ISIITA 2026

International Symposium on Innovation in Information Technology and Application

PROGRAM

Bali, Indonesia
Jan. 26-29, 2026.

Organized by
International Society for Information Technology and Application (ISITA)
Journal of Industrial Information Technology and Application (2586-0852)
Journal of Industrial Electronics Technology and Application (2635-635X)

WELCOME ADDRESS

Welcome to 2026 International Symposium on Innovation in Information Technology and Application

A sincere welcome awaits all visitor.

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 the 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) 2026, the world's premier networking forum of leading researchers in the highly active fields of information technology application, will be held in Bali, Indonesia. The ISIITA 2026 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 Bali, Indonesia, which is a perfect setting for the Joint Conference. We truly hope that you will have a technically rewarding experience as well as some memorable experiences in Bali, Indonesia.

It is our hope that you're participating in ISIITA 2026 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 Bali, Indonesia.

A sincere welcome awaits all visitors at the joint conference.

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PROGRAM AT A GLANCE

Jan. 26	
13:30~	SIG Meeting I / Special Meeting 1 : AI Research Group Meeting*
15:15~	Coffee Break
15:35~	SIG Meeting II / Special Meeting 2 : Smart Factory Research Group Meeting*
Jan. 27	
09:30 ~	Registration
10:00 ~	Opening Ceremony
10:30 ~	Keynote I
11:30 ~	Coffee Break
12:00 ~	Special Lunch Time (All together)
13:30 ~	Session 1
15:00 ~	Coffee Break
15:30 ~	Session 2
Jan. 28	
10:00 ~	Session 3(Hybrid Session)
11:30 ~	Coffee Break
14:00 ~	Session 4(Hybrid Session)
15:30 ~	Session 5(Hybrid Session)
Jan. 29	
10:00 ~	Session 6
11:30 ~	Session 7
14:00 ~	Special Meeting : Energy Technology Research Group Meeting*
	Special Meeting : MIS Research Group Meeting*
* Note that all special meetings are closed sessions and not open to general registrants.	

※Times are expressed in Indochina Time (ICT), UTC +7
※The schedule is subject to change due to various circumstances. Subject to Change Without Notice.

SCIENTIFIC PROGRAM

January 26, 2026	
Time	**Content (Offline)**
13:30~	SIG Meeting I / Special Meeting 1 : AI Research Group Meeting*
15:15~	Coffee Break
15:35~	SIG Meeting II / Special Meeting 2 : Smart Factory Research Group Meeting*

January 27, 2026		
Time	**Content (Offline)**	
09:30 ~	Registration	
10:00 ~	Opening Ceremony	
10:30 ~	Keynote I	
11:30 ~	Coffee Break	
12:00 ~	Special Lunch Time (All together)	
13:30 ~	**Session 1: Intelligent Systems** **Chair:** Ryu Jeong Tak (Daegu Univ.)	
	1S-1	**Enhancing Production Efficiency through Jig Standardization: A Case Study on Reducing Design Lead Time and Error Rates** *Donghwoon Kwon[1)], Ki-Doeok Kim[2)], Jeong-Tak Ryu[3)], and Seon Sun Pak[4)]* *[1)] Dept. of Computer Science and Engineering, North Central College, Naperville, IL 60540, U.S.A* *[2)] Dept. of Mechatronics Engineering, Daegu University, Republic of Korea* *[2,3)] Dept. of Electronic and Electric Engineering, Daegu University, Republic of Korea* *[4)] Dept. of Smart Convergence Systems Engineering, Daegu University, Republic of Korea*
	1S-2	**A Study on Automatic Crop Yield Measurement and Analysis System** *Heemok Park[1)], Kyuman Jeong[2)], Seung-kwang Ryu[3)], and SangJin Lee[4)]* *[1)] Dept. of Smart Convergence System Engineering, Daegu University, Gyeongsan, Korea* *[2)] Dept. of Artificial Intelligence, Daegu University, Gyeongsan, Korea* *[3,4)] Dept. of Smart Convergence Systems Engineering, Daegu University, Korea*
	1S-3	**Subspace-Based Multi-Template Correlation for Robust GPR Reflection Detection in Rough Environments** *Kyungtaeg Yang[1)], Sekyung Kim[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*

	1S-4	**Integrating Political Instability into Stock Market Prediction Using Deep Learning Models** *Suh Sang[1)] and Aarshna Vasaya[1)]* *[1)] Dept. of Computer Science, East Texas A&M University, Commerce, Texas 75428, U.S.A*
	1S-5	**Autonomous Drone System with Real-Time Object Detection and Hybrid Tracking Logic Based on Edge Device** *Gyumin Park[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*
15:00 ~		Coffee Break
15:30 ~		**Session 2: AI and Sensor Fusion for Smart Systems** **Chair : Hyung-kyu Lee (Duk-soung Women's University, Korea)**
	2S-1	**Stationary and Walking Human Indication Scheme using 24GHz FMCW Radar Sensor for Various Mobility Applications** *YoungSeok Jin[1)] and Eugin Hyun[1)]* *[1)] IS3 Lab, Division of Mobility Technology, DGIST, Daegu, Korea*
	2S-2	**Electrical Detection of Specific Protein Binding Using DNA-Based Nano-biosensor** *Hyung Jin Kim* *Dept. of Semiconductor Engineering, Ulsan College, Ulsan, 44610, South Korea*
	2S-3	**Attention-Based Early Multimodal Fusion for Robust In-Cabin Object Detection** *Hyunduk Kim[1)], Sang-Heon Lee[1)], Myoung-Kyu Sohn[1)] , and Junkwang Kim[1)]* *[1)] Division of Mobility Technology, DGIST, Daegu, Republic of Korea*
	2S-4	**Development of Pediatric Rehabilitation Robot with Differential Gear-based AAN System for Children with Central Nervous System Impairment** *Changmin Lee[1)], Kyungmin Jung[2)], 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*
	2S-5	**Dual-Path Cross-Attention U-Net for Poster Design Intent Detection Using Inverted Saliency** *Junkwang Kim[1)], Myoung-Kyu Sohn[1)], Sang-Heon Lee[1)], and Hyunduk Kim[1)]* *[1)] Division of Mobility Technology, DGIST, Daegu, Republic of Korea*

January 28, 2026	
Time	**Content (Offline)**
10:00 ~	**Session 3 : Artificial Intelligence for Medical Data Analysis** **Chair**: Dr. R. Velmurugan, Associate Professor, Presidency College, Chennai, India
	3S-1 **Technology-Enabled Law Practice: Ethical and Professional Responsibilities in Artifical Intelligent Systems** *R. Deepalakshmi[1)] and Ambedkar Law university[1)]* *[1)]The Tamil Nadu Dr. Ambedkar Law university, Chennai, India*
	3S-2 **Exploring The Synergy Between AI And Cloud Computing In The Digital Era** *Nandhini. R[1)], Sasikala. V[1)], and Padmini. B[2)]* *[1)] Department of Computer Science, D.R.B.C.C.C. Hindu College , Pattabiram, Chennai -72* *[2)] Department of Computer Science with Data Science, D.R.B.C.C.C. Hindu College , Pattabiram, Chennai -72*
	3S-3 **Serverless Paradigms for Next-Gen Cloud Systems** *S. Sivaranjani[1)] and R. Anandhi[1)]* *[1)] Dwaraka Doss Goverdhan Doss Vaishnav College, Chennai, India.*
	3S-4 **ADVANCED PREDICTIVE ANALYSIS OF DIABETS USING AXG BOOSTING ALGORITHM** *K. Emayavaramban[1)] and ThambusamyVelmurugan[2)]* *[1)] LoganathaNarayanasamy Government College, Ponneri, India* *[2)] Department of Computer Science, Dwaraka Doss Goverdhan Doss Vaishnav College, Chennai, India*
	3S-5 **AI for Digital Well-Being: Real-Time Moderation of Harmful Online Content** *C.Kalpana[1)], Manoj Devare[1)] and Bhagya P Bijay Kumar[1)]* *Institute of Information Technology, Amity University Mumbai, India*
11:30 ~	Coffee Break
14:00 ~	**Session 4 : Machine Learning for Recent Trend Analysis** **Chair:** Dr. U. Latha, Assistant Professor, D.G.Vaishnav College, Chennai, India.
	4S-1 **ANALYSIS OF CARDIOVASCULAR DISEASE BASED ON MACHINE LEARNING USING JFO ALGORITHM** *G. Ezhilvani[1)], J. Wessly[1)], and R. Durga[1)]* *[1)] Department of Advanced Computing and Analytics VISTAS, Chennai, India*
	4S-2 **Performance of Fusion Classifiers with different fusion schemes for Pattern Analysis**

		D.Vaishali[1)] and S.Lakshmi[1)] *[1)] Department of ECE, SRMIST, Vadapalani, Chennai, India*
	4S-3	**A Temporal and Explainable Machine Learning Framework for Probabilistic and Extreme Rainfall Prediction** *Soumya Yattinahalli[1)], Vijaya Ramineni[2)], Ramya M S[1)], and Prakash Kuppuswamy[3)]* *[1)] Department of Cloud Computing and AI-BC & BS, GM University, Karnataka* *[2)] Department of Information Security, MIC College of Technology, A.P.* *[3)] Department of Cyber Security & Information Security, GM University*
	4S-4	**Cyber Risks in High-Stakes Trading: Unmasking the Anatomy of Authentication Attacks in the Stock Market** *Malathy S[1)] and R. Anandhi[1)]* *[1)] Department of Computer Science ,Dwaraka Doss Goverdhan Doss Vaishnav College*
	4S-5	**An AI-Driven Intelligent Digital Cognitive Behavioral Therapy System for Internet Gaming Disorder and Social Anxiety Disorder** *S. Ramya[1)] and A.S. Arunachalam[2)]* *[1)] Department of Computer Science and Information Technology, Vels Institute of Science, Technology and Advanced Studies (VISTAS), Chennai, India* *[2)] Department of Computer Science and Information Technology,* *Vels Institute of Science, Technology and advanced studies (VISTAS), Chennai, India*
		Session 5 : Security for Market Data Analysis and Applications **Chair:** Dr. Ananthi Seshasayee, Asoociate Professor and Head, Quide E Millath College for Women, Chennai, India
15:30 ~	5S-1	**An integrated approach to URL security that incorporates Machine Learning and Threat Intelligence** *Ranjit Kumar S[1)], Krupakar S Billichod[1)], Sachin S[3)], and Prakash Kuppuswamy[1)]* *[1)] Department of Cyber Security & Information Security, Faculty of Engineering & Technology, GM University, Davanagere, Karnataka.* *[3)] Department of Internet of Technology, Faculty of Engineering & Technology, GM University, Davanagere, Karnataka.*
	5S-2	**Enhancing Cloud Data Security through Blockchain Integration: A Secure and Transparent Framework** *K. Ramya[1)]and R. Anandhi[2)]* *[1)] Department of Information Technology and BCA.* *[1,2)] Department of Computer Science, Dwaraka Doss Goverdhan Doss Vaishnav College, Chennai, India.*
	5S-3	**Diagnosis of Thyroid Disorder Classification using Machine Learning Algorithm** *K.Balasree* *Department of Computer Science SRM Arts and Science College, Kattankulathur*
	5S-4	**GlucoMind: An AI-Driven Framework for Predictive and Personalized Diabetes Management** *Padmini. B[1)], Nandhini. R[2)], and Grace. M[3)]* *[1)] Department of Data Science, D.R.B.C.C.C. Hindu College , Pattabiram, Chennai -72* *2) Department of Computer Science, D.R.B.C.C.C. Hindu College , Pattabiram, Chennai -72* *3) Department of Computer Applications, Soka Ikeda College of Arts and Science for Women*

	5S-5 **Understanding Cross-Device and Multi-Platform Authentication Failures: A Unified Framework** *Poojitha Shree R[1] and R. Anandhi[1]* [1] Dwaraka Doss Goverdhan Doss Vaishnav College, Chennai, India

January 29, 2026	
Time	**Content (Offline)**
10:00 ~	**Session 6 : Robust Object Detection and Recognition in Challenging Real-World Environments** **Chair:** Jonghun Lee (DGST)
	6S-1 **Analysis of the Impact of LOS and NLOS Conditions on Worker Behavior Recognition Performance Using Camera and Radar** *Jieun Park[1], Dokyung Kang[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*
	6S-2 **Comparative Evaluation of YOLO and Faster R-CNN Detectors for Cotton Weed Identification Using a Region-Specific Dataset from Uzbekistan** *Dauletnazarov Jaksilik Iskender-uli[1], Uteuliev Nietbay Uteulievich[1], Djaykov Gafur Muratbaevich[1], and Aminaddinov Khumoyun Ravshanovich[1]* *[1]Dept. Computer Science, New Uzbekistan University, Tashkent, Uzbekistan*
	6S-3 **Resampling Based Sequence Alignment for Reducing Temporal Offset Effects in Radar-Based Manufacturing Robot Motion Recognition** *Dokyung Kang[1], Jieun Park[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*
	Session 7 : Data-Driven Intelligence and Analytics for Advanced Decision-Making **Chair:** Sanghyuk Lee (American University in Vietnam)
11:30 ~	7S-1 **Inclusion and Preference Extension using Hesitation Degree** *Sanghyuk Lee[1] and Einmi Lee[2]* *[1] American University in Vietnam, Vietnam,* *[2] Kookmin University, Korea*
	7S-2 **Intelligent Manufacturing Analytics Dashboard Using Machine Learning for Real-Time Quality Prediction and Root Cause Analysis** *Lilian Marco and Yoosoo Oh* *Dept. of Computer and Information Engineering, Daegu University, Daegu 38453, Korea*

	7S-3	**Synthetic-to-Real Calibration of YOLO-Based Regression for GPR B-Scan** *Sekyung Kim[1)], Kyungtaeg 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-4	**Enhancing Brain Tumor Segmentation in MRI Through Boundary Delineation** *Sang Suh[1)] and Ozlem Deveci[1)]* *Dept. of Computer Science, Texas A&M University-Commerce, Texas, United States*
14:00 ~	Special Meeting : Energy Technology Research Group Meeting*	
	Special Meeting : MIS Research Group Meeting*	

Enhancing Production Efficiency through Jig Standardization: A Case Study on Reducing Design Lead Time and Error Rates

Donghwoon Kwon[1)], Ki-Doeok Kim[2)] , and Jeong-Tak Ryu[3)]

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Abstract: This study proposes a standardization framework for jig components to enhance manufacturing efficiency. By unifying technical specifications for highly reusable parts and implementing a modular design system, we addressed inefficiencies in traditional custom-design practices. Experimental results from real-world applications showed a 42% reduction in design lead time and a 66% decrease in error rates.

Keywords : Jig, Standardization, Design Efficiency, Productivity, Modular Design

1. Introduction

In the era of Industry 4.0, manufacturing efficiency relies on optimizing assembly through Design for Manufacturing and Assembly (DFMA) principles. Jigs are essential tools for ensuring precision, yet they are often designed as custom items without standardized criteria. According to recent surveys on fixture systems, the lack of standardized interfaces between components often leads to increased complexity and cost in large-scale manufacturing [1].

Furthermore, the increasing complexity of automotive components necessitates more sophisticated and adaptable tooling solutions. Without a unified standardization framework, the cumulative costs associated with individual jig customization become a significant burden on manufacturing scalability. Consequently, establishing a systematic database for jig components is essential to bridge the gap between traditional craftsmanship and modern automated production.

Moreover, the transition toward modular fixture design has been identified as a key driver for flexibility in smart factories [2]. Standardization is not merely a technical task but a prerequisite for Automated Fixture Design (AFD), which can significantly reduce human error [3]. Studies have also shown that standardization directly impacts Lean Manufacturing performance by eliminating non-value-added design time [4].

Without standardized parts, companies face "SKU proliferation," which complicates inventory management. This study addresses these issues by standardizing 50 core jig parts, providing a foundation for sustainable manufacturing through component reuse [5] and Digital Twin-based smart manufacturing [6].

2. Jig Review and Design

The jig design process involves sequential stages from product review to final inspection. Fig. 1 illustrates the standardized workflow established in this study.

