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Message from Chief Patron, CVMI-2026



Shri Vinayak Pai
Chairman, Board of Governance, COEP Technological University, Pune, and
Chief Patron-CVMI-2026

I am delighted to convey my warm greetings and best wishes to the 5th International Conference on Computer Vision & Machine Intelligence (CVMI-2026), being jointly organized by COEP Technological University, Pune and the Indian Institute of Information Technology, Allahabad from October 30 to November 1, 2026. As a proud alumnus of COEP, it gives me special joy to see my alma mater, with its legacy of service to the nation since 1854, host a premier international forum dedicated to some of the most transformative technologies of our time.

Having spent my career building and delivering large engineering and infrastructure projects in India and across the globe, I have witnessed first-hand how Artificial Intelligence and Computer Vision are reshaping industry. From intelligent design and digital twins to automated quality inspection, worksite safety monitoring, predictive maintenance and smart infrastructure, these technologies are no longer confined to laboratories; they are fast becoming the backbone of productivity, safety and sustainability in the real world.

I am confident that the keynote talks, technical sessions and the PhD colloquium will spark new ideas and build bridges between researchers, practitioners and young innovators. Strengthening the industry-institute connect has always been close to my heart, and platforms such as CVMI are vital to translating research into solutions that benefit society.

I compliment the leadership and organizing teams of COEP Tech and IIIT Allahabad, the IEEE UP and Pune Sections, the reviewers, sponsors and all participating institutions for their commitment in creating this vibrant platform. I wish CVMI-2026 every success and all delegates a rewarding and memorable experience in Pune.

Message from Chief Patron, CVMI-2026



Prof. Bhim Singh,
BoG-Chairperson, IIIT-Allahabad and
Chief Patron-CVMI-2026

It gives me immense pleasure to extend my warm greetings and best wishes to the 5th International Conference on Computer Vision & Machine Intelligence (CVMI-2026). Artificial Intelligence, Machine Learning, Computer Vision, Image Processing, and Machine Intelligence are transforming the way we address complex challenges across industry and society. Conferences such as CVMI provide an important platform for researchers, academicians, industry professionals, and young scholars to exchange ideas, present innovative research, and foster meaningful interdisciplinary collaborations. I am confident that CVMI-2026 will facilitate fruitful technical discussions, inspire new research directions, and contribute significantly to the advancement of intelligent and sustainable technologies. I congratulate the organizing teams from COEP-Tech., IIIT-Allahabad and IEEE UP & Pune sections, as well as all the participating institutions, organizations and industries/corporate sector for their genuine interest dedicated efforts, commitment in terms of time and resources in creating this vibrant platform for knowledge sharing, innovation, and collaboration. I wish CVMI-2026 great success and all the best for a memorable, enriching, and impactful conference.

Message from Patron, CVMI-2026



Prof. Sunil G. Bhirud
Vice-Chancellor, COEP Technological University, Pune and
Patron-CVMI-2026

It is a matter of great pride and joy for COEP Technological University to jointly organize, in collaboration with the Indian Institute of Information Technology, Allahabad, the 5th International Conference on Computer Vision & Machine Intelligence (CVMI-2026), being held from October 30 to November 1, 2026. On behalf of the COEP Tech family, I extend a warm and heartfelt welcome to all the distinguished guests, keynote speakers, delegates, authors and research scholars to our historic campus in Pune, an institution that has been in the service of the nation since 1854.

Computer Vision and Machine Intelligence today lie at the very heart of the technological transformation sweeping across healthcare, agriculture, manufacturing, mobility, security and governance. Having devoted a large part of my own academic journey to image processing and machine learning, I am especially delighted to see this vibrant field come alive on our campus through tutorials, keynote and plenary talks, technical sessions and a dedicated PhD colloquium that gives young researchers a valuable platform to present their work and connect with experts from India and abroad. The overwhelming response to CVMI-2026, reflected in the large number of high-quality research papers received from academia and industry and carefully selected through a rigorous peer-review process, is a clear testimony to the reputation and standing this conference series has earned. The coming together of COEP Tech and IIIT Allahabad, two institutions with proud legacies of excellence, is a fine example of how meaningful collaboration can strengthen the national research ecosystem.

