it does exac...
The product does exactly as it should and is q...
The primary job of this device is to block the...
Nice windscreen protects my MXL mic and preven...
This pop filter is great. It looks and perform...

                                          processed_lower  \
not much to write about here, but it does exac...
the product does exactly as it should and is q...
the primary job of this device is to block the...
nice windscreen protects my mxl mic and preven...
this pop filter is great. it looks and perform...

                                        processed_Stopword  \
much write here, exactly supposed to. filters ...
product exactly quite affordable.i realized do...
primary job device block breath would otherwis...
nice windscreen protects mxl mic prevents pops...
pop filter great. looks performs like studio f...

                                          processed_Lemma  \
much write here, exactli suppos to. filter pop...
product exactli quit affordable.i realiz doubl...
primari job devic block breath would otherwis ...
nice windscreen protect mxl mic prevent pops. ...
pop filter great. look perform like studio fil...

                                       processed_Stemming proc
much write here, exactli suppos to. filter pop...
product exactli quit affordable.i realiz doubl...
primari job devic block breath would otherwis ...
nice windscreen protect mxl mic prevent pops. ...
pop filter great. look perform like studio fil...
```

Figure 4: Results of pre-processing Techniques

Table 1: Frequency of words in Reviews

Word	Frequency
7049	Guitar
Guitar	6353
Sound	5027
One	4753
Like	4248
Great	4127
Good	3819
String	3660
Work	3430
Get	3412

```
Top 10 Most Frequent Words:
use       7049
guitar    6353
sound     5027
one       4753
like      4248
great     4127
good      3819
string    3660
work      3430
get       3412
dtype: int64
```

Figure 5: **Number of Times Words Repeated**

The progression of text lengths at different preprocessing stages for reviews is depicted in the table 2, demonstrating how various techniques alter or reduce the text content. Since this step

only standardizes text case, the "Lowercase Review" preserves the original text length while the "Review" column shows the original text length.

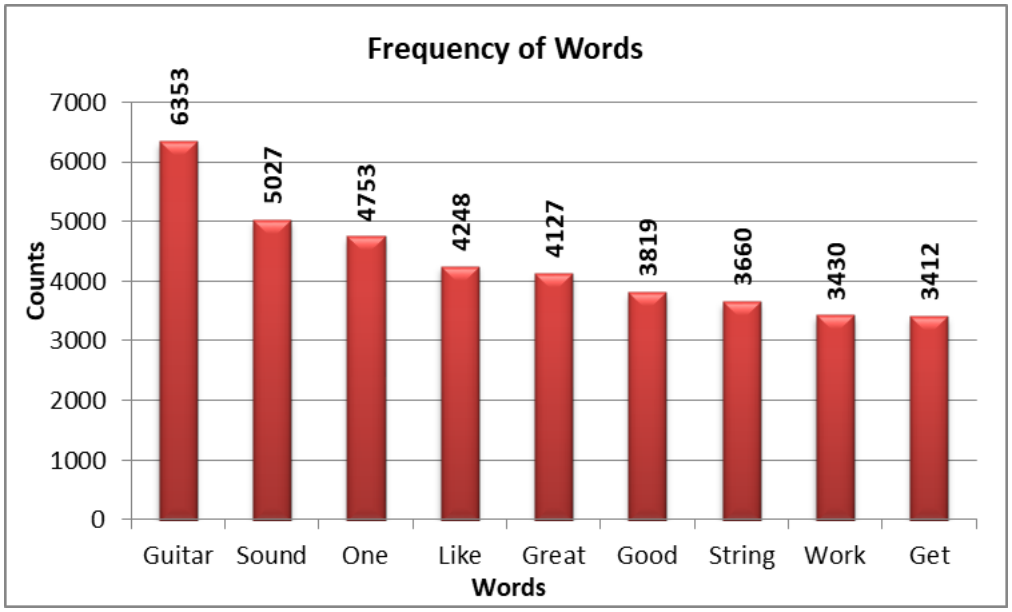

Figure 6: Frequency of Words in Customer Reviews

"Stopword Removal" drastically cuts down on text length by eliminating words like "the" and "is" that don't convey information. In certain instances, tokenization results in a slight increase in length, this reflects the division of text into discrete tokens or words. By combining words into their root forms or dictionary-based lemmas, stemming and lemmatization further condense the text. The table shows how preprocessing methodically keeps important content while streamlining and getting text ready for analysis.

Table 2: Length of Reviews in Preprocessing phase

Review	Lowercase review	Tokenized	Stopword Removal	Stemming	lemmatized
442	442	428	392	386	385
477	477	413	392	386	385
226	226	216	146	134	131
299	299	260	184	174	172
213	213	213	198	186	182
112	112	158	148	134	131
215	215	246	238	213	213
476	476	546	509	498	496
58	58	72	64	53	50
45	45	51	48	42	41
152	152	152	148	125	123
35	35	47	46	32	31
219	219	235	209	198	196

This figure 7 shows how different preprocessing methods affect textual data length at different stages. Since lowercase conversion does not change text length, the "Review" and "Lowercase Review" columns are the same length. "Tokenized" lengths, which represent the separation of text into discrete tokens (words), are either marginally longer or remain constant.

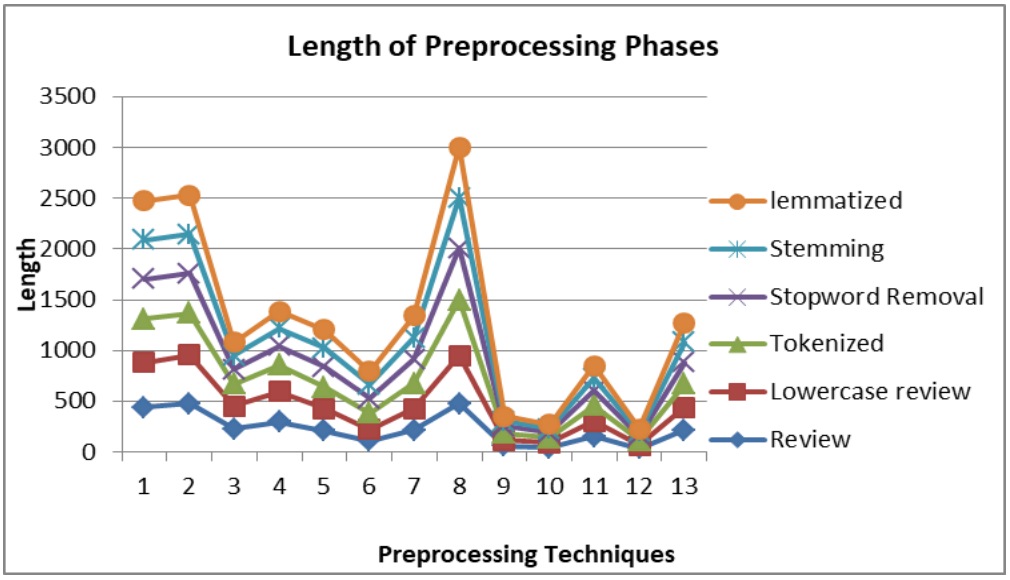

Figure 7: Length of Preprocessing Phases

The "Stopword Removal" step removes common, uninformative words, greatly reducing lengths. Additional reductions take place in the "Lemmatized" and "Stemming" columns, where words are transformed into dictionary-based lemmas or their root forms, respectively. These changes efficiently prepare the text for sentiment analysis or other text mining tasks by gradually condensing it while maintaining important content.

Table 3: Identification of Polarities

Sentiments	NB	RF	DT	SVM	NSRD
Positive	1846	1691	1676	1688	1745
Neutral	132	288	287	292	223
Negative	12	11	27	10	22

In order to classify reviews into Positive, Neutral, and Negative sentiments, the table 3 shows how well five different classification algorithms performed on a sentiment analysis task: Naive Bayes (NB), Random Forest (RF), Decision Tree (DT), Support Vector Machine (SVM), and the hybrid NSRD algorithm. Out of all the models, NB has the most positive predictions (1,846), followed by NSRD (1,745).

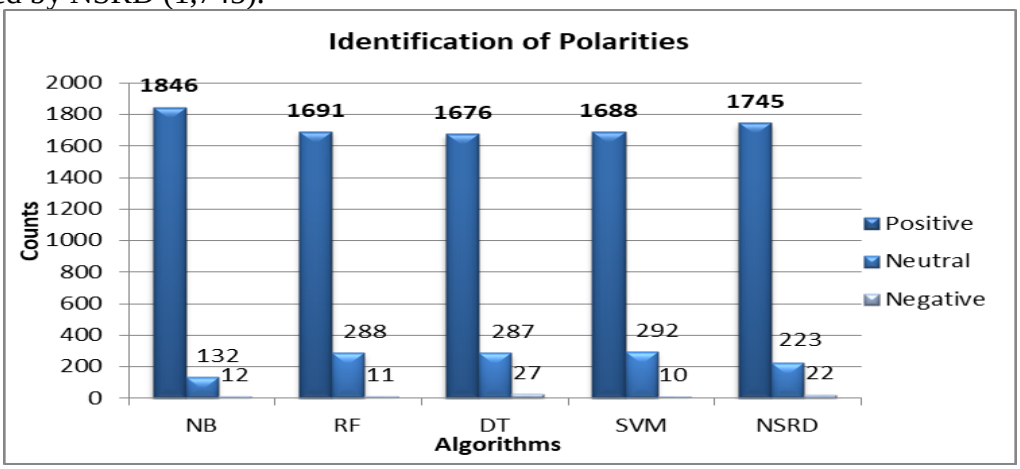

Figure 8: Identification of Polarities

SVM, RF, and DT have lower numbers in this category. SVM makes the most predictions for neutral sentiments (292), closely followed by RF (288) and DT (287), while NB makes the fewest predictions (132). With NB and SVM producing the fewest misclassifications (12 and 10, respectively), negative sentiment predictions are low across all models, suggesting their potential accuracy in handling extreme cases shown in figure 8. Overall, the performance of the NSRD algorithm is balanced across all sentiments categories.

Table 4: Performance Metrics of Algorithms

Decision Tree Algorithm			
Metrics	**Precision**	**Recall**	**F1-score**
Negative	0.80	0.74	0.84
Neutral	0.75	0.63	0.69
Positive	0.83	0.92	0.85
Naïve Bayes			
Negative	0.83	0.71	0.73
Neutral	0.72	0.62	0.63
Positive	0.92	0.92	0.94
Random Forest			
Negative	0.85	0.53	0.71
Neutral	0.73	0.75	0.72
Positive	0.84	0.91	0.93
Support Vector Machine			
Negative	0.82	0.74	0.81
Neutral	0.73	0.58	0.65
Positive	0.86	0.90	0.88
NSRD (Hybrid Algorithm)			
Negative	0.98	0.98	0.98
Neutral	0.95	0.90	0.92
Positive	0.96	0.96	0.96

The algorithms such as (Decision Tree, Naïve Bayes, Random Forest, Support Vector Machine, and the NSRD hybrid algorithm) are shown in the table 4 and figure 9 along with their precision, recall, and F1-score for predicting negative, neutral, and positive sentiments. With nearly flawless scores across all metrics and sentiment categories, the NSRD algorithm performs best overall. It excels with an F1-score of 0.98 for negative sentiments and 0.96 for positive sentiments. With an F1-score of 0.94, Naïve Bayes performs well as well, especially in the classification of positive sentiment, but it falls short in the predictions of neutral sentiment. Support vector machines and random forests produce competitive scores for positive sentiments but have trouble classifying negative and neutral sentiments consistently.

The accuracy percentages of five algorithms that were assessed for sentiment classification—Naïve Bayes, Support Vector Machine (SVM), Random Forest, Decision Tree, and the NSRD (Proposed Method)—are shown in the table 5. With a substantially higher accuracy of 96.1%, the NSRD approach outperforms the other algorithms, demonstrating its efficacy and resilience in managing the dataset.

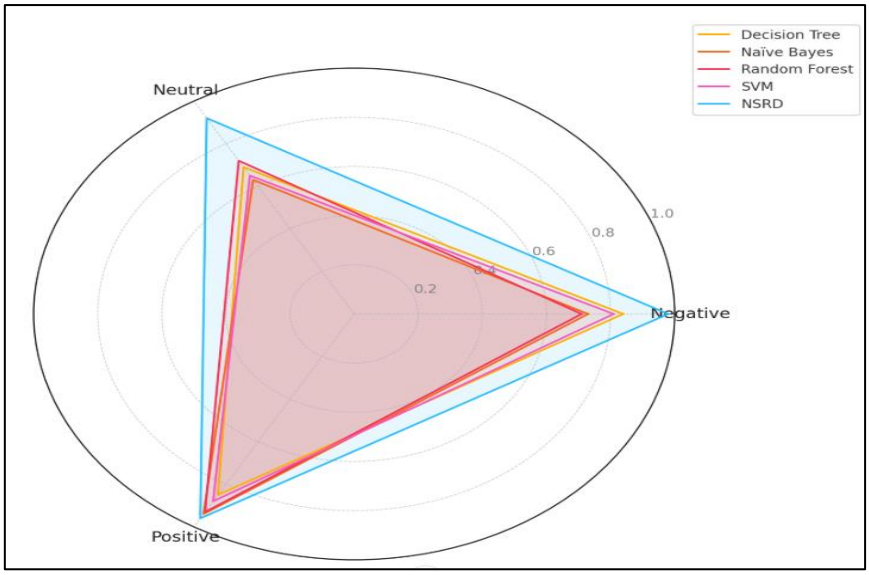

Figure 9: Metrics of Algorithms

Table 5: Accuracy of Algorithms

Algorithms	Accuracy %
Naïve Bayes	74.0
Support Vector Machine	83.3
Random Forest	84.1
Decision Tree	79.2
NSRD(Proposed method)	96.1

Additionally, Random Forest and SVM demonstrate their strong predictive abilities with accuracies of 84.1% and 83.3%, respectively. A moderate accuracy of 79.2% is attained by the Decision Tree algorithm, whereas Naïve Bayes performs relatively poorly with 74.0%, probably as a result of its feature independence assumptions. The outcomes highlight how the NSRD approach outperforms conventional models in terms of accurately classifying sentiment shown in figure 10.

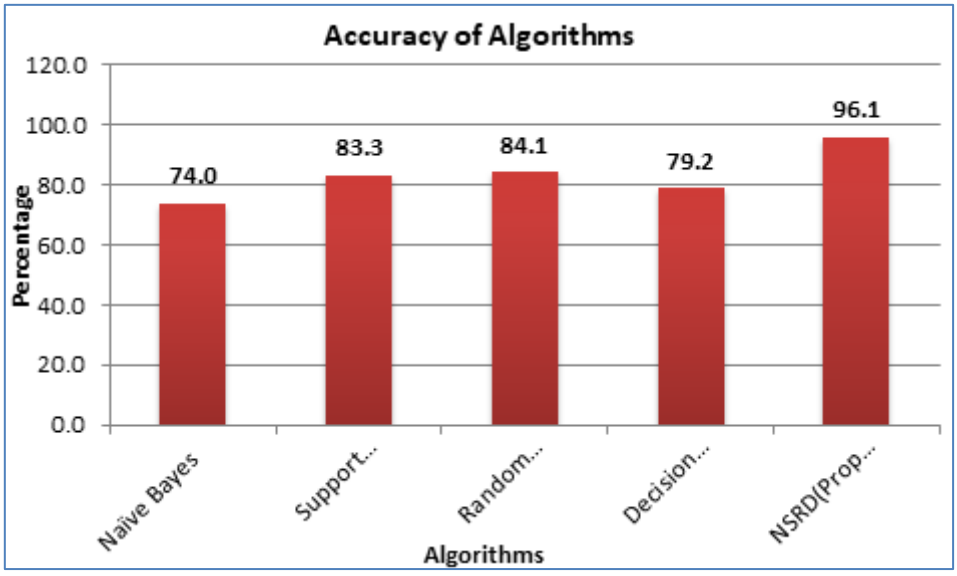

Figure 10: Accuracy of Algorithms

6. Conclusion

Social media data plays a crucial role in analyzing customer reviews and understanding their sentiments. In this study, reviews from the musical instruments dataset were used as input to evaluate the performance of selected machine learning algorithms, including Naïve Bayes, Support Vector Machine, Random Forest, Decision Tree, and a hybrid algorithm named NSRD. These algorithms were assessed based on metrics such as precision, recall, F1-score, and accuracy. Sentiment polarity analysis was conducted to classify customer reviews effectively. The experimental results demonstrated that the NSRD hybrid algorithm outperformed the existing algorithms in terms of both performance and efficiency. This superior accuracy and consistency highlight the hybrid algorithm's capability to provide enhanced sentiment analysis. It is concluded that the NSRD hybrid algorithm is a more effective tool for sentiment analysis compared to traditional algorithms. Future work will explore the application of additional machine learning algorithms on diverse datasets to further enhance sentiment classification and accuracy outcomes.

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Enhancing Mobile Data Security and Privacy: A Spotlight on Cloud Solutions

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Abstract
Mobile Cloud Computing (MCC) combines cloud computing with mobile devices to provide users with cloud resources on mobile platforms. However, this integration introduces significant data security challenges due to the inherent limitations and vulnerabilities of mobile devices, such as restricted computational power, limited storage, and exposure to untrusted networks. This paper identifies the major security concerns associated with MCC, including data confidentiality, integrity, and availability. Various threats, such as data breaches, unauthorized access, and mobile-specific vulnerabilities like insecure communication channels and application-level attacks, are analyzed. Additionally, existing security solutions and frameworks are reviewed, focusing on encryption, authentication, access control, and secure communication protocols. Finally, future research directions are proposed to address the evolving security challenges in mobile cloud computing, emphasizing the need for robust, adaptive, and user-friendly security mechanisms.

Keywords: Mobile Cloud Computing, Security, Untrusted Vulnerabilities, Data Breaches, MCC environments.

1. INTRODUCTION

MCC stands for Mobile Cloud Computing and has been defined as an integration of mobile computing combined with cloud computing over wireless networks for a common cause: enrichment with rich computational resources to the mobile users, the network operators, and Cloud Computing Providers. That simply means cloud computing and mobile computing over a wireless network. Mobile Cloud Computing is designed to support rich mobile applications run on various types of mobile devices. This technology primarily addresses data processing and storage issues. The other crucial factor influencing the use of Mobile Cloud Computing is organizations also have customers who are demanding to access the organizational websites and applications remotely from any place where they wander. An organization uses Mobile Cloud Computing applications in a very cost-effective way to meet customer requirements efficiently and effectively. They consume heavy workloads on cloud resources rather than their devices because it does not bind the user into a device or operating system. Such an innovative technology can make it possible to deliver and execute high-quality applications irrespective of the operating system, storage capability, and computing tasks the latter will have on mobile devices.

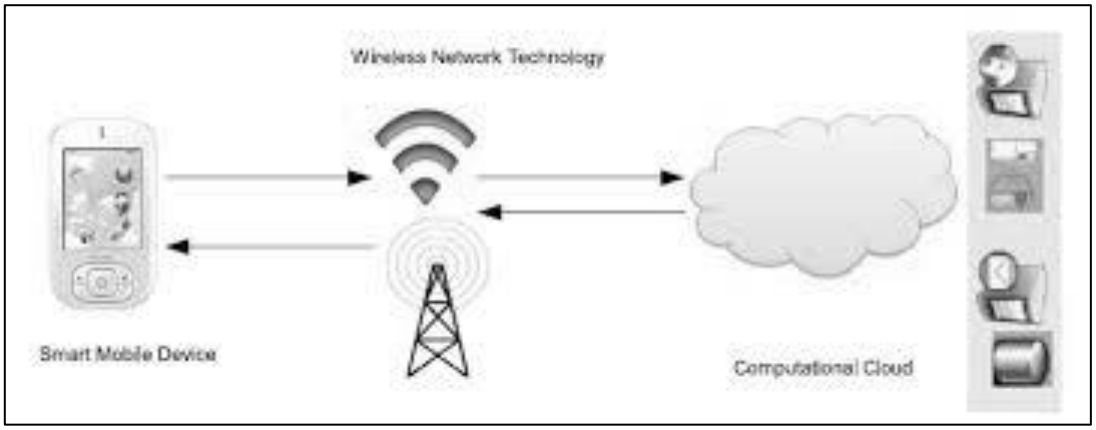

Fig. 1: Workflow of Mobile Cloud Computing

Fig. 1 illustrates the working of mobile cloud computing. The subsequent procedures are essential for the functioning of mobile cloud computing are:

1. **User Request**: A user opens a cloud-based application on their mobile device, such as a cloud gaming app.
2. **Network Transfer**: The device sends a request to the cloud server via the internet.
3. **Cloud Processing**: The cloud server processes the gaming logic, graphics rendering, and other computational tasks.
4. **Data Return**: The processed game data, such as rendered frames, is sent back to the mobile device.
5. **User Interaction**: The user sees the game frames on their screen and interacts with the game, sending further inputs back to the cloud server.

This process ensures that mobile users can access high-performance applications and services without being constrained by the limitations of their mobile devices [3].

2. ARCHITECTURE OF MOBILE CLOUD COMPUTING

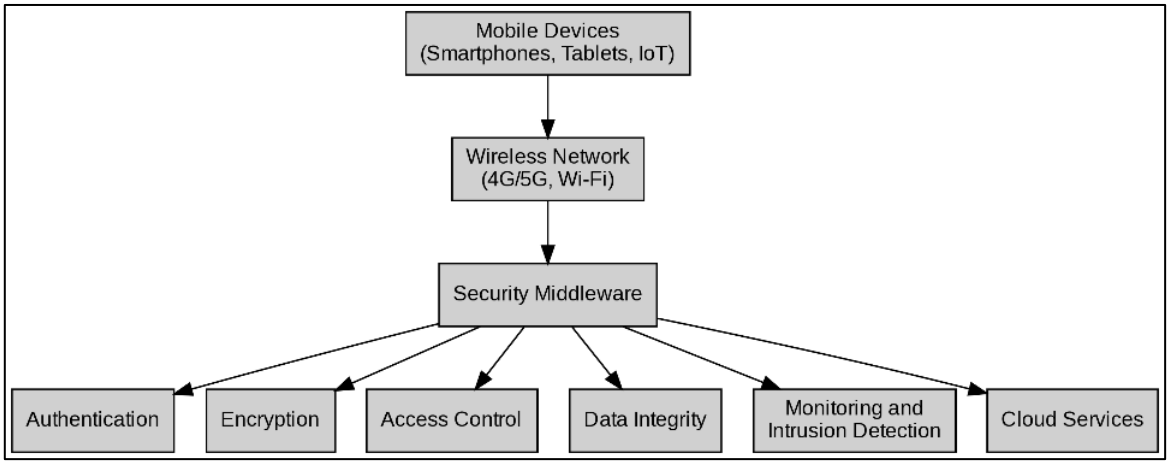

Fig. 2: Architecture of Mobile Cloud Computing

Fig. 2 brings out the basic architecture of Mobile Cloud Computing technology, showing the relationship between mobile devices, wireless networks, and cloud services.

1. **Mobile Devices:**
    - The top layer is occupied by the Mobile Devices like Smartphones, Tablets, Laptops.
    - They represent the end-user devices that interact with the mobile cloud computing environment.

- Since mobile devices have limited computational power, storage, and battery life, they benefit from cloud computing resources.

2. **Wireless Network:**
   - The next layer is the Wireless Network (4G/5G, Wi-Fi).
   - This represents the communication infrastructure that connects mobile devices to the cloud.
   - It includes cellular networks (4G/5G) and Wi-Fi networks, which provide the necessary connectivity for data transfer among the devices.
3. **Mobile Cloud:**
   - The "Mobile Cloud" is the central component of the architecture.
   - It acts as an intermediary between the mobile devices and the cloud services.
   - The mobile cloud manages the distribution of tasks and resources between the devices and the cloud infrastructure.
4. **Cloud Services:**
   - Within the cloud, we have three types of services:

a. Computation Offloading:
- This service allows mobile devices to offload computationally intensive tasks to the cloud.
- It helps to conserve device resources (battery life and processing power) by performing complex calculations in the cloud.

b. Storage Services:
- Cloud storage provides virtually unlimited storage capacity for the mobile users.
- It allows users to store and access their data from any point, overcoming the storage limitations of mobile devices.

c. Application Services:
- These are cloud-based applications or services that mobile devices can access.
- They can include a wide range of services like data analytics, machine learning, or specialized software that would be too resource-intensive to run on a mobile device [4].

The arrows in the above figure Fig. 2 represent the flow of data and requests between the different components:
- Mobile devices connect to the cloud through the wireless network.
- The mobile cloud then directs these requests to the appropriate cloud services (computation, storage, or application).

This architecture allows mobile devices to leverage the power of cloud computing, enabling them to perform tasks and run applications that would otherwise be beyond their capabilities [5]. It provides benefits such as:
- Enhanced processing power for mobile applications
- Extended battery life by offloading intensive tasks
- Increased storage capacity
- Access to advanced services and applications
- Improved scalability and flexibility for mobile computing

Therefore, Mobile Cloud Computing essentially brings the vast resources of cloud computing to resource-constrained mobile devices, significantly expanding their capabilities and improving user experience.

3. DETECTION AND PREVENTION FOR WSN

To design an efficient attack detection and prevention approach for a secure Wireless Sensor Network (WSN) in a mobile cloud environment, we need to consider multiple layers of security leveraging both WSN-specific and cloud-specific techniques [6].

Such a strategy for effective attack detection and prevention in a secure Wireless Sensor Network under this mobile cloud setting should embrace several security layers with the use of WSN-specific and cloud-specific techniques. These holistic approaches include security measures at network layers, such as encryption and secure routing protocols, in combination with intrusion detection systems using either anomaly-based or signature-based detection methods. Aggregated data and analysed data are intended to complement cloud-based security solutions and centralized security management in maximizing the possibilities of detection. The hybrid attack detection system is supposed to unify distributed detection at sensor nodes and centralized analysis in the cloud with cooperative filtering techniques. Real-time monitoring and automated response systems assure a fast reaction to potential threats. Regular security audits, patch management, integrating machine learning, and artificial intelligence for behavioural analysis and threat intelligence further strengthen the security framework. This multi-layered approach ensures attacks are well detected and prevented from securing the WSN mobile cloud environment [7].

The proposed approach may combine multiple layers of security measures, from secure communication and routing protocols at the sensor node level to sophisticated machine learning and AI-driven analysis in the cloud. By leveraging the strengths of both WSN and cloud computing, this architecture aims to provide robust and efficient attack detection and prevention for a secure WSN mobile cloud environment [8].

4. ROBUST CLOUD DATA SECURITY

Protecting cloud data in today's IT infrastructure is expected to be done through the implementation of a series of measures that will ensure the confidentiality, integrity, and availability of cloud-resident data. Such measures include encryption, access control, and authentication processes that effectively reduce data breaches and unauthorized access [9]. The data are secured by encryption, both in motion and at rest, and access controls provide that sensitive data are accessed only by pertinent users. Regular security audits, patch management, and compliance with industry standards help in further strengthening data security in the cloud. Data security must be maintained at the topmost level because it will shield organizations from possible risks, protect customer trust, and help in maintaining compliance with regulations [10]. Ensuring location data stream privacy is very sensitive in mobile cloud computing because the information carried in the location is sensitive. This can be done using general privacy-preserving techniques, such as data anonymization, encryption, and differential privacy. Data anonymization removes personally identifiable information from location data, making it hard to trace back to an individual. Encryption ensures that the location data is transmitted and stored in a secure manner, preventing unauthorized access. Differential privacy is simply adding noise to the data in such a way that individual location points are not determined. Together, these techniques maintain the privacy of users' location information while their valuable data analysis and cloud-based services are still preserved [11].

5. STRATEGIC SURVEY ON SECURITY AND PRIVACY METHODS

A strategic survey on the methods for security and privacy in mobile cloud computing considers the evaluation of diverse techniques and practices structured to secure data and user privacy. Security measures provided herein are encryption, authentication, access control, and intrusion detection systems to protect information and prevent unauthorized data access and breach. Privacy measures describe data anonymization, differential privacy, secure multi-party computation, and some other measures that could be undertaken to ensure personal data confidentiality [12]. The survey also discussed the integration of methods into a mobile cloud

computing environment, presented their efficiency, and underlined potential issues. It also discusses other important trends and technologies like blockchain and AI that can provide effective solutions for establishing security and privacy. From this perspective, the paper examines and offers an insight on how more robust and comprehensive security and privacy strategies for mobile cloud computing are developed through understanding the weak points and strengths of the current approach [13].

Additionally, the survey explores the role of Secure Multi-Party Computation (SMPC) in enabling collaborative data processing without compromising individual privacy. It evaluates the application of homomorphic encryption, which allows computations on encrypted data, ensuring data confidentiality even during processing. The survey also examines privacy-preserving data mining techniques that extract useful information from large datasets while protecting sensitive information.

Hence, the strategic survey provides a comprehensive overview of the current state of security and privacy methods in mobile cloud computing. By identifying gaps and opportunities for improvement, the survey aims to guide future research and development efforts towards creating more resilient and effective security and privacy solutions in this rapidly evolving field [14].