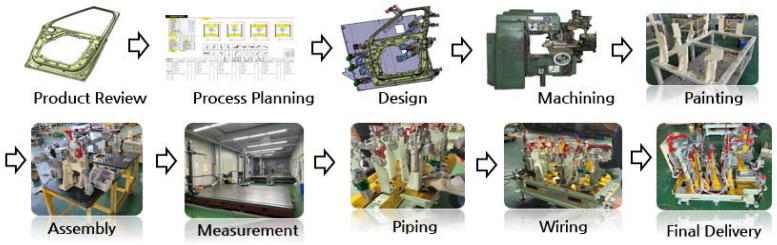

Fig. 1. Process flow of Jig Design

As shown in Fig. 1, the process begins with a comprehensive review of the product and the welding/assembly work process. Following this, the full jig system and individual components are designed and manufactured. A critical step involves a precision inspection to ensure the physical jig matches the 3D design data, followed by piping and wiring for air cylinders and electrical supply. Standardization at each of these stages ensures that feedback loops are minimized and overall quality is stabilized.

We selected 50 core groups with a reuse frequency of over 80% as standardization targets. These parts were reorganized into modules to allow "drag-and-drop" application in 3D programs.

Table 1. Selection Criteria for Standardization

Category	Selection Criteria	Detailed Description
Frequency	Reuse rate of 80% or higher	Components that can be commonly used across multiple projects
Function	Performance of core functions	Components performing critical functions such as positioning, clamping, or supporting.
Design Repetition	Parts designed repeatedly 3 or more times	Targets suitable for design automation.

3. Case Study and Results

3.1 Field Application and Analysis

To validate the effectiveness of the proposed standardization, we applied the system to automotive chassis production lines at Company A and Company B. Company A focused on the efficiency of the design phase, while Company B focused on inventory and procurement optimization.

In Company A, by utilizing a database of 50 standardized parts, the average design time per unit was reduced from 10 hours to 6 hours. This allowed engineers to allocate more time to structural stability analysis rather than repetitive modeling tasks. In Company B, the reduction in unique SKU counts from 200 to 140 facilitated a more streamlined supply chain, reducing the procurement lead time by approximately 25%.

3.2 Quantitative Performance Evaluation

Based on the quantitative data shown in Table 2, the implementation of standardized jig components has led to significant operational improvements. First, the Design Lead Time was reduced from 6.0 weeks to 3.5 weeks. This 42% improvement is attributed to the elimination of redundant 3D modeling tasks, as designers could utilize a pre-verified library of 50 core parts. Second, the Design Error Rate saw the most dramatic improvement, falling from 3.2% to 1.1% (a 66% enhancement). By using standardized parts with fixed tolerances, common assembly interferences and

human errors during the design phase were effectively minimized. Finally, the Maintenance Time decreased by 58%, from 12 hours to 5 hours per month. This indicates that standardization not only aids the initial production phase but also significantly eases the long-term operational burden by simplifying the replacement of worn-out components

Table 2. Comprehensive Performance Metrics after Standardization

Performance Item	Before Standardization	After Standardization	Improvement Rate (%)	Unit
Design Lead Time	6	3.5	42%	Weeks
Design Error Rate	3.2	1.1	66%	%
Maintenance Time	12	5	58%	Hours/Month

4. Conclusion

This study demonstrated that the standardization of jig components is a critical factor in maximizing manufacturing efficiency. By unifying the technical specifications of core parts, we achieved a 42% reduction in design lead time and a 66% decrease in error rates.

The quantitative data confirms that standardizing just 10% of high-frequency parts can influence over 70% of total design efficiency. Furthermore, the reduction in monthly maintenance time to 5.0 hours proves the economic viability of this framework. Future work will expand this database into an AI-driven design recommendation system, further bridging the gap between traditional engineering and smart factory automation.

References

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A Study on Automatic Crop Yield Measurement and Analysis System

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Abstract: This study proposes an automated system for measuring and analyzing crop yield data in smart farm environments. Traditional manual measurement methods suffer from low operational efficiency and a lack of data accuracy. To address these issues, a load cell-based weight measurement system was developed, featuring sector-based yield heatmap visualization and worker-specific statistical analysis. Experimental results demonstrate that the proposed system can transmit yield data to the cloud in real-time, supporting enhanced productivity and efficient labor management for farms.

Keywords : Smart Farm, Crop Yield, Load Cell, Heatmap Analysis, Data Visualization

1. Introduction

With the global decline and aging of the agricultural population, the demand for smart farm technology is rapidly increasing. Crop yield data is a critical indicator of agricultural productivity, yet many farms still rely on manual recording, which is prone to errors. This research aims to implement data-driven precision agriculture by developing a system that automatically measures the weight of crops during collection and provides visual analysis by sector and worker.

2. System Implementation and Hardware Design

The hardware is designed to be integrated into existing harvesting workflows. A high-precision load cell is installed at the base of the crop collection box. This sensor detects the weight changes in real-time as crops are added.

The system utilizes an Arduino-based controller to process the analog signals from the load cell into digital weight data. This data, combined with a unique worker ID and sector location, is transmitted to a central cloud server via Wi-Fi or LTE communication modules.

3. Software and Visualization Interface

All harvested data is stored in a structured cloud database. The web-based dashboard allows farm managers to monitor the harvesting progress from any device.

One of the core features is the heatmap visualization. By dividing the smart farm area into specific sectors, the system displays yield density through color coding. This allows managers to intuitively identify which areas are producing more crops and investigate the environmental factors (such as light or temperature) contributing to these differences.

The system tracks the harvest time and total weight for each worker. This data provides an objective basis for evaluating worker proficiency and optimizing human resource allocation during peak harvest seasons.

4. Experimental Results and Discussion

The performance of the system was analyzed through various experiments: Heatmap Analysis: By visualizing the yield across different sectors within the smart farm, deviations in production relative to

the distance from environmental control devices were intuitively identified. Worker Statistics: By tracking harvest times and daily yields per worker, an objective index was established to evaluate individual worker proficiency and operational efficiency. Accuracy: The load cell-based measurement significantly reduced error rates compared to manual measurement and resolved the issue of data omission.

(a) Hardware (b) Software

Fig. 1. Implementation result

5. Conclusion

This study successfully implemented a cloud-based automatic crop yield measurement system that enhances data utility in smart farms. The ability to visualize spatial productivity and monitor labor efficiency in real-time provides a significant advantage for modern agricultural management. Future work will focus on integrating AI algorithms to predict future yields based on the accumulated historical data.

References

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Subspace-Based Multi-Template Correlation for Robust GPR Reflection Detection in Rough Environments

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Abstract: This paper proposes a subspace-based multi-template correlation method that accounts for waveform distortion, which in turn enhances the robustness of ground penetrating radar (GPR) reflection detection in rough subsurface environments. GPR is widely used for non-destructive subsurface sensing in civil infrastructure inspection and disaster response scenarios. Conventional single-template correlation approaches suffer significant performance degradation due to waveform distortions caused by surface roughness and heterogeneous subsurface media. To address these limitations, a low-dimensional template subspace is constructed using a basis waveform and its derivatives. The optimal basis function and the number of templates are determined using the Bayesian Information Criterion (BIC), which balances detection performance against computational complexity rather than solely minimizing representation error. The proposed method improves the Area Under the Curve (AUC) by effectively representing distorted signals while maintaining practical computational efficiency through optimized template selection. Systematic experiments were conducted using a GPR propagation model incorporates rough surface conditions and subsurface heterogeneity. The experimental results demonstrate that the proposed method achieves a significantly higher AUC than the conventional single-template baseline, indicating its suitability as a robust front-end detection stage in challenging environments.

Keywords : Ground Penetrating Radar (GPR), Reflection Detection, Multi-template Correlation, Bayesian Information Criterion (BIC), Waveform Distortion

Rough subsurface environments, such as collapsed building scenarios, pose significant challenges for ground penetrating radar (GPR) time-delay estimation (TDE) and the detection of buried victims [1]. In these conditions, surface roughness and the heterogeneous nature of subsurface media significantly alter the propagation and reflection characteristics of GPR signals, leading to temporal spreading and severe waveform distortion [2]. Conventional correlation-based methods that rely on a single reference pulse often suffer from strong signal-template mismatch, resulting in unstable correlation responses and unreliable detection [3-4]. Rather than emphasizing precise delay localization at the initial stage, this work reformulates the TDE problem from a reflection existence detection perspective. By prioritizing detection over precise localization, this approach mitigates the adverse effects of signal-template mismatch and enables more reliable discrimination between true reflections and clutter even under severe distortion.

To evaluate the proposed method under realistic conditions, electromagnetic simulations were performed using gprMax, an open-source solver based on the finite-difference time-domain (FDTD) method. The simulation model integrates a stochastic rough surface profile to realistically capture the scattering effects of challenging terrain. Within the subsurface media, a 1-meter-wide void was placed as the target to generate clear reflection signatures. The interaction between the GPR pulse and the irregular surface boundary, combined with the presence of the void, induces significant waveform distortion and multipath effects. This synthetic dataset provides a rigorous baseline for comparing the detection performance of the proposed multi-template approach against conventional techniques.

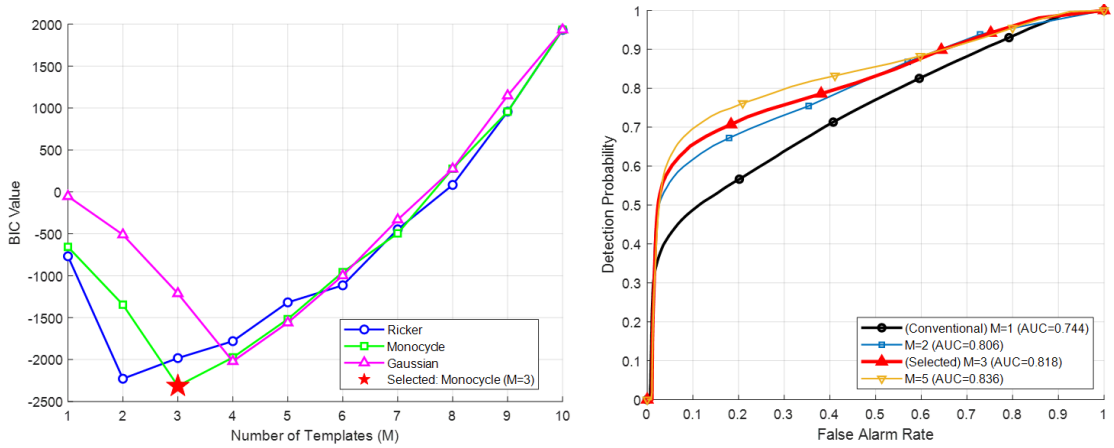

Fig. 1. Model selection based on BIC analysis and performance evaluation through ROC curves.

Simulation results show that the proposed BIC-based multi-template approach improves reflection existence detection performance, particularly in the low false-alarm regime. By explicitly modeling waveform distortion through a multi-template subspace, the method achieves a consistently higher AUC compared to the conventional single-template baseline. The Bayesian Information Criterion (BIC) is a model selection criterion that balances likelihood-based goodness of fit against model complexity by penalizing the number of model parameters. In this work, the BIC is utilized to manage the inherent trade-off between the flexibility of signal representation and computational complexity. While an increase in the number of templates M enhances the subspace's capacity to capture distorted reflections, it imposes a commensurate increase in computational overhead. The BIC identifies the optimal value of M by penalizing model complexity, thereby preventing further template expansion when the marginal improvement in detection performance no longer justifies the additional computational cost. The integration of the BIC enables the system to achieve near-optimal detection performance using a minimal number of templates, thereby avoiding unnecessary computational overhead. These findings suggest that BIC-optimized multi-template correlation provides a practical and effective strategy for reliable GPR detection in rough environments and serves as a robust front-end for subsequent delay refinement or localization stages.

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Integrating Political Instability into Stock Market Prediction Using Deep Learning Models

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Abstract: Financial markets are becoming increasingly vulnerable to volatility caused by political events; however, conventional predictive models often neglect to account for real-time political instability, leading to considerable prediction inaccuracies during uncertain times. This research aims to fill this void by presenting a Dynamic Political Instability Index alongside an innovative Hybrid Attention Model that combines Bidirectional Long Short-Term Memory (BiLSTM) networks with Multi-Head Attention mechanisms.

By integrating 40 years of data from the Dow Jones Industrial Average (DJIA) with the Daily Trade Policy Uncertainty (TPU) index and sentiment scores processed through VADER, the proposed framework effectively captures both temporal dependencies and discrete political shocks. Experimental findings indicate that the Hybrid Attention model significantly surpasses baseline LSTM, BiLSTM, and Transformer models. Importantly, the model addresses the "persistence bias" typically found in conventional recurrent networks, enabling the prediction of market trends instead of simply responding to past price levels. These results demonstrate that political instability is a measurable, latent variable that is vital for effective financial forecasting and for the development of explainable AI in the financial sector.

Keywords : Stock Market Prediction, Political Instability, BiLSTM, Multi-Head Attention, TPU Index

The Hybrid Attention Model attained the highest predictive accuracy among all evaluated models, achieving an R2 value of 0.9185 and the lowest RMSE of 177.65. As illustrated in Table 1, although the standard LSTM and BiLSTM models performed well, they displayed a “persistence lag” where predictions lagged behind actual prices. The Transformer model demonstrated a significant underperformance with an R2 of 0.4022, likely due to its insufficient inductive bias for handling small, noisy financial datasets. The attention mechanism within the Hybrid model allowed it to identify specific events of political volatility, enabling the anticipation of trend shifts before their occurrence.

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Autonomous Drone System with Real-Time Object Detection and Hybrid Tracking Logic Based on Edge Device

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Abstract: With the increasing threat of unauthorized small unmanned aerial vehicles (UAVs), there is a growing need for autonomous interceptor drones capable of neutralizing targets via kinetic impact (Hard Kill). However, implementing real-time deep learning detection and precision flight control on small UAVs remains a challenge due to limited onboard computing resources. This paper proposes an autonomous interceptor drone system utilizing a Raspberry Pi 5 integrated with a Hailo AI accelerator. To ensure real-time performance on the edge, the system employs a custom object detection model optimized for the Hailo hardware. We introduce a hybrid tracking strategy that combines ByteTrack for multi-object identification and CSRT (Channel and Spatial Reliability Tracking) for precision terminal guidance. Upon selecting a target ID from the ByteTrack stream, the system hands over the bounding box coordinates to the CSRT tracker. 2-axis gimbal then performs visual servoing to keep the target centered. Simultaneously, the drone's flight controller, communicating via the Pymavlink protocol, aligns the drone's body with the gimbal's orientation, effectively steering the vehicle toward the target for a collision. Experimental results confirmed that the proposed system stably detected and tracked objects at an adequate FPS even in edge device environments, and successfully performed target recognition through cooperative control between the gimbal and the airframe. This research is significant in that it enhanced the autonomous performance of small drones by utilizing a high-performance AI accelerator.

Keywords : Edge Device, Autonomous Drone, Computer Vision

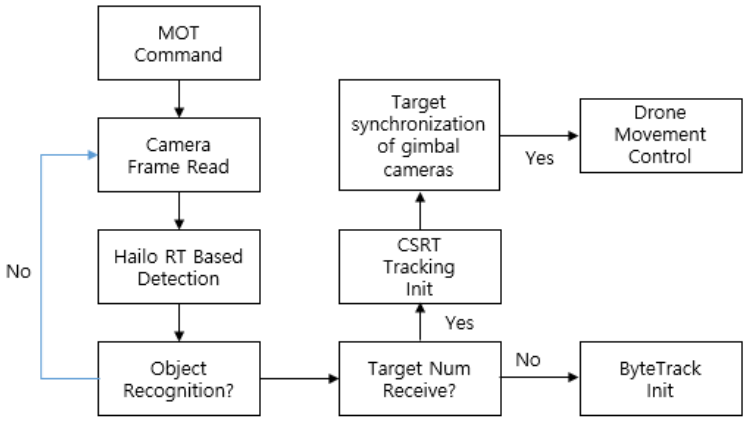

Fig. 1. A Flowchart of proposal system

Recent advancements in Unmanned Aerial Vehicles (UAVs) have raised significant security concerns, necessitating effective Counter-UAS (C-UAS) solutions. [5] In all recent wars and military actions, drones are playing a role in all missions. Among various neutralization methods, kinetic interception (Hard Kill) by an autonomous drone offers a practical solution for eliminating hostile targets. However, the primary challenge lies in the computational constraints of small-scale onboard computers. Running deep learning-based object detection models [4] while simultaneously executing high-frequency flight control loops creates substantial latency, making it difficult to intercept fast-moving targets in real-time.

However, when equipped with high-performance GPUs, flight time is greatly reduced due to power consumption and weight increase.