I congratulate the organizing teams of COEP Tech and IIIT Allahabad, the IEEE UP and Pune Sections, the technical programme committee, reviewers, sponsors and all participating institutions for their dedicated efforts in making this event possible. I wish CVMI-2026 a grand success and all participants a memorable, enriching and inspiring experience.

Message from Patron, CVMI-2026



Prof. Mukul S. Sutaone
Director, IIIT-Allahabad and
Patron-CVMI-2026

With a deep feeling of pride and contentment, I am truly gratified to share my warm greetings and best wishes to the 5th International Conference on Computer Vision & Machine Intelligence (CVMI-2026). As artificial intelligence rapidly reshapes the boundaries of human capability, computer vision stands at the vanguard of this technological revolution. It bridges the gap between digital data and visual understanding. From autonomous navigation and smart healthcare to industrial automation and immersive multimedia, the breakthroughs published in this proceeding represent the dedication of researchers, academicians, and industry practitioners pushing the frontiers of science.

I am honestly hopeful that conglomerations like CVMI-2026 help build an ecosystem of rigorous inquiry, translational research, and collaborative innovation. Hosting and contributing to a premier forum of this scale underscores everyone's commitment to solving complex real-world challenges through intelligent systems. The peer-reviewed papers compiled in this volume reflect high technical rigor, creative problem-solving, and robust experimental validation.

I extend my heartfelt gratitude to the organizing committee, program chairs, technical reviewers, and international partners whose tireless efforts brought this event to fruition. To our authors and attendees, thank you for sharing your cutting-edge findings and enriching this academic discourse.

May these proceedings inspire new ideas, foster enduring collaborations, and pave the way for a smarter, more connected tomorrow. MyBest wishes for a highly successful CVMI-2026.

Message from Patron, CVMI-2026



Prof. Sri Niwas Singh
Director, ABV-IIITM-Gwalior and
Patron-CVMI-2026

It is a matter of immense pride and profound joy to present the proceedings of the 5th International Conference on Computer Vision & Machine Intelligence (CVMI-2026).

In today's fast-changing world, research, innovation, and technological adaptation are more important than ever. This conference provides a vital platform for thinkers, researchers, and industry experts from around the globe to gather, exchange ground-breaking ideas, and address critical global challenges.

The overwhelming response to the CVMI-2026, as evidenced by the high caliber and large volume of quality research submissions received from diverse academic and professional backgrounds, is a testament of the dedication of our scientific community. These proceedings represent a carefully curated collection of knowledge that will undoubtedly inspire future investigations and long-lasting international collaborations.

I extend my heartfelt congratulations to the organizing committee, technical chairs, and every member of the faculty and staff whose tireless efforts, meticulous planning, and unwavering commitment transformed this vision into a resounding success. I also express my sincere gratitude to all the delegates, keynote speakers, and authors for choosing this platform to share their valuable findings.

May the insights contained within these pages ignite new avenues of discovery and contribute meaningfully to society. I wish all readers and researchers an enriching and intellectually stimulating experience.

Keynote Speaker



Prof. K. V. S. Hari
Director, Centre for Brain Research (CBR), IISc
Professor, Department of Electrical Communication Engineering, IISc
Research Areas: Signal Processing • Data Science • Machine Learning • Deep Learning • Wireless Communications • Neuroscience • Healthcare

Prof. K. V. S. Hari is the Director of the Centre for Brain Research (CBR) at the Indian Institute of Science (IISc), Bengaluru, and a Professor in the Department of Electrical Communication Engineering at IISc. With over three decades of experience in research, teaching, and academic leadership, his expertise spans signal processing, data science, wireless communications, and machine learning. His current work at CBR focuses on understanding brain aging and age-related neurodegenerative diseases, with an emphasis on early detection and data-driven approaches to brain health.