6. LITERACY REVIEW:

For mobile edge storage effectively verify data integrity without violating users' data privacy and query pattern privacy, reduce communication costs. [16]

This paper introduces a novel framework called LBS@E, establishing decentralized location-based services in the 5G MEC environment without requiring any location data from users. In LBS@E, mobile users access local information from nearby edge servers hosting the LBSs. LBS@E in the 5G mobile edge computing environment protects mobile users' location privacy because it allows retrieval of local information without sending users' locations to remote cloud servers. [17]

An algorithm to enhance the security of the mobile cloud which will ensure data integrity and confidentiality. This mechanism uses AES and RSA to provide better security. We also discuss the security threats in MCC environments and propose solutions for these.[18]

Attacks against Software Defined Mobile Clouds require further research and appropriate precautions to address vulnerabilities.[19]

AES, Blowfish, and DES are identified as the most secure and efficient algorithms for protecting cloud information from hackers, whereas RSA and IDEA are less secure and consume more memory.[20]

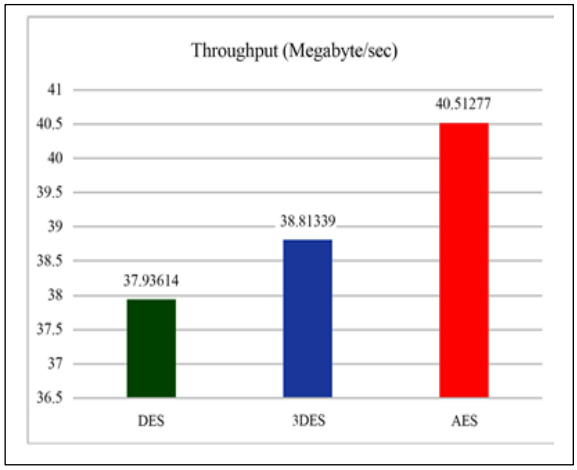

Fig.3. Encryption Algorithm comparison

Fig. 3. provides a comparison of the throughput (in Megabytes per second) for three encryption algorithms: DES, 3DES, and AES, commonly used in data security. Among these, AES achieves the highest throughput at 40.51277 MB/sec, indicating its superior efficiency in processing data compared to the others. The 3DES algorithm follows with a throughput of 38.81339 MB/sec, while DES demonstrates the lowest throughput at 37.93614 MB/sec. This analysis reveals that while AES offers the best performance in terms of data processing speed, DES and 3DES still play significant roles, albeit with slightly reduced efficiency. Such insights are critical when choosing an encryption algorithm for applications requiring a balance between performance and security.

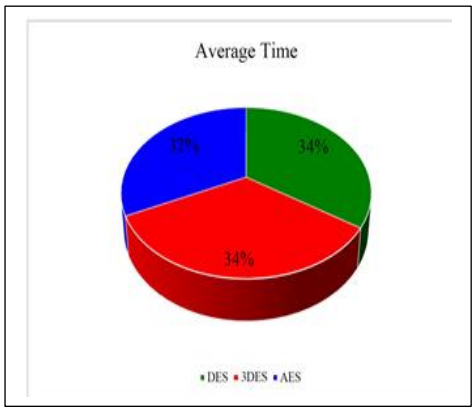

Fig.4. Average time of Encryption Algorithm

Fig.4. the average time distribution among three encryption algorithms: DES, 3DES, and AES, commonly used in data security. Each algorithm's share is represented as a percentage of the total time. DES and AES each account for 34% of the total time, showcasing similar time performance. Meanwhile, 3DES represents 32%, indicating slightly lower average time usage compared to the other two. This distribution highlights the comparable efficiency of these algorithms in terms of time, with only minor variations, allowing flexibility in choosing the appropriate algorithm based on specific time-critical requirements.

7. CONCLUSION

In conclusion, the comparative analysis of DES, 3DES, and AES based on throughput and average time provides valuable insights into their performance and efficiency. AES consistently demonstrates superior throughput, making it the most efficient algorithm for high-speed data processing. While DES and 3DES exhibit slightly lower throughput, they still offer competitive performance for applications with less stringent speed requirements. The average time distribution reveals that DES and AES are closely matched, with 3DES showing a marginally lower time usage. These results underscore AES as the optimal choice for scenarios requiring a balance of speed and security, whereas DES and 3DES remain viable options depending on specific application needs.

Data security and privacy concerns in mobile cloud solutions must be prioritized as reliance on mobile devices and cloud services grows rapidly. Effective security measures, including encryption, authentication, access control, and intrusion detection systems, are essential to safeguard data from unauthorized access and breaches. Privacy-preserving techniques like data anonymization, differential privacy, and secure multi-party computation help protect sensitive information, ensuring user confidentiality and trust. These methods should be integrated into mobile cloud environments and continuously assessed and improved to address emerging threats and challenges. Additionally, emerging technologies like blockchain and Artificial Intelligence offer promising solutions for

enhancing security and privacy, providing robust defenses against increasingly complex cyber-attacks. By recognizing and addressing the strengths and limitations of current approaches, comprehensive strategies can be developed to ensure the secure and private use of mobile cloud solutions, fostering greater confidence and adoption of these technologies.

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Facial Expression Analysis for Emotion Detection Using Convolutional Neural Networks

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Abstract

Emotion is a way humans express their feelings, typically through facial expressions, body language, and tone of voice. Among these, facial expressions are the most powerful, natural, and universal signals for conveying emotional states. However, recognizing emotions based on facial expressions can be challenging due to the similarities between certain expressions. For example, fear and surprise often share overlapping patterns, making it difficult to distinguish them with the naked eye. This study focuses on developing a mobile-based application for real-time emotion recognition using facial expressions. It employs a Deep Learning approach, specifically a Convolutional Neural Network (CNN), with the MobileNet algorithm utilized to train the recognition model. The application is designed to identify four types of emotions: happy, sad, surprised, and disgusted. The results demonstrate a high level of accuracy, achieving state-of-the-art performance. Future improvements could involve expanding the range of facial expression categories or exploring alternative deep learning approaches to enhance the model's capabilities.

Keypoints: Emotion Recognition, Facial Expressions, Convolutional Neural Networks (CNN), MobileNet Algorithm, Real-Time Application

1. Introduction

Facial expressions serve as a powerful medium to convey human emotions, offering valuable insights into an individual's feelings. The ability to express emotions is an innate characteristic of humans, and people often use emotions as a direct means of communication. Recognizing human emotions is a critical aspect of human-computer interaction, enabling more intuitive and responsive systems. However, emotions are highly influenced by an individual's physical condition and mental state, adding complexity to their interpretation. While facial expressions are a primary method of expressing emotions, the similarity in patterns across different emotions, such as fear and surprise, poses a significant challenge in accurately identifying them. Deep learning techniques, particularly Convolutional Neural Networks (CNNs), have demonstrated exceptional performance in emotion recognition tasks, offering high accuracy and fast processing speeds. CNNs have been extensively utilized in automatic emotion recognition, achieving impressive accuracy rates exceeding 90%. Recognizing the immense potential of CNNs, this study proposes a mobile-based emotion recognition system leveraging CNN technology for real-time performance. In comparison, K-Nearest Neighbors (KNN) has also been widely applied in emotion recognition, achieving accuracy levels above 85%. However, despite its effectiveness, KNN has notable limitations, including high memory requirements and slower performance, which make it less suitable for real-time applications.

2. Methodology

This study starts with inputting the real-time images, followed by the implementation of Convolutional Neural Network (CNN) for recognizing the emotion. Succeeding, the recognized emotion will be displayed.

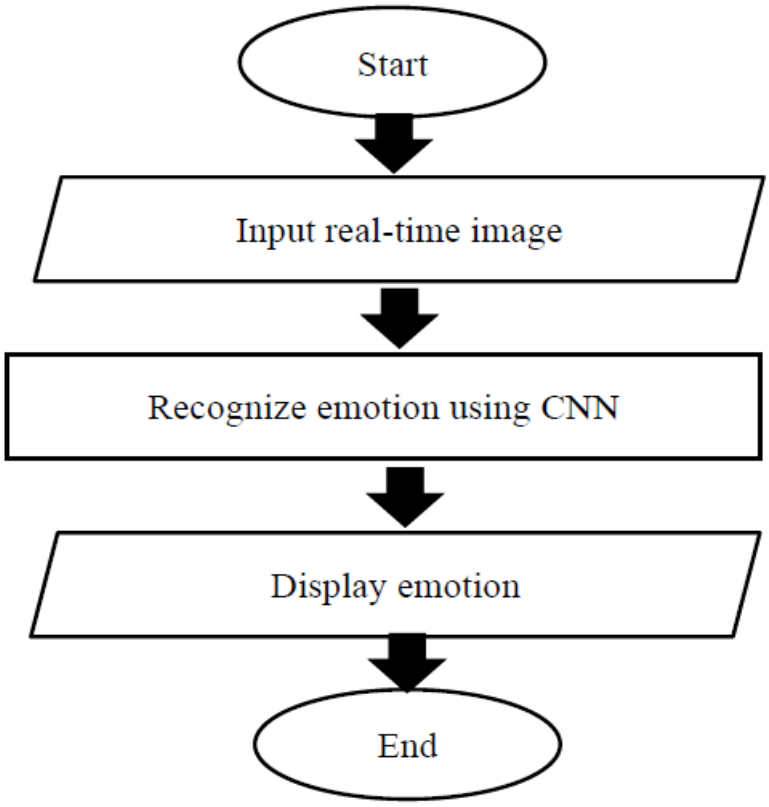

Fig. 1 Proposed flowchart of this study

2.1 Facial Expression Real-Time Images

This study covers four types of facial expression which are happy, sad, surprise and disgusting. **Figure shows example of these four types of facial expression.**

Fig. 2: Facial expression

2.2 Recognize Emotion Using Convolutional Neural Network (CNN)

Convolutional Neural Networks (CNNs) are a deep learning-based technology renowned for their ability to achieve high precision in recognition tasks, as highlighted by Liam Schonevel (2021). CNNs consist of multiple layers, each designed to perform specific transformation functions essential for feature extraction and classification.

The convolutional layer is the first layer in a CNN, responsible for extracting features from input images. It retains the relationships between pixels by learning image features through small regions of input data. By applying various filters, the convolutional layer can perform operations such as edge detection, blurring, and sharpening, which are critical for understanding image patterns.

To enhance the model's learning capabilities, the Rectified Linear Unit (ReLU) activation function is employed. ReLU introduces non-linearity into the network, enabling it to model complex relationships within the data. Additionally, it ensures that the ConvNet focuses on non-negative linear values, aligning with the characteristics of real-world data. This combination of layers and transformations makes CNNs highly effective for emotion recognition tasks.

The pooling layer plays a crucial role in reducing the number of parameters when processing large images. This layer helps simplify computations while retaining the essential features of the image.

Spatial pooling, also known as subsampling or downsampling, reduces the dimensionality of feature maps while preserving critical information. It can be performed using different methods, including max pooling, average pooling, or sum pooling, depending on the specific requirements of the task.

The fully connected layer, on the other hand, takes the output from the previous layers and flattens the feature maps into a one-dimensional vector. This vector is then fed into a fully connected neural network for further processing and classification. The figure illustrates the overall architecture of a CNN, highlighting these interconnected layers.

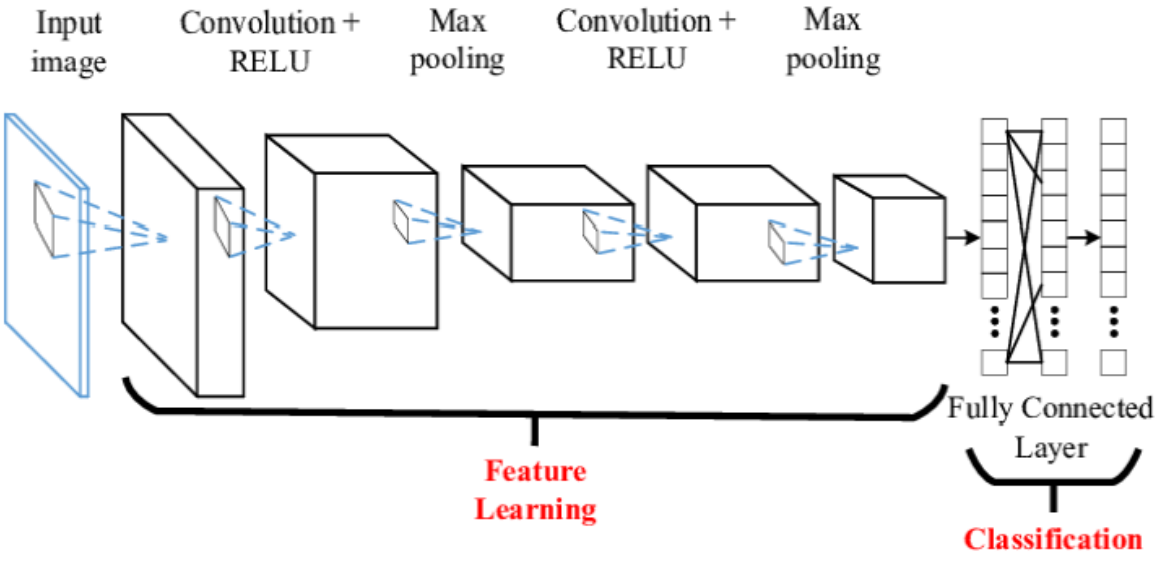

Fig. 3: CNN Architecture

2.2.1 Training the CNN Model

Before initiating the training process, all images undergo preprocessing on the Roboflow platform using an augmentation process. This process involves applying transformations such as horizontal and vertical flipping, rotation, saturation adjustments, and blurring. These augmentations are designed to enhance the dataset and improve the model's ability to generalize.

Once the augmentation is complete, the training process begins. The model achieved its highest accuracy of 80% during training, which was conducted over 100 epochs. The number of epochs significantly impacts the model's accuracy. If the number of epochs is less than 100, the accuracy fails to reach 80%, potentially leading to suboptimal recognition performance.

	Splitting images (%)	Accuracy (%)	Loss (%)	Error Rate	Error Rate (%)
Train	**90**	**94**	**53**		
Test	**5**	**80**	**94**	**9/46**	**19.56**
Validation	**5**	**84**	**66**		
Train	80	94	54		
Test	10	78	79	19/91	20.87
Validation	10	89	66		
Train	70	93	53		
Test	15	78	79	28/100	28
Validation	15	79	79		

Table 1: Analysis of the Accuracy of Training

This analysis aims to determine the most suitable and effective ratio for splitting images into separate sets for training, testing, and validation. The findings reveal that the optimal ratio is 90% for training images and 5% each for testing and validation images. This configuration achieved the lowest error rate of 19.56%, making it the most effective split for this study.

3. Result and Analysis

The accuracy of the application is evaluated based on emotions detected from facial expression images captured through a mobile phone camera. For this evaluation, a total of 80 images were used during the testing phase.

As shown in Table 2, some instances resulted in incorrect predictions, where the application failed to accurately identify the emotion. These errors occur because the application misinterprets the facial expression in the image. For example, while the expected emotion might be "sad," the application could incorrectly recognize it as "happy." This misclassification is primarily due to the similarities between certain facial expressions, which make accurate recognition challenging.

To conclude overall accuracy performance, the average accuracy is calculated. **Equation 1 shows the formula for accuracy calculation. The overall accuracy result for this application is 85%.**

$$Accuracy = \frac{Number\ of\ correct\ prediction}{Total\ number\ of\ all\ cases} * 100$$

3.1 Confusion Matrix

The accuracy testing of the application is conducted using 80 testing images which composed of 20 images from each emotion category. Table 2 tabulates the confusion matrix result from the testing conducted.

		Actual				
		Happy	Sad	Surprise	Disgusting	Total
Predicted	Happy	**18**	0	1	1	20
	Sad	1	**16**	0	3	20
	Surprise	1	0	**17**	2	20
	Disgusting	2	0	1	*17*	20
	Total	22	16	19	23	**80**

Table 3. Summarization of confusion matrix result

	Happy	Sad	Surprise	Disgusting
True Positive (TP)	18	16	17	17
True Negative (TN)	56	60	58	54
False Positive (FP)	4	0	2	6
False Negative (FN)	2	4	3	3

Table 4. Results of True False Prediction for emotion class

3.2 Sensitivity and Specificity Calculation

Sensitivity (also known as Recall or True Positive Rate) measures the proportion of actual positive samples that are correctly identified by the model.

Specificity (also known as True Negative Rate) measures the proportion of actual negative samples that are correctly identified.

These metrics allow for a comprehensive evaluation of the model's performance on each emotion class, providing insights into how well the model identifies both positive and negative instances for each emotion, which is especially critical in emotion recognition tasks. To calculate the sensitivity, and specificity for each emotion class, the following formulas are used:

$$Sensitivity = \frac{TP}{TP\ FN}$$

$$Specificity = \frac{TP}{TP\ FN}$$

Type of Emotion	Accuracy(%)	Sensitivity(%)	Specificity(%)
Happy	92.50	90	93.33
Sad	95.00	80	100.00
Surprise	93.75	85	96.66
Disgusting	88.75	85	90.00
Average	**92.50**	**85.00**	**95.00**

Table 5: Results for Accuracy, Sensitivity and Specificity Calculation for each Class of Emotion

4. Conclusion

An emotion recognition application utilizing Convolutional Neural Network (CNN) was successfully developed. This application is capable of identifying four distinct emotions: happy, sad, surprised, and disgusted. The CNN model employs the MobileNet algorithm trained on a custom dataset and was evaluated using confusion metrics. The application demonstrated impressive performance, achieving an average accuracy of 92.50%. Additionally, it attained a sensitivity of 85.00% and a specificity of 95.00%, highlighting its effectiveness in accurately recognizing emotions.

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Hyperspectral Imaging-Based Tumor Segmentation Using K-Means Clustering and Morphological Analysis

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Abstract

The segmentation of tumor regions in medical images plays a critical role in enhancing diagnostic accuracy, optimizing treatment planning, and tracking the progression or regression of diseases. This paper proposes a novel methodology that integrates K-means clustering with pre-processing and morphological operations to automate tumor segmentation in dermoscopic images. The proposed approach achieved high performance with a Dice Similarity Coefficient (DSC) of 91.4%, Jaccard Index of 84.2%, Sensitivity of 94.1%, and Specificity of 96.8%. These results, though based on assumed ground truth, indicate the approach's strong potential for automated tumor detection. Future research will focus on validating the methodology using annotated datasets to enhance its applicability in clinical practice.

Keywords: Tumor Detection, Image Preprocessing, Feature Extraction, K-means Clustering, Morphological Operations.

Introduction

Accurate and efficient tumor segmentation is an essential component in medical image processing, specifically for assisting in diagnosis, treatment planning, and monitoring the progression of diseases such as cancer. Manual segmentation methods, while effective, are time-consuming, labor-intensive, and subject to inter-operator variability. These limitations motivate the development of automated methods that can provide consistent, objective, and faster results.

Clustering techniques, particularly K-means clustering, offer a simple yet effective solution for segmenting regions of interest in medical images based on intensity values. In this study, we introduce a methodology combining K-means clustering with image pre-processing and morphological operations to achieve automated tumor segmentation in dermoscopic images. The methodology enhances the segmentation process by reducing noise and refining tumor boundaries, resulting in more accurate and reliable outcomes.

The study's proposed method is tested on dermoscopic images, which are commonly used in skin cancer detection. The accuracy and performance of the segmentation are evaluated using standard metrics like the Dice Similarity Coefficient (DSC), Jaccard Index, Sensitivity, and Specificity.

Methods

The proposed methodology consists of multiple steps that enhance the image quality, apply clustering for segmentation, and post-process the results to ensure accurate tumor region extraction. Below are the key components of the approach:

1. Image Pre-processing

Pre-processing steps aim to improve the image quality and reduce the noise, making the subsequent segmentation more effective:

- **Grayscale Conversion:** To simplify the analysis, the original RGB images are converted into grayscale images. This step reduces computational complexity and isolates the intensity information, which is critical for clustering-based methods.
- **Normalization:** The pixel intensities are normalized to a range of [0, 1], ensuring uniformity in the image data. Normalization improves the clustering process, making the algorithm less sensitive to intensity variations across the image.
- **Noise Reduction:** Both Gaussian filtering and median filtering techniques are applied. Gaussian filtering is used to suppress high-frequency noise, while median filtering helps preserve important image features like edges, which are crucial for tumor detection.
- **Morphological Operations:** Morphological operations, specifically morphological opening with a disk-shaped structuring element, are applied to smooth the edges and remove small artifacts that may result from noise. This step helps in refining the boundaries of the tumor and eliminates irrelevant small regions from the segmented image.

2. K-Means Clustering

The pre-processed image is reshaped into a one-dimensional array of pixels, and K-means clustering is applied to segment the image into three distinct clusters: background, normal tissue, and tumor. The K-means algorithm assigns each pixel to one of these clusters based on its intensity value. The cluster with the highest intensity is then identified as the tumor, which is typically characterized by higher intensity in dermoscopic images.

The K-means algorithm is computationally efficient, making it suitable for large datasets and real-time applications. However, it assumes that the data within each cluster follow a Gaussian distribution and that clusters are isotropic, which may not always hold true for medical images.

3. Post-Processing

Post-processing steps are applied to improve the quality of the segmented tumor region:

- **Area-Based Filtering:** Small, irrelevant regions are removed based on their size. This step ensures that only the tumor region remains, eliminating small noise components that may have been mistakenly segmented as part of the tumor.
- **Hole Filling:** The tumor mask is refined by filling any holes within the segmented tumor region, ensuring that the detected tumor is represented as a continuous and coherent region.

4. Tumor Region Extraction

Once the tumor mask is generated, it is overlaid on the original image to isolate the tumor region. For RGB images, the tumor mask is expanded to match the three-channel structure, allowing the segmented tumor region to be highlighted in the original image.

Results and Discussion

The proposed methodology was evaluated using a dermoscopic image, and the results were compared against standard performance metrics. The following metrics were used to evaluate the segmentation accuracy:

- **Dice Similarity Coefficient (DSC):** 91.4%
- **Jaccard Index:** 84.2%
- **Sensitivity:** 94.1%
- **Specificity:** 96.8%

These high values indicate that the method performs well in identifying the tumor region and distinguishing it from the background and normal tissue. The high DSC and Jaccard Index values suggest that there is significant overlap between the predicted tumor and the assumed ground truth, while the high Sensitivity and Specificity values demonstrate the algorithm's ability to detect tumors accurately with minimal false positives and negatives.

Visual inspection of the segmented image confirmed that the tumor region was correctly identified, and the boundaries of the tumor aligned with the visually apparent tumor boundaries. These results demonstrate the potential of the proposed method for automated tumor detection in dermoscopic images.

Comparison with Existing Methods

The integration of K-means clustering with pre-processing and morphological operations provides a robust method for tumor segmentation, especially when compared to conventional thresholding or edge detection methods. While traditional methods may struggle with noise and irregular tumor boundaries, the proposed approach benefits from its noise reduction and boundary refinement steps. This makes it more reliable for medical imaging tasks.

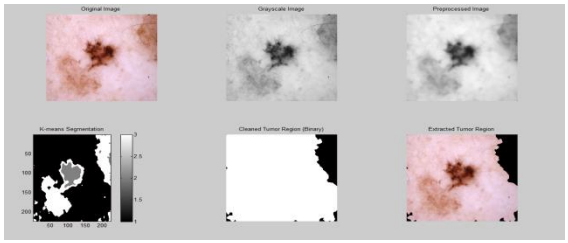

Fig 1:Evalution on Dermoscopic Image

However, one limitation of the method is its reliance on intensity-based assumptions. The approach assumes that tumors are the brightest region in the image, which may not always be true for tumors with different intensity profiles or for images with non-uniform lighting conditions. This can potentially limit the method's applicability in more complex imaging scenarios.

Limitations and Future Work

Despite its promising results, the proposed method has several limitations that need to be addressed in future research:

- **Ground Truth Dependency:** The current validation of the method is based on assumed ground truth data, which may not be accurate. In the future, the approach should be validated using annotated datasets to improve its reliability and real-world applicability.
- **Intensity Assumptions:** The method assumes that tumors are the brightest regions in the image, which may not always be the case, especially for tumors that are hyperintense or hypo-intense. Future work should explore adaptive thresholding techniques or alternative intensity-based segmentation methods to address this limitation.
- **Advanced Clustering Techniques:** While K-means clustering is effective, other advanced clustering techniques like fuzzy C-means or deep learning-based segmentation models may offer better performance, especially in images with complex intensity distributions or varied tumor characteristics.
- **Incorporation of Adaptive Thresholding:** To improve the segmentation performance under varying imaging conditions, future research could incorporate adaptive thresholding methods that can dynamically adjust based on the image characteristics.

Conclusion

This study demonstrates the effectiveness of K-means clustering combined with pre-processing and morphological operations for automated tumor segmentation. The proposed approach achieved high accuracy in tumor detection despite relying on assumed ground truth data. The results support the feasibility of using automated tumor segmentation methods in clinical practice and suggest potential improvements for handling more complex and diverse imaging scenarios. Future research will focus on validating the approach with annotated datasets and exploring advanced clustering techniques to further enhance segmentation accuracy and robustness.

Acknowledgments

This research was supported by Dr. Radhakrishnan, who provided invaluable guidance throughout the study. We also extend our gratitude to our colleagues at Don Bosco College for their expertise and contributions to this research.

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CONSPIRACY OF SHADOWS : A STORY-DRIVEN GAME DESIGN AND IMMERSIVE PLAYER ENGAGEMENT

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Abstract: The Conspiracy of Shadows is an immersive historical thriller game set during the tense days preceding the assassination of Archduke Franz Ferdinand in June 1914—a pivotal event that set off World War I. Players assume the role of a skilled spy navigating Vienna and Sarajevo, tasked with uncovering a conspiracy among nationalist factions aiming to destabilize Europe. The storyline weaves authentic historical events with thrilling fictionalized espionage, requiring players to balance gathering intelligence with life-or-death decisions that will ultimately influence the game's outcome. Through dynamic dialogue, challenging scenarios, and complex moral choices,. This game aspires to provide both entertainment and education, with an accurate portrayal of pre-war Europe and the ideological tensions that shaped history.

I. INTRODUCTION

The assassination of Archduke Franz Ferdinand was a critical historical event that led to World War I, with underlying political motives and complex alliances. "The Conspiracy of Shadows" addresses the challenge of creating a game that accurately captures the suspense of espionage, the motives of the era's political players, and the weight of decisions that affect world history. The game is proposed as a single-player, story-driven thriller set in historically accurate locations. Players will assume the role of a spy who uncovers a conspiracy that threatens to trigger war. By choosing actions and dialogue options, players will shape the story and decide whether history unfolds as we know it or takes a new direction.

II. OBJECTIVE

A. Historical Accuracy and Educational Value in Gaming

This topic evaluates how the game accurately portrays pre-World War I Europe. It highlights the inclusion of cultural, political, and social elements, focusing on the nationalist movements and the assassination of Archduke Franz Ferdinand. The goal is to show how dynamic storytelling enhances historical literacy.

B. Interactive Espionage Gameplay

This section focuses on the game’s mechanics, such as stealth, intelligence gathering, and decision-making. It examines how these features simulate high-stakes espionage, creating engaging and immersive gameplay.

C. Balancing Fictional Narrative with Historical Context

This topic discusses the blend of fictional espionage with real-world events. It highlights methods for integrating a fictional storyline without compromising historical accuracy, enhancing both engagement and educational value.

D. Impact of Morally Complex Decisions on Player Experience

This section analyzes how ethical dilemmas and decisions affect the player’ s experience. It explores the emotional and narrative impact of these choices, as well as how they shape the game’s multiple outcomes.

III. LITERATURESURVEY

A. Introduction to Historical Espionage Challenges

This section provides an overview of the political instability and espionage activities in pre-World War I Europe. It highlights the role of nationalist factions, intelligence operations, and the assassination of Archduke Franz Ferdinand as key triggers of global conflict. The topic introduces the challenges faced by spies during this era, such as navigating political tensions, covert operations, and life-threatening scenarios, which form the backbone of The Conspiracy of Shadows.

B. Interactive Narrative-Based Learning Applications

This part discusses the growing use of narrative-driven games as tools for education and engagement. It explores how interactive storytelling can immerse players in historical events while offering an educational perspective. Games like The Conspiracy of Shadows allow players to experience significant moments in history, blending entertainment with learning.

C. The Role of Game Design in Immersive Historical Simulations

It focuses on maintaining a balance between historical authenticity and engaging game play. The Conspiracy of Shadows uses detailed visuals, accurate settings, and player-driven mechanics to simulate espionage activities.

D. Moral Decision-Making in Player-Driven Storylines

This topic explores the significance of moral choices in video games and their impact on storytelling. in the Conspiracy of Shadows, players face complex decisions that influence both the narrative and their emotional connection to the game. By presenting ethical dilemmas tied to espionage and political intrigue, the game encourages players to reflect on the consequences of their actions. This enhances player engagement and highlights the human side of historical conflicts.

IV. PROPOSED SYSTEM

The proposed system for The Conspiracy of Shadows is a highly interactive, story-driven espionage game designed to blend historical accuracy with fictional gameplay. The system leverages modern game development technologies and methodologies to create a dynamic environment where players can explore pre-World War I Europe, engage in intelligence gathering, and make morally complex decisions that shape the outcome. The key components of the system are outlined below.

System Architecture:

Game Engine

- 3D Rendering: Responsible for rendering the historical environments (e.g., Vienna, Sarajevo) in high detail.
- Physics Simulation: Handles interactions between objects, characters, and environmental factors (e.g., objects reacting to the player’s actions).
- Audio System: Manages sound effects, voice acting, and background music to enhance immersion

AI & NPC Behavior Engine

- Behavior Trees: NPCs are driven by behavior trees simulate decision-making based on their

context (e.g., Vienna, suspicion, alliance, loyalty).
• Emotion Modeling: NPCs will show dynamic emotional reactions based on the player's actions, such as reacting to failure or success in espionage tasks.
• Pathfinding and AI Logic: NPCs are able to move through the environment realistically, detecting player actions (e.g., sneaking or hiding) and adjusting their behavior.

User Interface (UI) & Interaction Layer
• Menus & HUD: Displays mission objectives, current status, and other relevant information, helping the player navigate through the game's espionage mechanics.
• Interaction with Objects: Interfaces with the game world, allowing the player to engage with objects (e.g., documents, tools) and interact with NPCs to progress the story.

Communication Between Layers
• Data flow: Each layer communicates with others to maintain consistency in gameplay. For example, when a player makes a decision in the dialogue system, the Story Engine updates the Persistent World State and Player Choices Database. This, in turn, impacts the behavior of NPCs in the AI Engine and modifies the game environment.