To address these computational bottlenecks, this study proposes a lightweight drone system powered by a Raspberry Pi 5 integrated with a Hailo-8 AI accelerator. This architecture adopts a heterogeneous computing strategy: the computationally intensive object detection (YOLOv8) is offloaded to the Hailo NPU, while the CPU is dedicated to tracking logic and flight control. This distribution ensures stable, frame-rate processing essential for aerial engagements. The core innovation of this system is the Hybrid Tracking Algorithm with a Handover Mechanism. Initially, the system utilizes the Hailo accelerator and ByteTrack [1] to detect multiple objects and assign unique IDs in real-time. Subsequently, upon target selection, the system executes a "handover," initializing a CSRT (Channel and Spatial Reliability Tracking) [2] tracker initialized with the target's bounding box. This transition shifts the workload from deep learning inference to a lighter, correlation-filter-based tracking method, ensuring higher precision during the terminal phase. Finally, 2-axis gimbal creates a "Look-and-Follow" dynamic. The gimbal continuously centers the target based on CSRT output, while the drone's flight controller utilizes the Pymavlink protocol [3] to synchronize the airframe's Yaw and Pitch with the gimbal's orientation, effectively guiding the drone onto a collision course.

Experimental results demonstrate that the proposed system achieves robust real-time tracking at almost 20~30 FPS and effective autonomous guidance on an edge platform. By combining AI acceleration with a specialized handover tracking algorithm, the system successfully performs kinetic interception maneuvers, proving its viability as a cost-effective and autonomous drone solution.

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Stationary and Walking Human Indication Scheme using 24GHz FMCW Radar Sensor for Various Mobility Applications

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Abstract: This paper proposes a novel human indication scheme using 24 GHz FMCW radar to distinguish humans from non-human objects. The system employs a dual-path approach: respiration-based detection for stationary humans and Doppler scattering pattern analysis for moving humans. Experimental results demonstrate high robustness in complex indoor environments, achieving an overall accuracy of 96.3%

Keywords : radar, classification, pedestrian detection

1. Introduction

Reliable human detection is essential for the safety of autonomous vehicles and delivery robots. While FMCW radar offers privacy and lighting robustness, it faces challenges in distinguishing stationary humans from environmental clutter. This study addresses these limitations by leveraging human-specific physiological (respiration) and behavioral (scattering) traits.

2. Related Work

Vision-based sensors provide high-resolution visual data allowing for accurate recognition of object shapes and movements18. Models such as YOLO and Faster R-CNN enable highly accurate detection and classification19. However, vision-based sensors are highly sensitive to lighting conditions and raise serious privacy concerns, especially when monitoring vehicle interiors20 LiDAR sensors utilize laser beams to acquire 3D spatial information21. While advantageous for shape analysis, LiDAR systems are relatively expensive and their performance degrades under poor surface reflectivity or adverse weather conditions22. These limitations pose obstacles to large-scale deployment23. Radar sensors operate reliably even under low-light or adverse weather conditions24. For moving humans, radar can analyze Doppler effects to identify irregular gait patterns unique to human locomotion25. In the case of stationary humans, radar can detect physiological signals such as respiration and heartbeat to infer human presence26.

3. System Overview

The radar front-end sensor used in this study is composed of a fully integrated transceiver module equipped with four transmit antennas (Tx) and four receive antennas (Rx)27. The radar operates at a center frequency of 24 GHz and supports a maximum modulation bandwidth of 250 MHz28. The waveform parameters were set with a chirp duration of 100 μs and a repetition interval of 1 ms, collecting 64 chirps per frame29. The signal processing flow is as follows. First, reflected chirp signals are digitized through the ADC30. Next, a 1D Fast Fourier Transform (FFT) is applied to convert time-domain signals into a range profile31. A second 1D FFT is performed across multiple chirps to extract Doppler frequency shifts32. CA-CFAR detection is then applied to extract significant reflections and suppress noise33. Finally, clutter removal techniques like mean subtraction are used to enhance the clarity of physiological signal components34.

4. Proposed Method

The proposed method combines respiration-based analysis for stationary objects and Doppler scattering pattern analysis for moving objects.Stationary Objects: The system exploits the presence of human-specific respiration micro-movements. Doppler spectral analysis is performed over a 5-second observation window to detect periodic components in the 0.2–0.5 Hz frequency range. A majority voting mechanism across multiple frames is used to improve robustness against intermittent signal loss. Moving Objects: The system focuses on complex motion patterns. It extracts the number of high-energy scattering points and computes the variation between consecutive frames. These features form a two-dimensional feature vector for a binary decision tree classifier, distinguishing humans from stable mechanical objects.

5. Experiments and Results

Experimental Setup and Configuration To evaluate the performance of the proposed human indication scheme, experiments were conducted using a 24 GHz FMCW radar system in a controlled indoor environment1. The radar front-end consisted of a transceiver module with four transmit (Tx) and four receive (Rx) antennas2. The operating parameters were configured with a center frequency of 24 GHz and a modulation bandwidth of 250 MHz3. Each frame comprised 64 chirps with a duration of 100 and a repetition interval of 1 ms4. The ADC sampling rate was set to 5 MHz, and a total of 1024 frames were collected for each scenario to ensure statistical significance5. The experiments were performed in an open indoor space to preserve realistic multipath conditions and environmental clutter6.

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Electrical Detection of Specific Protein Binding Using DNA-Based Nano-biosensor

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Abstract: We describe a novel application for highly sensitive nano-biosensor based on DNA-templated gold nanowires (AuNWs) as the conducting channel to detect biotin-streptavidin binding. We confirmed that the nanodevice can be operated the highly sensitive nano-biosensor extending below the picomolar concentration regime after binding with streptavidin.

Keywords : DNA; AuNWs; Nanodevice; NanoBiosensor

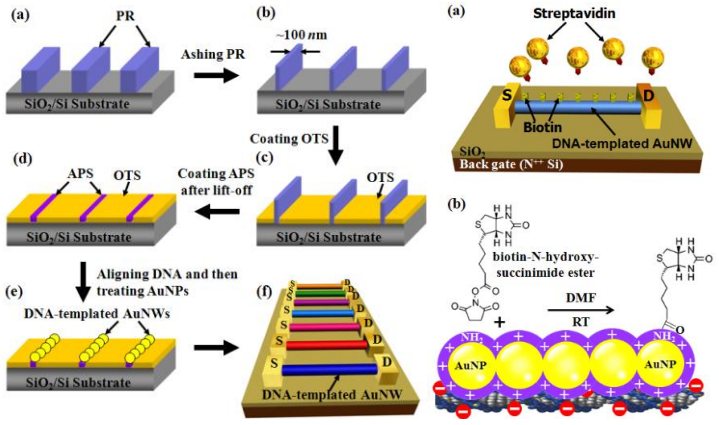

Fig. 1. The procedure forming a biosensor using DNA-templated AuNWs and schematic of DNA-based nano-biosensor and biotinylation reaction onto surface of the self-functioned nanowire

Current biological sensing techniques commonly rely on optical detection principles that are inherently complex, requiring multiple steps between the actual engagement of the analyte and the generation of a signal, multiple reagents, preparative steps, signal amplification, complex data analysis, and relatively large sample size [1]. Among the variety of systems explored, electronic detection techniques based on one-dimensional (1-D) nanostructures, such as semiconductor single-wall carbon nanotubes [2], silicon nanowires [3], SnO2 nanowires [4], and In2O3 nanowires [5], have been demonstrated as good candidates for ultrasensitive, miniaturized molecule sensors in many applications. The sensors based upon 1-D nanostructures could be generally understood in terms of change of surface charge of the nanostructures with the presence or absence of molecular species. Because of the high surface-to-volume ratio of the nanostructures, their electronic conductance may be sensitive enough to the surface species that single molecule detection becomes possible.

Fig. 1 shows the schematic diagram for architecture of DNA-based biosensor that uses a DNA-templated AuNW as a transducer. The process begins with the selective alignment of the DNA molecules on Si substrate using method combined molecular combing and surface pattering techniques and then thus synthesis of DNA-templated NWs as shown in Figure

Fig. 2 shows AFM images of a nano-biosensors based DNA-templated AuNWs after exposure to streptavidin. The DNA-templated AuNWs were manipulated by the positively charged gold nanoparticles (AuNPs) attached along λ-DNA molecules which were precisely positioned and uniformly separated on surface of large scale substrate by surface-patterning technique and connected

between the source and drain electrodes with a gap of 5 μm. The positively charged AuNWs were employed to avoid nonspecific binding of streptavidin, with attachment of biotin to the layer for specific molecular recognition. Specific biotin-streptavidin binding was detected by the change of current in the sensor characteristic.

Fig. 3 shows I-V responds from a DNA-based biosensor before and after exposure to streptavidin. HP4145 semiconductor parameter analyzer was used to detect the change of its electrical conductivity by specific biotin-streptavidin binding. We confirmed that the nanodevice can be operated the highly sensitive nano-biosensor extending below the picomolar concentration regime after binding with streptavidin. This approach opens up for large scale fabrication of highly sensitive biomolecule sensorchips for potential use in medicine and biotechnology. We describe a novel application for highly sensitive nano-biosensor based on DNA-templated gold nanowires (AuNWs) as the conducting channel to detect biotin-streptavidin binding. The DNA-templated AuNWs were manipulated precisely positioned and uniformly separated on surface of large scale substrate by surface-patterning technique and then were connected between the source and drain electrodes with a gap of 50 nm. The positively charged AuNWs were employed to avoid nonspecific binding of streptavidin, with attachment of biotin to the layer for specific molecular recognition. Specific biotin-streptavidin binding was detected by the change of current in the sensor characteristic. We confirmed that the nanodevice can be operated the highly sensitive nano-biosensor extending below the picomolar concentration regime after binding with streptavidin. This approach opens up for large scale fabrication of highly sensitive biomolecule sensor chips for potential use in medicine and biotechnology.

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Attention-Based Early Multimodal Fusion for Robust In-Cabin Object Detection

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Abstract: In-cabin object detection is a critical component for occupant monitoring but faces challenges due to fluctuating illumination. This paper proposes an attention-based early multimodal fusion framework integrating RGB, infrared (IR), and depth information. The system utilizes modality-aware attention to combine these features before performing detection with YOLOv12. Experimental evaluations on the SVIRO dataset indicate that the proposed attention-based RGB and depth fusion significantly outperforms standard fusion methods, providing superior robustness for in-cabin monitoring.

Keywords : multimodal; in-cabin monitoring system; attention fusion

1. Introduction

In-cabin monitoring systems are vital for safety applications like occupant detection and child-left-behind prevention in autonomous vehicles. Traditional RGB-based sensors suffer from reliability issues caused by nighttime shadows or harsh sunlight. To mitigate this, multimodal perception combining IR and depth—which provide illumination-invariant cues—is explored. This paper introduces a framework that integrates these modalities through early feature-level fusion followed by YOLOv12-based detection to ensure accurate monitoring under varying lighting conditions.

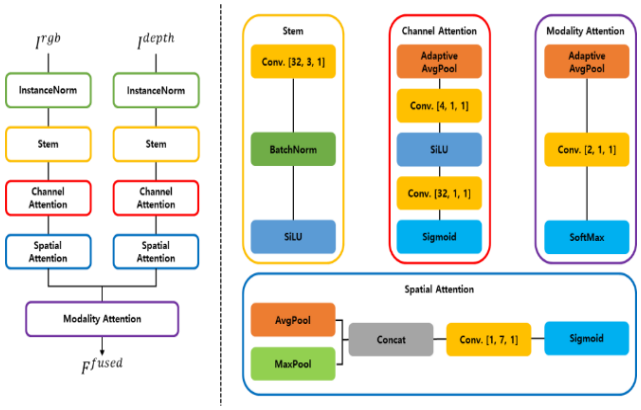

Fig. 1. Overall architecture of the proposed attention-based multimodal fusion module.

2. Methodology

The proposed framework aims to achieve robust in-cabin object detection under diverse illumination conditions by leveraging complementary visual modalities. As illustrated in **Fig. 1**, the architecture adopts an early multimodal fusion strategy that integrates RGB and depth inputs before detection using YOLOv12. To effectively integrate heterogeneous RGB and depth inputs, the proposed framework employs an attention-based early fusion design with instance normalization. Given concatenated RGB (3-channel) and depth (1-channel) inputs, modality-specific normalization and feature extraction are first applied to mitigate distributional discrepancies, followed by a lightweight attention-based fusion

module that emphasizes informative modality cues. As shown in **Fig. 1**, the multimodal fusion module integrates RGB appearance cues and depth-based geometric information using a lightweight hierarchical attention design. Each modality is independently normalized and processed through a dedicated stem consisting of a convolutional layer, batch normalization, and SiLU activation, mapping heterogeneous inputs into a shared embedding space.

To enhance discriminative representations, channel and spatial attention are sequentially applied to suppress background noise and highlight salient regions inside the vehicle cabin. In addition, a modality attention mechanism adaptively balances RGB and depth contributions by assigning modality-wise importance weights based on global context.The attention-refined features are then fused via weighted summation and projected to a three-channel representation using a convolution, ensuring compatibility with the YOLOv12 backbone while maintaining computational efficiency.

Modality	Fusion	Precision	Recall	mAP50	mAP50-95
RGB	-	0.489	0.708	0.624	0.52
IR	-	0.723	0.7	0.778	0.58
Depth	-	0.969	0.966	0.985	0.921
RGB +NIR	Concat	0.52	0.653	0.639	0.528
	Add	0.521	0.642	0.631	0.521
	Attention	0.486	0.811	0.67	0.566
RGB+Depth	Concat	0.97	0.946	0.983	0.922
	Add	0.979	0.96	0.987	0.924
	Attention	0.981	0.97	0.988	0.929
NIR+Depth	Concat	0.953	0.934	0.979	0.908
	Add	0.932	0.899	0.968	0.906
	Attention	0.972	0.945	0.982	0.912
RGB+NIR+ Depth	Concat	0.909	0.875	0.959	0.885
	Add	0.908	0.869	0.95	0.884
	Attention	0.949	0.944	0.982	0.918

Taible. 1. Comparison of Early Fusion Strategies on the SVIRO Dataset Using YOLOv12

3. Experiments

We evaluate the proposed multimodal early-fusion framework on the SVIRO [5] in-cabin dataset using YOLOv12 as the common detector, varying only the fusion front-end. Two simple baselines, concatenation (**concat**) and element-wise averaging after channel alignment (**add**), are compared against the proposed attention-based fusion module. Instance normalization is applied only to the proposed method to better align heterogeneous modality distributions, while **concat** and **add** are evaluated without normalization. **Table I** summarizes the results.

4. Conclusion

This paper presented an attention-based early multimodal fusion framework for robust in-cabin monitoring. Experimental results on the SVIRO dataset show that attention-based fusion more effectively exploits complementary modality cues compared to simple concatenation or addition. In particular, integrating RGB and depth with hierarchical attention leads to the most accurate results, indicating its potential for reliable monitoring under challenging illumination conditions.

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Development of Pediatric Rehabilitation Robot with Differential Gear-based AAN System for Children with Central Nervous System Impairment

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Abstract: This paper presents the development of a rehabilitation robot system (Fig.1) designed for children with central nervous system (CNS) impairments, such as cerebral palsy. The proposed system aims to provide effective gait and upper limb training while resolving the accessibility issues often found in existing rehabilitation devices. The robot is composed of three modular units: 1) a Drive Unit utilizing a differential gear-based Assist-As-Needed (AAN) mechanism, 2) a Support Unit with adjustable frames for various body sizes and postures, and 3) a Boarding Assist Slider Unit to facilitate easy patient transfer. The Drive Unit employs a single main motor to drive upper and lower limb modules simultaneously, using powder brakes to control the assist torque independently. The Support Unit features a tilting backrest and swing-away armrests to secure the child safely. The Slider Unit allows for 90-degree rotation and motorized sliding to help guardians easily transfer the child onto the device. This study details the mechanical design and implementation of each unit, demonstrating a comprehensive solution for pediatric rehabilitation.