Prof. Hari holds a PhD in Systems Science from the University of California, San Diego. He has held academic positions at leading international institutions, including Stanford University, KTH Royal Institute of Technology, and Aalto University, and has contributed to MIMO wireless channel modelling associated with the IEEE 802.16 standard. He has served as Vice President-Membership of the IEEE Signal Processing Society, Chair of the IEEE Bangalore Section, and Chief Editor (Electrical Sciences) of Sādhanā, published by Springer. His research spans applications of signal processing and artificial intelligence in neuroscience and healthcare, including physiological signal analysis and medical imaging, and has received over 6,500 citations.

Keynote Speaker



Prof. Sumantra Dutta Roy
Professor, Department of Electrical Engineering , IIT Delhi
Academic Leader | Researcher | Computer Vision Expert
Research Areas: Computer Vision and Image Analysis • Pattern Recognition and Machine Learning • Biometrics • Medical Informatics • Bioinformatics

Prof. Sumantra Dutta Roy is a Professor in the Department of Electrical Engineering at the Indian Institute of Technology Delhi. He received his B.E. in Computer Engineering from Delhi Institute of Technology and his M.Tech. and Ph.D. degrees from IIT Delhi. His research interests span computer vision, image analysis, pattern recognition, machine learning, biometrics, bioinformatics, medical informatics, and music information retrieval. His research contributions include object recognition, image and video analysis, tracking and gesture recognition, and intelligent visual information processing. He has received the prestigious INAE Young Engineer Award and the DST BOYSCAST Fellowship in recognition of his research contributions. Through his academic and research pursuits, Prof. Dutta Roy continues to contribute to the advancement of computer vision, pattern recognition, and intelligent image analysis.

Keynote Speaker



Prof. Arun K. Tangirala
Professor, Department of Chemical Engineering , IIT Tirupati
Academic Leader | Researcher | Expert in System Identification and Data Science
Research Areas: Signal Processing • System Identification • Process Control • Data Science and Artificial Intelligence • Machine Learning • Time-Series Analysis

Prof. Arun K. Tangirala is a Professor in the Department of Chemical Engineering at the Indian Institute of artificial intelligence, and complex networks, with applications in industrial process monitoring, intelligent transportation, agriculture, climate systems, and engineering sciences. He is the author of the widely used textbook Principles of System Identification: Theory and Practice, published by CRC Press, and has contributed extensively to research and education in systems engineering and data science. He has received the Young Faculty Recognition Award and the Institute Research and Development Award from IIT Madras. Through his interdisciplinary research and academic leadership, Prof. Tangirala continues to advance data-driven methods for modelling, analysis, prediction, and intelligent decision-making across diverse engineering domains.Technology Tirupati. He received his B.Tech. in Chemical Engineering from IIT Madras in 1996 and his Ph.D. in Process Control and Monitoring from the University of Alberta, Canada, in 2001. His research spans process systems engineering, system identification, signal processing, data-driven modelling,

Keynote Speaker



Dr Vikram Jamwal
AI Research Leader | Principal Scientist | Technology Innovator
Research Areas: Artificial Intelligence • AI for Creativity • Generative AI • Machine Learning • Computer Vision • Creative Technologies

Dr. Vikram Jamwal is a Principal Scientist at TCS Research, India, where he leads research initiatives in Computational Creativity. He holds a Ph.D. in Computer Science from the Indian Institute of Technology (IIT) Bombay. His research explores the intersection of artificial intelligence, machine learning, and human creativity, with a focus on developing intelligent systems capable of generating, interpreting, and transforming creative content. His work encompasses generative models, artistic image synthesis, style-based artwork analysis, and AI-assisted creative applications. Prior to joining TCS Research, he worked as a Design Executive at Crompton and Greaves Ltd. and as a Scientist at the National Centre for Software Technology, Mumbai. Beyond his technical pursuits, his interests in dramatics, poetry, music, fine arts, dance, and photography bring a distinctive interdisciplinary perspective to his research. Through his work, he explores how AI can extend the boundaries of creative expression and enable new possibilities in human–machine collaboration.