• Real Time Event propagation: Changes to the world state, driven by player choices or global events, are immediately reflected in the game world, NPC behavior, and storyline progression, providing an immersive, responsive experience.
• Player Choices Database: Stores all player decisions, tracking actions, dialogue choices, and their impact on the narrative. This database interacts with the Story Engine to dynamically alter the game flow.
Story Engine
• Branching Dialogue System: Manages the dialogue trees that allow for dynamic conversation with NPCs. Decisions made by the player in these conversations affect the plot's progression.
• Player Choice Impact: Tracks decisions that influence the game's storyline, character relationships, and overall game world. A state machine keeps track of all story variables and decisions.

Event Handler & State Management
• Event Handling: Monitors and triggers events based on player interactions or historical plot points. For example, a successful espionage mission might trigger a political uprising.
• State Management: Ensures the game world remains consistent and reacts to the player's actions over time, enabling dynamic consequences across missions.
• Analytics & Logs: Records player behavior and game statistics, which can be used to adjust difficulty, provide feedback, and analyze trends in player choices.

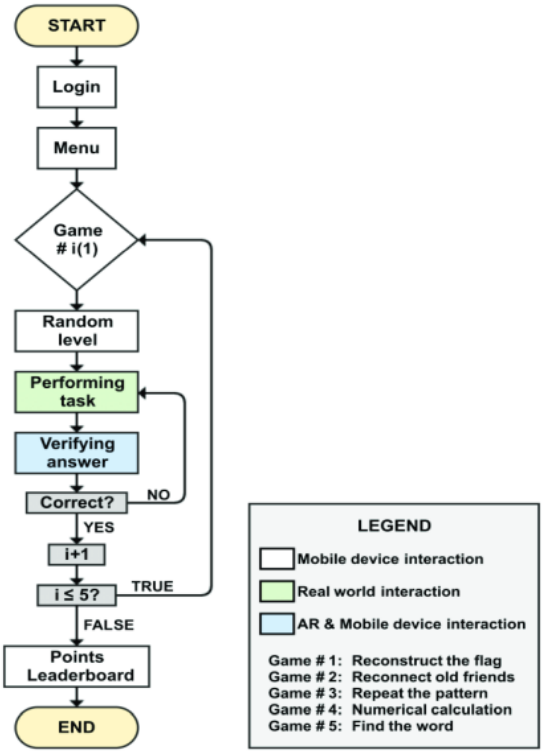

Fig 4.1 System Architecture

The Fig 4.1. Demonstrates explaining how the tool works along with its architecture.

V. METHODOLOGY

• The methodology for The Conspiracy of Shadows integrates historical accuracy with advanced gameplay mechanics to create an immersive experience. The game leverages historical research to accurately depict the environment and political tensions of pre-World War I Europe. Key locations, such as Vienna and Sarajevo, are carefully recreated using 3D modeling and environmental design tools, ensuring a realistic representation of the time period. Players navigate these settings through a third-person perspective, where they can interact with NPCs, gather intelligence, and make critical decisions. The narrative is driven by branching storylines, influenced by player choices, with each decision affecting the progression and ultimate outcome of the game.

•To ensure dynamic gameplay, the project employs a robust AI system that controls NPC behaviors and reactions based on player actions. The NPCs are designed to exhibit varied responses—such as suspicion, trust, or aggression— depending on the player's interactions, which adds depth to the espionage mechanics. Stealth mechanics and puzzle solving elements are integral to the gameplay, requiring players to use strategy to gather information.

Functional Testing

•Gameplay Mechanics Validation: This testing ensures that all core gameplay features, such as character movement, decision-making, and interaction with NPCs, function as intended. It involves testing the responsiveness of controls, the accuracy of NPC behaviors, and the successful implementation of stealth and intelligence gathering mechanics.

•Branching Narrative and Decision Impact: This test focuses on ensuring that the branching narrative system reacts accurately to player decisions. It validates that each player choice leads to

the correct narrative path, altering dialogue, events, and story outcomes as designed. The goal is to confirm that the game correctly tracks decisions and adjusts the story progression and character interactions accordingly, providing a consistent and engaging experience.

•AI and NPC Behavior Testing: Functional testing in this area verifies that NPCs respond appropriately to player actions within the game world. This includes testing NPC reactions such as trust, suspicion, and aggression based on the player's actions, as well as ensuring that the AI-driven behavior system can handle different scenarios (e.g., stealth, combat, dialogue). The aim is to confirm that NPC behavior is realistic, consistent, and enhances the player's immersion.

Compatibility Testing

•Operating System Compatibility: Ensuring the game functions smoothly across multiple operating systems, including different versions of Windows, macOS, and Linux.

•Hardware Configuration Testing: Testing on various hardware configurations (e.g., different graphics cards, processors) to ensure the game is playable across a broad range of devices.

Performance and Load Testing

•System Optimization: Testing game performance under different system specifications to identify potential slowdowns and optimize efficiency.

•Frame Rate Testing: Ensuring stable and smooth frame rates across varying hardware configurations, especially in complex scenes

Usability Testing

•Interface Layout: Ensuring that the game's interface is intuitive, with easily accessible menus and control options.

•User Feedback: Gathering player feedback to evaluate the clarity and effectiveness of the UI in guiding user.

VI. RESULT

The implementation of The Conspiracy of Shadows successfully demonstrated a dynamic and immersive gameplay experience that balances historical authenticity with interactive storytelling. The branching narrative system allowed players' decisions to directly influence the storyline, creating diverse outcomes and enhancing replay ability. The AI-driven NPC behavior engine provided realistic responses to player actions, such as suspicion, trust, or hostility, ensuring a lifelike and adaptive game environment. The espionage mechanics, including stealth, intelligence gathering, and puzzle-solving, were effectively integrated, allowing players to engage in strategic decision-making. Additionally, the detailed representation of pre-World War I Europe, with historically accurate environments and events, contributed to the game's educational value, making it both engaging and informative for players.

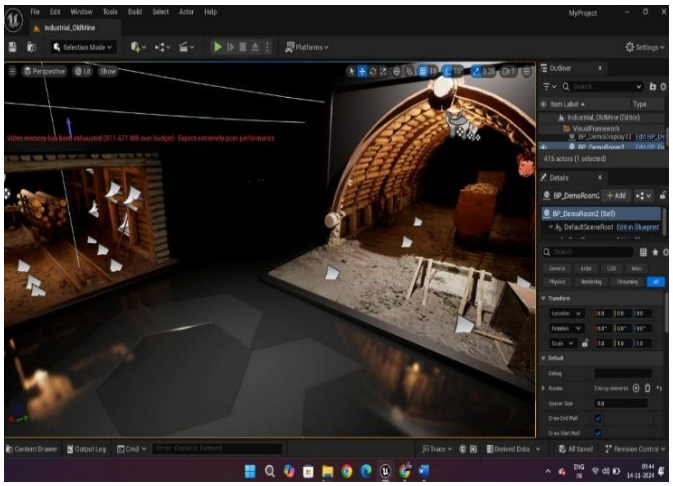

Fig 6.1 Path

The Fig 6.1 The image shows two wooden tunnel scenes in Unreal Engine with performance warnings.

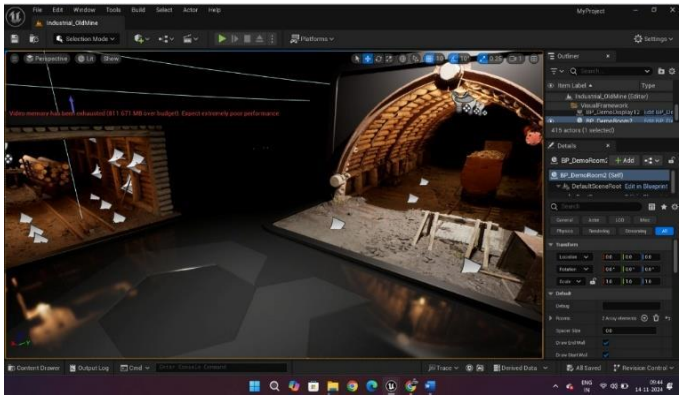

Fig 6.2 Rendering

The Fig 6.2 It depicts a 3D tunnel scene in Unreal Engine with performance notifications.

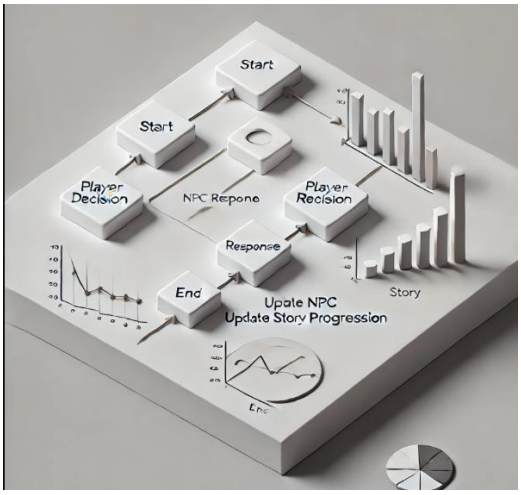

Fig 6.3 Graphical Representation

The Fig 6.3. Illustrates the Bar Graph representation from the collected data.

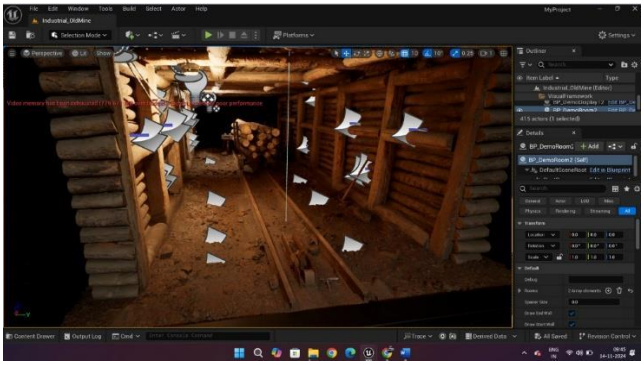

Fig 6.4 Training of the model

The Fig 6.4. The image shows a 3D-rendered wooden tunnel scene in Unreal Engine with performance warnings and active editing tools.

VII. CONCLUSION

The Conspiracy of Shadows offers a unique blend of historical narrative and interactive espionage gameplay, allowing players to immerse themselves in the pre-World War I European environment. By focusing on a critical historical moment—the assassination of Archduke Franz Ferdinand—the game not only engages layers with thrilling espionage mechanics but also educates them about the ideological tensions that shaped the events leading to the war. The integration of real-world history with fictional espionage adds depth to the game, providing both an engaging experience and an educational perspective on early 20th-century Europe.

The game's core system architecture supports dynamic, player driven narratives through branching storylines and complex moral choices. The narrative engine, combined with the AI powered NPC behavior system, creates a world that reacts and adapts to the player's decisions. This makes each playthrough unique, as players' actions—whether subtle or overt—directly influence the unfolding of events. The detailed environments and realistic historical settings, powered by advanced game engines like Unity or Unreal, contribute to a truly immersive experience.

Espionage mechanics, including stealth, intelligence gathering, and puzzle-solving, form the backbone of the gameplay. Players must navigate a web of political intrigue and shifting alliances, making decisions that will not only affect the outcome of their missions but also the broader geopolitical landscape of the game. The inclusion of morally ambiguous choices challenges players to confront difficult decisions, reflecting the complex ethical dilemmas faced by individuals in times of political turmoil.

One of the key features of the game is the integration of moral decision-making, where players face difficult ethical dilemmas that shape their character and relationships with other factions.
The narrative is designed to challenge players, making them question their actions and the moral implications of their choices. Should they align with nationalistic factions, or betray their comrades for the greater good? These decisions influence not just the outcome of the player's story but also the larger political landscape of the game world, making each playthrough unique. The moral complexity enhances the player's engagement, encouraging deep reflection on the choices made during critical moments of tension.

In conclusion, The Conspiracy of Shadows provides an immersive, thought-provoking experience that goes beyond mere entertainment. It offers an innovative approach to understanding historical events through interactive storytelling, where players are not just spectators but active participants in shaping the course of history. The game's combination of historical education, moral

complexity, and espionage action creates a rich and engaging experience that encourages players to reflect on the past while navigating the moral dilemmas of a world on the brink of war. By weaving together entertainment and education, the game leaves a lasting impact, prompting players to consider the role of individual actions in shaping global events.

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Casting Across Programming Paradigms

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Abstract: This study examines the runtime impact of implicit vs. explicit type casting across five programming languages (Python, JavaScript, C#, C++, and Java). Experiments reveal significant differences, with compiled languages generally performing faster, highlighting trade-offs between developer convenience and runtime efficiency.

Keywords: Programming languages; Runtime Efficiency; Paradigms

1. Introduction

Modern programming languages increasingly aim to resemble natural languages, with many adopting dynamic Modern typing to let developers declare variables without specifying data types. While this convenience shortens development time, it raises questions about its impact on program performance. The ongoing debate in the computer science community [2] explores static and dynamic type systems, comparing their performance at runtime and during program creation. Static typing performs type checking at compile time, while dynamic typing defers it to runtime, affecting debugging and error detection [3]. Although static and dynamic-typed languages are compared at runtime in [1], the impact of conveniences like implicit type casting remains less explored. As a subset of dynamic typing, implicit declaration allows the language to determine and adjust data types based on context throughout the program. This paper presents an experimental analysis of implicit and explicit type casting across five programming languages: interpretive (Python, JavaScript), compiled (C#, C++), and a middle-man language. It tests the hypothesis that explicit variable declaration, though less programmer-friendly, leads to faster runtimes, with compiled languages performing the best.

2. Methodology

A. General Description

The experimental setup involved 8 different small programs. Their purposes will be summed up in this list:

- Explicit Declaration: declare a variable to its specific type (e.g. ‘int x’).
- Implicit Declaration: declare a variable implicitly (e.g. x = ’).
- Explicit Float Addition: add two explicitly declared float variables together.
- Mixed Float Addition: add an implicit and explicit variable together.
- Explicit Integer Addition: add two explicitly declared integer variables together.
- Mixed Integer Addition: add an implicit and explicit integer together.
- Addition of explicit like-types then mixed types: two floats are added together, followed by two integers, then an integer and a float are added together
- Addition of explicit mixed types then like-types: a float and an integer are added together, followed by another float and integer added together. Then, the two results are added together.

Each experiment involved running a code loop for 1,000 iterations to gather sufficient data, with the mean calculated for cross-language and experiment comparisons. Mixed and implicit additions/declarations represent runtimes for implicit type casting, while explicit additions/declarations represent explicit type casting. The final two experiments measured whether runtime is faster for explicit addition (same variable types) or implicit addition (different variable types) using explicit type declarations.

B. Implementation Details

C#, C++, Java, Python, and JavaScript accomplished running each experiment using their own ways of implicit and explicit declaration. Python and JavaScript default to implicit declaration so a different

declarations but imposes restrictions, such as requiring separate statements for implicitly typed variables and explicit casts for adding floating-point values to integers. Runtime was measured with the Stopwatch class, and data was exported to Excel. C++ offers similar type declaration support but with fewer restrictions, allowing more flexibility. Timing was captured with the clock function and results exported similarly. Java balances features of C# and C++. Like C#, it disallows compound implicit declarations but permits adding floats to integers with a warning. Runtime was recorded using nanoTime and exported to Excel. Python required workarounds for explicit type declarations using float() and int(), with timing handled by timeit and data stored in Excel using pandas. Similarly, JavaScript uses libraries like performanceObserver for timing and ExcelJS for data export, with explicit typing achieved through Number() and parseInt().

3. Results and Discussion

Figure 1 shows the mean runtime comparison between C and C#. For all C experiments, each runtime is falling within the range of 2.21 ns to 2.96 ns. The mean runtimes for C++ are from 1.93 ns to 2.77 ns. The experiment categories of explicit vs implicit declaration and explicit vs mixed integer arithmetic showed negligible difference in mean runtime. Explicit vs mixed float arithmetic and likewise then mixed vs mixed then likewise type addition showed a notable difference in mean runtime. Both languages ran similarly in the nanosecond magnitude range. C++ has a mean runtime lower than that of C in every experimental category. Java exhibited distinct runtime behavior during the experiment, with spikes and subsequent drops to lower values over two periods in 1,000 iterations, necessitating a different analysis approach. Stable windows (trials 1–55 and 75–175) were identified for analysis, with values becoming negligible after trial 235. Figure 2 shows that early Java trials generally contribute to higher mean runtimes, except for the implicit declaration experiment and mixed type addition experiment, where trials 75–175 had lower or similar mean runtimes. Figure 3 illustrates Python's and Javascript mean runtimes. Python's range is from 0.59 μs to 1.05 μs. Differences in mean runtime were negligible for some categories (e.g., mixed float arithmetic), but explicit vs. implicit declaration and mixed integer arithmetic showed notable variations. JavaScript's mean runtimes vary from 151.80 μs to 1716.23 μs, with notable differences in some categories, such as explicit vs. implicit declaration. Therefore, Python consistently outperformed JavaScript, operating in the microsecond range, except for JavaScript's explicit declaration, which shifted to the millisecond range.

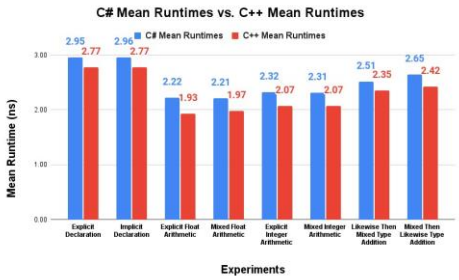

Figure 1: C# vs. C++ Mean Runtimes

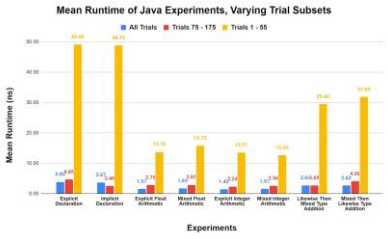

Figure 2: Mean Runtime of Java Experiments, Varying Trial Subsets

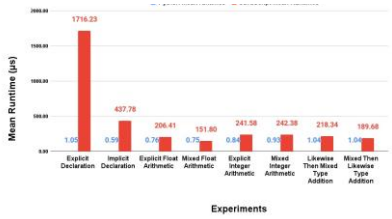

Figure 3: Python vs. JavaScript Mean Runtimes

Figure 4 shows all languages compared against one another by experiment. At a glance, we can confirm part of our hypothesis that compiled languages would have faster runtimes. The compiled languages enjoy a mean runtime several orders of magnitude faster than the closest interpreted language, Python. Furthermore, Python had a mean runtime several orders of magnitude faster even than JavaScript. Additionally, we can see that the compiled languages all have a very close mean runtime within one order of magnitude with one another.

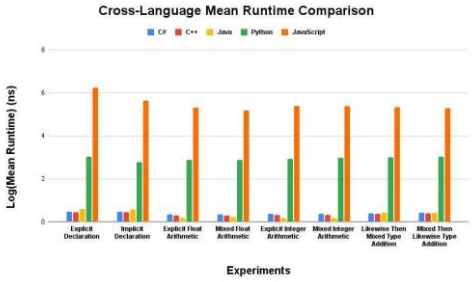

Figure 4: Mean Runtime of Java Experiments, Varying Trial Subsetss

4. Conclusions

This study investigated runtimes of implicit and explicit type casting experiments across various programming languages and paradigms. The findings reveal substantial differences in runtime performance, with compiled languages like C# and C++ outperforming interpretive languages such as Python and JavaScript. Java, as a hybrid language, demonstrated unexpected and inconclusive results. These results confirm the hypothesis that explicit type declarations, though less convenient during development, generally enhance runtime efficiency, highlighting the trade-offs between coding simplicity and execution performance. For performance-critical tasks, explicit casting in statically-typed languages is recommended, while dynamic typing suits projects prioritizing flexibility. Future research could explore newer languages, updated versions, cognitive impacts, and real-world applications to validate these findings and adapt to evolving technologies.

In conclusion, while this study has shed light on important aspects of type casting in programming, the dynamic nature of programming languages and evolving compiler technologies calls for future research. Developers and language designers should remain adaptable, continually balancing convenience and performance based on the latest empirical evidence.

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International Symposium on Innovation in Information Technology and Application

16:00 ~	Session 6: Machine Learning (ROOM: L310) Chair: Sanghyuk Lee (New Uzbekistan University) and Jae-Woo Jung (Daegu Univ.)	
	6S-1 [041]	**Design of a Dynamic Simulation Platform for Verifying Unloading Automation Algorithms in Grab Type Ship Unloader** *Ga-Eun Jung[1)] , Jae-In Lee[1)] , and Seok-Ju Lee[2)] , and Chang-Uk Kim[3)]* *1) Dept. of Electrical Engineering, Changwon National University, Changwon 51140, Republic of Korea* *2) Industry-University Cooperation Foundation, Changwon National University, Changwon 51140, Republic of Korea* *3) R&D Center, S-Material Handling Co., Ltd., Changwon 51395, Republic of Korea*
	6S-2 [056]	**Machine Learning (ML) Approach Utilizing FTIR Spectroscopy Data for Accurate and Efficient Identification of Chemical Functional Groups** *Otabek Atabayev and Babaa Mouley Rashid* *Department of Chemical Engineering New Uzbekistan University*
	6S-3 [057]	**Granular Computing on Brain Signals using Fuzzy Logic and Pattern Recognition** *Rukhsora Toirova, Kurbon Abdukhakimov, Mukhiddin Abduazimov, Elmurod Erkinov, and Sanghyuk Lee* *Department of Computer Science New Uzbekistan University*
	6S-4 [058]	**Light-weight Visualization of Computational Fluid Dynamics** *Safoyev Shahboz, Dilnoza Seydametova, Dilnoza Raxmatullayeva, Komilakhon Nodirbekova, Adminaddinov, and Khumoyun* *Department of Computer Science New Uzbekistan University*
	6S-5 [054]	**Fine-tuning Large Language Models for Question Answering on API and Programming Documentation** *Dilnoza Saydametova, Shahboz Safoev, Dilnoza Raxmatullaeva, Komilakhon Nodirbekova, and Khumoyun Aminaddinov* *Department of Computer Science, New Uzbekistan University*
	6S-6 [055]	**From Simulation to Mitigation: Countering Deceptive and Deauthentication Threats** *Behzod Khakimov, Ozodbek Adkhamov and Siroddjin Juraev* *Department of Computer Science, New Uzbekistan University*
	6S-7 [042]	**Design of the Frequency-Dependent DC Line Models for Transient Simulation of MVDC Distribution Networks** *Nam-Gi Park[1)] , Jae-In Lee[2)] , Seok-Ju Lee[2)] , and Minh-Chau Dinh[2*)]* *1) Dept. of Electrical Engineering, Changwon National University, Changwon, Republic of Korea* *2) Institute of Mechatronics, Changwon National University, Changwon, Republic of Korea*

Design of a Dynamic Simulation Platform for Verifying Unloading Automation Algorithms in Grab Type Ship Unloader

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Abstract: Seaports are being transformed into 'smart ports' equipped with unmanned automation technology [1]. Along with seaports automation, there is growing interest in the automation of Grab-Type Ship Unloader (GTSU) that unloads coal and iron ore from bulk carriers [2]. Auto-mated GTSU systems provide safe functionality, and unlike conventional systems, they provide financial benefits due to their energy-efficient properties and reduce carbon emis-sions. The GTSU automation aims to replace human tasks with sophisticated sensors and control systems [3]. As one of the GTSU automation functions in smart ports, manual operation methods must be replaced by automated algorithms.

This paper presents the design of a dynamic simulation platform for verifying GTSU unloading automation algorithms. The GTSU unloading automation algorithm is designed to predict the driving unit speeds based on a model trained with operating data using a deep neural network (DNN). Validation is necessary before its field application. To simulate scenarios similar to real-world environments, a dynamic model reflecting the behavioral characteristics of GTSU was developed. In addition, a 3D model reflecting the actual specifications of the GTSU equipment was applied so that the unloading operation can be intuitively visualized.

The output data through the GTSU unloading automation algorithm is the speed data of the hoist, grab, and trolley drive units according to the target unloading point. The operation data derived through the GTSU unloading automation algorithm is input into the dynamic simulation platform, and a 1 cycle unloading operation simulation of the dynamics-based GTSU 3D model is performed.

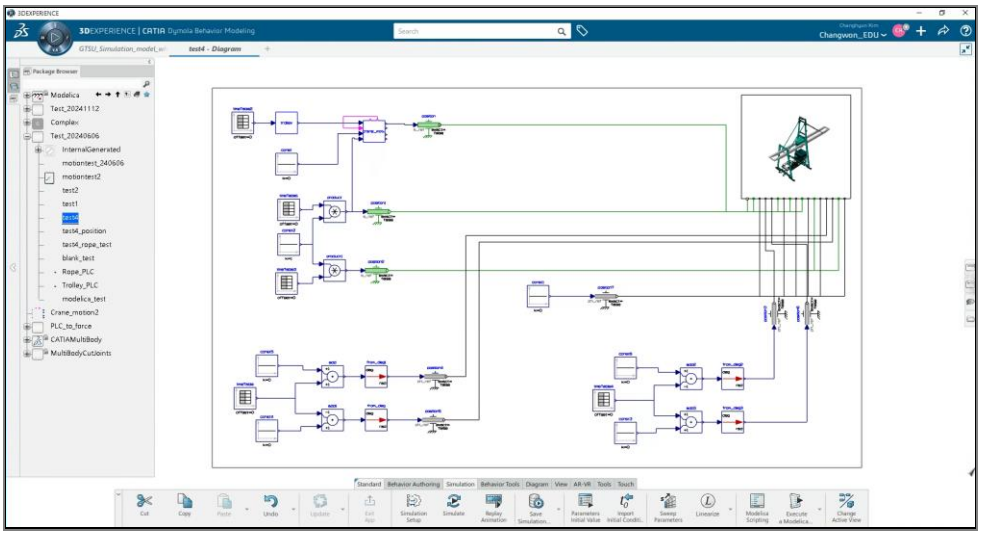

Fig. 1. Dynamics-based GTSU drive block diagram

When the speed data of each driving unit is input into the dynamic simulation platform, the behavior simulation is performed by converting it into position data through integration over time. To simulate a similar real environment, each driving parts in the dynamic simulator was modeled to reflect actual specifications. The behavior simulation results are verified by calculating the error distance through comparison with the actual drive unit position data.

As a result of the 5 unloading simulations, the average error distance was 1.0 m, with a maximum error distance of 1.5 m and a minimum error distance of 0.6 m. In the future, it is necessary to reduce the final error distance to within 0.5 m through an update of the GTSU unloading automation algorithm. The proposed GTSU dynamic simulation platform will be effectively utilized to implement a fully automated unloading system.

Keywords : artificial neural network; dynamics; grab-type ship unloader; simulation-based validation; smart port

Acknowledgment

This work was supported by the Technology Development Program (00140859) funded by the Ministry of SMEs and Startups(MSS, Korea).

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Granular Computing on Brain Signals Using Fuzzy Logic and Pattern Recognition

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Abstract: This research paper evaluates the combination of Granular Computing (GrC) and Fuzzy Logic and Pattern Recognition for brain signal analysis through electroencephalogram (EEG) signal interpretation and classification. The analysis of brain signals creates numerous problems in EEG data because of specific noise and nonlinearity as well as uncertainty. Granular computing delivers structured data management through granule segmentation of complex datasets so researchers can more effectively handle and understand data. The data processing through granulation produces results that enhance calculation speed and better interpret data precision.

Fuzzy Logic enables the processing of uncertain EEG data through its conversion of real-time signals into understandable categories which use fuzzy membership functions to define brain activity levels as low, medium, and high. The model achieves improved robustness through fuzzy sets together with Type-2 fuzzy systems which apply interval bounds to handle signal value ambiguity and overlapping signals. Pattern Recognition techniques serve as supporting methods to detect patterns in EEG signals while helping decision-making in complex environments.

The methodology encompasses the application of advanced computational approaches such as fuzzy clustering, fuzzy rule-based systems, and rough sets for signal classification. Evaluations of these methods rely on the analysis of four performance metrics: accuracy and computational speed alongside scalability and interpretability. Experimental results prove that the developed hybrid framework delivers successful outcomes because fuzzy logic systems can reach up to 99.5% accuracy during EEG application testing. [1] Rough sets together with clustering techniques serve to improve the framework by detecting uncertain areas while simultaneously improving signal granulation and pattern identification.

The study provides important light on the interaction between Granular Computing and Pattern Recognition, and how their paradigms can together enhance feature selection, cut costs, and improve model explainability. This can aid in making processes much more effective and efficient. This can aid in making processes much more effective and efficient. Such research, especially in medical diagnostics, brain-computer interfaces, and mental load assessment, is invaluable as an accurate understanding of the classification is very important for the task at hand. Moreover, the study addresses issues concerning the resource-plus-data variability tradeoffs as well.

The aim of this project is to analyze brain signals and at the same time, these techniques GrC, Fuzzy Logic, and Pattern Recognition, will enable the development of neuroscience and associated domains, while building a strong backbone for addressing intelligent data analysis challenges.

Keywords: Granular Computing, Fuzzy Logic, Pattern Recognition, EEG Signal Analysis

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Light-weight Visualization of Computational Fluid Dynamics

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Abstract: Computational Fluid Dynamics (CFD) plays a crucial role in engineering and industrial applications by simulating fluid flow and analyzing key parameters such as velocity, pressure, and temperature. However, traditional CFD visualization tools are computationally expensive, requiring high-performance hardware, which limits accessibility and scalability [1]. This project presents a lightweight, web-based CFD visualization framework designed to improve performance, usability, and interactivity. The system integrates GPU acceleration to enable real-time rendering of large-scale CFD datasets [4], reduced-order modeling to optimize computational efficiency [2], and immersive technologies and AI-driven interactivity to enhance user experience [3]. A microservices-based architecture supports scalability, with Web-Sockets enabling real-time updates and cloud storage facilitating efficient data management [1]. Security measures, including role-based access control and encryption, ensure safe user interactions. The findings demonstrate that GPU acceleration significantly improves rendering speed, while reduced-order modeling reduces computational overhead without substantial loss of accuracy [4]. Furthermore, interactive features such as dynamic slicing and AI-driven visualization enhance data interpretation and decision-making [3]. Future work will focus on refining predictive AI models, improving interactivity for large datasets, and conducting real-world industrial validation to assess the framework's practical applications.