Keywords : Pediatric Rehabilitation, Assist-As-Needed (AAN), Differential Gear, Patient Transfer System, CNS Impairment

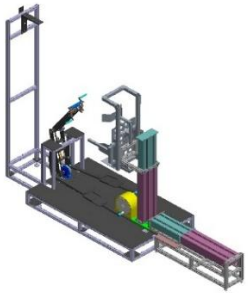

Fig. 1. Pediatric rehabilitation robot

1. Introduction

Children with central nervous system (CNS) impairments, including cerebral palsy, require continuous and repetitive physical therapy to improve motor function and prevent contractures. However, conventional manual therapy is labor-intensive for therapists, and existing robotic devices are often too bulky or lack the adaptability required for growing children. Furthermore, transferring a child with limited mobility onto a rehabilitation machine poses a significant physical burden on caregivers and safety risks for the child. To address these challenges, this study proposes a novel pediatric rehabilitation robot. The system is designed not only to provide effective AAN (Assist-As-Needed) training using a compact differential gear mechanism but also to ensure ease of boarding and optimal postural support through specialized modular units.

2. System Configuration

The proposed system is divided into three main modules: the Drive Unit, the Support Unit, and the Boarding Assist Slider Unit. To facilitate transportation and installation, the Drive Unit and the Boarding/Support Unit are designed as separable modules. The Drive Unit is the core of the rehabilitation exercise. It utilizes a unique mechanism where a single main motor drives a differential gear system. Mechanism: The power from the main motor is distributed to the upper and lower limb exercise modules. The differential gear structure allows for the integration of a powder brake and a torque sensor on one side of the gear output, while the other side connects to the user's pedal or handle. Functionality: This configuration enables the implementation of the AAN control strategy. By controlling the brake torque based on the sensor feedback,the system can provide appropriate assistive or resistive force while maintaining the reference speed set by the main motor. Modules: The unit supports an Elliptical Module for lower limb gait training and a Pedal/Steering Module for upper limb exercise. The angle of the drive unit can be electrically adjusted to fit the child's height and physique. The Support Unit is designed to maintain the correct posture for children with varying degrees of trunk stability. Adjustability: It features a headrest with height adjustment and a backrest capable of tilting (approx. 10–15 degrees) to accommodate both standing and sitting exercises. Safety & Convenience: The unit includes a swing-away armrest and saddle to facilitate side entry. A harness is combined with the frame to prevent falls and ensure the child's torso is securely supported during vigorous exercise. Boarding Assist Slider Unit, To solve the difficulty of transferring patients, a dedicated Slider Unit is integrated. Rotation: The entire seat assembly can rotate 90 degrees (manual operation) to face the wheelchair or entry point, allowing the child to sit without complex maneuvering. Sliding & Elevation: Once seated, the unit can slide forward/backward and adjust its height via a motorized system controlled by a remote. This brings the child into the correct position relative to the Drive Unit efficiently.

3. Control and Operation

The control system focuses on the AAN strategy. The main motor maintains a constant rehabilitation speed, while the powder brakes in the Drive Unit modulate the torque. If the child exerts force in the direction of motion (detected by torque sensors), the brake releases load to assist; if the child is passive, the brake applies torque to guide the movement. This ensures active participation from the patient, which is critical for neuroplasticity and motor learning.

4. Conclusion

This study developed a comprehensive pediatric rehabilitation robot featuring a differential gear-based drive system and a user-friendly boarding mechanism. The separation of drive and support modules enhances portability, while the adjustable support and slider units significantly improve usability for both patients and caregivers. Future work will involve clinical trials to verify the therapeutic effects on children with CNS impairments.

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Dual-Path Cross-Attention U-Net for Poster Design Intent Detection Using Inverted Saliency

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Abstract: Design intent detection is a critical component in poster layout generation systems as it directly affects placement quality and generation stability. Existing single-image approaches often struggle with complex compositions containing mixed text–image content. This paper proposes an inverted saliency-guided design intent detector using a U-Net backbone with a dual-encoder architecture. By inverting the saliency map to highlight background and whitespace, we provide an explicit spatial prior to a dedicated hint encoder. Multi-scale Cross-Attention fusion is employed to integrate these features effectively. Experimental results on the PKU poster dataset show that our method achieves an IoU of 0.876 and a Dice coefficient of 0.928, outperforming existing baselines

Keywords : design intent detection, poster layout generation, multi-scale cross-attention

1. Introduction

Poster layout generation aims to place design elements such as titles, subtitles, body text, and graphics into visually coherent compositions while respecting readability and aesthetic constraints. A practical prerequisite for high-quality layout generation is design intent detection, i.e., identifying regions that are suitable or unsuitable for placing layout elements. When intent regions are inaccurately estimated, downstream layout systems may place text over salient objects, violate visual balance, or produce unstable generation behavior across diverse poster styles. Despite recent progress, a common limitation in existing design intent detection pipelines is their reliance on a single input image. In real posters, visual structure is often complex: multiple objects coexist with decorative patterns, backgrounds may contain textured content, and text and graphics interact across several hierarchy levels. Under these conditions, single input models can have difficulty separating "placement-friendly" whitespace/background from visually important content, leading to blurred boundaries and fragmented intent maps.

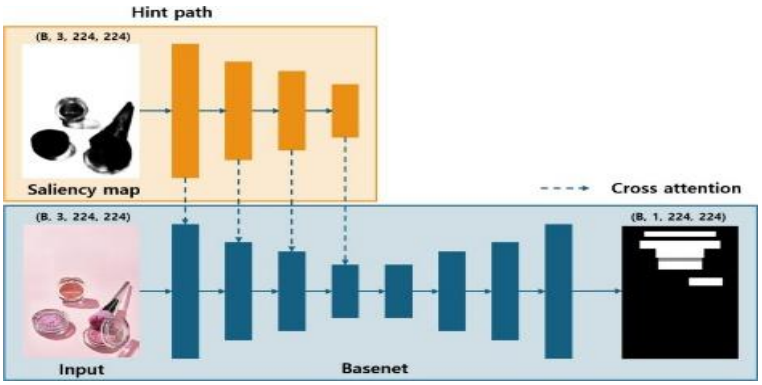

Fig. 1. Overall architecture of Design Intent Detection network

2. Methodology

Conventional saliency maps mainly highlight visually dominant foreground regions. For layout placement, however, the complementary regions background and whitespace are often more informative because they represent feasible areas for inserting new elements such as text blocks. To align the hint with this objective, we invert the saliency map and use it as an explicit whitespace prior:

$$H_S = 1 - S$$

Here, high values in H_S correspond to low-saliency areas, which are treated as placement- friendly candidates. This hint is simple, interpretable, and does not require extra annotations beyond what is already available from a saliency estimator. To leverage the whitespace prior effectively, we introduce a second encoder (hint path) and integrate it with the base image encoder via Cross-Attention at multiple scales. Intuitively, the hint path provides "where-to-place" cues, while the image path provides "what-is-there" cues; Cross-Attention lets the model condition image features on the hint features in a content-aware manner.

$$\tilde{F} = F_{\text{img}} + \text{CA}(F_{\text{img}}, F_{\text{hint}}),$$

where CA denotes a standard Cross-Attention operation and $\tilde{F}$ is the fused feature map used for subsequent decoding through skip connections. Applying this fusion at multiple scales allows the model to incorporate coarse placement priors at low resolution and refine intent boundaries at higher resolution, improving spatial separation in complex poster compositions. We train the model with a weighted sum of a pixel-wise supervision term and a global consistency regularizer. The pixel-level objective uses mean squared error (MSE) to match the predicted intent map to the ground truth

3. Experiments

This section presents the experimental setup used to evaluate the proposed inverted- saliency-guided dual-encoder U-Net with multi-scale Cross-Attention and reports quantitative and qualitative results on the PKU poster dataset.

We evaluate design intent detection as a pixel-wise prediction task using three standard segmentation metrics: Intersection over Union (IoU), Dice coefficient, and Pixel Accuracy (PA). Let Pred denote the predicted intent region and GT denote the ground-truth intent region. IoU measures the overlap ratio between prediction and ground truth:

4. Conclusion

We presented an inverted-saliency-guided design intent detection framework. By integrating a hint encoder with multi-scale Cross-Attention, our model achieves superior boundary delineation in complex poster compositions. Future work includes integrating this detector into end-to-end poster generation pipelines to measure downstream layout stability.

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Technology-Enabled Law Practice: Ethical and Professional Responsibilities in Artificial Intelligent Systems

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Abstract: Artificial Intelligence (AI) is transforming the legal profession by revolutionizing how law is practiced, researched, and adjudicated. Integrating technologies such as Machine learning and Natural Language Processing introduces unprecedented efficiency and accessibility across legal services, but it also raises new and complex ethical challenges. This chapter examines how AI- driven tools are reshaping fundamental legal ethics, including competence, confidentiality, professional supervision, conflicts of interest, and transparency. It highlights the evolving responsibilities of legal professionals in ensuring the accuracy, fairness, and accountability of AI-assisted legal work. Through a comparative analysis of regulatory developments across jurisdictions—such as the United States, European Union, United Kingdom, India, and Canada—the chapter explores recent reforms and judicial responses to AI integration. Key case studies are presented, such as court sanctions for unsupervised use of AI-generated text, data breaches in automated discovery, and the introduction of AI-assisted decision-making in Indian courts. The role of legal education in fostering AI literacy and the global need for harmonized ethical guidelines are emphasized. Finally, the article offers recommendations for practitioners, bar councils, educators, and developers to navigate AI adoption responsibly while preserving trust in the legal system. As lawyers and judges increasingly rely on intelligent systems, maintaining professional standards and ensuring human oversight remain vital to the integrity of justice delivery.

Keywords : AI, legal ethics, professional responsibility, legal technology, transparency, bias, data protection

1. Introduction

Artificial Intelligence (AI) is revolutionizing how law is practiced, researched, and adjudicated. Its integration brings both unparalleled opportunities and novel ethical challenges for lawyers, judges, and legal institutions. This article critically examines how AI, especially machine learning and natural language processing systems, is reshaping established standards of competence, confidentiality, responsibility, and fairness in legal practice. Emphasis is placed on evolving global codes, risks of automation, and actionable recommendations for ensuring ethical legal professionalism in the digital age.

Extent literature highlights both the *promise* of greater efficiency, accessibility, and fairness, and the *perils* of biases embedded in data, opacity of algorithms and risks to privacy.

Area	Risk	Best Practice
Confidentiality	Cross-border data breach/location uncertainty	Encryption, detailed vendor due diligence
Competence	Overreliance on AI outputs	Regular training, manual critical review
Conflicts	Data or strategy leakage	Use anonymized data, enforce strict segregation
Bias	Discriminatory or unfair outcomes	Ongoing bias audits, explainable AI only

Table. 1. This table summarizes key ethical risks in legal AI and their corresponding mitigation strategies.

2. Discussion

The integration of AI into the legal sector necessitates a fundamental re-conception of professional responsibility, positioning lawyers as "stewards" who must critically oversee digital tools rather than relying on them passively. Since AI functions as an augmentative resource rather than a substitute for human judgment, proactive training is essential to mitigate the risks of automation bias. This shift demands a systemic overhaul of legal education, encompassing innovative law school curricula and specialized programs for both practitioners and the judiciary focused on AI ethics and governance. Furthermore, addressing the current "global regulatory patchwork" is imperative; harmonizing divergent international standards will reduce the operational complexities faced by legal professionals and technology vendors in an increasingly interconnected landscape.

3. Conclusion

AI's integration in law is inevitable and transformative. However, the legal profession must balance technological innovation with adherence to fundamental ethical values: confidentiality, competence, fairness, and accountability. The lawyer remains ultimately responsible for work produced using AI, mandating continuous education, rigorous supervision, and transparent regulatory frameworks. The future of justice depends on such careful harmonization between man and machine.

Exploring The Synergy Between AI And Cloud Computing In The Digital Era

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Abstract: In the digital era, the convergence of Artificial Intelligence (AI) and Cloud Computing has emerged as a transformative force, reshaping industries, businesses, and everyday life. Cloud computing provides scalable infrastructure, flexible storage, and on-demand computational power, enabling organizations to harness AI capabilities without the constraints of traditional hardware. Meanwhile, AI enhances cloud platforms with intelligent automation, data-driven insights, and advanced analytics, driving efficiency and innovation. This synergy empowers enterprises to accelerate digital transformation, optimize decision-making, and deliver personalized user experiences at scale. Furthermore, the integration of AI and cloud fosters cost-effectiveness, agility, and global accessibility, making advanced technologies available to businesses of all sizes. As the demand for real-time data processing, predictive intelligence, and smart applications continues to rise, the collaboration between AI and cloud computing will play a pivotal role in shaping the future of digital ecosystems.

Keywords : Artificial Intelligence (AI), Cloud Computing, AI–Cloud Integration, Scalable Infrastructure, Intelligent Automation, Data Analytics, Digital Transformation, Predictive Intelligence, Smart Applications, On-Demand Computing, Big Data, Personalized User Experience

1. Introduction

The digital era is marked by an unprecedented acceleration in technological innovation, where artificial intelligence (AI) and cloud computing have emerged as two of the most disruptive forces. Individually, both technologies have transformed the way organizations process information, deliver services, and create value. However, their convergence is redefining the very essence of digital transformation by fostering an intelligent, scalable, and highly adaptive technological ecosystem. Cloud computing provides the essential foundation of elastic infrastructure, ubiquitous storage, and on-demand computational power, while AI adds the cognitive layer of intelligence, enabling machines to analyze vast datasets, derive actionable insights, and automate decision-making. Together, AI and cloud computing are driving a paradigm shift from traditional IT models toward data-centric, intelligent, and service-driven ecosystems that empower businesses to innovate at scale. This synergy is not only democratizing access to advanced AI capabilities but also shaping the future of industries, economies, and societies in the digital age.

2. Conclusion

The convergence of AI and cloud computing represents more than just a technological advancement—it is the foundation of the next digital revolution. By combining scalable infrastructure with cognitive intelligence, this synergy enables transformative innovation across industries and societies. While challenges in security, privacy, sustainability, and governance persist, ongoing advancements promise to address these barriers. The fusion of AI and cloud will continue to shape the digital economy, redefine human-machine collaboration, and drive unprecedented levels of efficiency and creativity. As organizations and nations invest in this synergy, AI-cloud integration will stand as the defining pillar of progress in the digital era.

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Serverless Paradigms for Next-Gen Cloud Systems

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Abstract: This paper examines the transformation of traditional urban environments into smart, interconnected cities through the integration of serverless computing, cloud platforms, and Internet of Things (IoT) technologies. It highlights how real-time data processing enables the conversion of urban resources into measurable economic and social value. By leveraging serverless and IoT-enabled systems, cities can improve operational efficiency, optimize resource allocation, and enhance quality of life, while community cloud resources and third-party platforms support seamless data integration within adaptive urban ecosystems.

Keywords : serverless computing, Urban Conglomerates, Cloud Computing, Smart Cities, Information sharing, IoT.

1. Introduction

The paper describes cloud computing as an advanced form of internet-based computing that enables scalable and efficient service delivery, with the Internet of Things (IoT) enhancing performance, operational efficiency, and throughput in cloud environments [1]. Smart cities are defined as urban areas that adopt advanced information and communication technologies to promote sustainability, infrastructure optimization, public health, and long-term socio-economic development, with IoT integration and cloud-based serverless computing forming the foundation of intelligent urban management and responsive services [2].

2. Literature Review

Cloud computing is identified as a core infrastructure for managing the large-scale data and communication demands of IoT systems, which, despite their scalability and flexibility, face limitations related to resources, energy, and interoperability [3–6]. By providing shared, cost-efficient resources for data processing, storage, and software services, cloud-based IoT frameworks enable efficient data collection, analysis, and management across diverse domains, including manufacturing, transportation, emergency services, and urban infrastructure [7–11]. Further studies highlight that cloud–IoT integration supports scalable provisioning, real-time monitoring, and applications such as disaster and environmental sensing while reducing infrastructure costs, particularly for small and medium-sized enterprises, although challenges related to energy efficiency, privacy, scalability, and advanced analytics remain for Intelligent and Elegant Smart Cities [13–25].

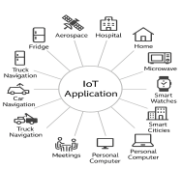

Fig. 1. Smart Device Networking

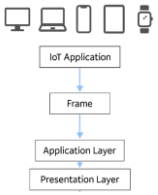

Fig. 2. Smart Tech in Action

3. Strategic Applications in Modern Capitals

This section discusses the strategic deployment of technological and financial resources to maximize long-term value and sustainability in modern cities. Smart capital applications emphasize efficiency, reduced risk, and responsible resource utilization. The paper argues that smart city development requires interoperable systems, citizen-centric services, and data-driven planning supported by state-of-the-art solutions [27].