Keynote Speakers



Dr. Vishwas Ramkrishna Udpikar
Corporate Leader | Researcher | Technology Professional
Research Areas: Corporate Governance • Signal Processing • Biomedical Signal Analysis • Computer Vision

Vishwas Ramkrishna Udpikar is a technology professional, researcher, and corporate leader based in Pune, India. He serves as the Managing Director of Sci-Com Software India Private Limited and has held leadership roles in several organisations, including Wavelet Technologies Private Limited, IFM Engineering Private Limited, and Dema Mechatronics Technologies Private Limited. His professional experience spans corporate management, engineering, manufacturing, and technology-related businesses.

He holds a PhD in Electronics Engineering from the Indian Institute of Technology Madras. His research interests and contributions include signal processing, biomedical signal analysis, visual evoked potentials, EEG analysis, wavelet-based techniques, digital imaging, face detection, and gesture recognition. His career brings together academic research, engineering expertise, and corporate leadership.

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Department of Computer Science and Engineering, COEP Technological University



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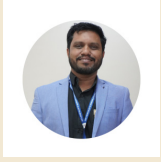
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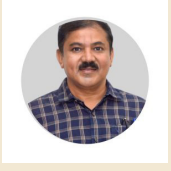
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CVMI 2026 Programme Schedule

TIME	PROGRAMME / SESSION	VENUE
DAY 0 | Friday, 30 October 2026 | Tutorials		
8:30 – 9:30 am	Tutorial Registration	**Mini Auditorium**
9:30-9:45 am	**Tutorial Inauguration**	**Mini Auditorium**
9:45 am – 1:00 pm	**1) Tutorial by Global Foundries** **2) Tutorial by Mathworks**	1) Cognizant Lab 2) Department Computer Center
1:00 – 2:30 pm	**Lunch Break**	**Academics Complex Lobby**
2:30 – 5:00 pm	**1) Tutorial by Aspire Knowledge, Pune and StemLearn.AI Mumbai** **2) Tutorial by ANRF-PAIR on Saral AI 3) Tutorial by COEP Tech and IIIT-Allahabad**	1) Cognizant Lab 2) Department Computer Center
DAY 1 | Saturday, 31 October 2026 | Conference Day		
8:30 –09:30 am	Registration & Breakfast	Academics Complex Lobby
09:30 – 11:15 am	**Inaugural Session and Plenary Address by Prof. KVS Hari, IISc Bangalore**	**Main Auditorium**
11:15 – 11:30 am	**Tea Break and Networking**	**Academic Complex Lobby**
11:30 – 12:00 noon	**Keynote Address 1 – Prof. Sumantra Dutta Roy, IIT Delhi**	**Main Auditorium**
12:00 – 2:15 pm	**Presentations: Session 1 (07 papers-in-person)**	NC 01
12:00 – 2:15 pm	**Presentations: Session 2 (07 papers-in-person)**	NC 02
12:00 – 2:15 pm	**Presentations: Session 3 (08 papers-in-person)**	NC 03
12:00 – 2:15 pm	**Presentations: Session 4 (07 papers-Online)**	NC 04
12:00 – 2:15 pm	**Presentations: Session 5 (07 papers-Online)**	NC 05
2:15 – 3:00 pm	**Lunch, Exhibition and Networking**	**Academics Complex Lobby**
3:00 -3:30 pm	**Keynote Address 2– Prof. Arun Tangirala, IIT Tirupati**	**Mini Auditorium**
3:30 – 5:45 pm	**Presentations: Session 6 (07 papers-in-person)**	NC 01
3:30 – 5:45 pm	**Presentations: Session 7 (07 papers-in-person)**	NC 02
3:30 – 5:45 pm	**Presentations: Session 8 (07 papers-in-person)**	NC 03
3:30 – 5:45 pm	**Presentations: Session 9 (07 papers-Online)**	NC 04
3:30 – 5:45 pm	**Presentations: Session 10 (08 papers-Online)**	NC 05
6:00 – 7:00 pm	**Cultural Programme**	Mini Auditorium
7:00 pm onwards	**Conference Dinner**	**PYC Gymkhana Terrace, Pune-411 004**