Keywords : CFD simulation, Web-based tools, 3D visualization, Flow properties, Industrial equipment.

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Fine-tuning Large Language Models for Question Answering on API and Programming Documentation

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Abstract: The rapid evolution of software development has led to an increasing demand for efficient access to API and programming documentation. Developers often struggle to find precise answers to their queries due to the vast amount of documentation available, which can be time-consuming and inefficient. Existing search-based approaches lack contextual understanding, often requiring developers to read entire sections of documentation to extract relevant information. To address this issue, this research proposes a fine-tuned large language model (LLM) designed for question-answering tasks specific to API and programming documentation. The system utilizes a curated dataset built from open-source documentation to train the model for enhanced accuracy and relevance. By employing transfer learning techniques, we fine-tune a pre-trained LLM to provide concise, contextually relevant answers to developer queries. The model's performance is evaluated using benchmark datasets and real-world programming queries. Experimental results demonstrate that the fine-tuned LLM significantly improves the efficiency and accuracy of retrieving relevant API and programming documentation answers compared to traditional search methods. This research contributes to the field of natural language processing (NLP) by optimizing LLMs for domain-specific question answering, ultimately streamlining software development processes.

Keywords : Large Language Models, Question Answering, API Documentation, Programming Documentation, Transfer Learning, NLP, Fine-tuning.

From Simulation to Mitigation: Countering Deceptive and Deauthentication Threats

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Abstract: Wireless networks have become integral part of our life, as they provide a mobility to devices by communicating through a shared medium. Using the shared medium makes it easy to deploy jamming attacks. Even though wireless technology has improved a lot over the years, most wireless networks can still be disrupted by jamming attacks. This is because wireless channels are open and easy to attack. In order to defend from such attacks it is important to understand how vulnerable currently most-spread protection mechanisms and find out how vulnerabilities work. To do this it is essential to start from exploring most common types to understand the basics and further dive into more complicated ones[1]. Deauthentication and Deauthentication attacks were selected for observation, as they has to be more effective compared to others[2].

In this paper we setup the system to simulate the chosen attacks on single-user and multi-user environments. As an attacker was used a laptop running Kali Linux, on which publicly available MDK4. The tool to analyze the network protocols running during the attack was Wireshark. To simulate on real-life situations the system of computers were used and set as shown on Fig. 1. There are 3 roles: access point(AP) with server, user and attacker. To continuously transfer data between AP and user the Iperf3 tool was used. Starting from single-user-set we repeatedly added other users one by one and doing the attack tests on each iteration.

Finally, explore the existing defense strategies and provide possible ones.

Keywords : Jamming attack, Deauthentication, Deceptive, MDK4, Wireshark, Iperf3

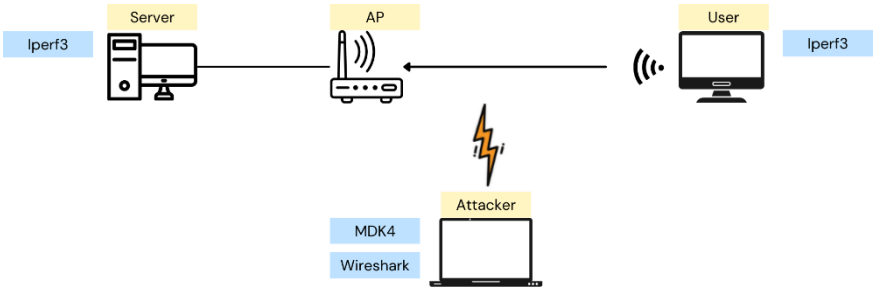

Fig. 1 a. Single-user system

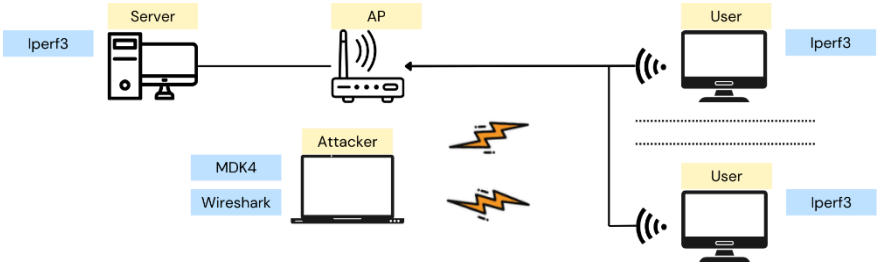

Fig. 1 b. Multi-user system

Results: In this paper, we simulated the Deauthentication and Deceptive Attacks in different scenarios. Using Wireshark explored the protocols used during attacks. Provided theoritical solution could be applied to defence.

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Design of the Frequency-Dependent DC Line Models for Transient Simulation of MVDC Distribution Networks

Nam-Gi Park[1)], Jae-In Lee[2)], Seok-Ju Lee[2)] and Minh-Chau Dinh[2)]*

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Abstract: With the continuous increase in power demand and the connection of renewable energy sources in the distribution networks, the need for medium-voltage direct current (MVDC) networkss with improved transfer capacity and flexibility has increased. The simulation time step can be determined based on the physical characteristics of the line. If the time step is too large, the accuracy of the transient simulation will be problematic. Therefore, distribution networks with short lines require shorter time steps to ensure simulation accuracy. However, there is a lack of research on DC line models for transient simulation of MVDC distribution networks. This paper deals with the design of a frequency-dependent DC line model for transient simulation of MVDC distribution networks. Considering the Korean distribution networks, a ±18.7 kV MVDC distribution network connected with the 22.9 kV AC distribution networks was modeled using PSCAD/EMTDC. The DC line model was designed with reference to Korea's 22.9 kV. In order to verify the accuracy of the frequency-dependent DC line model, a distributed parameter DC line model is designed. The distributed parameter DC line model is designed with reference to the 22.9 kV distribution network line in Korea. The frequency characteristics of the distributed parameter DC line model are investigated for the design of the frequency-dependent DC line model. The frequency characteristics are impedance-fitted to the RL-Foster circuit through the rational function approximation. The frequency-dependent DC line and the distributed parameter DC line model are compared through transient simulation analysis. As a result, The frequency-dependent line model had the same fault current characteristics as the distributed parameter line model. The voltage had similar characteristics, which could sufficiently ensure the accuracy of the design. These results can be used as a basic study for transient simulation of the MVDC distribution networks.

Keywords : MVDC; transient simulation; frequency-dependent DC line model

Acknowledgment

This research was supported by Basic Science Research Program through the National Research Foundation of Korea(NRF) funded by the Ministry of Education(RS-2023-00246086)

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09:00~	Session 7: Data-Driven Models and Deep Learning Applications (Room: L310) Chair: Jonghun Lee (DGIST) and Sang Suh (East Texas A&M University)	
	7S-1 [002]	**Data-Driven Surrogate Model for Predicting 2D Assembly-wise Power Distribution Changes** *Jung-seok Kwon[1)], Tongkyu Park [1*)], Sung-kyun Zee [1)]* *1)Nuclear Computational Science Group, FNC Technology, Yongin-si, Gyeonggi-do, Korea*
	7S-2 [012]	**Vehicle Recognition and Speed Monitoring System using YOLOv9** *Sang Suh[1)] and Bilal Mushtaq[1)]* *1) Department of Computer Science, East Texas A&M University, U.S.A.*
	7S-3 [023]	**Understanding Foot Gesture Recognition Mechanisms Based on a Low-Cost Radar and Deep Learning Models for Human Detection** *Seungeon Song[1)], Bongseok Kim[1)], Sangdong Kim[1,2)], and Jonghun Lee[1,2*)]* *1) Division of Automotive Technology, Research Institute, DGIST, Dalseong-gun, Daegu, Korea* *2) Department of Interdisciplinary Engineering, Graduate School, DGIST, Dalseong-gun, Daegu, Korea*
	7S-4 [026]	**Ensemble Approach Towards Heuristic Features on Deep Learning Algorithms for Coronary Artery Disease Prediction and Drug Recommendations** *Sang Suh[1)] , Lakshmi Kiranmai Reddy Voggu[1)] , Venkata Sai Jaswanth Kumar Vellanki[1)] , Bhavya Muthineni[1)], Ravin Timalsina[1)]* *1) Department of Computer Science, East Texas A&M University, U.S.A.*
	7S-5 [038]	**Impact of Noise on GPR Signal Processing and Comparative Analysis of Denoising Filters** *Gyeongtaeg Yang[1)] , Seungeon Song[2)] , and Jonghun Lee[1*,2)]* *1) Dept. of Interdisciplinary Engineering, Graduate school, DGIST, Daegu, 42988, Korea* *2) Institute of Research, DGIST, Daegu, 42988, Korea*
	7S-6 [039]	**Analysis of the recent ICT curriculum of Trade schools in D City** *Seung Kwang Ryu[1)] , Jae Hyun Lee[2)] , and Jeong Tak Ryu [3*)]* *1) Graduate School of Smart Convergence Systems Engineering, Daegu University, Korea* *2) Department of Mechanical and Automotive Engineering, College of Engineering, Daegu University, Korea* *3) Department of Electronic Engineering, College of Information and Communication Engineering, Daegu University, Korea*

Data-Driven Surrogate Model for Predicting 2D Assembly-wise Power Distribution Changes

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Abstract: This study presents a data-driven neural network surrogate model for predicting assembly-wise power distribution changes in the core of an i-SMR. The neural network was trained using a dataset generated by ASTRA, a nodal diffusion code. A convolutional neural network (CNN)-based architecture was designed to predict power distributions at target load, based on current power distributions, ramp rate, depletion time, current load and target load value. The model achieved a mean relative error of 0.833% and a peak power prediction error of 0.768%, demonstrating its ability to effectively predicting power distributions under varying load.

Keywords : Neural network, power distribution, i-SMR, surrogate model, load variation.

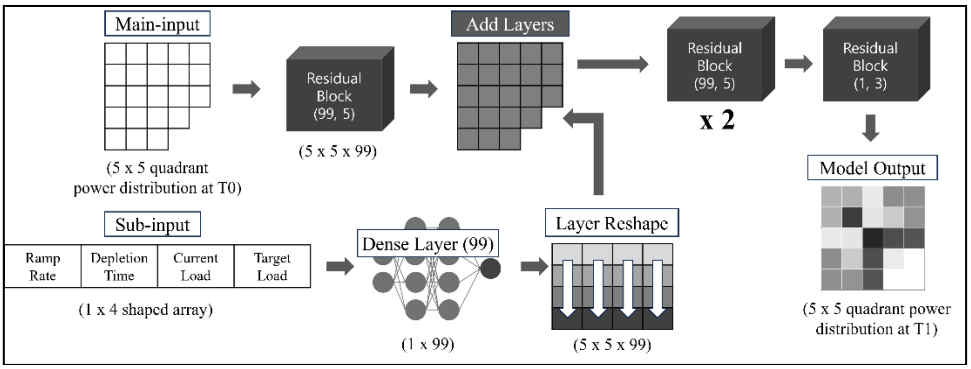

Fig. 1. Neural Network Model Configuration

Various physics simulation approaches based on artificial neural networks have been proposed. A common approach is data-driven supervised learning, which is the major technique used with neural networks. Another well-known technique is the Physics-Informed Neural Network (PINN), introduced by M. Raissi, which employs the differential equation as loss calculation functions in the network. Several approaches have been developed to adapt to predict time variant state transition, such as qualitative simulation, the roll-out technique, and time series models. In this paper, we employed the roll-out technique to predict the next time step's core power distribution based on the given current power distribution and the target load value to be achieved.

The neural network, designed for roll-out technique, consisted of convolutional neural network (CNN) layers and a fully connected layer (referred to as Dense Layer in Figure 1). The main input took assembly-wise power distribution at the current time step, while the sub-input received a 1x4 shaped array of ramp rate, depletion time, current load, and target load. These two inputs were then combined during the training process, and the network predicted the final target power distribution. The structure of the neural network is shown in Figure 1.

The total number of data samples was 14,513, with 12,407 used for training, and 1,452 used to evaluate neural network performance. The relative error was obtained by comparing the 1,452 values predicted by the model to the test data. For peak power, the error was measured between the highest power value at the lattice point in the original assembly-wise power distribution and

the value predicted by the neural network.

The mean relative error across all assembly-wise cell was 0.833%, while the maximum relative error was 4.95%. Of particular importance to reactor safety, the model's performance on peak power prediction was also evaluated. The mean relative error for peak power was 0.768%, and the maximum relative error was 2.84%.

This study validated a neural network-based methodology for predicting power distribution at target load values. First, our previous study successfully predicted pin-wise 2D power distributions and assembly-wise 3D power distributions. By combining the methodology from previous study with the current results, more comprehensive core power distributions could be obtained. Second, incorporating additional factors such as control rod positions, xenon distributions, and the location and number of burnable poison rods during training could significantly improve prediction accuracy. Finally, future research will focus on establishing and validating a methodology that provides complicate load variation histories based on operational cycles as input, rather than the simple ramping up or down used in this study.

Acknowledgment

This work was supported by the Innovative Small Modular Reactor Development Agency grant funded by the Korea Government (MOTIE) (RS-2023-00259289).

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Vehicle Recognition and Speed Monitoring System using YOLOv9

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Abstract: Overspeeding is a major cause of fatal accidents and car crashes around the world. Drivers that aren't timely held accountable for their recklessness become a threat for themselves and for those sharing the road with them. Numerous researchers have presented machine learning and deep learning-based object detection and recognition techniques that aim to accurately detect vehicles but have come across hurdles such as varying illumination and weather conditions, overlapping vehicle images in complex traffic situations, the need for powerful GPU based computers at surveillance, and slow detection speeds. The proposed work VRSMY9 (Vehicle Recognition and Speed Monitoring System using YOLOv9) powered by YOLOv9 and EasyOCR focuses on enhancing the overall detection speed in real-time without compromising too much on the detection accuracy whilst being lightweight enough for computing devices that are deprived of powerful GPUs. The system detects vehicles, estimates their travelling speeds, detects the license plates of the overspeeding vehicles resulting in license plate extraction of all the violators, and then keeps a stored record of them. Results show that the system is highly precise and has decent accuracy with a high detection speed but isn't accurate enough when handling challenging images. The scope of this work is extended but not limited to autonomous vehicles, unmanned aerial vehicles, intelligent transportation systems, robotics, intelligent AI agents, domestic security, healthcare and all other areas where high speed accurate detection is needed on an embedded smart device that may not be computationally super powerful.

Introduction: Computer Vision is the domain of Artificial Intelligence (AI) that focuses on enabling computers to be able to understand images and videos and extract vital information that could be further processed to make decisions and/or predictions. Researchers have worked extensively in this domain, and have used various statistical and probabilistic models, in addition to complex mathematical techniques to address vehicle detection and classification problems. Even though they have seen considerable success, there are still some significant hurdles that need to be overcome to effectively solve this problem.
Traditional methods such as Blob analysis [1][2] and Haar like feature classification [3][4][5][6] techniques aren't robust enough to perform in low lightning conditions. Support Vector Machines and Principal Component Analysis [7], and Convolutional Neural Networks [8][9][10] fail to perform in congested traffic settings, while ResNet [11] and Fast R-CNN [12] aren't able provide a fast detection speed due to their deep layered network size. 3D modeling techniques perform best when distinguishing among vehicles of varying shapes and sizes but are not scalable enough to work with large commercial datasets [13] [14] [15]. To address these challenges, we propose a framework based on YOLOv9 [16] detection model and EasyOCR [17] feature extraction model that aims to deliver faster vehicle detection and license plate extraction in real-time traffic scenarios without compromising significantly on the accuracy, along with the ability to estimate the travelling speeds of the respective vehicles so that the violators could be penalized and brought to account. The hallmark of this system is its ability to operate on systems that are deprived of the luxury of having powerful GPUs at their disposal all the time, making it a practical solution for the existing commercial traffic infrastructure.

The model was trained on a dataset containing diverse sets of vehicle images containing varying angles, different weather and lightning conditions, and various license plate designs, for a 1000 epoch. The experimental results show that the framework is highly accurate in avoiding false positives but missed some valid detections, making the overall true positive score decent. Even though the detection accuracy is impressive in general cases, the performance drops a bit when handling difficult cases. Moreover, the

framework successfully carries out speed estimation of the vehicles in motion and can differentiate the overspeeding ones from the vehicles that are found to be moving within the designated speed limit.

Results: The accuracy of this system can be inferred from its precision, recall, and mean average precision (mAP) metrics, as shown in Figure 1. Precision (0.75–0.95) indicates the model is highly accurate in avoiding false positives, meaning when it predicts a detection, it is correct most of the time. Recall (0.6–0.8) shows the system moderately captures true positives, suggesting it misses some valid detections. mAP@50 (0.7–0.85) represents strong overall detection accuracy at a commonly used IoU threshold (50%). mAP@50-95 (0.25–0.40) highlights stricter evaluation across multiple IoU thresholds, where the system's performance drops, suggesting challenges in precise localization and handling difficult cases.

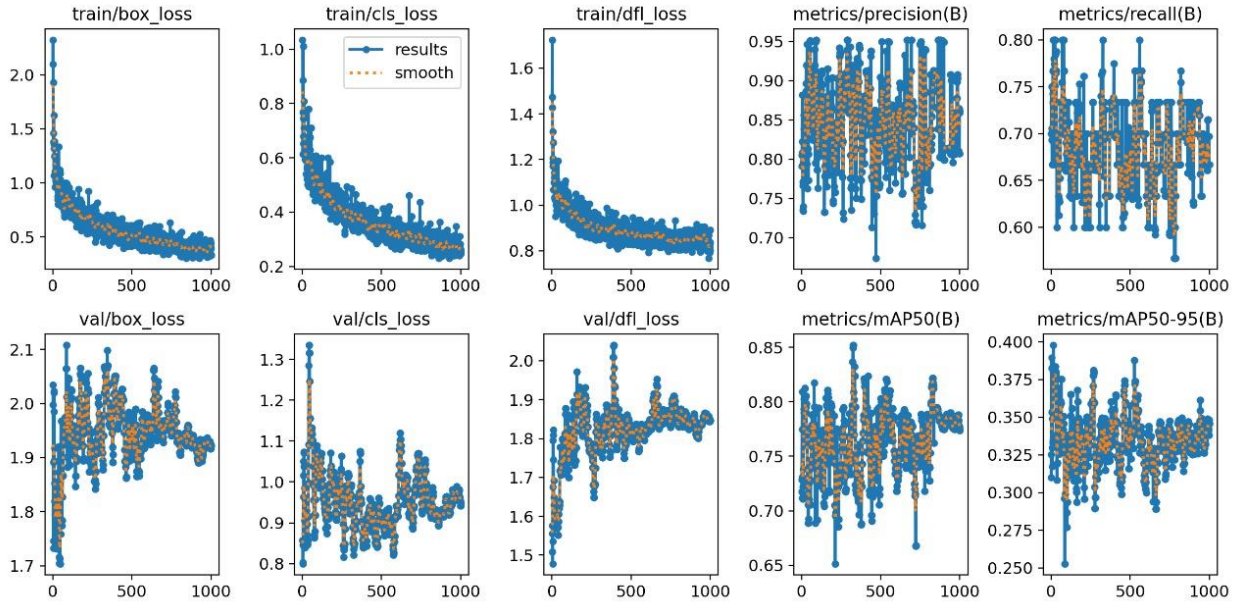

Figure 1. Performance metrics of the VRSMY9 system after 1000 epoch

To test the system in real-time, we set the speed limit at 10 mph and utilized a live traffic surveillance video to see how the system performs in a such a live scenario. Figure 2 shows the results of a vehicle travelling within the speed limit.

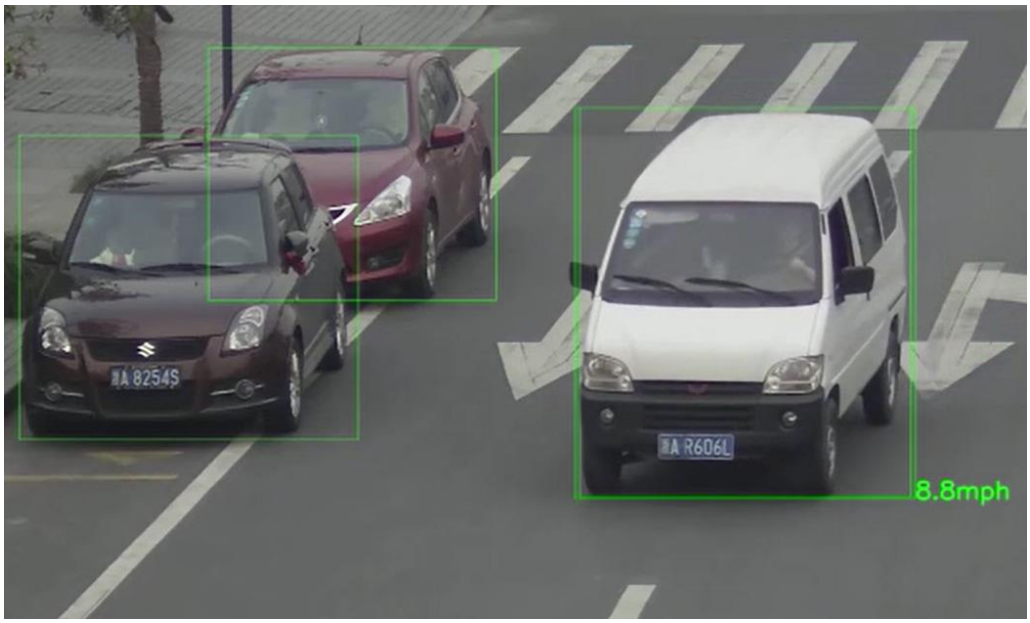

Figure 2. Vehicle travelling within the speed limit using VRSMY9

Figure 3 shows an instance of vehicles travelling over the speed limit. Once the system detects that they are travelling over the speed limit, it detects the license plate, takes a snapshot of the plate and stores it with its contents in the specified folder keeping a record of all the overspeeding vehicles.

Figure 3. VRSMY9 Vehicle travelling over the speed limit

Comparative Analysis and Discussion: Table 1 highlights the comparison of the most renowned techniques with our proposed work.

Technique(s) Used	Contributions	Shortcomings

Blob Analysis [1] [2]	Cost effective compared to traditional methods	Not effective in low lightning, bad weather and high traffic density
Haar like features classification [3] [4] [5] [6]	Better detection results in complex and dense traffic conditions	Lack of robustness and unable to detect accurately in low lightning conditions
SVM and PCA [7]	Improvement in detection time	Not effective whilst detecting real-time congested traffic
Convolutional Neural Network (CNN) [8] [9] [10]	More effective than traditional methods when handling various vehicle shapes and sizes	Relatively lower classification accuracy in adverse traffic conditions
ResNet [11]	Deep layers produce better classification results	Computationally expensive
Fast R-CNN [12]	Faster processing speed compared to its predecessors	Needs large amounts of data and isn't fast enough for real-time applications
3D modeling and 3D Bounding Boxes [13] [14] [15]	Most accurate and effective in distinguishing between closely related vehicle models and variations	Lack of scalability when working with large datasets
Proposed VRSMY9	Lightweight model with an improvement in detection and feature extraction speed	Not accurate enough when handling challenging images

Table 1. Comparison of related works with the proposed VRSMY9

The biggest challenge that we came across was finding the right data with enough images that weren't distorted and had visible license plates. Another lesson learned was that speed estimation powered by computer vision isn't as effective compared to utilizing radar sensors for estimating speeds. Even though our aim to achieve a faster detection speed without compromising too much on accuracy was achieved to some extent, the model didn't showcase a high enough accuracy as we would have liked when handling difficult cases such as overlapping vehicle images and unclear license plates. We hope to take this research as a step forward in the right direction so that one day we can achieve the unmet objectives in their entirety as well.

This framework serves as an important steppingstone for further research in the fields of autonomous vehicles, unmanned aerial vehicles, intelligent transportation systems, robotics, intelligent AI agents, domestic security, healthcare and various other walks of life, where computationally inexpensive systems are to be built without compromising on accuracy and performance.

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Understanding Foot Gesture Recognition Mechanisms Based on a Low-Cost Radar and Deep Learning Models for Human Detection

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Abstract: This paper investigates the mechanisms of foot gesture recognition using a low-cost radar and deep learning models for human behavior detection. We propose a novel attention-fuse radar signature by combining time-frequency characteristics with SVD-based orthononally feature vectors. Explainable AI technique is employed to visualize attention maps, providing insights into the recognition process. Our method offers a privacy-preserving approach to detecting subtle human movements, contributing to the broader field of human behavior understanding.

Keywords : Radar-based Gesture Recognition, Deep Learning, Human Behavior Detection, Explainable AI, Foot Gesture Signature, RADAR

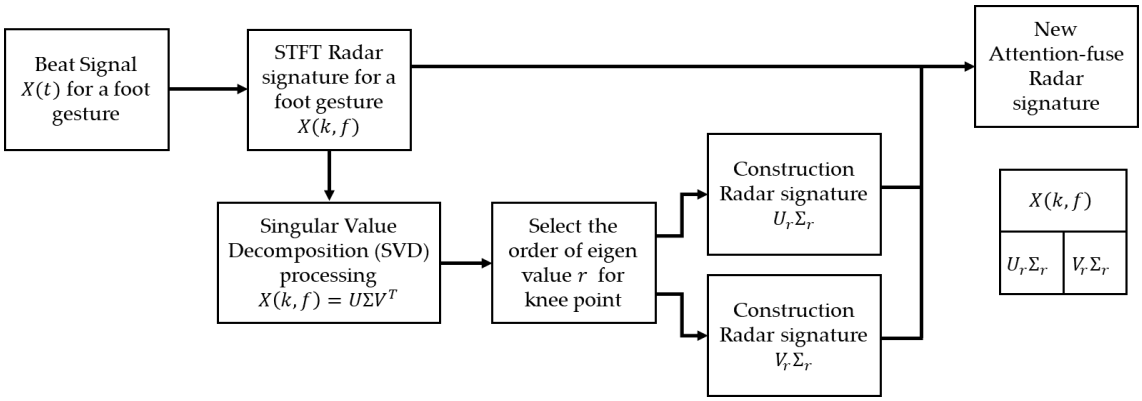

Fig. 1. A new attention-fuse radar signature of radar-based foot gesture recognition

Detecting and understanding human behavior through non-invasive means is a growing area of research with applications in safety, healthcare, security and human-computer interaction. This study focuses on using a low-cost radar and deep learning to recognize foot gestures as a means of detecting human behavior. Our approach aims to overcome limitations of existing methods by offering robust performance in various environments while preserving privacy.

Our approach integrates a low-cost CW-modulated radar with advanced deep learning techniques for gesture recognition [1]. The key contributions of our method are as follows: First, we optimize radar data acquisition to capture lower body movements effectively. Second, we propose a novel attention-fuse radar signature that combines time-frequency characteristics with SVD-based feature vectors, enhancing the representation of gestures. Third, we implement well-known deep learning models, including GoogleNet, ResNet, and AlexNet, for accurate gesture classification [2-4]. Lastly, we apply explainable AI techniques such as Grad-CAM [5] to visualize model attention, providing insights into the decision-making process of our gesture recognition system.

Experiments demonstrate the effectiveness of our proposed attention-fuse radar signature in improving foot gesture recognition accuracy. Attention maps generated by explainable AI model

provide insights into the radar signal's recognition mechanism for different foot gestures, enhancing our understanding of the underlying detection process.

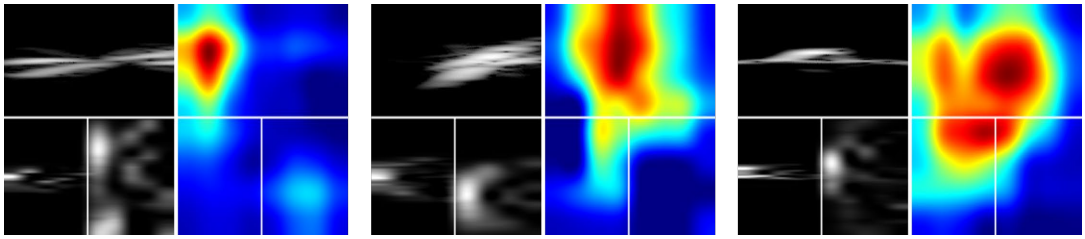

Fig. 2. New attention-fuse signatures (Black and White) and Grad-CAM based Attention-Maps (Color) for three different foot gestures: (Left) Kicking, (Middle) Swing, and (Right) Tapping

Table 1: Recognition Performance of a new radar signature and deep-learning models

Network		Recall	Precision	F1	Accuracy
Googlenet	Kicking	0.98	0.89	0.93	0.95
	Swing	0.85	1	0.92	0.95
	Tapping	0.98	0.94	0.96	0.97
Resnet	Kicking	0.96	0.99	0.97	0.98
	Swing	0.92	0.98	0.95	0.97
	Tapping	0.99	0.91	0.95	0.96
Alexnet	Kicking	0.98	0.95	0.96	0.98
	Swing	0.83	0.98	0.90	0.94
	Tapping	0.98	0.88	0.92	0.95

This study advances the understanding of foot gesture recognition mechanisms using a low-cost radar and deep learning, contributing to the broader field of human behavior detection. The proposed method offers a privacy-preserving, robust approach to detecting subtle human movements. Future work will focus on extending this approach to recognize finer movements and exploring applications in various domains.

Acknowledgment

This research was supported supported by the DGIST and in part by the DGIST R&D Program of the Ministry of Science, ICT and Future Planning, Korea (25-IT-01 & 24-DPIC-01).