IoT-enabled smart lighting systems provide real-time monitoring, adaptive illumination, and cost efficiency [28]. By integrating sensors, communication networks, and centralized management platforms, cities can optimize street lighting based on pedestrian activity, traffic flow, and environmental conditions, while supporting services such as surveillance, electric vehicle charging, wireless connectivity, and public information delivery [29].

The integration of IoT in transportation and logistics improves safety, route optimization, cost efficiency, and user experience [30]. By leveraging vehicle tracking, wireless communication, and real-time analytics, smart transport systems enhance operational coordination, passenger safety, fleet management, and adaptive traffic control through cloud-based monitoring.

4. Conclusion

The study concludes that serverless computing and IoT enable intelligent urban governance through real-time, data-driven decision-making, reducing operational costs and improving infrastructure efficiency and quality of life. Cloud-based IoT systems further enhance urban adaptability, support sustainable resource management, and improve public services, highlighting the need for future research on expanded cloud-integrated IoT applications for sustainable smart city development.

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ADVANCED PREDICTIVE ANALYSIS OF DIABETS USING AXG BOOSTING ALGORITHM

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Abstract: This study proposes an Advanced Extreme Gradient Boosting (AXGBoosting) ensemble model for diabetes risk prediction and classification. Using clinical and demographic data from a Kaggle dataset, the model improves predictive performance by approximately 5% over traditional methods, demonstrating its effectiveness in accurate diabetes risk assessment.

Keywords : Information Boosting algorithm, Machine learning algorithm,AXGB algorithm , diabetes

1. Introduction

Diabetes mellitus is a widespread chronic disease that can lead to severe complications if not detected early. With the growth of clinical data from EHRs and wearable devices, machine learning offers an effective alternative to traditional diagnosis by identifying complex patterns in patient data. Building on existing ML models, the proposed AXG Boosting algorithm improves diabetes risk prediction by classifying patients into high, moderate, and low risk groups, supporting personalized care and enabling early detection even in unlabeled datasets.

2. Related works

Prior studies have extensively explored diabetes prediction using machine learning and deep learning approaches, including traditional classifiers (e.g., Logistic Regression, SVM, KNN), ensemble methods (e.g., Random Forest, XGBoost, CatBoost), and advanced deep learning models (e.g., GRU, CGRU, attention-based multimodal networks). Research has addressed early diagnosis, risk classification, complication prediction, gestational-to-type 2 diabetes progression, and data challenges such as imbalance and incompleteness, using datasets like PIMA and large-scale EHRs. Overall, ensemble and gradient boosting–based models consistently demonstrate superior predictive performance, supporting the effectiveness of advanced AI-driven frameworks for early detection, risk stratification, and personalized diabetes management.

3. Research methodology

The study uses a medical dataset from the Kaggle repository containing clinical and demographic features. Data preprocessing includes converting text to lowercase, removing punctuation and stop words, handling missing values, and cleaning feature formats. Categorical risk levels (low, moderate, high) are converted to numerical labels using label encoding. The proposed Advanced Extreme Gradient Boosting (AXGBoosting) algorithm is then applied with a 60% training and 40% testing split. AXGBoosting supports both supervised learning, using labeled data, and unsupervised learning, leveraging unlabeled or incomplete records to predict diabetes risk categories.

AXGBoost is an enhanced XGBoost variant that improves regularization and overfitting control in decision tree boosting. Given training data with feature–label pairs, the model iteratively builds trees using gradients and Hessians of a differentiable loss function. Key hyperparameters include the learning rate, regularization term, minimum split loss, and an additional tree-depth regularization factor. At each iteration, leaf weights are computed using gradient-based optimization with added depth penalization,

and model predictions are updated accordingly. This depth-aware regularization enables AXGBoost to achieve better model complexity control and generalization than standard boosting approaches.

4. Results and Discussion

The proposed AXG Boosting method consistently outperforms standard XGBoost across six diabetes-related datasets. AXG Boosting achieved near-perfect or perfect accuracy (99–100%) on all datasets, compared to XGBoost accuracies ranging from 75% to 95%. These results demonstrate that AXG Boosting provides superior predictive performance and reliability for diabetes prediction tasks.
Multiple diabetes datasets of varying sizes were used to evaluate the proposed model's ability to classify patients into low, moderate, and high risk categories. The results showed different risk distributions across datasets, reflecting variations in patient characteristics. Overall, the model demonstrated strong adaptability and consistency in predicting diabetes risk levels across diverse medical datasets.

5. Evaluation metrics

The AXG Boosting algorithm was evaluated on six diabetes-related datasets using Precision, Recall, and F1 Score. Results showed near-perfect performance across all datasets, with most achieving 100% on all three metrics. The only exception was the Pima Indians Diabetes dataset, which showed slightly lower but still high performance (Precision 99.6%, Recall 99.4%, F1 98.8%), likely due to greater data variability. Micro and macro average metrics both exceeded 99%, indicating consistent and reliable performance across datasets regardless of size. Overall, the results demonstrate that AXG Boosting is a highly accurate and robust model for diabetes classification, though the consistently perfect scores highlight the need to assess potential overfitting.

6. Conclusion

The Collection of dataset is taken from the kaggle repository implemented in XGboost and proposed AXG boosting, The proposed AXG Boosting method demonstrates superior performance compared to the existing XGBoost algorithm across all assessed diabetes-related datasets. Consistent improvements in accuracy have been observed, with the proposed method attaining near-perfect or perfect accuracy levels ranging from 99% to 100%, in contrast to the existing method lower accuracy range of 75% to 95%. This illustrates the strength and efficiency of AXG Boosting in improving predictive performance for diabetes diagnosis and easy to classify the patients categorize for predicting a diabetes mellitus.

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AI for Digital Well-Being: Real-Time Moderation of Harmful Online Content

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Abstract: The platforms for online communication have expanded rapidly. These are creating new opportunities for interaction but also increasing the chances of offensive and harmful content. These types of messages affect the mental health of the user, which also affects the social well-being of the individual user. This shows the importance of strategies for moderating such issues. In this work, we present a real-time framework for detecting and blocking harmful text using Natural Language Processing (NLP) and machine learning techniques. The text is represented with Term Frequency–Inverse Document Frequency (TF–IDF) features and classified using Random Forest, Support Vector Machine, and XGBoost algorithms. From our experiments and comparison the tuned XGBoost model performed the best, reaching 90% accuracy with an F1-score of 0.75. The per-sample prediction latency was of only 0.004 seconds. We further implemented the system as a web application by deploying it through a Streamlit-based interface, thus enabling instant alerts and preventive moderation. The main novelty of this study lies in showing that it focuses on lightweight models, which, when carefully tuned, can deliver reliable real-time performance. With the help of this balance between accuracy and efficiency, our framework offers and ensures safer digital converstaions and improved social well being of the users.

Keywords : AI based message detection, social well-being, Machine Learning, Natural Language Processing , TF-IDF

1. Introduction

The rapid expansion of digital communication platforms such as social media, online forums, and instant messaging applications has changed the way how individuals interact and share information. Even though these platforms promote a global way for communication, openness, and help in community building, they have equally big problems like the spread of toxic and harmful content. Toxic comments, including hate speech, abusive language, and personal attacks, these types of messages not only degrade the quality of the discussions but also cause various problems for the users, like severe mental health issues and psychological harm [1],[2]. Left unmoderated, such content may escalate into cyberbullying, misinformation campaigns, and even offline conflicts. If not moderating such content, it may lead to an increase in online conflicts, may cause misinformation, and may even cause cyberbullying.

In traditional moderation approaches, it included methods such as manual review or rule-based keyword filters. These are insufficient for modern digital environments, as they generate millions of user-generated comments every second. Manual moderation of these will be slow and not efficient, while keyword filters can fail to capture the actual context, or the sarcasm, and the evolving nature of the toxic expressions. Therefore, there is an increasing need for systems that can accurately and efficiently detect toxicity in real time.

This research presents a real-time toxicity detection framework that uses Natural Language Processing (NLP) and machine learning models. Unlike many existing offline studies, our approach

focuses on the low-latency prediction, making it suitable for live chat and interactive platforms. We will use a TF–IDF representation of text and then compare several tuned models, including Random Forest, Support Vector Machines, and XGBoost after tuning. After these comparisons, the best- performing model is selected and deployed through a Streamlit-based application. This will ensure immediate feedback to the users and moderators. This real-time mechanism is designed to make and promote healthier digital environments by reducing harmful content before it spreads further.

2. Conclusion

Our proposed AI-powered chat moderation system demonstrates efficiency in detecting the offensive, harmful, or toxic messages that may affect the mental health and well-being of an individual. The system works well with the help of TF-IDF and with 90% accuracy using the XGBoost model among the various machine learning algorithms compared. It also has a very low prediction latency. The system provides instant alerts, ensuring intervention, handling such contents before itself ensuring safety during online communication.

While the current study focuses on the English language dataset, in the future, we can add models for detecting offensive words in other languages, thus making it more effective for social well-being and for making it global. The model can also be used for other platforms like comment sections, emails, etc. These add-ons will help the system to expand its role for encouraging respectful and healthful interactions online.

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ANALYSIS OF CARDIOVASCULAR DISEASE BASED ON MACHINE LEARNING USING JFO ALGORITHM

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Abstract: Nerve affliction is individual of ultimate famous and poisonous ailments in the concern, and in abundance arrangement diminish their existences from that affliction every twelvemonth. Premature understanding concerning this affliction is aware drop family's lives. ML, a stylized discourse demesne, is human of net seasonable, fastest, and low-cost explanation to observation affliction. In this opine almost, we aim to get an ML influence that can meet congestive nerve nonstarter incidental the highest available kill utilizing the Chairman insight ill Dataset. This countenance in those datasets resorted to take the pretend and the belief. To refrain overfitting (on account of the exclamation of dimensionality) on account of the Brobdingnagian decide of visage in the President dataset, these datasets existed shortened to a depreciate spatial subspace using the Siphonophore bettering treasure. The Medusan treasure has a superior touching percentage and is versatile to mature the importance looks. The models acquired by nurture the feature-picked dataset with opposition ML algorithms were demonstrated, and their acts were dignified. The maximum appear was got for the SVM classifier Modify of 98.56%, 98.37%, 98.47%, and 94.48%, respectively. This outcome dissembling that the connexion of the Medusa amendatory innovation and SVM classifier has the maximum calculation for use in suspicion affliction rendition.

Keywords : Machine Learning, Dataset, Medical Diagnosis, Feature Selection, Dimensionality reduction, Support Vector Machine,

1. Introduction

Despite progresses in disease and ideas, mortality from myocardial infarction debris the chief cause of demise general, giving reason for about one- tertiary of annual passing. [1] Articulator nausea refers to a disagreement of cheek environments and diseases, containing Thrombosis Arteria Disease, Cardiopathy, Suspicion Controller Disease, and Temperament Casualty, that venture the feeling not to function correctly [1]. Coronary Arteria Disease is an ultimate untreated type of nerve affliction, as it results in reduced or shut heart failure channels on account of plaque addition on their central divider. [2] This can bring about weighty complications to a degree heart failure, tool deficiency, as well as arrhythmias, because this reduces ancestry flow to the heart [2]. In few cases, processes in the way that angioplasty or expressway medical procedure grant permission be necessary to about-face misstep bleed to the send. Arrhythmia is another casual heart disease generated by disruptions in the native energetic proof of the nerve. [3] The natural rhythmic periodicity of the soul is upset cause the energetic drives in the soul are not working right. Symptoms can contain a prestissimo or jerking sample, need of suggestion, light-headedness or succumbing, and pectus defeat types of arrhythmias, that maybe reliable or life- threatening. Many sufferers grant permission knowledge uneven scenes of temperate cardiopathy in their lives, but others grant permission be hereditary or created by behaviour determinants or other essence ailments [3].

2. Conclusion

This study proposed to cultivate a reliable and correct machine intelligence (ML) demonstrative finish for blood-pumping organ in an animate being affliction utilizing the city dataset. The choice of appearance in the dataset is important for the model's killing, as excessive can bring about overfitting. To prevent this, the Medusa invention was accustomed to choose the best looks from those datasets. The Cnidarian rule, a swarm-located metaheuristic treasure, was used to correct hyperparameters in ML plans. The excellent appearance was before second hand in the preparation and experiment stages of

the replica. The capital classification quality (98.47%) was worked out accompanying the Support Vector Machine (SVM) order, accompanying Sensibility, Specificity, Truth, and AUC principles acquired at 98.21%, 97.96%, 98.09%, and 90.21% without the Medusa recipe. However, utilizing the Jellyfish invention, these principles were acquired at 98.56%, 98.37%, 98.47%, and 94.48%, individually.

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Performance of Fusion Classifiers with different fusion schemes for Pattern Analysis

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Abstract: Classification algorithms generally require an adequate and representative set of training data to establish an appropriate decision boundary. In many machine learning applications, such as automated identification, data collected from multiple sources describing the same physical phenomenon may contain complementary information. In these cases, data fusion can provide deeper insights into the phenomenon than any single source alone.The objective of this paper is to investigate the fusion of multiple machine learning classifiers and to analyze various data fusion schemes. The performance of four classifiers—multilayer perceptrons (MLP), support vector machines (SVM), decision trees (DT), and k-nearest neighbors (KNN)—is first evaluated individually. Their results are then compared when fused in different combinations. Findings indicate that the best performance for pattern recognition applications is achieved by combining the SVM, MLP, and DT classifiers.

Keywords : Classifier Fusion, Multiple Classifier System(MCS), multilayer perceptrons (MLP), the support vector machines (SVM), the decision tree (DT) and K–Nearest Neighborhood (KNN)

1. Introduction

The primary objective in designing a pattern recognition system is to achieve the highest possible classification performance for a given task. This requirement has motivated the development of a variety of classification methodologies. In general, classification algorithms necessitate the availability of adequately representative training data to construct appropriate decision boundaries and ensure satisfactory generalization performance. This requirement becomes particularly critical in ensemble-based approaches, where classifiers are combined using trainable rules such as weighted majority voting, weighted sum, or weighted product, as opposed to fixed rules such as simple summation, product, or majority voting. A multiple classifier system (MCS) integrates an ensemble of typically weak and/or diverse classifiers [3].Classifier diversity, achieved through variations in training parameters such as random sampling, produces distinct decision boundaries. Since individual classifiers are prone to different errors, their collective fusion reduces the total error rate..Improving accuracy through classifier combination has emerged as a significant research direction, often referred to in the literature as classifier fusion, mixture of experts, consensus aggregation, or ensemble learning. These paradigms differ in their assumptions regarding classifier dependencies, classifier output types, aggregation strategies (global or local), and aggregation procedures (functions, neural networks, or algorithms). Ensemble learning is generally characterized by two phases: classifier selection and classifier fusion. Classifier selection presumes that each classifier acts as an expert within a localized region of the feature space. When a feature vector X is submitted for classification, the classifier responsible for the vicinity of \(x\) is accorded the highest weight in assigning the class label.In contrast, classifier fusion assumes that all classifiers are trained across the entire feature space, thereby treating them as competitive rather than complementary. Data fusion refers to the application of techniques that integrate information from multiple sources and consolidate it into discrete and actionable outputs to enable more efficient inference [4].A classification system capable of combining information from multiple sources or feature sets is thus considered capable of performing data fusion.

2. Conclusion

The main advantages of combining classifiers are revealed by studying how the diversity of classifiers and the efficiency of data fusion strategies affect the results. Among all features, classifier diversity, which reflects also differences in decision boundaries, error patterns, and learning biases, is the one that most significantly increases ensemble performance. Consequently, fusion schemes, by taking advantage of such diversity, can neutralize the drawbacks of single classifiers and thus raise the classification's overall robustness and accuracy.This research will then investigate ensemble models constructed from various base classifiers, namely Multilayer Perceptrons (MLPs), Support Vector Machines (SVMs), Decision Trees (DTs), and Radial Basis Function (RBF) Networks. The fusion, level methods like Majority Voting, Mean Rule, Bayesian Combination, and the Decision Template approach will be employed to unify these classifiers. The main focus will be on how well each fusion method can integrate the outputs of heterogeneous classifiers and enhance performance of recognition in different tasks. Building on previous research, the current study also seeks to expand the fusion framework to multimodal biometric systems. The paper envisions that naturally integration multiple biometrics, like facial, voice and fingerprint, would increase the system's reliability and become a tougher opponent against the noise caused by any one of the modalities, which could be incomplete or ambiguous. The effectiveness of different multimodal fusion configurations will be tested with early fusion (feature, level integration) and late fusion (decision, level integration) techniques, aiming to find the most efficient set, up for robust pattern recognition.