CVMI 2026 Programme Schedule

DAY 2 | Sunday, 1 November 2026 | Conference Day 2		
8:30 – 9:30 am	Registration / Breakfast	Academics Complex Lobby
9:30 – 10:00 am	**Keynote Address 3 - Dr. Vikram Jamwal, TCS Research Group**	Mini Auditorium
10:00 - 10:30 am	**Keynote Address 4 - Dr. Vishwas Udpikar, Sci-Com Software India Pvt Ltd.**	Mini Auditorium
10-30 – 11:00 am	**Tea Break and Networking**	**Academics Complex Lobby**
11:00 – 1:15 pm	**Presentations: Session 11 (08 papers-Online)**	NC 01
11:00 – 1:15 pm	**Presentations: Session 12 (08 papers-Online)**	NC 02
11:00 – 1:15 pm	**Presentations: Session 13 (07 papers-Online)**	NC 03
11:00 – 1:15 pm	**Presentations: Session 14 (07 papers-Online)**	NC 04
11:00 – 1:15 pm	**Presentations: Session 15 (08 papers-Online)**	NC 05
1:15 – 2:15 pm	**Lunch, Exhibition and Networking**	**Academics Complex Lobby**
2:15 – 2:45 pm	**Keynote 5 – Prof. Gaurav Sharama (Online Session)**	**Mini Auditorium**
2:45 - 3:45 pm	**Panel Discussion: Role of AI in Higher and Technical Education**	**Mini Auditorium**
3:45 – 4:15 pm	**High Tea and Networking**	**Academics Complex Lobby**
4:15 – 5:00 pm	**Valedictory Session**	**Mini Auditorium**

CVMI 2026 Programme Schedule

Session 01
Date: Saturday, 31st October 2026

Time	Paper - Id	Title of the Paper	Venue
11:30 – 1:30 pm (Offline)	1044	Forecasting River Water Quality using AI, Satellite Data and IoT Insights	NC 01
	984	Adversarial Robustness in AI-Driven Brain Tumor Diagnostics: A Unified Framework of Feature-Space Detection, Denoising Autoencoder Purification, and Multi-Attack Generalization	
	722	HAD-FERNet: Hybrid Augmentation with Distribution-Guided GAN for Class-Imbalanced Facial Emotion Recognition	
	1151	Multi-Class Microplastic Detection,Segmentation in Marine Environment Using Deep Learning	
	771	Graph RAG for Structured Legislative Document Retrieval on Economic Survey Documents	
	1155	Comparative Analysis of Filter-Based Feature Selection Methods for DDoS Attack Classification	
	1142	From Sanskrit to Pali: A Comprehensive Survey of Computational Sandhi Splitting and Open Research Challenges	

Session 02
Date: Saturday, 31st October 2026

Time	Paper - Id	Title of the Paper	Venue
11:30 – 1:30 pm (Offline)	1106	A SMART SYSTEM FOR MULTI-MODAL SKIN DIAGNOSIS	NC 02
	1117	Intelligent Scheduling for AI-Native 6G Radio Access Networks: Taxonomy and Comparative Benchmarking	
	485	MediScopic-BC: A Reliability-Aware Dual-Brain Architecture for Safe Histopathology Classification	
	179	A Multimodal Fake News Detection Framework using Parallel Pipelines and Late Fusion	
	651	Design of a Machine Learning–Based Microwave Sensor for Dielectric Characterization of Solid Materials	
	1141	Mixed Music Separation using Deep Convolutional Neural Network	
	1137	Machine Learning-based EEG Analysis for Brain Synchronization and Cognitive Enhancement	

CVMI 2026 Programme Schedule

Session 03
Date: Saturday, 31st October 2026

Time	Paper - Id	Title of the Paper	Venue
11:30 – 1:30 pm (Offline)	1161	HealthPilot: A Pre-Diagnostic Health Self Assessment informatics with Anatomical Retrieval	NC-03
	638	CoViT: Convolutional Kernel based Vision Transformer to Recognize Indian Sign Languages for Human-Computer Interaction	
	921	A Retrieval-Augmented Generation Based Medical Chatbot for Intelligent Disease Prediction and Real-Time Doctor Recommendation	
	1173	A Comprehensive Survey on Artificial Intelligence and Deep Learning Techniques for Legal Information Retrieval and Case Matching	
	697	A Two-Stage NLP Pipeline for Dataset Citation Provenance Classification in Scientific Literature: Extending Contextual Embedding-Based Citation Intent Classification	
	1140	RFID-Based Industrial Tools Management System for Automated Inventory Control and Retrieval	
	1136	LectureMind AI: A Hybrid VideoRAG Architecture for Educational Lectures with Temporal Grounding	
	744	FedACR: A Robust Algorithm for Dirichlet Distribution-based Label-Skewed Data in Horizontal Federated Learning	