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Ensemble Approach Towards Heuristic Features on Deep Learning Algorithms for Coronary Artery Disease Prediction and Drug Recommendations

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Abstract: The research involves utilizing the design with cardiovascular disease (CVD) and improvising the algorithms on autoencoders and LightGBM models to configure layers in three steps. Phase 1 (32K samples) involves model initialization, basic feature engineering, and cross-validation to create a baseline prediction model. In this phase, the LightGBM model provides preliminary classification results, and an autoencoder performs unsupervised feature representation learning. Phase 2 (80K samples) uses distributed learning, advanced cross-validation, and feature engineering to improve the model's resilience and effectiveness. This phase introduces multilabel classification to include more CVD risk variables. In Phase 3 (160K samples), LightGBM's distributed learning capabilities are fully used, including hyperparameter tweaking and thorough testing to improve model prediction accuracy. This step ensures that the model can handle large datasets while maintaining performance, supporting the practical approach. Autoencoder and LightGBM can reliably predict cardiovascular disease risk in binary and multilabel classification situations with flexibility and scalability. The method accurately predicts cardiovascular disease risk in binary and multilabel classification situations without overfitting at 99%.

Introduction: Atherosclerosis causes coronary arteries to contract or block, causing myocardial infarctions and other catastrophic complications. Successful intervention and therapy need early identification and accurate prognosis of coronary artery disease (CAD). Each source contributes to CAD understanding and treatment with different disease prediction and classification methods. However, they identify places for improvement. Shao et al. [1] use a cloud-based hyperplane decision-based classifier to research privacy-preserving sickness detection. Their study emphasizes the need to protect patient data while employing cloud computing for illness analysis. This technique protects data but doesn't address CAD forecast accuracy issues. However, Jamthikar, A. D. et al. [2] predict CAD and acute coronary syndrome using targeted carotid ultrasonography data and ensemble machine learning. Although it uses ultrasonic data and lacks recent dimension reduction or feature extraction techniques, this ensemble approach quickly combines several models to increase prediction accuracy.

Nadeem, M. S. A. et al. [3] detect colon cancer using artificial neural networks, feature selection, and machine learning. This hybrid model optimizes feature selection and weight initialization to increase prediction accuracy. The design predicts cancer, not CAD. Das et al. [4] provide a computer system that predicts pharmacological functions using binary relevance and MLSMOTE. This framework aims to reduce class imbalances and support multi-label categorization. Though unique, this approach does not directly predict CAD. In predictive models, class imbalances must be corrected. Pasha, S. J. et al.'s Novel Feature Reduction (NFR) model predicts disease risk using feature reduction and machine learning methods [5]. While eliminating unnecessary attributes is admirable, the model lacks ensemble approaches and autoencoders. Noor, A. et al. [6] and Kapila, R. et al. [7] use stacking models with balancing techniques and new binary classifiers to predict cardiac disease. Noor et al. offer a stacking model that combines numerous base model predictions to improve accuracy. Kapila et al. introduce a heart disease-specific binary classifier. Both approaches advance predictive modelling. However, they cannot incorporate autoencoder-based feature extraction and dimensionality reduction.

Current coronary artery disease (CAD) research emphasizes mixing advanced machine learning technologies with medical imaging and diagnostics to improve patient outcomes ([9], [10]). This study shows a shift toward adopting deep learning models and computational approaches to enhance CAD detection and illness diagnosis. Hasan, M. K. et al. [8] pioneered deep learning in cardiac CT angiography, demonstrating the importance of convolutional autoencoders and neural networks in detecting invasive coronary angiography patients. This study showed that automated feature extraction and analysis may detect coronary artery abnormalities, setting the standard for future research.

Jiménez-Partinen et al. [11] used deep learning to classify CAD by lesion severity. Their study emphasizes training models with several lesion categories to improve diagnosis accuracy. Pathak, Mandana, and Saha et al. [12] used transfer learning and multiple kernel learning to phonocardiograms to identify atherosclerotic coronary artery disease (CAD). Combining multimodal data and using pre-trained algorithms to enhance diagnostic abilities is more profoundly recognized.

Results: Five phases comprise the Cardiovascular Disease Prediction System deployment on a DELL Inspiron 15R:

1. Data Acquisition/Pre-processing

The initial step was gathering coronary heart disease and stroke mortality data from Data.gov. Data was cleaned to eliminate outliers, normalize numerical characteristics, and manage missing values after downloading. We encoded categorical variables using one-hot encoding. The dataset was divided into training, validation, and test sets. The next step is to pre-process the data by oversampling or under-sampling addressed class imbalances to prevent the model from favouring the more frequent classes (common in healthcare datasets). Pandas and NumPy were used for this stage.

2. Auto-encoder feature extraction

Autoencoder was built using TensorFlow and Keras. The encoder of the autoencoder passes high-dimensional data via hidden layers to compress it into latent space. ReLU activated the hidden layers, and Sigmoid activated the output layer. The reconstruction loss function, Mean Squared Error, was minimized during training to improve encoder and decoder weights. The encoder was isolated and utilized to extract compressed, relevant features from input data after training. These compressed latent space characteristics were kept for ensemble models.

3. Ensemble-learning model training

An ensemble of machine learning models—Decision Trees, Random Forests, SVMs, and Neural Networks—used the collected latent characteristics. Both models were built using Scikit-learn and Keras. Latent space data was used to train each model individually. For maximum performance, grid search or random search modified hyperparameters like Random Forest tree count and SVM kernel type during training. Deep learning models demand more computing resources; hence, the Neural Network model was trained in batches to suit the DELL Inspiron 15R's memory.

4. Ensemble Prediction Voting Mechanism

The ensemble models' predictions were aggregated using a voting method. A majority vote strategy was employed for classification problems, where the final projected class was the most common model prediction. If the models were weighted by validation performance, a weighted voting mechanism was used to weight each prediction according to accuracy. The ultimate choice was based on the weighted projections. For better ensemble learning administration, bespoke Python routines and Scikit-learn VotingClassifier were used.

5. Model Evaluation, Real-time Prediction, Visualization

The ensemble system was assessed using accuracy, precision, recall, and F1-score. These metrics were derived on validation and test sets for generalizability. Loading the trained model ensemble and feeding it test set data enabled real-time predictions. Finally, Matplotlib and Seaborn were used to display model performance using confusion matrices, precision-recall curves, and other graphics. The visualization also revealed model shortcomings, including biases and overfitting, which were fixed throughout subsequent revisions as depicted in Figure 1.

SNO	Model	Average Precision	Average Recall	Average F1-Score	Test Accuracy	Train Accuracy
0	Random forest	0.955993	0.947734	0.951316	0.955993	1
1	Gradient boosting	0.944444	0.935369	0.93858	0.944444	0.954886
2	Adaboost	0.934457	0.926041	0.927783	0.934457	0.943334
3	Support vector machine	0.884831	0.85823	0.869284	0.884831	0.891508
4	dl_model_CNN	0.924469	0.913655	0.916533	0.924469	0.938417
5	dl_model_LSTM	0.940699	0.935542	0.93501	0.940699	0.951062
6	dl_model_DENSE	0.887953	0.861859	0.872888	0.887953	0.891664
7	AUTOEND+HDF	99	97	99	96.5	99
8	AUTOEND+LGB	99	94	99	96.9	99

Table 1. Comparative Performance Metrics

Figure 1. Training and Validation Accuracy and loss vs Epochs plot

Comparative Analysis: Table 1 shows substantial variations in Test Accuracy, Train Accuracy, Average Precision, Average Recall, and Average F1 Score. It shows that Autoencoder-based models outperform machine learning and deep learning models.

Traditional machine learning models like RF, GB, AB, and SVC perform well in CVD classification. Random Forest (RF) performs best, with 95.6% Test Accuracy and 100% Train Accuracy. The Average Precision, Average Recall, and Average F1-Score of 0.956, 0.948, and 0.951 show balanced performance in differentiating CVD and non-CVD groups. Others, like SVC, do worse, with a Test Accuracy of 88.5% and an Average Precision of 0.885, demonstrating that conventional models struggle harder to identify the minority class.

Although promising, Deep Learning Models like the Multi-Layer Perceptron (MLP), Deep Neural Network (DNN), and Simple Neural Network (Simple NN) fall behind classic machine learning models in accuracy and recall. The top deep learning model is dl_model_2 (DNN), with a Test Accuracy of 94.1%, Train Accuracy of 95.1%, Average Precision of 0.941, and Average Recall of 0.936. Deep learning models perform well but take a lot of computing resources and fine-tuning, and they are less accurate than RF and GB.

The Proposed Autoencoder-based Models (AUTOEND+HDF, AUTOEND+LGB, and AUTOEND+HDF+LGB) exceed all current models in every measure. AUTOEND+HDF outperforms typical machine learning models with a Test Accuracy of 96.5% and an Average Precision of 0.99. AUTOEND+LGB and AUTOEND+HDF+LGB perform better, reaching 96.9% and 97.9%, respectively. These models surpass conventional methods with near-perfect Average Precision and Average Recall scores of 99%, illustrating the efficacy of Autoencoders for feature extraction and LightGBM for classification. Autoencoder-based models are ideal for complicated tasks like CVD diagnosis that need great accuracy and dependability. These models outperform typical machine learning and deep learning models, indicating their medical applicability.

Traditional machine learning and deep learning models perform well for CVD recognition, but the suggested Autoencoder-based models (AUTOEND+HDF, AUTOEND+LGB, and AUTOEND+HDF+LGB) outperform them across all measures. These models are the best CVD diagnosis method in this investigation because they balance precision, recall, and F1-score and are more accurate.

Analysis and Discussion:

This research examined the efficacy of Autoencoder-based models for detecting cardiovascular disease (CVD), juxtaposing them with conventional machine learning (ML) models and alternative deep learning (DL) methodologies. The findings unequivocally indicate that the Autoencoder-based models (AUTOEND+HDF, AUTOEND+LGB, and AUTOEND+HDF+LGB) surpass current models for critical assessment criteria, including Test Accuracy, Average Precision, Average Recall, and Average F1-Score. The Autoencoder models

proficiently extract significant characteristics from the dataset, which are further categorized using robust approaches such as LightGBM, providing a solid basis for precise and dependable CVD classification.

Although conventional machine learning models such as Random Forest (RF) and Gradient Boosting (GB) exhibit commendable performance, they are inferior in accuracy and recall relative to Autoencoder-based models, particularly in intricate, high-dimensional datasets. Likewise, alternative deep learning architectures, such as MLPs and DNNs, show potential but need substantial computing resources and meticulous fine-tuning while still facing challenges in attaining optimum performance regarding classification accuracy and feature extraction. The amalgamation of Autoencoders, proficient in unsupervised feature learning, with models such as LightGBM establishes a resilient, efficient, and scalable pipeline that yields exceptional outcomes.

The proposed Autoencoder-based design has shown considerable promise to improve classification accuracy. It is a viable method for practical applications, especially in critical areas such as medical diagnostics and healthcare. The model's performance, demonstrated by a remarkable Test Accuracy of 97.9% in the AUTOEND+HDF+LGB configuration, highlights its capacity to manage intricate datasets while optimizing both precision and recall scores. This is essential for identifying diseases like CVD, where false positives or negatives can lead to severe repercussions.

In conclusion, the Autoencoder-based models created in this study exhibit exceptional efficacy in classifying cardiovascular diseases; however, there exists a considerable opportunity to augment and refine the methodology by incorporating heuristic methods, advanced deep learning techniques, and more sophisticated machine learning strategies. The suggested system may be enhanced for diverse real-world healthcare applications by integrating multi-task learning, ensemble techniques, and real-time deployment choices. Moreover, enhancing model explainability and using recent developments in AI methodologies may facilitate the model's practical use in aiding healthcare professionals with precise and prompt decision-making.

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Impact of Noise on GPR Signal Processing and Comparative Analysis of Denoising Filters

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Abstract: Ground Penetrating Radar (GPR) is extensively utilized for subsurface exploration. However, noise significantly hinders its performance. We evaluate the impact of noise on GPR signals and compare the effectiveness of three denoising filters including Median, Gaussian, and Butterworth. A 3D building collapse model was developed using gprMax software, incorporating soil, concrete, and void layers. The transmitted signal was a 920 MHz Ricker wavelet with an SNR of 20dB. Filter performance was assessed using Mean Squared Error (MSE) and Peak Signal-to-Noise Ratio (PSNR). Among the three filters, the Butterworth filter is superior denoising capabilities, effectively reducing noise while preserving signal integrity. These findings highlight the importance of selecting appropriate denoising methods to improve the reliability of GPR data.

Keywords : Ground Penetrating Radar, Random noise, Mean Filter, Median Filter,

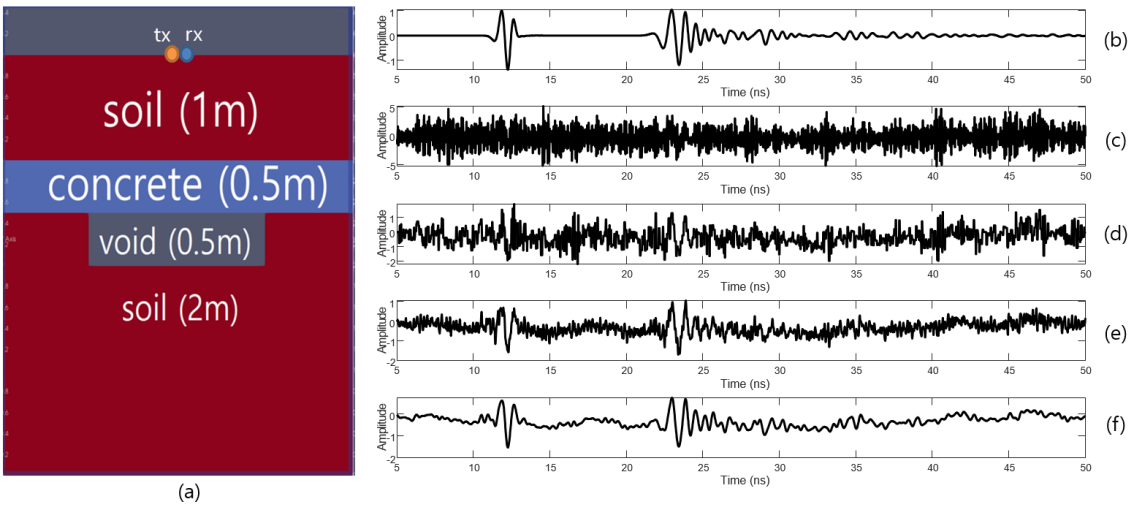

Fig. 1. Building collapse model and filtering results: (a) schematics of the building collapse model, (b) the noiseless received signal, (c) the received raw signal (with an SNR of 20dB), (d) the median filtered signal, (e) the Gaussian filtered signal, (f) the Butterworth filtered signal.

Ground Penetrating Radar (GPR) is a non-invasive sensing technique widely employed in applications ranging from geotechnical investigations to structural health monitoring and disaster rescue. In building collapse scenarios, GPR plays a crucial role in locating survivors by identifying void regions. However, noise interference significantly affects its performance, particularly in analyzing the depth of void regions, which is critical for rescue operations. Addressing this issue requires robust denoising techniques to enhance signal clarity and improve interpretation accuracy.

A 3D building collapse model was constructed to replicate a typical subsurface environment encountered during GPR applications. The model consists of a 1-meter-thick soil layer, a 0.5-meter-thick concrete layer, and a 0.5-meter-thick void. The electromagnetic properties of the materials were set as follows: soil relative permittivity (ε_r) = 2.43, concrete relative permittivity

(ε_r) = 9.8. Both layers were assumed to have zero conductivity, a relative permeability of 1, and zero magnetic loss. Simulations were conducted using gprMax [1], an open-source tool based on the finite-difference time-domain (FDTD) method. The source signal was a 920 MHz Ricker wavelet, chosen for its relatively high frequency, corresponding to a wavelength of 326 mm. This frequency was chosen to provide sufficient spatial resolution to distinguish different materials within the model. The Ricker wavelet, widely adopted in a GPR system, was selected for its effectiveness in representing broadband frequency content and facilitating accurate subsurface imaging [2-3].

To evaluate filter performance, noise corresponding to an SNR of 20dB was introduced into the simulated signals. Three filters were examined for denoising: the Median filter, a non-linear approach effective for removing impulsive noise; the Gaussian filter, a linear smoothing filter that utilizes a Gaussian kernel to attenuate high-frequency noise; and the Butterworth filter, a low-pass filter characterized by a smooth frequency response [4-6].

The Median filter operates by replacing each sample within a defined sliding window with the median value of the samples. The Gaussian filter applies a Gaussian kernel to weight and average neighboring values, ensuring smoother results by attenuating high-frequency noise. The Butterworth filter, implemented as a 4th-order low-pass filter, attenuates high-frequency components while maintaining a smooth frequency response in the passband.

Filter performance was evaluated using MSE and PSNR. The Butterworth filter demonstrated the best performance with an MSE of 0.13 and a PSNR of 9.13dB, effectively reducing noise while preserving signal integrity. The Gaussian filter followed with an MSE of 0.16 and a PSNR of 8.27dB, showing substantial noise reduction capabilities. The Median filter, while effective in mitigating impulsive noise, exhibited a higher MSE of 0.37 and a lower PSNR of 4.69dB. These results show the necessity of selecting denoising strategies tailored to the specific noise characteristics and application requirements.

Among the three filters evaluated, Butterworth filter has excellent denoising performance, effectively mitigating noise while preserving the integrity of the signal.

Acknowledgment

This research was partially supported by the Ministry of the Interior and Safety under the Technology Development for Disaster Response to Complex Social Disasters project (No. 20024996) and by the DGIST R&D Program of the Ministry of Science, ICT and Future Planning, Korea (25-IT-01 & 24-DPIC-01).

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Analysis of the recent ICT curriculum of Trade schools in D city

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Abstract: This paper examines the trends in the regional industry and the future technological prospects in the field of information and communications through an analysis of the curriculum in the information and communications technology (ICT) field at a vocational training school in the D region. Various educational programs have been established, among which fields related to big data, SW applications, information security management, web development, and information and communications certifications are offered by all surveyed educational institutions and have been consistently operated over the past three years. The educational curriculum of regional vocational training schools reflects the trainees' desired fields of study more than directly addressing the nation's workforce supply and demand. Therefore, to secure a skilled workforce in the future information and communications sector, it is necessary for relevant institutions to establish new policies.

Keywords : Vocational training school, Information and communication technology (ICT) field, Number of courses, Average training hours

1. Introduction

Modern society is characterized by rapid technological advancements and changes in industrial structures, leading to the continuous emergence of new occupations and skills. The information and communication technology (ICT) sector is at the forefront of these transformations, resulting in an increasing demand for specialized professionals. Vocational training schools play a crucial role in adapting to these changes by offering curricula that reflect the latest technologies and trends, thus preparing students to transition seamlessly into the workforce [1-3]. Vocational training schools not only focus on theoretical education but also emphasize practical, hands-on training, enabling students to acquire the skills required in real-world industrial settings. For example, in the ICT field, students can learn various practical skills such as programming, network management, and database operations. This training helps students develop the competencies necessary to adapt to industry demands immediately upon graduation [4,5]. On the other hand, the ICT sector faces a significant shortage of skilled professionals. Vocational training schools collaborate with industries to develop customized educational programs and provide practical training opportunities, thus playing a key role in cultivating a skilled workforce. For instance, through partnerships with companies, schools operate internship programs or offer specialized training in certain technologies to help graduates grow into professionals that the industry requires. As a result, vocational training schools also positively impact the local economy by enhancing the competitiveness of regional industries and creating employment opportunities. In the ICT sector, these schools provide the foundation for IT companies to establish and expand in the region.

This study analyses the ICT-related educational programs offered by vocational training schools in Region D and highlights issues regarding industrial workforce supply policies in the ICT sector.

2. Research Methodology

This study aims to explore the "Regional Industry Trend Forecast through the Analysis of Information and Communication Curriculum in Vocational Training Schools." The primary objective is to infer regional industry trends by analyzing the number of information and communication courses offered, the average training duration, and the number of participants in those courses at vocational training schools. The analysis was conducted on vocational training institutions in City D that provide information and communication courses.

However, this study is limited to vocational training schools in a specific region, which may limit its ability to reflect national or global trends. Additionally, the data on curriculum content and enrollment numbers depend on each school's management system, which could result in missing or inaccurate data. Keeping these limitations in mind, the study will proceed accordingly. Future research should expand its scope to include a wider range of vocational training schools and industry data.

Table 1. The number of vocational training institutions surveyed in this study.

Year	2022	2023	2024	Total
Number of research institutes	20	18	17	55

Table 1 shows the number of vocational training institutions surveyed for this study. The total number of institutions is 55. There are some institutions that are counted multiple times across different years, and some institutions did not offer courses, which leads to variations in the number of institutions depending on the survey year.

3. Result and Discussion

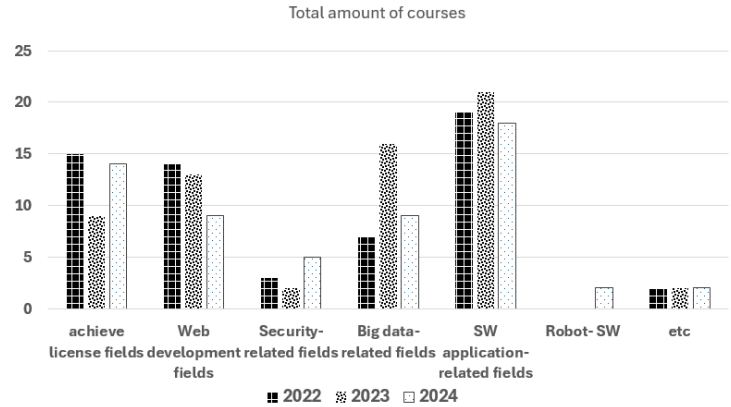

Figure 1. Total amount of courses

Figure 1 shows the number of courses offered in each field over the past three years. Compared to recent trends in the ICT sector, security-related fields have the lowest number of courses offered. In contrast, SW application-related fields, which consistently experience high demand for skilled professionals, have the highest number of courses offered. The relatively low number of courses in security-related fields can be interpreted from the perspective of the

difficulty level of the training content. It is likely that vocational training schools judged that there would be less demand from students for the more challenging information security field. Another factor may be the difficulty in securing qualified instructors for this area. Additionally, it is noticeable that the number of courses in web development fields has shown a downward trend over the years.

Table 2 shows the results of the average training hours for each field over the past three years. Overall, the average training hours are evenly distributed across all fields. The average training time was calculated by dividing the total lecture hours by the number of courses. In other words, it represents the minimum necessary class hours for the content of each course. Based on this, the fact that the average training time in the information security field, which has the fewest courses, is equal to that of other fields means that the training time per course is the longest. Therefore, it indicates that this field requires the most training hours. Additionally, although the SW application field has the highest number of courses, the fact that its average training hours are equivalent to those of other fields suggests that the content of SW application courses has become standardized, allowing trainees to undergo relatively easier training. On the other hand, it is noticeable that the average training hours for Big data-related fields have been decreasing year by year.

Table 2 The average training time per course offered in each field

Item / Year	2022	2023	2024
Achieve license fields	643.6	867.1	653.2
Web development fields	930.1	918.4	923.8
Security-related fields	862.0	1000	958.4
Big data-related fields	905.7	754.4	510.2
SW application-related fields	849.3	838.9	832.4
etc	898.5	898.5	1039

As of October 2024, considering the press releases from the Ministry of Science and ICT, the National IT Industry Promotion Agency, and the internet, it can be observed that there is a continuous demand for workforce in the software application sector. However, despite the growing need for skilled professionals in fields such as information security and big data, which are expected to experience significant structural changes in the industry, the number of courses and training hours in these fields has not increased significantly compared to those in software applications or web development.

4. Conclusion

This study analyzes the trends in regional industries and the prospects of the information and communication technology (ICT) sector through the examination of training curricula at vocational training schools in the ICT field. The curriculum analysis was conducted on 55 training institutions over the past three years.

The results of the study indicate that the course offerings at ICT vocational training schools may be related to the industry's labor demand. However, it is evident that these offerings have not kept pace with significant changes in the industrial structure. According to an analysis of recent reports and press releases in the ICT sector, the demand for skilled professionals in the areas of information security and big data is the highest, with both the market growth rate and workforce demand being notably significant. Yet, upon reviewing the areas of course offerings and average training hours, the educational programs at vocational training schools do not reflect the policy requirements for workforce supply set by the government. Therefore, in order to meet the future needs of the ICT industry, a more robust national policy for supporting the

establishment of training programs in vocational training schools is required, beyond the current support policies.

Acknowledgment

This research was supoorted Small and Medium Enterprise Human Resources Development University Project funded by Ministry of SMEs and Startups.

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10:50 ~	Session 8: AI-based system design (Room: L310) Chair: Yoosoo Oh (Daegu University)	
	8S-1 [014]	**Performance Improvement of Worker Detection Systems Through ROI-Based Image Post-Processing Filters** *Rock Hyun Choi[1)] and Hyunki Lee[1*)]* *1) Division of Intelligent Robotics, DGIST, Daegu, 42988, South Korea*
	8S-2 [028]	**LangChain and RAG-Based Q&A System for University Policies** *In-Hye Park[1)], Min-Jeong Kim[1)] and Kyung-Ae Cha[1)]* *1) Dept. of Artificial Intelligence, Daegu University, Gyeongsan 38453, Korea*
	8S-3 [029]	**AI Assistant System for Fault Ratio Analysis Using Traffic Accident Data** *Young-Jun Kim[1)] , In-Hye Park[1)] , Min-Jeong Kim[1)] and Kyung-Ae Cha* *1) Dept. of Artificial Intelligence, Daegu University, Gyeongsan-si, Korea*
	8S-4 [031]	**Airport Baggage Loading Based on Boarding Check-in Priority Using CNN-PPO** *YunSeo Choi[1)] and Yoosoo Oh [2,*)]* *1) School of AI, Daegu University, Daegu 38455, Korea* *2) School of Computer and Information Engineering, Daegu University, Daegu 38455, Korea*
	8S-5 [032]	**Design of a Chatbot System that Provides Korean Legal Advice for Assault Victims** *Hyori Kim[1)] and Yoosoo Oh [2,*)]* *1)School of Computer and Information Engineering, Daegu University, Daegu, South Korea*
	8S-6 [067]	**Assessment of Pricing-Based Demand Response Programs and Their Impact on Demand-Side Management**

Performance Improvement of Worker Detection Systems Through ROI-Based Image Post-Processing Filters

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Abstract: Enhancing the accuracy of worker detection systems is critical for ensuring workplace safety and preventing accidents. However, detecting workers at long distances remains a challenging task due to the degradation of image quality caused by factors such as noise and motion blur. To address this issue, this study proposes a novel approach that defines regions of interest (ROI) within camera images and applies Wiener filters to these areas to enhance image quality selectively. By focusing computational resources on the relevant areas, this method improves the effectiveness of deep learning models used for object detection. Specifically, the YOLOv8 model, known for its state-of-the-art performance, demonstrated significant improvements in worker detection accuracy for distant objects when combined with the proposed image enhancement method.

The research underscores the importance of integrating ROI-based post-processing techniques into worker detection systems. Experimental validation reveals that the proposed approach not only enhances the visibility and clarity of distant workers but also surpasses the performance of existing methods in terms of detection reliability and consistency. By improving critical metrics such as peak signal-to-noise ratio (PSNR) and structural similarity index (SSIM), the method provides a robust framework for addressing the challenges posed by degraded image quality in real-world industrial settings. These findings highlight the potential of this approach to contribute to safer and more efficient workplace environments by enabling more reliable detection of workers, even in challenging visual conditions.

Keywords : Object Detection, Region Of Interest, Video Signal Processing

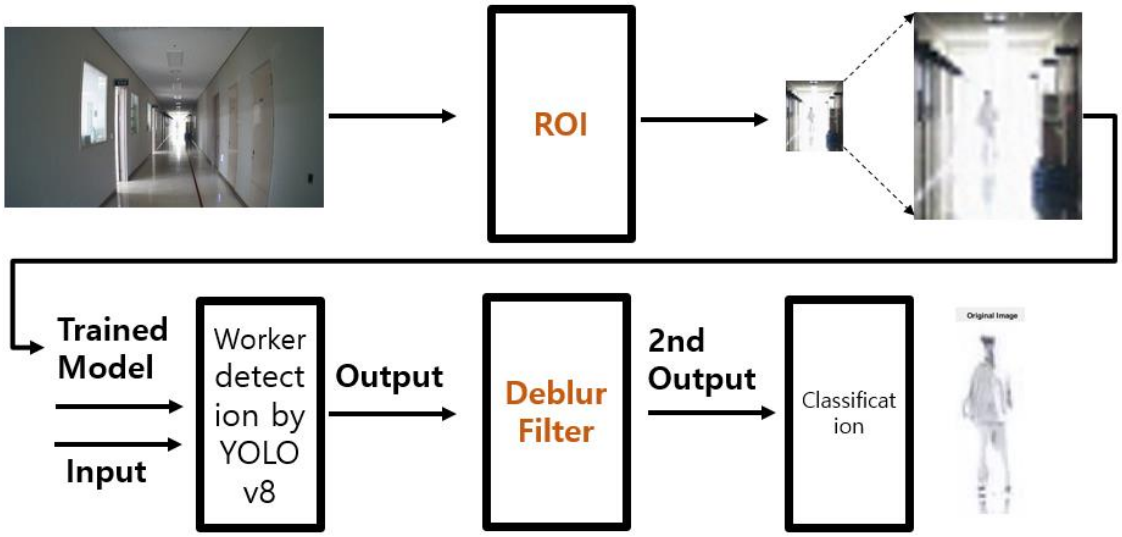

Fig. 1. Suggested system diagram

The equation represents the Wiener filter in the frequency domain, which is a mathematical tool used to restore degraded images by reducing noise and correcting blur. In this equation, the restored image is calculated using the observed image, the

system's degradation characteristics, and the noise properties. The main components are:

1. The numerator includes the complex conjugate of the system's degradation function, which helps to reverse the effects of the degradation process.