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A Temporal and Explainable Machine Learning Framework forProbabilistic and Extreme Rainfall Prediction

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Abstract: The forecasting of rainfall is critical to the management of water resources, reducing disaster risks, and resiliency to climate change. The application of machine learning techniques to modeling complex meteorological relationships has shown promise; however, many existing studies use random data splits, accuracy-centered evaluations, and opaque black-box models that limit their usefulness in real-world applications. Using Australian Weather AUS data, this study proposes a probabilistic, explainable, and temporal machine learning framework for rainfall prediction. The primary predictive model was an XGBoost classifier, with class imbalances handled through cost-sensitive learning rather than resampling. The proposed model achieved ROC–AUC and precision–recall AUC under temporal evaluation. Forecast reliability was significantly improved using Platt scaling, reducing Brier's score from 0.132 to 0.110 and mitigating systematic overconfidence. We extended the framework to include multiclass rainfall intensity forecasting, distinguishing between events with no rain, light rain, and heavy rain. Multiclass models were 98.9% accurate overall and 87.4% accurate for heavy rainfall events, despite their rarity. In addition, McNemar's test confirmed XGBoost's statistical significance over the logistic regression baseline. Overall, the proposed framework offers interpretable, reliable, and operationally meaningful rainfall predictions, enabling risk-aware decision-making.

Keywords : Rainfall Prediction; Temporal Evaluation; Explainable AI; Probability Calibration; Extreme Rainfall; XGBoost

1. Introduction

Rainfall forecasting plays a crucial role in hydrology and meteorology, with significant implications for environmental sustainability, disaster prevention, and socio-economic development. Accurate rainfall predictions support flood mitigation, efficient water resource management, and improved agricultural decision-making. However, rainfall forecasting remains challenging due to the complex, dynamic, and nonlinear nature of atmospheric processes influenced by multiple interrelated climatic factors. Traditional statistical models such as linear regression and ARIMA have been widely used because of their simplicity and interpretability, but their reliance on linearity and stationarity assumptions limits their effectiveness in capturing complex climate dynamics. In contrast, machine learning approaches have emerged as powerful alternatives, as they can automatically learn hidden patterns from data without strict assumptions. Among these techniques, the Random Forest algorithm has gained considerable attention for rainfall prediction due to its robustness and high predictive accuracy. By aggregating multiple decision trees built on random subsets of data and features, Random Forest reduces overfitting, improves generalization, and effectively models nonlinear relationships among climatic variables, making it a reliable tool for accurate rainfall forecasting.

2. Conclusion

This study presents a comprehensive, explainable, and statistically validated machine learning framework for rainfall prediction under realistic temporal conditions. By integrating strict chronological evaluation, SHAP-based explainability, probability calibration, extreme rainfall intensity modeling, and formal statistical significance testing, the proposed approach addresses several key limitations of conventional machine learning studies in meteorological forecasting. The results demonstrate that the
framework not only achieves robust predictive performance on future unseen data but also provides physically interpretable and reliable probability estimates, enhancing its suitability for operational and risk-informed decision-making. Future research directions include extending the framework to analyze long-term climate change trends, incorporating attention-based deep learning architectures to capture complex temporal dependencies, and

developing multi-day rainfall forecasting models for longer prediction horizons. Additionally, integrating the proposed machine learning approach with hydrological simulation systems and incorporating radar or satellite-derived observations may further improve extreme rainfall detection and support comprehensive flood risk assessment.

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Cyber Risks in High-Stakes Trading: Unmasking the Anatomy of Authentication Attacks in the Stock Market

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Abstract: The buzzwords "stock" , “stock market” and "share market" are the order of the day as they play a vital role in finance and economic growth of a country. Since it involves the money transactions, security remains an issue, especially on the side of investors (ie) retail participants tend to lose more funds and have less trust compared to large investors, mostly due to cybersecurity frauds. All these threats exploit vulnerabilities in the stock market to bring about manipulated prices that shake investor confidence even further. This article details how these threats, cyberattacks, frauds, and data breaches in the stock market can be detected and identified to minimize their occurences. This paper further explains the tools and technologies to detect the same in the real time scenario to ensure safety of the market from such malicious activities as they point out that strong security measures and guarantee the chance of trading more safe and transparent environment for all investors, retail investors in particular.

Keywords : Cybersecurity, Cyberattacks, Fraud Detection, Cyberthreat Detection Tools.

1. Introduction

The stock market is a financial marketplace where individuals and organizations trade shares of publicly listed companies, enabling firms to raise capital while allowing investors to earn returns. It plays a vital role in economic development by supporting capital formation, wealth creation, and efficient allocation of financial resources. Investing in the stock market offers benefits such as financial growth, income generation, and risk diversification. Key components of the stock market include **stock exchanges** such as the NYSE, Nasdaq, BSE, and NSE; **investors**, who may be individuals or institutions seeking returns; **regulatory bodies**, which ensure transparency and legal compliance (e.g., SEBI in India and the U.S. SEC); and **indices** like the S&P 500, Nifty 50, and Sensex that reflect market performance. The stock market facilitates fund mobilization for corporate growth, wealth generation through dividends and capital gains, market liquidity through easy buying and selling of shares, and serves as an indicator of overall economic health.

2. Conclusion and Future Work

There is rising concern over identifying and controlling the cybersecurity issues in the stock market. These have a negative consequence on financial fraud and erode investor trust. AI measures may prevent all these threats in real-time. This study discusses the relevant attack vectors and their solution to fortify security in the stock market. The future work is based on the analysis of other threat groups in the stock market, including market disruption attacks, AI-based manipulation attacks, and data breach attacks. A framework for an AI-driven cybersecurity model to detect, mitigate, and prevent such attacks will also be designed and implemented. Case studies and data-driven insights regarding real-world events can add further richness to research to make security measures more effective in financial markets.

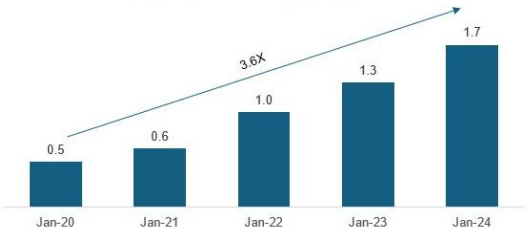

Fig. 1. Growth of retail investors

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An AI-Driven Intelligent Digital Cognitive Behavioral Therapy System for Internet Gaming Disorder and Social Anxiety Disorder

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Abstract: This study proposes an AI-integrated digital Cognitive Behavioral Therapy (CBT) system for treating Internet Gaming Disorder (IGD) and Social Anxiety Disorder (SAD). By using behavioral and psychometric data, the system delivers personalized and scalable interventions, addressing limitations of traditional CBT and improving treatment adherence and therapeutic outcomes.

Keywords : Cognitive Behavioral Therapy, Internet Gaming Disorder, Social Anxiety Disorder, Artificial Intelligence, Digital Mental Health, Generative AI, Machine Learning, Conversational AI, and Personalized Therapy.

1. Introduction

This study addresses the growing mental health concerns of Internet Gaming Disorder (IGD) and Social Anxiety Disorder (SAD) among adolescents, which have intensified with increased digital technology use. IGD is recognized in ICD-11 as a behavioral addiction and is associated with negative outcomes such as sleep problems, academic difficulties, and impaired psychosocial functioning. SAD commonly emerges during adolescence and is characterized by fear of negative evaluation, social avoidance, and long-term psychological impairment if untreated. Research indicates a bidirectional relationship between IGD and social anxiety, with socially anxious adolescents using online gaming as a coping mechanism that ultimately reinforces anxiety. Cognitive Behavioral Therapy (CBT) is a first-line treatment for both conditions, and recent advances in computerized CBT, AI-driven chatbots, and virtual reality have improved accessibility and treatment effectiveness. However, existing AI-assisted CBT approaches largely focus on single disorders and lack integrated, adaptive systems for comorbid conditions. To address this gap, the study proposes an AI-driven intelligent digital CBT system that combines diagnostic assessment, predictive modeling, and personalized interventions to provide a scalable and adaptive solution for treating comorbid IGD and SAD in adolescents.

2. Conclusion

This study introduces an AI-driven CBT system for Internet Gaming Disorder (IGD) and Social Anxiety Disorder (SAD) that enhances accessibility and personalization. Results show that greater trust in generative AI chatbots is associated with higher acceptance of AI-assisted therapy, particularly among individuals with more severe symptoms.

3. Future Directions

Future studies should validate AI-based CBT for high-risk adolescents, emphasize relapse prevention, and advance explainable and ethical AI. Hybrid AI–human approaches may improve accessibility and affordability, highlighting the promise of AI-driven CBT for treating behavioral addictions and anxiety.

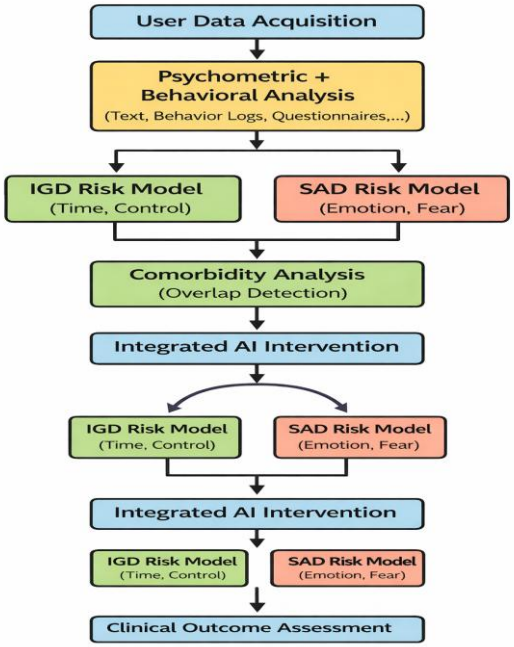

Fig.1. AI-Driven Dual Path Framework for IGD and Social Anxiety Assessment

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An integrated approach to URL security that incorporates Machine Learning and Threat Intelligence

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Abstract : The growing prevalence of phishing, malware distribution, and website defacement necessitates effective mechanisms for detecting malicious URLs. Conventional blacklist-based approaches are inadequate, as attackers continuously register new domains and use obfuscation techniques to evade detection. This paper presents a hybrid malicious URL detection system that integrates machine learning (ML) classification, external threat intelligence APIs, and trusted domain verification to provide accurate, real-time protection. The system extracts lexical, structural, and content-based features from input URLs and applies a pre-trained ML model to classify them into Benign, Phishing, Defacement, or Malware categories. Predictions below a confidence threshold are flagged for manual review, ensuring human oversight in uncertain cases. High-confidence results are validated through VirusTotal and Google Safe Browsing APIs, with outcomes combined in a decision-making algorithm to compute an overall malicious confidence score. A Stream based interface presents final outcomes Safe, Suspicious, or Malicious along with confidence levels and actionable recommendations. This hybrid approach reduces false positives, enhances accuracy, and establishes a scalable framework for mitigating emerging cyber threats. By leveraging a multi-layered detection strategy, the Malicious URL Scanner reduces false positives, increases detection accuracy, and balances automation with human oversight. This hybrid methodology not only enhances reliability but also establishes a scalable framework for combating emerging cyber threats, making it a valuable contribution to real-time cybersecurity defense mechanisms.

Keywords : Phishing attack; Malware URL detection; Machine Learning; Malicious code, Cyber threats etc.

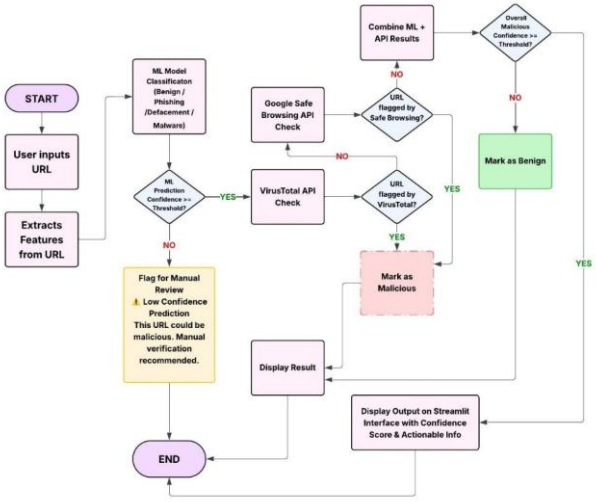

Fig. 1. Flow chart

The rapid growth of the internet has led to a significant increase in malicious URLs used for phishing, malware distribution, fraud, and website defacement. Traditional security approaches, such as blacklist-

based detection, are limited in their ability to identify newly created or obfuscated malicious URLs. To address these challenges, this paper proposes a **hybrid malicious URL detection system** that combines machine learning (ML), external threat intelligence APIs, and trusted domain verification.

The proposed system classifies URLs into four categories—Benign, Phishing, Malware, and Defacement—using a pre-trained machine learning model that analyzes lexical, structural, and behavioral features of URLs. To improve reliability and reduce misclassification, the system integrates external security services, including VirusTotal and Google Safe Browsing, to cross-verify ML predictions. A trusted domain whitelist is also employed to minimize false positives for well-known legitimate websites.

The system is implemented as a user-friendly web application using Streamlit, enabling real-time URL analysis without requiring technical expertise. Experimental evaluation shows that the hybrid approach achieves higher accuracy (approximately 95%) compared to ML-only and API-only methods, while maintaining efficient response times.

Overall, the study demonstrates that combining automated machine learning techniques with external threat intelligence and human-in-the-loop mechanisms provides a robust, scalable, and reliable solution for malicious URL detection. Future enhancements include continuous model retraining, integration of additional threat intelligence sources, adoption of deep learning models, and browser extension development.

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Enhancing Cloud Data Security through Blockchain Integration: A Secure and Transparent Framework

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Abstract: Cloud computing has become an essential technology for today's data storage and service offerings. However, concerns regarding security, privacy, integrity, and transparency have created barriers for widespread acceptance of cloud computing as a viable option. The traditional mechanisms of securing a cloud service rely heavily on centralised solutions; consequently, these security mechanisms are more susceptible to cyber-attacks, unauthorised users, and limited ability to audit activity within the cloud. This study will look at how integrating blockchain technology with cloud computing may complement the traditional models of securing clouds, and that by using blockchain technology, it provides a highly secure method for increasing security in a cloud environment. The properties of blockchain technology (decentralised, immutably, and transparently-based) enable the design and development of a cloud environment that is tamper resistant and trustworthy. The integration model will include a blockchain-based method for managing identity in the cloud; blockchain-based encryption for storing files in a cloud; and using smart contracts to enable automated access control and enforcement of security policies. In addition, the use of consensus mechanisms will ensure that data stored in the cloud has maintained integrity and fault tolerance across all distributed cloud nodes. Through analysing the architecture of a blockchain-based cloud system and comparing it to the architecture of traditional cloud systems, this research provides evidence that a blockchain-based cloud system provides increased data integrity, transparency, and resistance to tampering at a moderate performance impact. The results of this research suggest that the proposed blockchain-cloud security model is a viable option for applications that have high needs for data security, verifiable and audit-ready activities, and higher levels of confidence in the security of the data

Keywords : Blockchain technology, Cloud computing security, Smart contracts, Data integrity, Decentralized systems

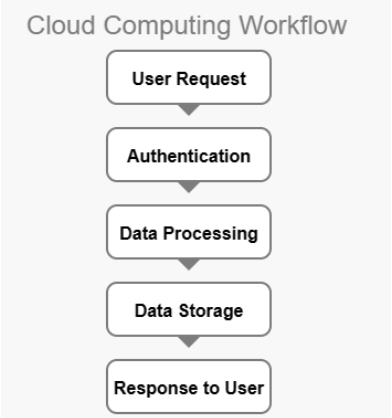

Fig. 1: Workflow of Cloud Computing

Cloud computing enables on-demand access to computing resources and data over the internet, offering scalability, flexibility, and cost efficiency. However, the increasing reliance on cloud-based and mobile applications for storing sensitive data has raised serious concerns regarding data security, privacy, and trust. Traditional cloud architectures are largely centralized, making them vulnerable to data breaches, tampering, and single points of failure.