Session 04
Date: Saturday, 31st October 2026

Time	Paper - Id	Title of the Paper	Venue
11:30 – 1:30 pm (Online)	723	Deep Learning-Based Offline Handwritten Gurumukhi Word Recognition: A MobileNetV2 Approach	NC 04
	1133	A Risk-Aware Hybrid Structural-Semantic Framework for Automated Software Vulnerability Detection	
	1037	Camera-Based Facial Skin-Tone Identification Using Video Reflectance Analysis Across Diverse Indian Skin Tones	
	1033	An Empirical Evaluation of Proximity Bias and Environmental Occlusion in 2D Spatio-Temporal Graph Normalizing Flows for Anomaly Detection	
	778	Advanced EEG-Based Schizophrenia Detection Using CNN+BiLSTM with Novel Biomarkers and Explainable AI	
	824	Diffusion-Augmented Vision Transformer Framework for Osteosarcoma Classification with Clinical Staging and Explainable AI	

CVMI 2026 Programme Schedule

	712	Sequential Visual Feature Refinement for Memory-Efficient Video Question Answering	**NC 04**

Session 05
Date: Saturday, 31st October 2026

Time	Paper - Id	Title of the Paper	Venue
11:30 – 1:30 pm (Online)	509	Generative Adversarial Networks (GANs) for Wheat and Sugarcane Crop Monitoring: A Comprehensive Survey	**NC 05**
	645	SkyGuard: A Transparent and Reliable AI System for Robust UAV Detection in High-Clutter Environments	
	1028	Crop Maturity Detection using Deep Learning and IoT	
	1059	CTSG-MHQC: Clinical Transformers with Semantic Grounding for Mental Health Query Classification	
	1061	Multi-Sensor Fusion Approach for Forklift Task Tracking and Environmental Adaptability	
	663	Interpretable Deep Learning Framework of Breast Cancer Image Classification Using ResNet50 and GhostNet	
	635	AquaFusionNet:A Deep Learning Framework for Underwater Object Detection	

Session 06
Date: Saturday, 31st October 2026

Time	Paper - Id	Title of the Paper	Venue
3:15 – 5:30 pm (Offline)	1116	A Multi-Protocol Legacy-Interface IP for UCIe-Based Heterogeneous AI Compute Systems	**NC-01**
	1166	An ML-Driven Parallel Asymmetric Hybrid Intrusion Detection Framework for CAN-Based ADAS	
	1134	AI-Driven Algorithmic Trading and Portfolio Management	
	1124	Comparative Performance Analysis of Automatic Number Plate Recognition Techniques in CCTV Surveillance Systems	
	1158	Explainable AI for Skin Disease Diagnosis in Rural Healthcare	
	1171	BharatNyaya: A Multilingual Retrieval-Augmented Legal Question-Answering System for Indian Citizens	
	1091	A SHAP-Based Bias Audit of RLHF Reward Models	

CVMI 2026 Programme Schedule

Session 07
Date: Saturday, 31st October 2026

Time	Paper - Id	Title of the Paper	Venue
3:15 – 5:30 pm (Offline)	1156	Graph-Structured versus Flat Representations of Anatomical Landmarks for Endpoint Prediction in Endotracheal Intubation Video: A Controlled Ablation Study	NC-02
	854	AI-Powered Smart Autonomous Rover for Nursery Plant Health Monitoring	
	1145	Interpretable Multimodal Fusion in Healthcare	
	1154	Towards Trustworthy Epilepsy Diagnosis: An Explainable CNN GRU Framework for EEG Seizure Detection and Forecasting	
	1144	Empirical Analysis of Machine Learning Classifiers for Intrusion Detection in the Internet of Medical Things	
	1153	Comparative Analysis of Enhanced Deep Learning Models for Multi-Class Weed Detection	
	1115	Hardware-Software Co-Design for Real-Time Cancer Detection and Feature Extraction	