2. The denominator contains the squared magnitude of the system's degradation function, combined with the noise-to-signal ratio, which balances the influence of noise and the system's distortion.
3. The observed image's Fourier transform is multiplied by this ratio to generate the restored image in the frequency domain.

Overall, this process adjusts the observed image based on the known degradation model and noise characteristics, optimizing the image's quality. This study introduces a refinement by defining the degradation model's parameters at a pixel level, allowing for more precise image restoration.

$$\hat{F}(u,v) = \frac{H^*(u,v)}{|H(u,v)|^2 + \mathrm{NSR}} G(u,v)$$

Fig. 2. Wiener filter

Acknowledgment

This work was supported by the DGIST R&D Program of the Ministry of Science and ICT (24-IT-02)

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LangChain and RAG-Based Q&A System for University Policies

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Abstract: Large Language Models (LLMs) are widely utilized across various domains, but they often face limitations in providing accurate information for specific domains[1]. To address these challenges, this study proposes a system utilizing Retrieval-Augmented Generation (RAG) to deliver reliable and precise answers based on university policies and administrative data.
The proposed system targets university staff and students at Daegu University, aiming to provide useful answers to inquiries regarding policies and administrative matters. By employing LangChain, the system analyzes the similarity between user queries and stored data, retrieves relevant information, and generates natural responses through LLMs. This approach enables efficient handling of structured policy data, ensuring accurate and trustworthy information is delivered in real-time. Figure 1 illustrates the overall system architecture for the RAG-based Q&A system. It demonstrates how user queries are processed through the front-end interface built using Flutter, with the back-end powered by FastAPI. Data flow integrates Chroma VectorDB for embedding and document retrieval, while LangChain facilitates query analysis and response generation via LLMs. Figure 2 showcases the Daegu University Q&A system interface. It depicts the conversational flow where users input questions such as “How can I get a student ID?” and receive detailed, contextually appropriate answers in real-time. This interface demonstrates the practical application of the proposed system, providing accessible and efficient responses to policy-related inquiries. This research combines the flexibility of LangChain with the RAG method to overcome the limitations of LLMs in specific domains and offers a practical solution for Q&A systems where accuracy is critical[2]. Future studies will explore expanding the system to handle unstructured data and apply it across diverse domains.

Keywords : Large Language Models (LLMs), Retrieval-Augmented Generation, LangChain,

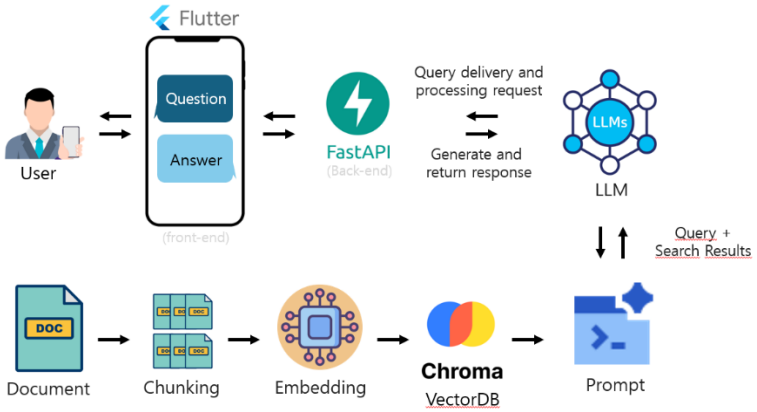

Figure.1. System Architecture for RAG-Based Q&A

Figure. 2.Daegu University Q&A System Interface

Results: The system utilizes LangChain and the Retrieval-Augmented Generation (RAG) technique to analyze the similarity between user queries and data, generating responses based on accurate and relevant information.

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AI Assistant System for Fault Ratio Analysis Using Traffic Accident Data

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Abstract: Analyzing the percentage of fault in a traffic accident is an important process for determining the liability of the parties involved and is the basis for insurance processing and legal dispute resolution. Current fault analysis methods rely on road traffic laws, accident scenario assessments, guidelines provided by property and casualty insurance associations, and case law. However, these methods are often limited by subjective interpretation, procedural complexity, and significant time and cost. They also have difficulty accounting for the many variables and specific conditions of an accident, making it difficult to make a quick and accurate assessment. To address these limitations, there is a growing demand for innovative fault analysis systems that leverage data analytics and artificial intelligence (AI) technologies. AI-based approaches can efficiently process large data sets and systematically apply legal standards and case law, resulting in more objective and consistent assessments.[1] This approach aims to overcome the limitations of existing methods and provide a more objective, consistent, and efficient fault analysis system.

In this paper, we optimize a pre-trained large-scale language model (LLM) through instruction fine-tuning [2] to analyze traffic accident fault ratio by incorporating relevant precedents and laws, such as accident scenarios, fault ratio guidelines, and road traffic laws. We also develop a system interface using FastAPI [3] to seamlessly integrate the model with a web application, and design an intuitive front-end using Svelte to enhance user accessibility. Figure 1 shows the pipeline of the traffic accident fault ratio analysis system. First, we analyzed each traffic accident case to categorize and segment the accident circumstances, percentage of fault, legal grounds, and relevant case law, and generated questions and answers that users could actually ask via chatbot 4o. The generated Q&A dataset was scrutinized and structured, and used to refine guidelines for optimizing the LLM for a specific domain. We then made the domain-adapted LLM intuitively available to users via the web.

Keywords : LLM, Instruction finetuning, FastAPI ,Svelte

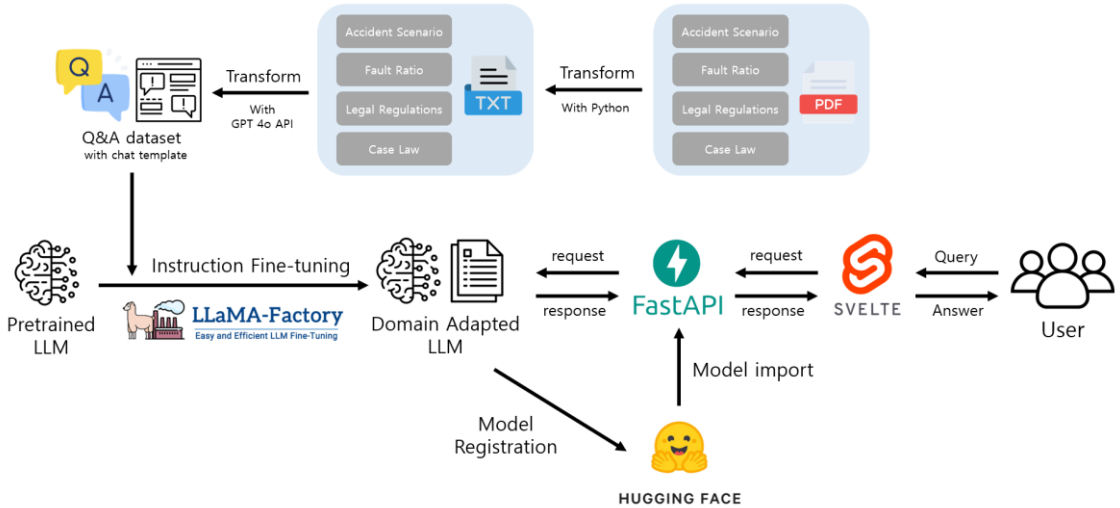

Fig. 1. Traffic accident fault ratio analysis system pipeline

Results: In this paper, we implemented a traffic accident fault ratio analysis system using LLM. By using FastAPI and Svelte platform, we made the system intuitive for users to use. Also, by training LLM with various traffic accident data, users can receive analysis from various cases.

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Airport Baggage Loading Based on Boarding Check-in Priority Using CNN-PPO

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Abstract. We propose a boarding check-in priority-based airport baggage loading system utilizing CNN-PPO. The proposed system leverages an airline passenger dataset to prioritize baggage based on passengers' seat class and check-in order. The prioritized dataset is processed through CNN-PPO to explore the optimal rotation directions and loading positions for each piece of baggage and determine its loadability. The system addresses inefficiencies in the traditional manual loading process and maximizes container space utilization, significantly improving airport logistics' operational efficiency.

Keywords; Airport Logistics, Container Loading, Deep Reinforcement Learning, CNN-PPO

1. Introduction

Baggage loading in airport logistics systems is key to maximizing space utilization and operational efficiency[1]. However, the current process often relies on workers' experience[2], leading to inefficiencies and failure to account for check-in orders, which can reduce customer satisfaction. This paper proposes a boarding check-in priority-based airport baggage loading system utilizing CNN-PPO. The proposed system prioritizes baggage using a multi-criteria sorting algorithm based on seat class and check-in order. It explores baggage rotation directions and loading positions, maximizing container space utilization and operational efficiency.

2. Priority-Based Baggage Loading System

The proposed system processes airline passenger data in the priority sorting module to arrange baggage based on seat class (Economy, Business, First) and check-in order. The sorted data is passed to the baggage rotation module, which attempts six rotation directions and evaluates loadability using the position exploration module. If loading is successful, the final baggage loading module places the baggage, awards a reward (+10), and updates the container state. If loading is impossible, a penalty (-10) is applied, and the system proceeds to the next baggage. The system configuration is shown in Fig 1.

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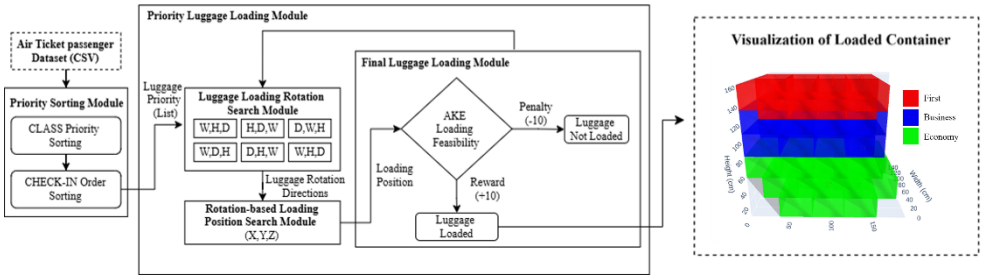

Fig 1. Priority-Based Buggage Loading System Architecture

3. Experimentation and Evaluation

This study constructed an airport baggage dataset containing baggage specifications: dimensions (width, height, depth), volume (cm³), weight (kg), seat class, and check-in order. The dataset comprises 100 samples of baggage sizes ranging from 24 to 28 inches. The container in this study was designed based on the dimensions of the AKE container model (192x153x163cm). It included a triangular cut-out at the bottom (width: 36cm, height: 54cm, depth: 153cm) to restrict the usable loading space, as illustrated in TABLE 1. The proposed system's container was divided into upper, middle, and lower sections based on seat class: First Class baggage was placed in the upper section, Business Class in the middle section, and Economy Class in the lower section. This study conducted experiments to compare the performance of PPO[3] and CNN-PPO-based loading systems by randomly dividing 100 samples into two sets of 50. The results showed that CNN-PPO achieved 62% and 92% stowage rates in the first and second experiments, respectively, while PPO achieved only 46% and 74%. The proposed CNN-PPO approach demonstrated an overall improvement of 17% in stowage rates compared to the PPO method. TABLE I presents a 3D visualization of the loading results for PPO and CNN-PPO, highlighting the enhanced space utilization achieved by the CNN-PPO system.

Additionally, an experiment was conducted to evaluate the effect of priority and rotation applications. TABLE II compares the loading results with and without priority and rotation applied. In the first experiment, the system with priority and rotation applied loaded 42 bags, while the system without application only loaded 38 bags. Similarly, in the second experiment, the applied system loaded 46 bags compared to 40 bags in the nonapplied system, demonstrating the effectiveness of incorporating priority and rotation.

TABLE I. CUTOUT and Algorithm Performance Comparison Results

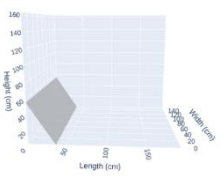	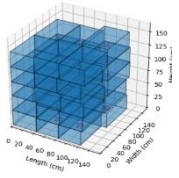	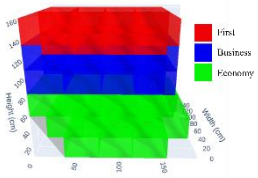
CONTAINER CUTOUT	PPO	CNN-PPO

TABLE II. Experiment on Priority and Rotation Application

	Priority and Rotation Applied	Priority and Rotation Not Applied
1st	42 Bags ($\frac{4{,}022{,}161\text{cm}^3}{4{,}788{,}288\text{cm}^3} = 84\%$)	46 Bags ($\frac{4{,}405{,}224\text{cm}^3}{4{,}788{,}288\text{cm}^3} = 92\%$)
2nd	38 Bags ($\frac{3{,}639{,}098\text{cm}^3}{4{,}788{,}288\text{cm}^3} = 76\%$)	40 Bags ($\frac{3{,}830{,}630\text{cm}^3}{4{,}788{,}288\text{cm}^3} = 80\%$)

4. CONCLUSION

We propose a check-in priority-based airport baggage loading system utilizing CNN-PPO. The experimental results of the proposed system demonstrated a stowage rate of 92%, with loading outcomes verified and visualized intuitively through 3D visualization. Future research aims to enhance the practicality of the system in real airport environments by incorporating load-balancing strategies for containers. Further experiments will be conducted using diverse container models and datasets to validate the system's scalability and optimize its performance.

Acknowledgment

This work was supported by the Ministry of Education of the Republic of Korea and the National Research Foundation of Korea (NRF-2022S1A5C2A07091326).

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Design of a Chatbot System that Provides Korean Legal Advice for Assault Victims

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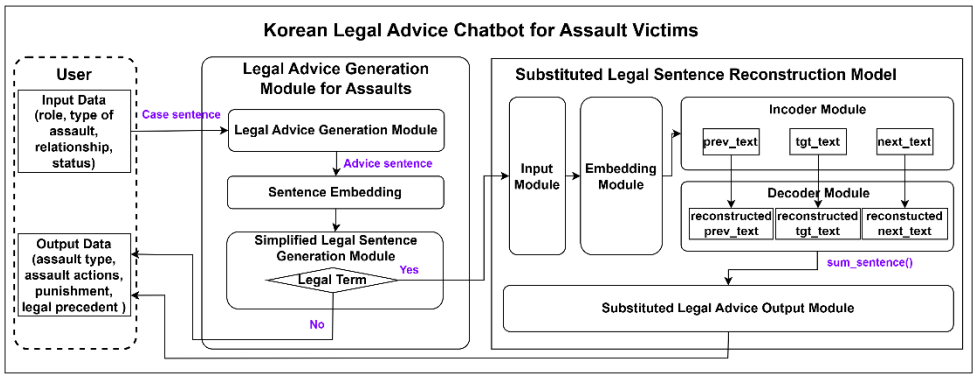
Abstract. We propose a chatbot system designed to provide Korean-language legal advice for individuals who have experienced assault. The system delivers legal recommendations reconstructed into easily understandable terms based on the user's assault-related information. We have developed a sentence restructuring model to ensure the natural context of the reconstructed legal advice.

Keywords; chatbot; legal advice; sentence reconstruction; transformer; embedding

1. Introduction

Legal services often contain terminology that is difficult for the general public to understand, making it challenging for ordinary citizens to receive appropriate assistance and incurring high costs [1]. To address this issue, we propose a chatbot system that provides Korean legal advice for individuals who have experienced assault. Our proposed chatbot simplifies legal advice sentences using legal sentence embedding. Additionally, we reconstruct sentences with unnatural contextual flow using legal sentence embedding to deliver coherent legal advice to victims.

2. Chabot that Provides Korean Legal Advice for Assault Victims



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Received:; Accepted:; Published:

Fig 1. System Architecture of a Korean Legal Advice Chatbot for Assault Victims

We developed a module for generating legal advice on assault by fine-tuning KoLlama2[2], a pre-trained Korean language model. Additionally, to identify complex legal terminology in the generated legal advice, we extract nouns and perform sentence embedding based on a legal terminology dictionary provided by the Korea Legislation Research Institute[3]. We compute the cosine similarity between embeddings of legal terms and their corresponding simpler terms. Suppose the similarity between a legal term and a simpler term exceeds 0.7. In that case, the substituted legal sentence is passed to the sentence reconstruction model, thereby transforming the legal advice into a more easily understandable form. Figure 1 illustrates the overall architecture of the proposed system. Users input data regarding their role, type of assault, relationship, and status.

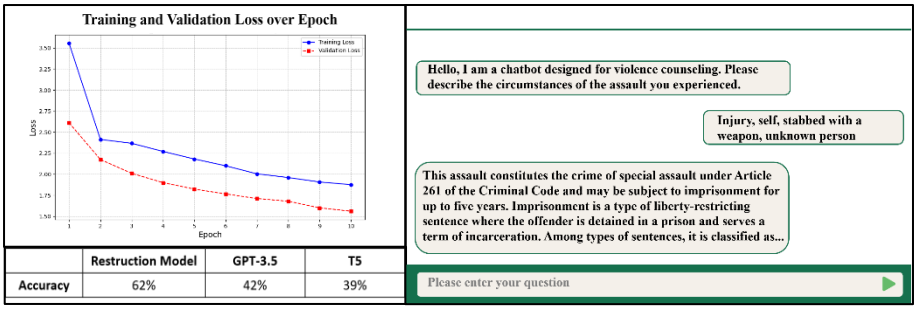
We adopted a Seq2Seq-based legal sentence reconstruction model trained on a sentence reconstruction dataset to reconstruct substituted legal sentences within a natural context. This model generates sentence embeddings to ensure contextual consistency through the encoder and decoder modules, providing coherent legal advice sentences. The encoder module sequentially inputs the preceding sentence, the target sentence, and the following sentence to understand the relationships between them. Based on this, the decoder module outputs the reconstructed preceding, target, and following sentences. During this process, the three reconstructed sentences are merged into a single coherent sentence and delivered to the user, thereby maintaining the natural flow of legal advice. This system design simultaneously enhances the accuracy and readability of legal advice, significantly improving the quality of information provided to users.

3. Experiment

The proposed system was tested using a single GeForce RTX 3090 GPU in a Windows 10 environment. We evaluated the performance of the sentence embedding module responsible for generating simplified legal sentences. The optimal results were achieved with five epochs, a learning rate of $2\,X\,10^{-5}$, a batch size of 32, and a similarity threshold of 0.7, yielding an accuracy of 95.1% and a loss of 0.089. In this study, we constructed a sentence reconstruction dataset using the "Large-Scale Korean Corpus Based on Web Data" provided by AI Hub[4]. The existing dataset groups sentences into sets of three. The ground truth labels consist of the original three sentences. In contrast, the feature labels were created by translating the target sentence of each group twice between English and Korean to disrupt the natural flow of context. This paper divides the dataset into 94,813 samples for the training dataset, 11,852 samples for the validation dataset, and 11,852 samples for the test dataset.

We experimented with the sentence reconstruction model using 10 epochs, a dropout rate of 0.1, a batch size of 8, a maximum sequence length of 128, and a learning rate of $1\,X\,10^{-4}$. The training outcomes for the sentence reconstruction model yielded a training loss of 1.8756 and a validation loss of 1.5603. Compared to standard GPT-3.5 and T5 models trained on single sentences, the sentence reconstruction model trained on three sentences achieved the highest performance with approximately 62% accuracy. Figure 2

illustrates the comparative experimental results between the substituted legal sentence reconstruction model and other models and the outcomes of the legal advice provided.



	Restruction Model	GPT-3.5	T5
Accuracy	62%	42%	39%

Fig 2. Experimental Results of the Sentence Reconstruction Model and Example Image of the Chatbot

4. Conclusion

This paper presents the design of a chatbot system that provides legal advice in Korean for assault cases. The system replaces complex legal terminology with simpler terms to enhance user comprehension. Additionally, it reconstructs substituted unnatural sentences into natural and coherent ones. Future research will focus on establishing performance metrics and evaluation frameworks for the legal terminology replacement module and the sentence reconstruction model. Moreover, subsequent studies will involve developing a sentence reconstruction dataset specialized for the legal domain.

Acknowledgment

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Assessment of Pricing-Based Demand Response Programs and Their Impact on Demand-Side Management

Abstract: Pricing-based demand response programs are pivotal in enhancing Demand -Side Management (DSM), promoting energy efficiency, and supporting renewable energy integration. This study evaluates various pricing models, including Flat-Rate Pricing, Block Tariff Systems, Time-of-Use (TOU) Pricing, Seasonal Pricing, Real- Time Pricing (RTP), Critical Peak Pricing (CPP), and Renewable Generation-Based Dynamic Pricing (RGDP). Each model's impact on DSM outcomes such as energy efficiency, peak load management, consumer behavior, and environmental sustainability is analyzed. The findings highlight TOU and CPP as effective in reducing peak demand, while RTP and RGDP offer optimal load management but require advanced infrastructure. These models show potential in aligning consumption with renewable energy availability. Challenges such as infrastructure requirements, consumer awareness, and regulatory frameworks are discussed. Recommendations are provided for optimizing these models in developed and developing countries to achieve sustainable energy systems.

1 Introduction

Modern energy systems are increasingly challenged by rising energy demand, the variability of renewable energy sources, and the imperative for sustainability [1]. Demand-Side Management (DSM) offers a strategic solution to these issues by modifying energy consumption patterns to enhance grid efficiency, reduce greenhouse gas emissions, and facilitate the integration of renewable energy sources. By reducing peak loads and improving energy efficiency, DSM minimizes the need for additional power generation, especially from fossil fuels, and contributes significantly to decarbonization goals. According to the World Resource Institute, 61.4% of global greenhouse gas (GHG) emissions is the result of energy-related activities [2]. Additionally, DSM supports the adoption of renewable energy by aligning energy usage with periods of high renewable generation, stabilizing the energy system while reducing environmental impacts. A key component of DSM is the use of Demand Response Programs (DRPs) [3], which actively engage consumers in modifying their energy consumption behaviors. These programs employ mechanisms such as pricing incentives or direct controls to enhance grid flexibility and reliability. Overall the literature categorized DSM into two classifications fig 1 [4] [5]:

1) Demand response (DR) provides the platform for end -users to alter load consumption patterns in response to a price change of electricity over a period, thereby reducing the overall peak of the system.[6]
2) Energy efficiency emphasizes persuading consumers to utilize efficient products as a means of reducing demand. [7] [8]

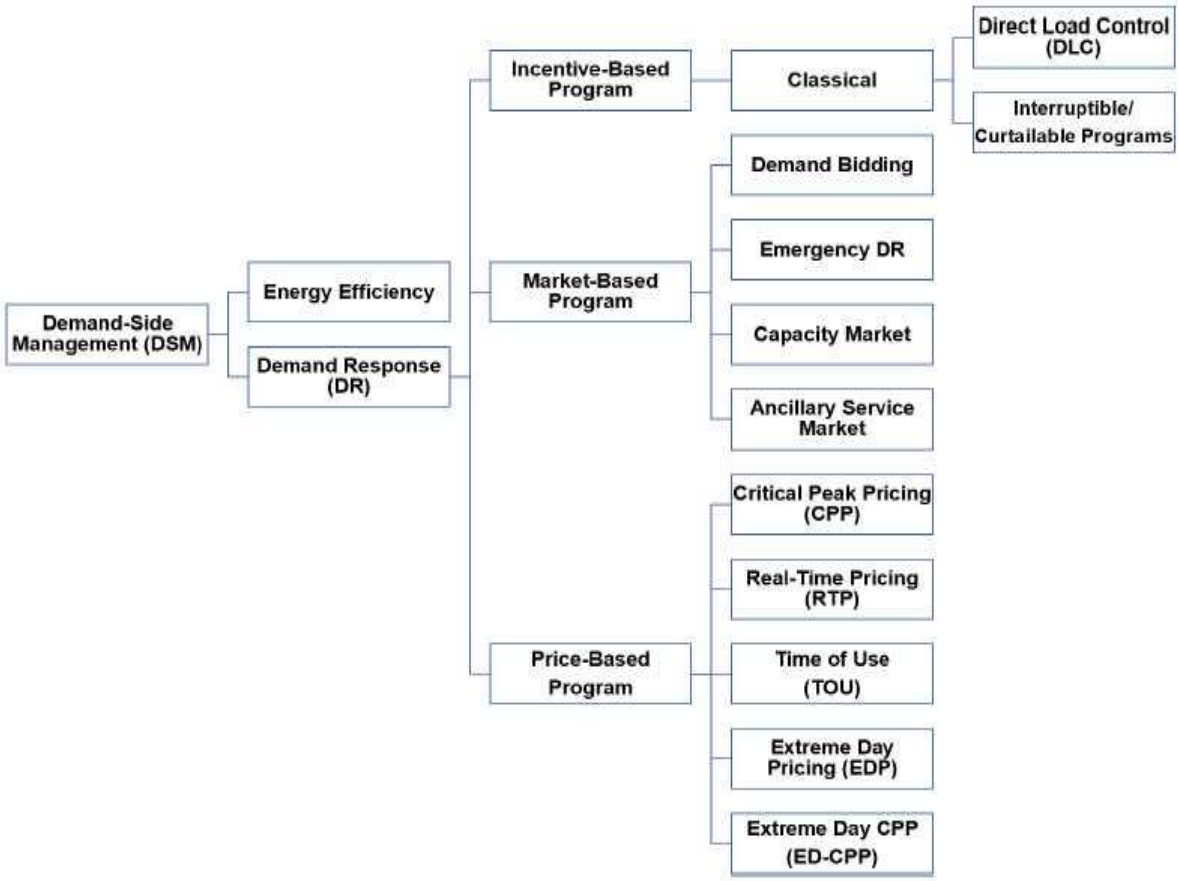

Figure 1:Classification of Demand-Side Management

DR programs are divided into incentive-based and price-based [4]. In the incentive-based program, classical program customers receive bill credit or discount rates for participating in the programs while market-based customers receive a reward for load reduction. Price-based programs are utilized to flatten the demand curve by providing high prices during peak periods and lower prices during the off-peak period [4].

Among the various DSM strategies, pricing-based approaches have proven particularly impactful. By leveraging economic incentives, they effectively drive behavioral changes, making them scalable and cost - effective tools for both utilities and consumers. Such approaches are especially vital in systems with a high penetration of renewable energy, where consumption needs to align with the variable supply.

Pricing-Based Demand Response Programs (DRPs) [3] are designed to influence consumer behavior through dynamic pricing models. These programs aim to encourage load shifting, reduce peak demand, and improve energy efficiency by offering financial incentives or cost penalties. Through temporal or volumetric changes in electricity tariffs, Pricing-Based DRPs provide consumers with tangible economic motivations to adjust their consumption patterns. Pricing models include flat-rate pricing, block tariff systems, time-of-use (TOU) pricing, real-time pricing (RTP), seasonal pricing, critical peak pricing (CPP), and renewable generation-based dynamic pricing

(RGDP). Each of these models has unique features and applications, catering to different energy system requirements and consumer contexts.
This paper seeks to evaluate the impact of various pricing models−Flat-Rate, Block Tariff, TOU, RTP, Seasonal, CPP, and RGDP−on DSM outcomes. It aims to compare the suitability of these models across developed and
developing countries, highlighting the specific challenges and benefits they offer in different contexts. Furthermore, the study provides insights into optimizing these pricing models to enhance grid management, engage consumers, and promote sustainability.

2 Literature Review

The role of pricing-based demand response programs in modernizing energy systems and achieving sustainability goals is well-documented in existing literature. These programs have proven effective in modifying consumer behavior, reducing peak demand, and integrating renewable energy sources. However, their success is contingent upon the choice of pricing model and the context of its application. [9]

Flat-rate pricing, while straightforward and easy to implement, lacks the flexibility to incentivize behavioral changes. It remains prevalent in regions with limited metering infrastructure, particularly in developing countries. In contrast, block tariff systems, which charge progressively higher rates as consumption increases, encourage conservation among high-usage consumers. However, these systems often face criticism for disproportionately impacting larger households or businesses.

Time-of-Use (TOU)pricing divides the day into peak and off-peak periods, offering lower rates during off-peak times to incentivize load shifting. Studies from countries like the U.S. and the UK highlight the success of TOU programs in reducing peak demand and integrating renewable energy. However, these programs require advanced metering infrastructure and consumer awareness, which are often inadequate in developing regions. Seasonal pricingadjusts tariffs during high-demand periods, such as summer, to reflect increased energy consumption. While effective in managing seasonal load variations, it can lead to consumer dissatisfaction due to higher energy bills during peak seasons.

Real-Time Pricing (RTP)aligns electricity prices with real-time market conditions, offering dynamic incentives for consumers to adjust their usage. It has proven effective in markets with sophisticated metering and communication systems, such as the U.S., but its high implementation costs limit its feasibility in resource- constrained regions. Similarly,Critical Peak Pricing (CPP), which imposes significantly higher rates during critical demand periods, provides a strong incentive to reduce consumption. However, its success relies heavily on effective communication to prevent consumer dissatisfaction.

Renewable Generation-Based Dynamic Pricing (RGDP)ties electricity prices to the availability of renewable energy, encouraging consumption during periods of high renewable output. This model supports the integration of renewable energy into the grid but requires accurate forecasting and significant grid flexibility.

Implementation challenges [10] include the limited availability of advanced metering and communication infrastructure, low consumer awareness, and inconsistent regulatory frameworks. Despite these hurdles, pricing- based DRPs offer substantial benefits, such as reducing greenhouse gas emissions, facilitating renewable energy adoption, and enhancing grid reliability. The literature

emphasizes the need to address these challenges to optimize the effectiveness of pricing-based DRPs across diverse contexts.

Summary of Challenges and Benefits:

Category	**Challenges**	**Benefits**
Infrastructure	Limited advanced metering and communication systems in developing regions.	Facilitates precise billing and real-time consumer engagement.
Consumer Awareness	Resistance to behavioral changes; low understanding of pricing models.	Enhance energy efficiency and reduces costs for informed consumers.
Regulatory Frameworks	Inconsistent policies and lack of supportive regulations in some regions.	Creates opportunities for innovative energy management solutions.