This paper explores the integration of blockchain technology with cloud computing as a solution to these challenges. Blockchain introduces a decentralized, transparent, and immutable ledger that enhances data integrity and security. By incorporating smart contracts, blockchain enables automated access control, service-level agreement (SLA) enforcement, and secure data-sharing mechanisms. The proposed blockchain–cloud architecture combines cloud service models (IaaS, PaaS, and SaaS) with blockchain layers, identity management, and consensus mechanisms to create a secure and trustworthy data environment.

The study highlights key features of blockchain, including decentralization, transparency, immutability, cryptographic security, and consensus mechanisms such as Proof of Work and Proof of Stake. It also examines real-world applications of blockchain-enabled cloud systems across domains such as healthcare, supply chain management, digital identity, government services, and decentralized cloud storage.

Despite its advantages, blockchain integration faces challenges related to scalability, performance, security vulnerabilities (such as 51% and Sybil attacks), regulatory uncertainty, interoperability, and user adoption. The paper discusses mitigation strategies including Layer 2 solutions, sharding, alternative consensus mechanisms (PoS, PBFT, RAFT), formal verification of smart contracts, cross-chain interoperability, and regulatory-compliant privacy technologies.

A proposed blockchain-cloud security framework is presented, featuring encrypted cloud storage, distributed blockchain ledgers, smart contracts, and efficient consensus algorithms (RAFT and PBFT). Performance analysis shows that blockchain-enabled cloud systems significantly improve data integrity, transparency, auditability, and user trust, while introducing only a slight increase in access time.

In conclusion, the integration of blockchain with cloud computing provides a robust approach to securing cloud data, enhancing trust, and improving operational resilience. The proposed framework demonstrates strong potential for future secure cloud environments, with further advancements expected through improved scalability, regulatory alignment, and wider adoption.

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Diagnosis of Thyroid Disorde Classification using Machine Learning Algorithm

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Abstract: In healthcare and educational services, data mining is crucial. The main challenging tasks in healthcare is to diagnose the condition of health and in early stage itself give the proper treatment to them. The treatment of preventing such a disease is rather than that to cure them, because many of the treatments are consisting long term, so the analyzing is done first in this paper and shown graph. The current study is focused on the particular sickness of thyroid classification in two of the most common forms, hypothyroidism and hyperthyroidism, respectively. In order to create correct predictions, machine learning plays a crucial role in the process of sickness prediction, and this work focuses on the classification and analysis model with accuracy and recall. To find thyroid ailment in the patient's data, support vector machine (SVM), Random Forest, Nave Bayes, and Decision Trees were utilised. It's predicted using the Rapid Miner Tool and analysed using Decision Tree, Random Forest, Support Vector Machine, and Nave Bayes, with a 94 percent accuracy. The data and information were gathered from the UCI Machine Learning repository, and the results were forecasted using the Rapid Miner Tool and analysed using Decision Tree, Random Forest, Support Vector Machine, and Nave Bayes, yielding a 94 percent accuracy.

Keywords : Thyroid disease diagnosis, Decision Tree, Support Vector Machine, Naïve Bayes, Random Forest.

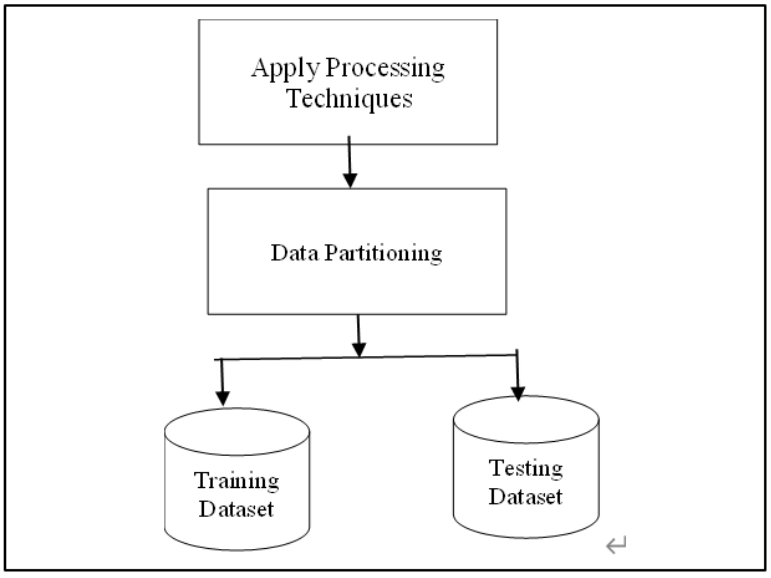

Fig. 1. Training Data Pre Processi

Thyroid disease is a very common disease that spreads widely in today's growing world. Because it is now so widely diffused, it often causes major health and life-threatening diseases in those who are infected. The functions that affected by thyroid gland is in results that turn the secretion of thyroid hormone. The symptoms that includes in thyroid are "Fatigue, Cold tolerance, Dry skin, Weight gain, Face swelling, menstrual cycles and Hair Fall" etc. Based on the statistics, the thyroid disorders are

rising in India and discussing about the thyroid disease and also about the hypothyroid and hyperthyroid caused and symptoms are discussed. According to the survey, many peoples are affected by hypothyroid. Thyroid disease affects around 42 million people in developing countries like India, where it affects the majority of the population. Thyroid illness is discussed in this document, which includes information on hypothyroidism and hyperthyroidism.

The machine learning algorithm used to forecast the accuracy of algorithm's outputs, which serves to lower the risk of thyroid disease in people. The author discussed and applied four classification models ("Naïve Bayes, Support Vector Machine and Random Forest"). The dataset are taken from UCI Machine Learning repository, and it is used to predict the accuracy of precision and recall result using algorithm's. It shows results with rapid miner tool. In this, the best classification is Naïve Bayes with 93.7 accuracy and also classified with the effective data's which helps to find the treatment with better cost and facilitates the management. The next study will concentrate on the elements that contribute to the identification of thyroid illness in a greater number of individuals and testing with more data mining techniques.

The machine learning algorithm used to forecast the accuracy of algorithm's outputs, which serves to lower risk of thyroid disease in people. The author discussed and applied four classification models ("Naïve Bayes, Support Vector Machine and Random Forest"). The dataset are taken from UCI Machine Learning repository, and it is used to predict the accuracy of precision and recall result using algorithm's. Tables contains the attributes and values, table 1 contains the Boolean values true/false. The records that included 6900 samples and 30 features which it contains a classes and has such a classifications mainly hypothyroidism, hyperthyroidism. Table 2 represents the hypothyroidism accuracy statistics and table 3 represents about the hyperthyroidism accuracy statistics with the use of Accuracy statistics with precision, recall and F measure.

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Understanding Cross-Device and Multi-Platform Authentication Failures: A Unified Framework

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Abstract: In today's world, users commonly use digital services from multiple devices and platforms. This includes desktops, smartphones, tablets and smart TV's. Authentication methods vary from passwords, pattern locks, Biometrics and Multi-factor authentication to password-less authentication. Password-less protocols like FIDO or WebAuthn are generally designed and tested under single-device assumptions. This approach creates design-level vulnerabilities when authentication methods and credentials are deployed over different devices and platforms.
This paper presents a structural analysis of prior work on authentication failures in cross-device and multi-platform environments. This paper introduces a cross-layer failure taxonomy comprises incorrect assumptions about device trust, small failures escalating into large compromises, usability security trade-offs, observability gaps and deployment constraints. Further, this paper demonstrates by case studies. This comprises of re-using password, SMS based MFA Vulnerabilities, Inconsistencies in biometric, incorrect configurations and password-less authentication deployment failures. In conclusion, this paper identifies open research challenges with regard to building deployable, user-friendly and flexible authentication systems that operate reliably across devices and platforms.

Keywords : Cross-device authentication, multi-platform authentication, FIDO/WebAuthn, biometrics, password-less authentication, multi-factor authentication, security failures, structural analysis.

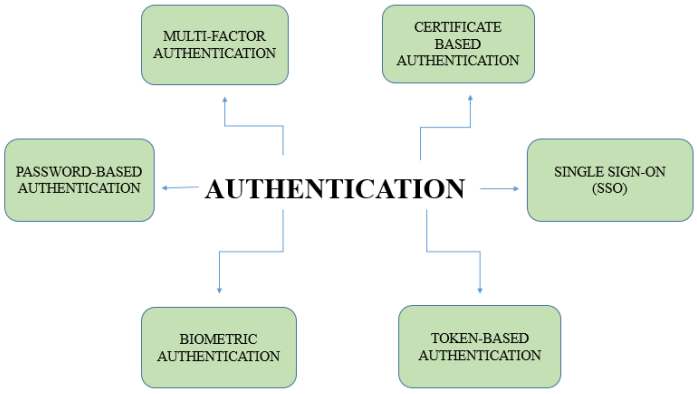

Fig. 1. Authentication Mechanisms

Authentication is a fundamental component of system security, yet failures remain common despite decades of research. Modern users frequently authenticate across multiple devices and platforms, while most authentication mechanisms are still designed and evaluated under single-device assumptions. This mismatch leads to recurring and predictable failures such as password reuse, multi-factor authentication (MFA) bypasses, biometric inconsistencies, and misconfigured federated login systems. These failures stem not from weak cryptography, but from complex interactions across devices, platforms, and authentication services.

This paper addresses the lack of systematic analysis of **cross-device and cross-platform authentication failures** by proposing a unified framework that explains why theoretically secure

authentication methods fail in real-world deployments. The study synthesizes prior research and introduces a **cross-layer failure taxonomy** capturing five key dimensions: assumption mismatches, amplification effects, usability–security trade-offs, observability gaps, and deployment constraints. These dimensions span user behavior, hardware, operating systems, network services, and cloud-based identity infrastructures.

Through real-world case studies—including password reuse and credential stuffing, SMS-based MFA vulnerabilities, biometric disparities across devices, federated login misconfigurations, and incomplete FIDO/WebAuthn deployments—the paper demonstrates how failures emerge and propagate across devices and platforms. Each case illustrates how small design assumptions or usability compromises can scale into system-level security risks.

Finally, the paper identifies open research challenges critical to building resilient authentication systems, including secure cross-device key synchronization, platform-independent passwordless authentication, privacy-preserving behavioral biometrics, reliable federated login validation, and adaptive MFA designs that balance security with usability. Overall, this work provides a structured foundation for understanding and mitigating systemic authentication failures in multi-device environments and guides future research toward more robust, deployable authentication solutions.

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Analysis of the Impact of LOS and NLOS Conditions on Worker Behavior Recognition Performance Using Camera and Radar

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Abstract: Reliable recognition of worker behavior in manufacturing environments is essential for ensuring industrial safety. Most existing studies rely on camera-based visual sensors. However, their performance degrades under environmental conditions such as illumination changes, occlusion, and structural obstructions that limit visibility. This paper considers Line-of-Sight (LOS) and Non-Line-of-Sight (NLOS) conditions as key factors affecting worker behavior recognition performance in manufacturing sites. The recognition performance of camera-based and FMCW radar-based sensing is compared under identical task scenarios. The experimental environment is categorized into LOS, Partial LOS, and NLOS conditions. The recognition characteristics of each sensor are analyzed according to environmental visibility changes. Experimental results using a YOLO-based object detection model show that camera-based recognition achieves high performance in LOS and visually observable Partial LOS conditions. However, recognition is impossible when the worker is not visually observable. In contrast, the radar sensor maintains relatively stable recognition performance even under NLOS conditions with visual occlusion.

Keywords : YOLOv8n, Manufacturing Environment, LOS/NLOS, FMCW Radar, Camera

Worker behavior recognition in manufacturing environments is a key factor in ensuring industrial safety. In recent years, deep learning-based object detection methods have been widely studied for this task[1]. Camera-based recognition techniques show high accuracy when sufficient visual information is available. However, many previous studies assume Line-of-Sight (LOS) conditions in which the worker is clearly visible. As a result, they often fail to adequately reflect real manufacturing environments where structures or equipment restrict the field of view [2]. In such experimental settings, occlusion and visibility constraints are insufficiently addressed, motivating further analysis of recognition performance under different visibility conditions.

This paper analyzes worker behavior recognition performance under different environmental visibility conditions (LOS and NLOS) in manufacturing sites. The environment is categorized into LOS, Partial LOS, and NLOS conditions according to the degree of visual occlusion. In LOS conditions, the worker performs representative box-handling tasks, whereas in Partial LOS and NLOS conditions, the worker moves laterally and longitudinally behind a wall, respectively. Figure 1 presents examples of the radar input data and camera images obtained in the experimental environment.

The collected camera and radar data are evaluated using a YOLOv8n-based object detection model. Performance is evaluated using frame-level recall. The performance of camera-based recognition is evaluated only for frames in which the worker is visually observable, while non-visible intervals are classified as unobservable frames and excluded from evaluation. In contrast, radar-based recognition performance is evaluated across both LOS and NLOS environments.

Table 1 summarizes the frame-level recall results for both camera-only and radar-only configurations under LOS, Partial LOS, and NLOS conditions. The camera-based model achieved 100% frame-level recall in both LOS and visible segments of Partial LOS conditions. This result indicates that camera-based recognition is highly effective under visually observable conditions. In NLOS environments, where visual information is unavailable, camera-based detection is not feasible and such segments are excluded from evaluation. On the other hand, the radar-only model exhibited distinct recognition

characteristics depending on environmental visibility. As shown in Table 1, the radar-based recognition achieved a frame-level recall of 56.25% under LOS conditions, and 88.75% and 88.33% under Partial LOS and NLOS conditions, respectively. This indicates that the radar sensor can detect worker presence with relatively stable performance even under visually occluded environments, and its role becomes particularly important in NLOS conditions where camera-based recognition is not feasible due to the absence of visual information.

This paper presents an experimental design that explicitly incorporates LOS and NLOS environmental settings in worker behavior recognition for manufacturing environments. The results confirm that radar-based recognition provides an effective alternative under NLOS conditions.

Fig. 1. Examples of radar input data and camera images

Table 1. Detection rate (%) of worker detection for camera-only and radar-only configurations under LOS and NLOS conditions.

	LOS(%)	Partial LOS(%)	Full NLOS(%)
Radar	56.25	88.75	88.33
Camera	100	100	N/A

Acknowledgment

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Resampling Based Sequence Alignment for Reducing Temporal Offset Effects in Radar-Based Manufacturing Robot Motion Recognition

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Abstract: In radar-based manufacturing robot motion recognition, temporal offsets occur frequently due to variations in robot operating speed and sensing latency. Such offsets distort sequence length and temporal alignment, leading to performance degradation in sequence learning models such as Long Short-Term Memory (LSTM) and Temporal Convolutional Network (TCN) classifiers. To mitigate performance degradation caused by temporal offsets, this paper proposes a resampling-based sequence alignment strategy applied during the training phase. Each motion cycle is interpolated and resampled to tune a predefined number of data points corresponding to one motion cycle, so that all cycles are temporally aligned with zero offset. Experimental results show that models trained with resampled sequences achieve higher classification accuracy compared to those trained on misaligned raw data. These findings demonstrate that resampling-based sequence alignment is an effective approach for suppressing offset-induced performance degradation in radar-based robot motion recognition systems.

Keywords : Radar-based manufacturing robot motion recognition, Temporal offset, Interpolation, Resampling, LSTM, TCN, Sequence alignment

Radar has attracted increasing attention in industrial robot motion monitoring due to its robustness to lighting, dust, and occlusion. In manufacturing settings, robots repeatedly execute predefined motions, producing characteristic temporal patterns in radar signals. To classify such temporal patterns, deep learning models such as LSTM and TCN have been widely adopted[1]. However, in radar-based robot motion recognition, temporal offsets frequently arise from variations in robot motion speed and sensor latency. These offsets introduce inconsistencies in sequence length and temporal misalignment, which in turn degrade the performance of sequence-based learning models. Most conventional training approaches assume well-aligned, fixed-length sequences, leading to reduced inference reliability when trained on data with temporal offsets. Therefore, there is a strong need for an offset-tolerant training strategy that mitigates the impact of temporal misalignment without requiring modifications to the network architecture[2].

This paper proposes a resampling-based alignment training strategy that normalizes the temporal representation of motion cycles during the training phase. After interpolation, each motion cycle is resampled to a predefined number of data points corresponding to a reference motion cycle. The proposed approach effectively mitigates performance degradation caused by temporal offsets and maintains stable classification performance under temporally misaligned conditions. Radar data were collected in an environment designed to emulate repetitive industrial robot motions, where each motion cycle corresponds to a specific operational state. The collected radar data reflect realistic temporal offsets across motion cycles.