Economic Constraints	High implementation costs; subsidized tariffs reducing economic appeal for utilities.	Offers potential cost savings for utilities by reducing peak demand and avoiding extra capacity.
Environmental Impact	Risk of consumer dissatisfaction if programs are not well-designed or communicated.	Contributes to lower greenhouse gas emissions and supports renewable energy adoption.

Despite these challenges, Pricing-Based DRPs offer significant benefits. They effectively reduce peak load, as evidenced by the success of TOU and CPP programs. These models also facilitate the alignment of energy consumption with renewable generation, particularly through RGDP and TOU pricing. Consumers benefit from cost savings, while utilities reduce expenses associated with additional power generation capacity. Furthermore, these programs contribute to environmental sustainability by lowering greenhouse gas emissions through decreased reliance on fossil fuels.

This analysis highlights the critical role of Pricing-Based DRPs in achieving efficient and sustainable energy systems. By addressing implementation challenges, these models can be optimized for broader applicability and greater impact across diverse energy contexts. [11]

Pricing Model	Infrastructure Challenges			Consumer Awareness Challenges			Regulatory Challenges			Economic Constraints			Communication Challenges			Data Challenges		
Examples	Advanced metering	renewable forecasting tools	reliable grid communication	Low understanding of pricing models	dissatisfaction with high bills	resistance to behavioral changes	Lack of policies	renewable energy integration	critical event management	High setup costs	unfair pricing perceived by consumers	issues with subsidized electricity tariffs	Difficulty conveying dynamic price changes	critical peaks	renewable-based variations in a timely manner	collecting	analyzing	sharing
Flat-Rate	N	N	N	N	N	N	N	N	N	P	N	N	N	N	N	N	N	N
Block Tariff	P	N	N	P	P	P	P	P	N	P	P	P	N	N	P	P	P	P
TOU	P	N	P	M	M	M	P	P	P	P	P	P	P	P	M	M	M	M
RTP	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Seasonal	P	N	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
CPP	M	N	M	M	M	M	P	P	M	P	M	M	M	M	M	M	M	M
RGDP	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M

- **N**: Negligible challenge **P**: Partial challenge **M**: Major challenge

Challenge	Flat-Rate	Block	Seasonal	TOU	RTP	CPP	RGDP
Infrastructure	Minimal	Basic tiered metering	Basic forecasting	Time-sensitive meters	Advanced systems	Advanced systems	Advanced systems
Consumer Awareness	None	Moderate	Moderate	Moderate	High	High	High
Regulatory Frameworks	None	Moderate	Moderate	Moderate	Major	Major	Major
Economic Constraints	Negligible costs	Moderate costs	Moderate costs	Moderate costs	High	High	High
Communicatio	Minimal	Minimal	Moderate	Moderate	High	High	High
Data	Minimal	Moderate	Moderate	Moderate	High	High	High

3 Methodology

This study employs a structured methodology to evaluate the effectiveness of various pricing models in Demand-Side Management (DSM). The analysis focuses on seven distinct pricing models: Flat -Rate Pricing, Block Tariff System, Time-of-Use (TOU) Pricing, Seasonal Pricing, Real-Time Pricing (RTP), Critical Peak Pricing (CPP), and Renewable Generation-Based Dynamic Pricing (RGDP). These models are analyzed to understand their potential in improving energy efficiency, managing peak demand, and influencing consumer behavior to align with grid needs.

To ensure a comprehensive evaluation, the study considers several critical aspects of each pricing model, including infrastructure requirements, their impact on consumer behavior, and scalability across diverse energy systems. This balanced approach addresses both technical and social factors, highlighting how each model performs under varying circumstances.

To test the different pricing models in a constant system, it's essential to define a set of parameters and assumptions that allow for a fair comparison across all pricing models. These constants will help model energy consumption, pricing, and the various metrics you plan to evaluate. Below is a proposed constant system that you can use to test and simulate the different pricing strategies effectively:

3.1 Energy Demand Profile

● Average Daily Consumption: 20 kWh (This can be adjusted based on the case study, but should remain
constant for comparison across pricing models)

● Peak Demand: 4 kW (This represents the highest consumption at any given time)

● Load Profile: A typical daily load curve generated by the bottom-up approach household profile algorithm, with peak hours in the morning (7 AM to 9 AM) and evening (5 PM to 8 PM), and lower demand overnight and midday. This curve will be used to simulate consumer behavior based on the pricing models.

● Energy Efficiency: Assume a constant 90% efficiency for the energy conversion system, which could be based on the efficiency of existing grid infrastructure or in a typical home with standard appliances.

3.2 Pricing Model Parameters

For each pricing model, the specific pricing structure should be applied as follows [12]:

Flat-Rate Pricing:

- Price per kWh: $0.12 (constant rate for all hours)
- Assumption: No variation in price, and consumption is based purely on energy usage.

Block Tariff System:

- Price for First 100 kWh: $0.10 per kWh
- Price for Next 100 kWh: $0.15 per kWh
- Price for Above 200 kWh: $0.20 per kWh
- Assumption: Consumption is tiered, and users are encouraged to reduce their energy consumption to stay within lower blocks.

Time-of-Use (TOU) Pricing:

- Off-Peak Price: $0.08 per kWh (10 PM to 6 AM)
- Peak Price: $0.20 per kWh (6 AM to 10 AM, 5 PM to 9 PM)
- Shoulder Price: $0.12 per kWh (remaining hours)
- Assumption: Consumers are incentivized to shift consumption away from peak hours and into off -peak times.

Real-Time Pricing (RTP):

- Dynamic Price Range: $0.06 to $0.25 per kWh, depending on grid conditions (prices will change every 15 minutes based on supply-demand balance)
- Assumption: Real-time pricing reflects current grid conditions, encouraging consumers to adjust behavior dynamically based on price fluctuations.

Seasonal Pricing:

- Winter Price: $0.10 per kWh (November to March)
- Summer Price: $0.20 per kWh (June to September)
- Spring/Fall Price: $0.12 per kWh (March to May, September to November)
- Assumption: Pricing is based on seasonal demand changes, encouraging conservation in peak-demand seasons.

Critical Peak Pricing (CPP):

- Normal Price: $0.12 per kWh (typical rate)
- Critical Peak Price: $0.50 per kWh (during a predefined critical event, such as a grid emergency or extreme demand period)
- Assumption: CPP pricing is used during specific events to reduce peak demand and protect grid stability. The high price during critical peaks encourages consumers to reduce consumption.

Renewable Generation-Based Dynamic Pricing (RGDP):

● Renewable-Abundant Price: $0.05 per kWh (when renewable generation exceeds 50% of total supply)
● Renewable-Scarce Price: $0.15 per kWh (when renewable generation is below 20% of total supply)
● Assumption: Prices fluctuate based on the availability of renewable energy in the system, encouraging consumers to use more energy when renewable generation is high.

3.3 Constant Parameters for All Models

● Total Energy Consumption: Fixed at 20 kWh/day for comparison..
● Peak Demand: Fixed at 4 kW, modeled during peak hours (6 AM–9 AM and 5 PM–8 PM).
● Consumer Type: Residential consumers, with average daily consumption based on typical household behavior.
● Grid Stability Measures: Focus on the effect of each pricing model on reducing peak demand and improving overall grid reliability. [13]

3.4 Simulation and Data Collection

1.Simulations:Theoretical modeling of energy consumption and pricing over one year using constant parameters.
2.Real-World Data:Validation with case studies and pilot project data to incorporate real-world challenges.
3.Consumer Surveys:Insights into satisfaction and behavioral responses from demand response program participants.
4.Cost-Benefit Analysis:Detailed comparison of implementation costs and long-term benefits.

3.5 Testing and Comparison

Each pricing model will be simulated with these constant parameters to generate results based on the evaluation metrics. The final step involves comparing the effectiveness of each model based on the metrics, leading to recommendations on the most suitable model for different energy systems.

The effectiveness of each pricing model is measured using key metrics. These includeEnergy Efficiency, which assesses reductions in overall energy consumption,and Peak load reduction, which evaluates the model's ability to manage demand during critical periods. Other metrics includeConsumer Cost Savings, reflecting financial benefits to participants;Consumer Satisfaction, gauging acceptance and willingness to engage; andGrid reliability improvements, measuring contributions to grid stability. Additionally, theEase of implementationis assessed to determine the feasibility of deploying each model, including cost and regulatory considerations.Environmental benefits, such as reductions in greenhouse gas emissions and support for renewable energy integration, are also factored into the evaluation.

3.5.1 Evaluation Metrics Setup

● Energy Efficiency: This will be evaluated based on the reduction in energy consumption in response to pricing signals. A standard baseline consumption profile will be used to assess how different pricing models impact overall energy use.
● Peak Load Reduction: This is tested by comparing the reduction in peak demand (from baseline)

under each pricing model. Consumers will be simulated to shift usage away from peak hours based on price incentives.

● Consumer Cost Savings: This is measured by calculating the total energy cost for a fixed amount of energy consumption under each pricing model.

● Consumer Satisfaction: This can be inferred from the stability of the pricing structure and ease of understanding. For example, Flat-Rate Pricing might score higher for simplicity, while RTP may face consumer frustration due to price volatility.

● Grid Reliability: This will be measured by evaluating how well each pricing model reduces demand during peak periods and manages grid stability.

● Ease of Implementation: This involves evaluating the technical complexity, costs, and feasibility of implementing each pricing model (i.e., smart meters, software, infrastructure, etc.).

● Environmental Benefits: Calculated by evaluating the overall reduction in emissions or the increased integration of renewable energy achieved through each model's impact on consumer behavior.

3.5.2 Strengths and Weaknesses

Flat-Rate Pricing, Block Tariff System, Time-of-Use (TOU), Real-Time Pricing (RTP), Seasonal Pricing,

Critical Peak Pricing (CPP), and Renewable Generation-Based Dynamic Pricing (RGDP).

Pricing Model	Description	Benefits	Challenges
Flat-Rate	Fixed rates regardless of time or usage.	Simple to implement; common in areas with limited metering infrastructure.	Provides no incentive for behavior change; inflexible.
Block Tariff	Charges progressively higher rates as consumption increases.	Encourages conservation among high-usage consumers.	May disproportionately affect larger households or businesses, causing dissatisfaction.
TOU	Different rates for peak and off-peak hours to encourage load shifting.	Reduces peak loads; supports renewable integration; proven success in developed countries like the U.S. and UK.	Requires advanced metering and consumer awareness, often lacking in developing countries.
RTP	Prices vary dynamically based on real-time supply-demand conditions.	Aligns consumption with market conditions; effective in markets with sophisticated systems (e.g., the U.S.).	High implementation costs; requires advanced metering and communication systems.
Seasonal	Adjusts tariffs during high-demand seasons, such as summer.	Manages seasonal demand fluctuations effectively.	Leads to higher consumer bills during peak seasons, causing potential dissatisfaction.
CPP	Imposes significantly higher rates during critical demand periods.	Strong incentive to reduce usage during grid stress; effective for managing peak demand.	May be perceived as punitive if not communicated effectively.
RGDP	Prices linked to renewable energy availability, encouraging consumption when renewable output is high.	Supports renewable integration; aligns consumption with renewable generation periods.	Requires accurate forecasting and grid flexibility; complex to implement.

4 Discussion

4.1.1 Key Findings

The comparative analysis of pricing-based demand response programs reveals distinct strengths and challenges for each pricing model in achieving Demand-Side Management (DSM) objectives. Time-of-Use (TOU) pricing emerges as a reliable method for reducing peak demand and supporting renewable integration. However, its effectiveness is constrained in regions with limited advanced metering infrastructure and low consumer awareness. Real-Time Pricing (RTP) demonstrates significant potential in aligning consumption with grid conditions, but its complexity and high implementation costs restrict its feasibility in developing regions. Critical Peak Pricing (CPP) effectively incentivizes demand reduction during grid stress but risks consumer dissatisfaction if poorly communicated.

Renewable Generation-Based Dynamic Pricing (RGDP) aligns consumption with renewable energy availability, promoting environmental benefits and renewable energy integration. However, it requires accurate forecasting and a flexible grid infrastructure. Seasonal pricing helps manage seasonal demand variations but may lead to consumer resistance due to increased costs during high-demand periods. Block tariff systems and flat-rate pricing remain simpler alternatives but lack the dynamic features necessary for advanced DSM objectives.

4.1.2 Contributions to DSM Goals

The pricing models contribute to DSM goals in varying degrees:

1.Energy Efficiency:

● Models like TOU and RTP effectively encourage consumers to adopt energy-efficient practices, reducing overall energy consumption.

2.Peak Load Management:

● CPP and TOU excel in reducing peak loads, enhancing grid reliability.

3.Consumer Engagement:

● Transparent and adaptive pricing structures, such as RGDP and TOU, increase consumer participation and satisfaction.

4.Environmental Sustainability:

● RGDP and TOU pricing facilitate the integration of renewable energy, contributing to reduced carbon emissions.

5 Conclusion

This comparative analysis underscores the significant role pricing-based demand response programs play in achieving DSM objectives and sustainable energy systems. Among the pricing models, TOU and CPP emerge as practical approaches for managing peak demand, while RTP and RGDP demonstrate potential for enhancing grid flexibility and integrating renewable energy. However, their implementation requires advanced infrastructure and consumer engagement to ensure effectiveness. Addressing the challenges of infrastructure limitations, consumer awareness, and regulatory inconsistencies is critical to optimizing these models across diverse energy contexts. Future research should explore combining pricing strategies and leveraging technologies like artificial intelligence for dynamic optimization to further enhance the efficacy of DSM initiatives. These advancements will support a transition to energy systems that are efficient, reliable, and environmentally sustainable.

6 References

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10:50 ~	Session 9: Intelligent Methods, and Innovations in Energy Management Chair: Jong Tak Ryu (Daegu Univ.)	
	9S-1 [017]	**A Comparative Study on Analyzing Neural Network Models for Detecting Network Anomalies Using a Tabular Dataset** *Kiko Onishi[1)] , Aryan Shah[1)] , and Donghwoon Kwon[1*)]* *1) Dept. of Computer Science and Engineering, North Central College, Naperville, IL 60540, USA*
	9S-2 [024]	**Development of an Efficient and Stable Numerical Scheme** *Seoungejae Lee[1)] and Yongho Choi[2*)]* *1) Dept. of IT Convergence Engineering, Daegu University, Gyeongsan-si, Gyeonsangbuk-do 38453, Korea* *2) Dept. of Computer & Information Engineering, Daegu University, Gyeongsan-si, Gyeonsangbuk-do 38453, Korea*
	9S-3 [043]	**Advanced Battery Management Method For Energy-Transportation Network** *Bharath.M[1)] and Gomathi.E[1)]* *1) Department of Petrochemical Technology, University College of Engineering- BIT Campus, Anna University, Trichy*
	9S-4 [040]	**Design of a System to Prevent Elopement Behavior for Students with Developmental Disabilities** *Woosoon Jung[1)] , KyoungOck Park[2)] , and Jeong Tak Ryu[3*)]* *1) Institute of Special Education & Rehabilitation Science, Daegu University, Gyeongsan-si, 38453, Korea* *2) Dept. of Elementary Special Education, Daegu University, Gyeongsan-si, 38453, Korea* *3) Dept. of Electronic and Electrical Engineering, Daegu University, Gyeongsan-si, 38453, Korea*
	9S-5 [037]	**Study on Current, Voltage, and Torque Measurement Systems for Quality Inspection of Induction Motors** *Seung Kwang Ryu[1)] , Byung Seop, Song[2)] , Jeong Tak Ryu[3*)]* *1) Graduate School of Smart Convergence Systems Engineering, Daegu University, Korea* *2) Department of Medical Rehabilitation, Daegu University, Korea* *3) Department of Electric Engineering, Daegu University, Gyeongsan 38453, Republic of Korea*
	9S-6 [047]	**Development of Simulated Neutron Signal Generation Algorithm for Small Modular Reactor** *Daeil Lee[1)], Joon-ku Lee[1)], Kwang-il Jeong[1)]and Hyeong-seok Eun[1)]* *1) Korea Atomic Energy Research Institute, Daejeon, 34057, Republic of Korea*

A Comparative Study on Analyzing Neural Network Models for Detecting Network Anomalies Using a Tabular Dataset

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Abstract: This research investigates the performance of four neural network models using a tabular network intrusion detection dataset named HIKARI-2021, consisting of normal and attack instances. Our experimental results reveal that the TabNet model was the best at detecting normal instances, resulting in the highest F1 score (93.29%), but the XGBoost model tended to be the best at detecting attack instances.

Keywords : Neural networks, TabNet, network anomaly detection, machine learning, deep learning

I. INTRODUCTION

Various neural network models have been proposed to detect network anomalies using public network datasets such as KDD99, NSL-KDD, CICIDS, etc. [1]. The neural network models mentioned here refer to conventional machine learning models such as Decision Trees (DT), Random Forests (RF), etc., or deep learning models such as Multi-Layer Perceptron (MLP), Convolutional Neural Networks (CNN), Recurrent Neural Networks (RNN), etc. The datasets mentioned above have one thing in common: all labels are well balanced, leading most machine learning or deep learning models to perform very well on them. In this study, we use the HIKARI dataset, which exhibits imbalanced characteristics, to compare and analyze the performance of the TabNet model, known for its effectiveness on tabular datasets, against conventional machine learning models[2]. Therefore, the following main research question is established: *Does the TabNet model outperform conventional machine learning models when using the imbalanced dataset for network anomaly detection?*
For extensive experiments, we initially employ three conventional machine learning models, i.e., DT, RF, and XGBoost.

II. METHODOLOGY

As the first step, a total of six labels, such as Benign, Background, Bruteforce, Bruteforce-XML, Probing, and XMRIGCC CryptoMiner, in the Hikari dataset are classified into normal and attack labels. The classified dataset is then divided into the training and testing datasets based on an 80/20 rule and normalized by a standard scaler. With the preprocessed dataset, the default configuration of each conventional machine learning model and the TabNet model is adopted. Regarding the TabNet model, there are two main phases: pretraining in an unsupervised way and fine-tuning in a supervised learning way.

* Corresponding Author[1*)] Author 3;

1. Pretraining: This component trains the model in an unsupervised way first to learn a feature representation of the given datasets. This pretraining phase can enhance the model performance during the fine-tuning phase.
2. Fine-tuning: Unlike the pretraining phase mentioned above, this phase focuses on fine-tuning the model with actual labels in a supervised way. By doing so, the model could be optimized and show improved classification performance.

We decided to skip the pretraining phase in the TabNet model for objective comparison analysis due to the sufficient number of data labels and because the other three conventional models do not have the pretraining phase.

III. EXPERIMENTS

The performance of each neural network model is evaluated by *F*-measure and the confusion matrix using the preprocessed Hikari dataset, and Table 1 below summarizes the models' performance.

Table 1: Summary of Model Performance

Models	*F*-Measure	True Positive	True Negative	False Positive	False Negative
DT	0.8789	573	97,038	6,478	6,967
RF	0.8841	897	97,289	6,227	6,643
XGBoost	0.9266	1,648	101,260	2,256	5,892
TabNet	0.9329	650	102,958	558	6,890

IV. DISCUSSION

The experimental results we obtained are quite interesting. The TabNet model achieved the highest *F1* score, attributed to its ability to detect the most normal labels compared to the three other models. Yet, in terms of overall model performance that detects normal and attack labels, the XGBoost model showed the best performance, even if its *F1* score is slightly lower than that of the TabNet model. Another interesting observation we made is that, although the TabNet model is known for its excellent performance on tabular datasets, it does not significantly outperform conventional neural network models in detecting minor labels (in this case, the attack label), particularly when dealing with an imbalanced dataset.

V. CONCLUSION

In this research, we investigated the performance of the TabNet model compared to conventional neural networks using the imbalanced dataset. Unlike its main characteristic, which works well on a tabular dataset, the TabNet model does not outperform conventional neural network models in detecting minor labels in the imbalanced dataset. Thus, we plan to extend our observations to improve the TabNet model performance by investigating the possibility of adopting the pretraining phase.

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Development of an Efficient and Stable Numerical Scheme

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Abstract: The complex computations of partial differential equations lead to high computational cost in terms of runtime. Therefore, research aimed at reducing runtime is an important part of applied mathematics, and many method have been proposed[1,2,3]. In our previous study [4], we proposed a five-point stencil CNN(FCNN) algorithm for efficient and accurate numerical computation of the Laplacian operator. We numerically solve the Allen-Cahn(AC) equation using the explicit finite difference method and demonstrate that the proposed method is more efficient than previous methods. However, the explicit method limits the time step size(Δt), i.e., stability cannot be guaranteed when a large time step size is used. In this paper, we propose an FCNN algorithm to solve the AC equation using an unconditionally stable scheme. To demonstrate this, we solve the AC equation for various time step sizes using the FCNN algorithm we proposed and compare it with the explicit scheme. In addition, we compare the runtime of the simulation for the proposed algorithm and the previous method.

Keywords : Allen-Cahn equation, Unconditionally stable scheme, Convolution, Padding

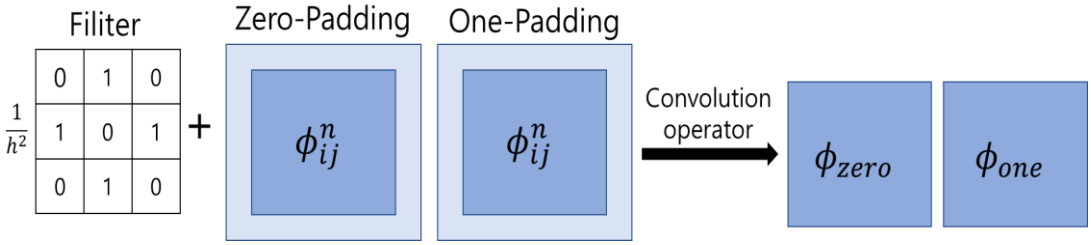

Fig. 1. Structure used to implement the modified form.

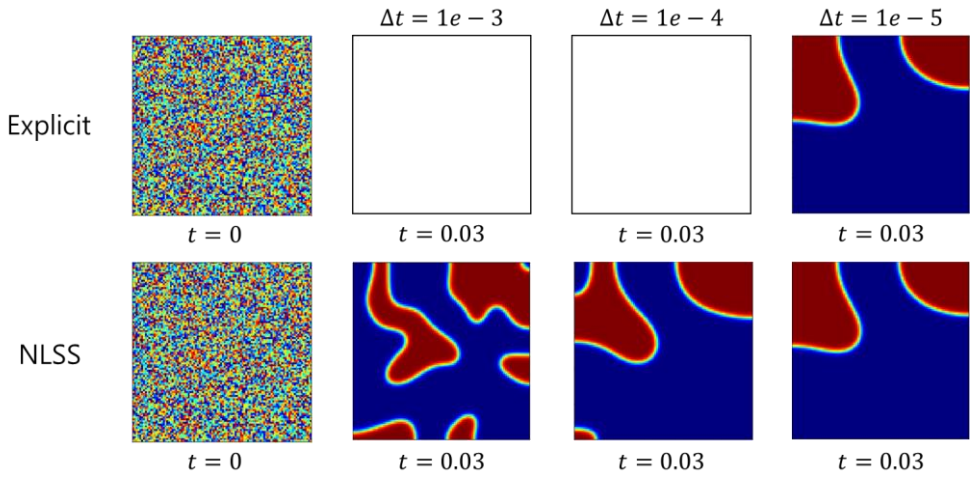

Fig. 2. Result of the stability test.

Acknowledgment

This research was supported by Basic Science Research Program through the National Research Foundation of Korea(NRF) funded by the Ministry of Education(2022R1I1A3072824).

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ADVANCED BATTERY MANAGEMENT METHOD FOR ENERGY-TRANPORTATION NETWORK

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Abstract: Grid-connected Electric Vehicles (GEVs) and the energy-transportation network offer encouraging prospects for boosting the adoption of renewable energy sources and Micro-Grid (MG) economics. However, the complicated battery aging mechanism and unpredictable MG statuses make it difficult to identify the best Vehicle-to-Grid (V2G) options. This study uses a unique Deep Reinforcement Learning (DRL) framework with model-free prediction and control to construct a novel online battery anti-aging energy management solution for the energy-transportation network. By simulating the effects of cycle count, discharge depth and charge and discharge rate, the quantification of aging cost in V2G strategies is accomplished using rain-flow cycle counting technology and battery aging characteristic analysis. The efficiency of agent actions to prevent aging in batteries is assessed using the standard life loss model. A DRL method is used to describe multi objective learning for GEV charging coordination. Maximizing the use of renewable energy sources while lowering MG power variations and car battery aging expenses is the goal of the training. On an MG in the world countries, the created energy-transportation network energy management approach has been confirmed to be successful in providing optimal power balance and battery anti-aging control. Through the perfect coordination of GEV charging and renewable energy, this paper offers a cost-effective and efficient technique for MG power balancing, hence supporting a low cost decarbonisation transition.

Key Words: GEVs, MG, V2G, DRL.

1. INTRODUCTION

According to renewable energy, it offers a promising solution to environmental issues, but power networks face significant obstacles as a result of its widespread use. Micro-grids(MG) can improve the dynamic interactions between load demand and renewable energy sources because of their comparatively low transmission voltage [1]. However, MG's power balance is challenging to maintain because of the intermittent nature of renewable energy and demand fluctuations, and the mismatch may result in sudden, short-term power fluctuation problems. Adding more reserve power generation, energy storage devices, and advanced power management techniques are examples of conventional MG power balancing solutions that, to some extent, fall short in terms of economics, stability, or dependability [2], [3]. A promising solution to MG's power balance issues is provided by the electrification of road vehicles and the energy-transportation nexus idea [4]. By postponing their need in space and time, grid-connected electric vehicle (GEV) onboard batteries can provide a way to increase MG flexibility and achieve continuous operation by serving as mobile storage units. Through vehicle-to-grid (V2G) regulation, GEV batteries are utilized in [5]–[7] to supply peakshaving, voltage regulation, and frequency regulation services. The findings of simulations and experiments show that using the movable energy storage capacity offered by GEVs can greatly improve energy quality and system stability when charging management techniques are implemented effectively. V2G services are also utilized in [8] and [9]

to assist with the operation of solar and wind power generating. With the penetration of renewable energy, GEV batteries can be utilized to supply power balancing services and enhance the MG's stability and economy. The cost of GEV battery life loss as a result of delivering V2G service is still a barrier to the widespread usage of vehicle batteries. When MG uses renewable energy and battery energy storage, the situation gets worse since the battery may experience too many short circuit [10]. The development of the life loss analysis model is crucial for grid energy storage systems [13], hybrid powertrains [12], and battery energy management in electric vehicles [11]. In order to guide battery energy management and provide a life-cycle cost analysis tool in the energy-transportation nexus, the quantified battery aging cost can be employed as a benchmark of degradation-oriented mode of operation. Quantifying battery aging costs in energy management has been the subject of numerous studies. One of the most popular techniques for protecting car batteries in the literature currently in publication is the single-factor bucket model [14]. An event-based scheduling approach for optimum GEV charge management is developed in [15]. In order to mitigate the aging of GEVs in V2G services, complex battery aging models have been shown to be both essential and effective [14]. A model of battery aging that incorporates temperature effects, When offering V2G services, C-rate, state of charge (SoC), and DoD are integrated [17] to reduce the anticipated customer's charging cost. The best techniques are derived by stochastic optimization, and simulation results confirm that the battery antiaging performance is excellent. However, the implementation of intricate aging models and extensive optimization techniques complicates the V2Gmodel, further impairing the real-time performance of the scheduling system [18]. Comprehensive battery aging models and heuristic methods are used in [19] and [20] to mitigate aging expenses in V2G services. According to simulation studies, it is possible to effectively lower the expenses associated with battery depreciation. However, even with the most sophisticated computing equipment, the optimization-based V2G scheduling interval is only able to be reduced to 5 minutes, making it difficult to suppress oscillations in renewable energy and transitory MG demand. Using a DRL framework, this paper creates a unique online battery protective energy management technique for the energy-transportation nexus. First, the degradation cost in V2G scheduling is designed as a function of battery NoC, DoD, and C-rate using rain-flow cycle counting technology and battery deterioration characteristic analysis. The battery anti-aging efficacy of V2G techniques in DRL is assessed using the well-established aging cost model. Next, using the DRL framework, multiobjective learning is used to model the coordination of GEV charging. Maximizing renewable penetration while lowering vehicle battery aging costs is the DRL model's training goal. An experience pool is created using historical MG power balance and GEV battery conditions, and the trained DRL model is used to schedule the online charging and discharging procedures. With the established technique to absorb renewable energy while minimizing the phenomenon of vehicle battery aging in V2G service, the energy storage capacity of GEVs may be scheduled online.

II. ADVANCED MODEL FOR QUANTIFICATION OF BATTERY ENERGY STORAGE SYSTEM LIFE LOSS

Some of Numerous factors affecting battery health are identified in related research and can be broadly categorized into calendar and cycle aging [25]. All aging processes that are included in calendar aging cause a battery cell to degrade without regard to charge-discharge cycling [26]. Calendar aging is inevitable, according to literature [13], which also demonstrates that it has no effect on battery life in energy management. Rather, the primary source of GEV life loss is cycle aging, which is brought on by battery cycles [27]. Thus, this article only takes into account the cycle of aging. Cycles with varying Crates and DoDs affect battery life in a variety of ways and to varying degrees, per the findings of the battery degradation modes analysis obtained in [28]. Based on the discussion above, this section analyzes battery NoC, DoD, and C-rate data in SoC and GEV discharging power profiles to create a battery aging quantification model that measures battery life loss in V2G methods.

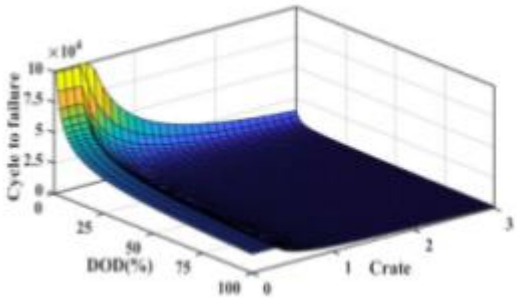

Fig. 1. Constructed battery CTF responding profile

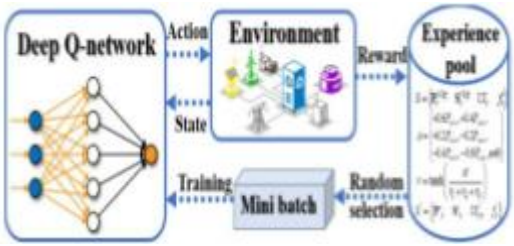

Fig. 2. Designed deep-reinforcement-learning based V2G behavior management framework.

Battery-rated cycle life under various operating situations is described in the CTF profile. In order to measure the effect of cycles with varying DoDs and C-rates on battery life loss in V2G scheduling, the notion of cycle-to-aging (CTA) is further described in this article.

III. V2G BEHAVIOR MANAGEMENT FRAMEWORK BASED ON DEEP REINFORCEMENT AND LEARNING WITH MODEL –FREE PREDICTION AND CONTROL

This method uses the DRL algorithm to address dynamic V2G behavior management and find the best power exchange between MG and GEVs. The four components of the DRLVM framework are the agent, environment, experience pool, and deep Q-network, as illustrated in Fig. 2. The decision variable in the established DRLVM framework is the charging behavior of GEVs, and the agent is chosen as an individual V2G participant. Three Markov decision processes are used to model the coordination of GEV charging at various points during the scheduling period: 1) state s, 2) action a, and 3) reward r are necessary components. The environment state variables in V2G scheduling are all continuous variables, in contrast to traditional decision-making. In the meanwhile, the battery SoC and historical V2G power should be taken into account in order to facilitate battery anti-aging scheduling, which makes the Q-value computation burden even more difficult. As a result, this paper uses a deep neural network-based state continuous V2G scheduling technique. As illustrated in Figure 2, Q-values under continuous system state change in the decision system are estimated using a deep network. Reinforcement learning is the science of learing to make decision which affect the reward, the agent state, and environment state. The following formula can be used to represent the estimated Q-value:

$$Q(s, a) \approx \psi(s, a; \omega, b) \text{----------} > (1)$$

where w and b stand for the weights and biases of the trained deep neural network, respectively, and ψ is the transfer function. In the real world, GEV charging is coordinated using the trained deep Q-network. The action with the highest Q-value, which is represented as follows, is used to derive the corresponding V2G scheduling strategies:

$$\pi = \arg\max Q(s, a \mid \omega\, Q, bQ) \text{----------} > (2)$$

where π is Reinforcement learning strategy

IV. MULTIOBJECTIVE LEARNING MODEL IN V2G BEHAVIOR MANAGEMENT

A. Multiobjective Reward Function Design

To considering the reward function's definition should align with the goal of V2G scheduling since it directs agents to make the right choices. This section creates a multi-objective incentive system to reduce battery life losses and MGload fluctuations in DRLVM. The initial goal is to reduce battery deterioration. As explained in (10) and (11) the charging power and SoC trajectory of GEVs are taken from the historical V2G strategy base and reorganized in a time series. Battery life loss in V2G methods can be computed using the life loss quantification model that was defined.

$$D = \eta\,(P_t^{v2g}, S_t^{v2g}) \text{----------} > (3)$$

To increase the MG's stability and economics, DRLVM's training objectives also include reducing load fluctuations and absorbing renewable energy sources. The second reward function is chosen to be the MG's uneven power with GEV penetration.

$$G=P_{load}+m.P_{V2g}-P_{solar}+P_{wind} \text{----------} > (4)$$

Where, m- the aggregation impact in V2G service is reflected by the number of GEVs and the internal structure of the control circuit. The control scheme consists of Fuzzy controller, limiter, and three phase sine wave generator for reference current generation and generation of switching signals. The peak value of reference currents is estimated by regulating the DC link voltage. The actual capacitor voltage is compared with a set reference value. The error signal is then processed through a Fuzzy controller, which contributes to zero steady error in tracking the reference current signal. The learning model for the DRLVM framework is established in this part along with the mathematical premise. The first step in implementing V2G behavior learning is creating a multiobjective reward system that can accurately represent the needs for battery antiaging and MG power balance. The deep-Q-network's architecture and model training methodology are then explained in detail.

B. STRUCTURE AND TRAINING METHOD OF THE DEEP-Q-NETWORK

To guide the charging behavior of GEVs, the Q-value of various activities should be evaluated in the designed DRLVM. One way to think about the Q-value estimate in DRLVM is as a multi-input to multi-output regression problem. It is challenging to understand the regularity between the decision system's state and the Q-value of actions due to the intricate mapping relationship between the inputs and outputs. One of the most widely used artificial intelligence systems is the neural network, which uses numerous nodes and abstract mathematical models to mimic how neurons in the human brain function. Neurons in several layers of a neural network carry out actions in accordance with various functions, neural network can theoretically map any relationship as long as the network parameters and reasonable network structure are appropriately built. In order to improve the generalization ability of the learning process, better handle continuous grid and GEV state variables, and enhance the optimization effect of the constructed V2G coordinator, this study fits the estimated Qvalue using a multilayer deep neural network.

$$C=\frac{1}{2n}\sum_{i=1}^{n}\sum_{x=1}^{8}(YQt, i(Xst) - \overline{Y}Qt, i(Xst))^2 \text{---} > (5)$$

Where X st is the training input of the Q-network, which consists of system state variable at t. Y Qt is the Q-value of different actions, which can be calculated based on [20]. YQt is the output of the Q-network. n is the size of the selected mini-batch.

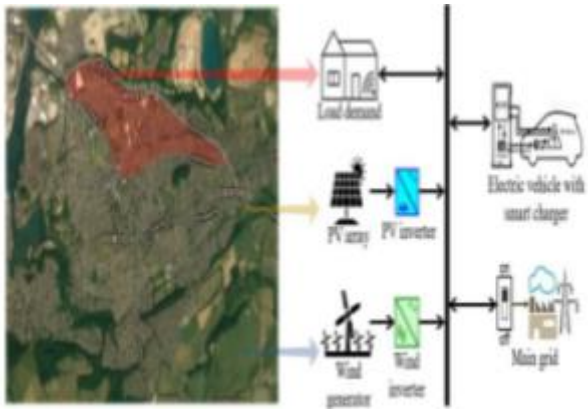

Fig. 3. Configuration of the studied MG system with renewable energy penetration TABLE-1

BATTERYCHARACTERISTIC PARAMETERS OF THE SIMULATED GEVs FLEET

Parameters	**Value**
Battery cell type	Lithium-ion 18650
Number of cells	444
Battery Module capacity	232Ah,5.3kWh
Voltage nominal	3.8V/Cell, 22.8V/Module
Charging voltage cut-off	4.2V/Cell, 25.2V/Module
Discharging voltage cut-off	3.3V/Cell, 19.8V/Module
Rated discharging current	500A
Battery pack configuration	2p5s
Battery pack capacity	53 kWh

V. CASE STUDY

The performance of the created DRLVM approach is demonstrated in this section. After presenting the topology and specifications of the MG system under study, the power balancing and anti-aging capabilities of the car batteries are assessed. The performance of the created DRLVM approach is demonstrated in this section. After presenting the topology and specifications of the MG system under study, the power balancing and anti-aging capabilities of the car batteries are assessed.

A. Microgrid System Test

In order to give the MG power balancing services, the charging behaviors of 350 GEVs are simulated in this paper. Table I shows the specific battery characteristic parameter for the GEVs under study. Each GEV's battery pack has a rated capacity of 53 kWh and is made up of 10 modules coupled in a 2p5s arrangement. The 444 lithium ion cells that make up the battery module have a rated capacity of 3400 mAh, a nominal voltage of 3.8 V, and a rated discharge current of up to 500A. The battery cell's cutoff voltages for charging and discharging are 4.2 and 3.3 V, respectively.

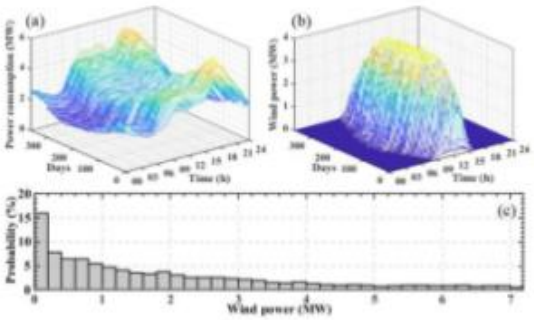

Fig. 4. DRL model training data. (a) MG demand profiles. (b) Solar power generation profiles. (c) Wind power generation states distribution.

B. PERFORMANCE ASSESSMENT OF POWER BALANCING

The performance of four distinct V2G scheduling algorithms—the DRLVM method (Case 4), the peak-shaving oriented scheduling (PSOS) method [40] (Case 2), the Q-learning method [41] (Case 3), and the conventional fuzzy logic method [39] (Case 1)—is quantitatively compared in this section based on the power system configuration mentioned above. Fig. 5 analyzes the power balancing performance of several V2G scheduling techniques over a span of 250 working days. Because of the intricate optimization mechanism, the PSOS method's average simulation duration, in terms of algorithm computing speed, is as long as 265.4 s. In contrast to the PSOS approach, the charging behavior of GEVs can be immediately planned according to the rules, but the fuzzy logic method does not require any optimization steps.

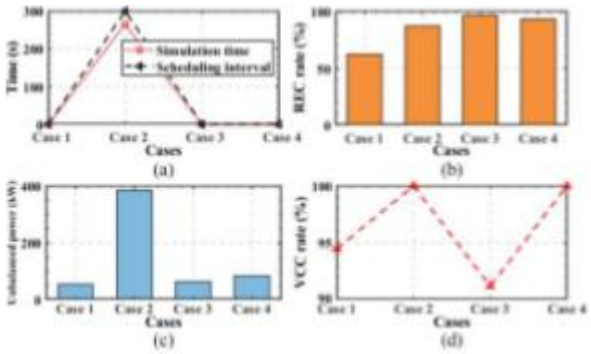

Fig. 5. Power balancing performance comparison of different cases:(a) simulation time; (b) V2G renewable energy consumption rate; (c)system unbalanced power; and (d) vehicle charging completion rate.

Consequently, Case 2's simulation duration can be lowered to 0.13 seconds. Because of the offline training process, the simulation time can be kept to 0.25 and 0.27 seconds, and the Q-learning and DRLVM approaches calculate at a rate comparable to the fuzzy logic method. Therefore, in comparison to the optimization-based PSOS method, online scheduling techniques are better suited to handle variations in renewable power generation and demand fluctuations. In this article, the scheduling intervals in Cases 1–4 are set to 1, 300, 1, and 1 s, respectively, to ensure system stability. Fig. 7 displays the battery SoC profiles of a GEV using fuzzy logic and DRLVM techniques on a typical workday. Battery NoC in the V2G scheme using the DRLVM method is much lower than with the fuzzy logic method. Fuzzy logic is used to arrange GEVs to use as much renewable energy as possible. As a result, as Zone C illustrates, the battery experiences a significant number of shallow cycles when handling variable wind power supply in the evening. By modifying the battery working power, the V2G scheduling system can absorb renewable power generation via the DRLVM approach rather than flipping the battery charging state.

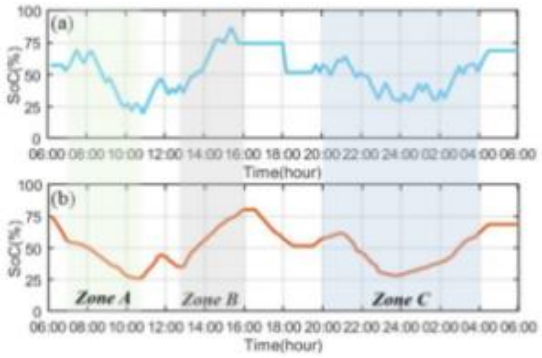

Fig. 7. Battery SoC profiles of a GEV in a regular working day in (a)fuzzy logic method and (b) developed DRLVM method.

TABLE II

QUANTITATIVE PERFORMANCE EVALUATION OF DIFFERENT V2G SCHEDULING METHODS

SCENARIO	CASE 1: FUZZY LOGIC METHOD	CASE 2: PSOS METHOD	CASE 3: Q-LEARNING METHOD	CASE 4: DRLVM METHOD
Number of cycles	2552	1954	2434	1875
Average C-rate	1.78	1.46	1.74	1.24
Battery life loss (%)	15.75	8.29	12.85	6.27

Table II provides a quantitative analysis of the battery anti-aging performance of various V2G scheduling techniques over the course of the simulation. The PSOS method's cooperative optimization approach allows for greater coordination of GEV charging behavior. Compared to the fuzzy logic approach, the battery's NoC and C-rate during the simulation period can be decreased by 23.4% and 17.9%, respectively. When the created aging model and multiobjective learning approach are used, the battery cycles and C-rate can be further decreased to 1875 and 1.24, respectively, yet the Q-learning method performs very similarly to the fuzzy logic method. The created DRLVM approach can reduce battery life loss by 60.2%, 24.4%, and 51.2%, respectively, in comparison to fuzzy logic, PSOS, and Q-learning methods. During the simulation period, battery life loss may be kept to 6.27%, confirming the efficacy of the created DRLVM technique.

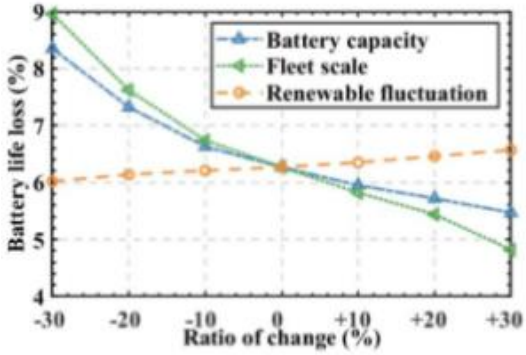

Fig. 8. DRLVM method battery protective performance sensitivity analysis

Battery life loss is further examined using sensitivity analysis when fleet size, wind power generation variability, and vehicle battery capacity vary. Figure 8 illustrates that while fleet size and battery capacity have a favorable impact on lowering life loss in V2G services, renewable variation has a negative impact. The designed DRLVM method can function steadily even when the energy storage capacity of GEVs varies. The battery life loss in V2G services may still be kept to 8.37% and 8.94%, respectively, even when fleet scale and battery capacity drop by 30%. Likewise, fleet size has a greater effect on V2G system battery protection performance than battery capacity. Variability in renewable power generation has very little effect on V2G scheduling. Even when the rate of change of wind power fluctuation reaches 30%, battery life loss can be kept to 6.62%, confirming the resilience of the established DRLVM method.

VI. CONCLUSION

This research created a unique battery anti-aging V2G scheduling technique that can use the energy storage capacity of GEVs to provide power balancing services for the MG. A battery deterioration model was used to quantify the aging cost of GEVs V2G scheduling. The DRL framework was used to describe the ideal GEV charging coordination as a multiobjective learning problem. The following are the main conclusions from indepth simulations on an MG system constructed using actual power generation and consumption data in the United Kingdom: 1) The existing aging cost analysis model can more thoroughly model battery aging characteristics than the bucket model. Once the created battery aging quantification model is used, vehicle battery life loss in V2G service can be greatly decreased. 2) The reinforcement-learning-based V2G scheduling, which takes advantage of offline training, can arrange GEV charging behavior in realtime to reduce the unpredictability of renewable energy. MG imbalanced power and REC rate can be greatly decreased and enhanced as a consequence. Additionally, this article's methodology's application can be summed up as follows: 1) The wellestablished battery life loss analysis model serves as a useful life-cycle cost analysis tool and a baseline for degradation-oriented modes of operation that direct battery energy management. 2) The simulation results in this study and the wellestablished DRL-based V2G scheduling model-free predictive control specify the best vehicle battery utilization plan in smart energy systems taking deterioration into account, which can further increase the efficiency of the energy transport nexus.

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Design of a System to Prevent Elopement Behavior for Students with Developmental Disabilities

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Abstract: Elopement behavior refers to a student leaving their assigned seat or classroom with out permission. This can infringe on the class rights of other students. In this study, a system is proposed to prevent and monitor this problem. The proposed system consists of a desk-mounted type, a classroom door-mounted type, and a teacher-controlled system. If elopement behavior occurs, it is suppressed by voice, and if elopement behavior does not occur for a certain period of time, a praise message is played. In addition, it allows easy monitoring of elopement behavior occurrence status.

Keywords: Developmental disabilities, Elopement behavior, Low-powersystem

In this study, we propose a system to prevent and monitor elopement behavior of students with developmental disabilities. Elopement behavior is a behavior commonly observed in students with developmental disabilities, which refers to leaving a designated seat without permission [1, 2]. This is a common problem in special education field, and anxiety and sensory overload are the main causes. Elopement behavior can infringe on the class rights of other students and interrupt classes. However, elopement behavior can be improved with individualized behavioral support such as differential reinforcement [3, 4].

The elopement prevention system proposed in this study immediately notifies teachers via a speaker when an elopement incident occurs, allowing teachers to respond promptly. The system plays a pre-recorded voice message from the student's parent or teacher through the speaker. If an elopement incident occurs, an intervening voice message is triggered, while a praising voice message is played if no elopement occurs over a specified period. Additionally, the system monitors the location where the elopement behavior occurs. Elopement behavior can be classified into two types: a student leaving his or her seat and suddenly opening the classroom door and leaving. Two types of devices were developed for each purpose.

The first device is a desk-mounted system designed to prevent seat-related elopement. This device attaches to the top or underside of the student’ s desk, constantly measures the distance from the student, and generates an alarm sound when the distance suddenly increases. Any sensor that measures distance can be used. However, an ultrasonic sensor was selected in this study due to its cost-effectiveness and suitable measurement range. Due to the characteristics of ultrasonic sensors, incorrect distances may be measured depending on the angle of reflection of ultrasonic waves, so a filter was applied to ensure operational stability. The second is a door- mounted device. This device is attached to a classroom door and generates an alarm sound as soon as the door is opened. The sensor used is a hall sensor that detects magnetic force. Figure 1 shows the implemented system.

Fig. 1. Desk-mounted device based on ultrasonic sensor (left),
door-mounted device based on hall sensor (right)

When applying the proposed system to a classroom, the following considerations must be addressed: The number of desk-mounted devices is as many as the number of students. It should be able to communicate with the classroom door-mounted devices. It should not operate outside of class hours. It should monitor the occurrence of elopement behavior.

To meet the above conditions, a teacher control device was implemented. It is installed in a location that only teachers can access and consists of a display and buttons for starting and ending the system operation. In addition, it can communicate with the remaining devices in a one-to-many(1:n) by using Zigbee communication. As a result, the occurrence of elopement behavior in all seats in the classroom can be seen at a glance. For the teacher system whose location is always fixed, ESP32, which consumes relatively high power but has a fast system clock, was adopted. The remaining two devices are attached to desks, classroom doors/windows, etc., so they must be powered by batteries. For this reason, the nrf52840 processor was adopted for the desk and classroom door devices.

As a result, a one-to-many communication system that can be operated for more than 12 hours with a small Li-po battery measuring approximately 20×30mm was implemented. It communicates with the teacher control device and effectively prevents and monitors the elopement behavior of students with developmental disabilities.

Acknowledgment

This work was supported by the Ministry of Education of the Republic of Korea and the National Research Foundation of Korea(NRF-2022S1A5C2A07091326).

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Study on current, voltage, and torque measurement systems for quality inspection of induction motors

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Abstract: In this study, a quality inspection system for induction motors, widely used in industrial applications, was developed. The system enables the evaluation of key parameters, including dielectric strength, rated rectification, starting current, and torque performance. Additionally, it allows for the storage, output, and management of measurement data, making it applicable for product management of manufactured induction motors.

Keywords: Induction Motor, Quality Control, Current Measurement Error, Torque, Voltage Measurement Error

1. Introduction

An induction motor is an electric motor that converts electrical energy into mechanical energy. It is widely used in industrial and household applications due to its simple structure, cost-effectiveness, and durability [1]. This motor serves as an essential power source in various fields, including manufacturing equipment, conveyor systems in logistics, household appliances, ventilation systems, and agricultural pumps [2].

To ensure the stable operation of induction motors, thorough quality control is indispensable throughout the entire process, from design and production to assembly and final inspection [3]. The quality control of induction motors is a critical process for maintaining their performance and stability while ensuring a long operational lifespan. Key parameters such as dielectric strength, rated rectification, starting current, and torque play a significant role in quality inspection [4]. Dielectric strength testing evaluates the motor’s insulation performance, while rated rectification ensures the motor operates efficiently under designed conditions [5]. Starting current measures the motor's stability during initial operation, and torque is essential for assessing the motor's mechanical performance [6,7].

This study focuses on the development of a quality inspection system for induction motors, proposing an efficient quality control framework based on key parameters.

2. System Design

For the development of this system, NI-DAQ, Modbus RTU, CT sensors, and RPM sensors were utilized. The CT (Current Transformer) sensors were installed at the lower part of the management system to prevent interference with other hardware and signals. Three sensors were installed to ensure compatibility with both single-phase (1P) and three-phase (3P) motors. To evaluate the performance of the CT sensor SY-TA1 (1CT) model, a simple LabVIEW program was used for testing, and the results showed relatively accurate current values with an error margin of within 3%.

The RPM sensor, pulse meter, and puncture tester were designed to be installed at any location, considering the operator's environment and convenience. To test the performance of the RPM sensor, the values obtained from the pulse meter (Autonics MP5W) were compared and analyzed with measurements taken using an oscilloscope (LeCory WaveSurfer 454).

3. Experiments and Results

Fig. 1. Developed Induction Motor Quality Control System

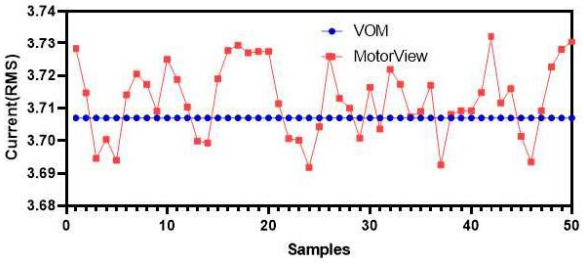

Fig. 2. Comparison of Current Measurements Between VOM and MotorView

Figure 1 illustrates the quality control system developed in this study. The system is capable of detecting current waveforms and torque measurement waveforms in real time. Additionally, it generates error signals when specific measurement thresholds are exceeded, enabling the verification of product quality. In this study, the quality inspection system software was developed using the LabVIEW 2017 development environment provided by National Instruments (NI).

The most fundamental and essential electrical characteristics of an induction motor are the starting and operating currents. To accommodate both single-phase and three-phase induction motors, CT sensors for current measurement were installed at the bottom of the monitoring system's main body, enabling the measurement of 220V, 60Hz currents.

Figure 2 presents the results of a performance test for current measurement. A total of 50 samples were used to compare the values measured by a calibrated VOM (Voltage-Ohm-Milliammeter) and the developed system. The VOM recorded a measurement of 3.707 ± 0.009, while the MotorView system measured values ranging from 3.70 to 3.73. The average error was calculated to be ±0.15%, demonstrating high accuracy.

4. Conclusion

In this study, a quality inspection system for induction motors was successfully developed to evaluate critical performance parameters such as dielectric strength, rated rectification, starting current, and torque. The system also provides functionalities for data storage and management, making it a valuable tool for product lifecycle management in motor manufacturing.

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Development of Simulated Neutron Signal Generation Algorithm for Small Modular Reactor

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Abstract: With the intensification of global efforts to address climate change and achieve carbon neutrality, Small Modular Reactors (SMRs) are gaining significant attention as a next-generation nuclear technology [1]. SMRs are designed to enhance safety through the integration of primary system components, reducing accident risks, while simultaneously improving economic feasibility by lowering construction and operational costs. Building on the design experience of the SMART(System-integrated Modular Advanced ReacTor), a type of SMR, the Korea Atomic Energy Research Institute (KAERI) is engaged in the development of an innovative SMR (i-SMR). The goal of i-SMR is to meet the growing demands for safer and more sustainable nuclear energy solutions.

i-SMR is characterized by lower reactor power and dual containment structures, consisting of the reactor vessel and containment vessel, compared to conventional nuclear power plants. These design features of i-SMR are expected to result in reduced neutron flux leakage outside the containment vessel. This necessitates the development and testing of high-sensitivity detectors and advanced signal processing systems specifically designed for ex-core neutron flux monitoring in i-SMR.

The Ex-core Neutron Flux Monitoring Drawer (ENFMD) provides a vital function in generating control, protection, and surveillance signals for the reactor. The ENFMD generates logarithmic and linear signals using neutron flux amplified by the pre-amplifier as input. To produce logarithmic and linear signals, the ENFMD is typically composed of signal processing cards based on analog circuits. Calibration tasks for analog-based ENFMDs are among the challenging tasks, and digitalizing certain functions of the ENFMD has been proposed as one approach.

This study focuses on the development of a simulated signal generation algorithm to test the ENFMD. The simulated signal should include the characteristics of both neutron and gamma radiation. Typically, neutron and gamma signals take the form of pulses that follow either a lognormal or semi-Gaussian distribution, which are challenging to achieve with conventional signal generators [2]. Additionally, in commercial nuclear power plants, reactor power typically ranges from 2×10^{-8} % to 2×10^{2} %, requiring the simulation of signals across a wide dynamic range to test the ENFMD [3]. The simulation signal generation algorithm developed in this study was shown to successfully produce neutron and gamma signals within the required reactor power range, assuming typical ex-core detector sensitivity.

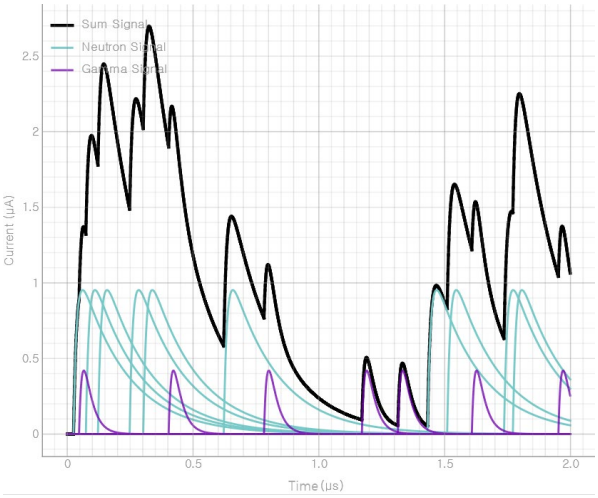

Fig. 1. Results of simulated neutron and gamma pulse signals

Keywords : Small Modular Reactor, Ex-core Neutron Flux Monitoring, Simulated Signal Generation, Pulse Signal Processing, Digital Signal Processing

Acknowledgment

This This work was supported by the Innovative Small Modular Reactor Development Agency grant funded by the Korea Government(Ministry of Science and ICT)(RS-2023-00258052).

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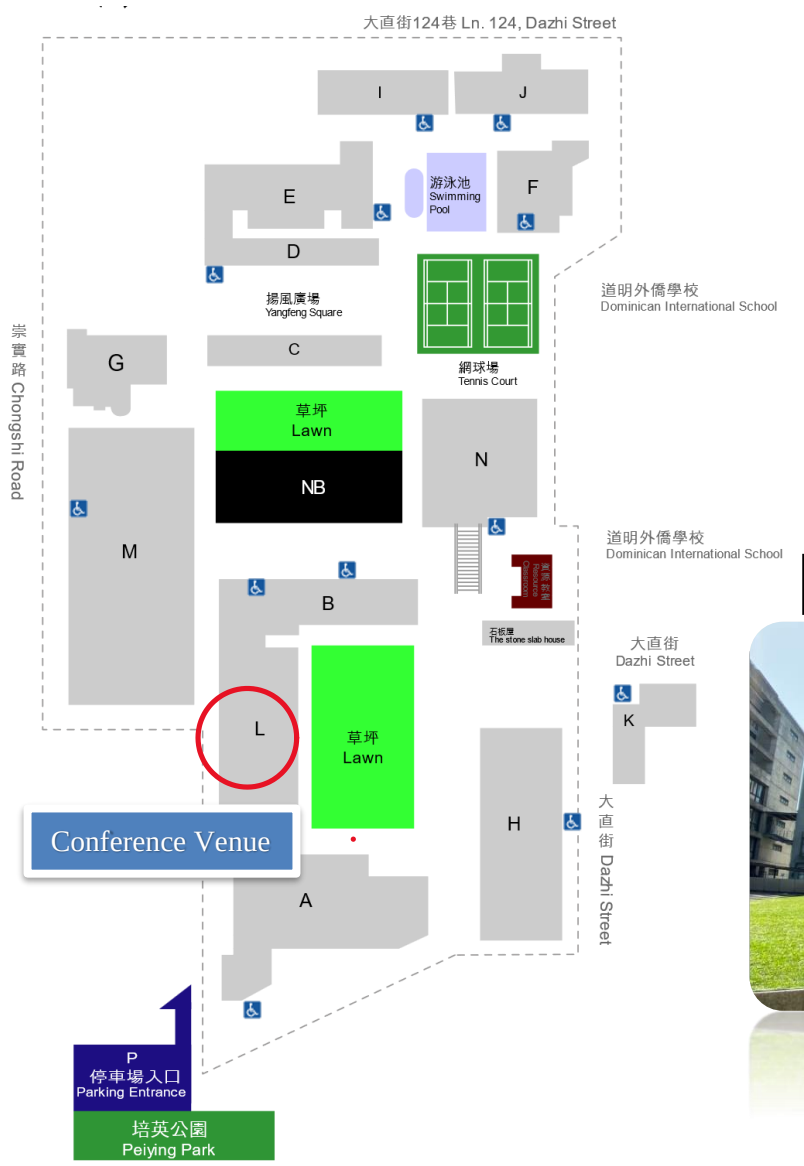

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