To mitigate the effects of temporal offsets, each radar signal cycle is resampled to a fixed length L to normalize the number of temporal samples across cycles. For an original sequence of length N_i, the normalized time axes are defined as:

$$\tau_{orig} = \left\{ \frac{n}{N_i - 1} \,\middle|\, n = 0,1,\ldots,N_i - 1 \right\},\ \tau_{\text{target}} = \left\{ \frac{l}{L-1} \,\middle|\, l = 0,1,\ldots,L-1 \right\}$$

The resampled sequence $\tilde{x}_i \in R^L$ is obtained by evaluating the original signal x_i on the target time grid τ_{target} using linear interpolation:

$$\tilde{x}_i(\tau_{\text{target}}) = \mathcal{I}\left(x_i(\tau_{\text{orig}})\right)$$

where $\mathcal{I}(\cdot)$ denotes linear interpolation. This process preserves the overall shape of the radar signal while reducing temporal misalignment. Since it is applied only at the preprocessing stage, no additional modifications to the network architecture or loss function are required.

The effectiveness of resampling-based alignment was evaluated using LSTM and TCN models under real and ideal offset conditions, as shown in Fig. 1.

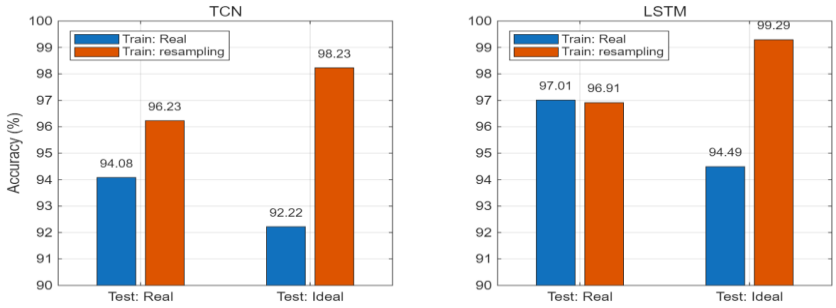

Fig. 1. Performance comparison of TCN and LSTM trained with real and resampling aligned data under different test alignment conditions

For TCN, accuracy improved from 94.08% when trained on real data and tested on real data to 96.23% when trained on resampled data and tested under real conditions, reaching 98.23% when trained on resampled data and tested under ideal conditions. For the LSTM model, accuracies of 97.01% and 96.91% were obtained when trained on real data and tested on real data, and when trained on resampled data and tested on real data, respectively. Although performance slightly decreased when trained on resampled data and tested on real data, confusion matrix analysis revealed clearer sensitivity to offsets in real test data. The highest accuracy of 99.29% was achieved when trained on resampled data and tested under ideal conditions. This study demonstrates that resampling-based sequence alignment applied during training effectively suppresses offset-induced performance degradation in radar-based robot motion recognition. The proposed approach is computationally efficient, model-agnostic, and provides reliable inference by more effectively capturing offset effects present in real-world data.

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Intelligent Manufacturing Analytics Dashboard Using Machine Learning for Real-Time Quality Prediction and Root Cause Analysis

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Abstract: Ensuring consistent product quality remains a critical challenge in modern manufacturing, where defects can lead to significant material waste, production downtime, and increased costs. In this study, we present a comprehensive intelligent manufacturing analytics dashboard that leverages advanced machine learning techniques for real-time quality prediction, automated root cause analysis, and production optimization in smart factory environments. The system integrates multiple data streams from raw material inspection, molding machine settings, quality control, and production logs to provide predictive insights for detecting NG (Not Good) products and optimizing processes. Through automated ML model selection and feature importance analysis, the dashboard enables data-driven decision-making for manufacturing process improvements.

Keywords: Smart Factory, Machine Learning, Predictive Analytics, Root Cause Analysis, Quality Prediction, Manufacturing Optimization

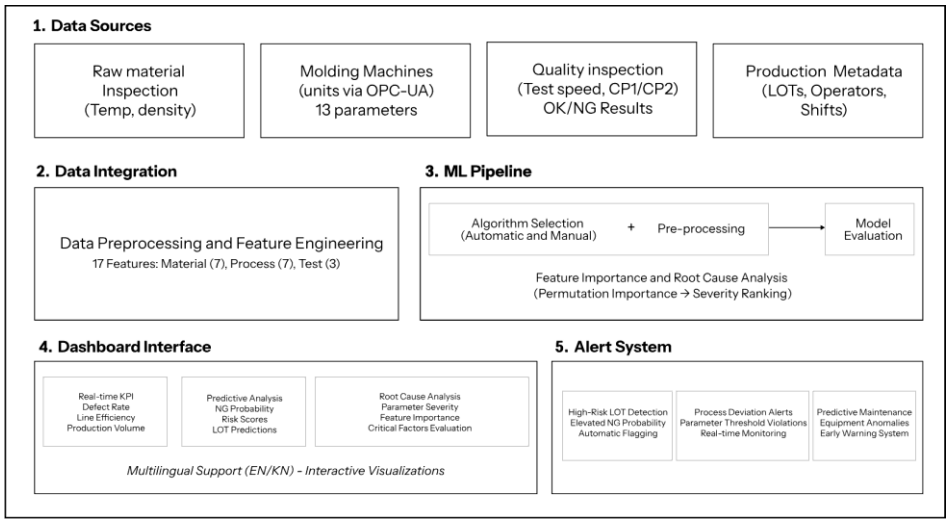

Fig. 1. Smart Manufacturing Analytics Dashboard Architecture

Modern manufacturing faces challenges in detecting defective (NG) products and performing timely root cause analysis due to fragmented data and reliance on post-production inspection. This study proposes a Smart Manufacturing Analytics Dashboard, integrating multi-source production data—including raw material conditions, molding machine parameters, quality inspection results, and production logs—into a unified platform with advanced machine learning analytics.

The system employs a supervised learning pipeline for binary OK/NG classification using 17 features across material, process, and test conditions. An automated ML framework systematically evaluates multiple algorithms and preprocessing techniques, selecting the optimal model based on F1-score. The best-performing combination, Power Transformer + XGBoost, achieved 0.788 F1-score and 0.895

accuracy. A root cause analysis engine identifies critical process parameters using permutation importance, categorizes their impact, and provides actionable insights.

The web-based dashboard delivers real-time KPI monitoring, predictive defect probability, interactive root cause analysis, and multilingual support. Deployment resulted in 29.96% reduction in defect rate, 86.51% improvement in line efficiency, and 39 minutes of downtime reduction. Key innovations include automated model selection, intelligent root cause analysis, and real-time alerting for high-risk lots and process deviations.

Overall, the system demonstrates the value of AI-driven predictive quality control and process optimization, with future work focusing on IoT integration, advanced deep learning, and closed-loop process adjustments.

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Synthetic-to-Real Calibration of YOLO-Based Regression for GPR B-Scan

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Abstract: This paper presents a synthetic-to-real calibration framework that aligns regression-based physical estimates from a YOLO–regression model with the coordinate system of measured GPR data. In our previous work, a YOLOv8-s detector combined with a regression model was trained on synthetic B-scan data and achieved accurate estimation of void location and size within the synthetic domain. However, the learned regression mapping is inherently tied to the simulation settings and cannot be directly applied to measured GPR data without loss of physical validity. In this study, the proposed YOLO-based framework detects voids in measured GPR B-scan data and applies a metadata-driven synthetic-to-real calibration to reinterpret the regression outputs in the measured coordinate system. As a result, void depth and size can be estimated within physically valid ranges, even in the absence of ground-truth labels in the measured data.

Keywords : Ground Penetrating Radar, YOLOv8-s, gprMax, Regression Model, Calibration

Ground Penetrating Radar (GPR) is a non-destructive technique used to detect subsurface voids and buried structures beneath road pavements by analyzing hyperbolic patterns in B-scan data. However, conventional GPR interpretation is sensitive to interpreter subjectivity and system-specific factors, which can reduce result consistency [1]. To address these limitations, recent studies have explored automatic hyperbola detection using deep learning–based object detection models. In our previous work, a YOLOv8-s–based detector combined with a regression model was trained on synthetic B-scan data generated using gprMax. The results demonstrated that subsurface void locations and sizes could be estimated in metric units with high accuracy ($R^2 \approx 0.98$) within the synthetic domain [2]. However, these estimates are inherently dependent on the simulation conditions and may lose physical validity when directly applied to measured GPR data.

To address this issue, this paper proposes a framework in which the regression model is used to learn the relationship between detected hyperbolic patterns and physical parameters, while a metadata-driven synthetic-to-real calibration aligns the estimates with the coordinate system of measured GPR data. In this framework, synthetic B-scan data provide reliable depth and size labels that are difficult to obtain from measured GPR data, enabling the regression model to learn the inversion under controlled simulation conditions. The subsequent calibration step then reinterprets the synthetic-domain estimates within the measured coordinate system and enforces physical validity using real-data metadata.

The measured GPR data used in this study were released as a public dataset through AI-Hub. The dataset includes system parameters such as a time window of 40 ns, a maximum investigation depth of 2 m, a trace spacing of 5 cm, and a scan length of 15 m [3]. For the measured data, bounding box parameters obtained from YOLO detection are provided as inputs to the regression model, which outputs physical parameters defined in the synthetic domain. A synthetic-to-real calibration function is then applied to align these estimates with the measured GPR coordinate system by applying linear scaling and offset corrections in both the depth and horizontal directions. This calibration is formulated as a coordinate transformation that reinterprets the regression outputs based on the measured data metadata, without retraining the regression model. Figure 1 illustrates the overall framework consisting of YOLO-based hyperbola detection, a simulation-based regression model, and a metadata-driven calibration applied sequentially.

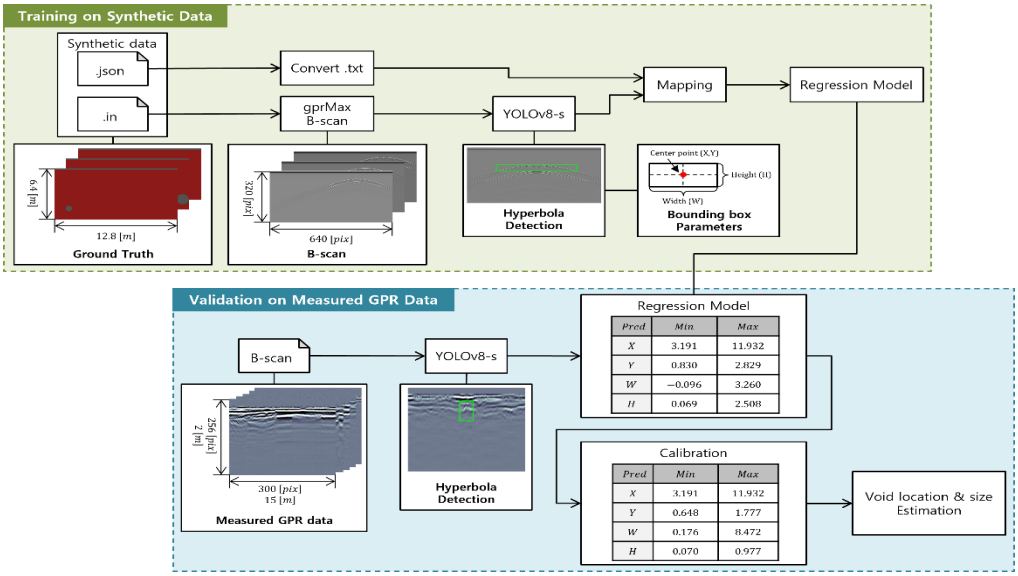

Fig. 1. Overall framework for synthetic-to-real parameter estimation

When only the YOLO detector and regression model are applied to measured GPR data, physically invalid estimates are frequently produced, including depths exceeding the maximum detectable range or negative size values. In addition, the class-wise distributions extend well beyond the expected range (approximately 0.3–1.3 m). In contrast, after applying the metadata-driven calibration, all estimated parameters satisfy the system specifications (depth of 0–2 m and horizontal extent of 0–15 m), and the resulting distributions become stably concentrated within the expected range, indicating improved estimation stability.

This study extends the existing gprMax-based simulation–YOLO–regression framework to measured GPR data through a synthetic-to-real calibration strategy. By aligning simulation-derived physical parameters with the measured data coordinate system without retraining the regression model, the proposed framework enhances estimation stability and physical validity rather than focusing on detection performance. Future work will further extend the applicability of the framework by integrating advanced preprocessing algorithms.

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Enhancing Brain Tumor Segmentation in MRI Through Boundary Delineation

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Abstract: Brain tumor segmentation in MRI scans is essential for accurate diagnosis and treatment planning. Manual segmentation is labor-intensive and susceptible to human error, with reported inter-observer error rates reaching 20%. This research proposes an enhanced segmentation approach using the hybrid TransUNet architecture integrated with a boundary-aware loss function. The model utilizes a convolutional encoder for local feature extraction and a Transformer module to capture global context. The boundary-aware loss improves accuracy in clinically significant regions by combining Dice, Cross-Entropy, and edge-focused terms. Evaluation on the BraTS 2023 dataset shows that the proposed BS-TransUNet achieves a Dice coefficient of 0.879, producing sharper boundaries and more anatomically consistent results than the baseline.

Keywords : Brain tumor segmentation, enhancing tumor segmentation, boundary delineation, TransUNet architecture

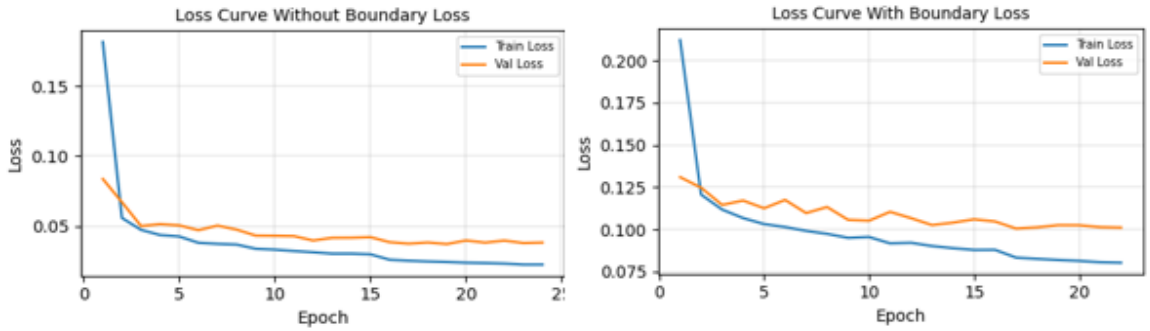

Fig. 1. Boundary-aware Supervision

Brain tumor diagnosis and treatment planning require accurate and timely segmentation of tumor subregions from MRI scans. Although MRI is the gold standard for brain tumor imaging, manual tumor segmentation is time-consuming, prone to inter-observer variability, and susceptible to errors, particularly for small and low-contrast regions such as enhancing tumors. Traditional machine learning approaches rely on handcrafted features and struggle with class imbalance, while deep learning models, including U-Net–based architectures, often fail to preserve sharp tumor boundaries critical for clinical decision-making.

This study focuses on improving the segmentation of brain tumors—especially enhancing tumor regions—by incorporating boundary-aware supervision into a transformer-based segmentation framework. A **Boundary-Supervised TransUNet (BS-TransUNet)** is proposed, which combines convolutional feature extraction and transformer-based global context modeling with a hybrid loss function consisting of Dice loss, cross-entropy loss, and an additional boundary loss. This design aims to enhance boundary delineation while maintaining robust volumetric segmentation across all tumor subregions.

The proposed model was evaluated on the BraTS dataset and compared against a baseline TransUNet. Although BS-TransUNet exhibits higher training and validation loss due to the inclusion of boundary loss, it achieves superior segmentation performance. The overall Dice coefficient improves from 0.862

to 0.879, with notable gains in necrotic tumor core segmentation and slight improvement in enhancing tumor accuracy. While performance on the edema subregion shows a marginal decrease, qualitative results demonstrate sharper, smoother, and more anatomically coherent tumor boundaries, particularly in clinically critical regions.

Overall, the results indicate that boundary-aware supervision improves the model's ability to capture fine structural details and clinically meaningful tumor edges, even when global loss values do not decrease. This approach enhances the reliability of automated brain tumor segmentation and has strong potential to support clinical assessment, treatment planning, and longitudinal monitoring of tumor progression.

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