Session 08
Date: Saturday, 31st October 2026

Time	Paper - Id	Title of the Paper	Venue
3:15 – 5:30 pm (Offline)	726	AutoML-Based Multi-Task Malware Detection Using Residual Networks and Ensemble Learning	NC-03
	1123	Secure Image Steganography to Enhance Embedding Capacity Using Advanced Multi-Tier Bit-Plane LSB Embedding and Random Pixel Mapping	
	731	Modelling and Control for Electric Boat Design	
	641	A Comparative Study of CNN and Vision Transformer Architectures for Diabetic Retinopathy Detection with Explainable AI	
	1152	An Efficient HDR Image Quality Enhancement Framework Using the Butterfly Algorithm	
	1157	Industrial Defect Detection and Classification using Classical Image Processing Techniques	
	936	GhostWipe: Reliable Data Removal For Reusing Renowned IT Resources	

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Session 09
Date: Saturday, 31st October 2026

Time	Paper - Id	Title of the Paper	Venue
3:15 – 5:30 pm (Online)	552	Automated Pull Request Quality Assessment Using LLMs in a Scalable CI/CD Pipeline	NC 04
	228	Multi-Domain RAG Framework for Intelligent Academic Information Retrieval and Placement Analytics	
	566	Emotion Detection in Social Media Text Using DistilRoBERTa with Explainable AI	
	746	A Deep Residual Learning Approach for MRI-Based Brain Tumor Classification	
	1147	A Lightweight MobileNetV2–BiLSTM Framework for Spatiotemporal Pedestrian Crossing Intention Prediction	
	1053	Cross-Domain Facial Emotion Recognition via Composite Dataset Training and Progressive Fine-Tuning	
	1003	API Call Analysis and Automated Alert System with Rule Based Root Cause Analysis for Microservice Architecture	

Session 10
Date: Saturday, 31st October 2026

Time	Paper - Id	Title of the Paper	Venue
3:15 – 5:30 pm (Online)	1100	GynoLens-XAI: Explainable ML–NLP for Gynaecological Disease Prediction	NC 05
	852	CLIP-Based Feature Extractor with Lightweight Neural Network for Diagnosis of Kidney Condition using CT Images	
	1095	CVBL-CCTV-Face Dataset for Real-World Face Enhancement and Recognition in Surveillance	
	930	Crowd Detection and Social Distance Monitoring Using YOLOv5	
	1165	Surface-Form Consistency: A Label-Free Diagnostic for Retrieval-Augmented Generation	
	911	Mind Mask:- Real Time Face Parsing And Alert System For Mental Wellness	
	1118	High-Performance Computing Based GPU-Accelerated Molecular Docking for Tuberculosis Drug Discovery	
	920	An AI-Based System for Indian Accent Speech Recognition and Speaker Diarization	

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Session 01
Date: Sunday, 1st November 2026

Time	Paper - Id	Title of the Paper	Venue
Time	**Paper - Id**	**Title of the Paper**	
11:30 – 1:30 pm (Online)	1146	Deep Learning-Based Copy-Move Forgery Localization Using Laplacian-of-Gaussian Preprocessing	**NC 01**
	1049	Depth-Aware Safety Evaluation for Object Detection in Indoor Navigation	
	818	A Hybrid Mechanism for Anomaly Detection and Classification Using Auto-Encoder with Random Forest	
	1130	Text-to-Speech Synthesis Using FastSpeech2 and WaveGlow on IndicTTS Corpus	
	932	Carbon-Aware Retraining for Sustainable MLOps Under Stochastic Performance Drift	
	717	Finding Winning Tickets in Pre-trained LLMs: Compression via Iterative Magnitude Pruning	
	1149	Multimodal AI and Computer Vision Framework for Automated Crack Detection, Severity Classification, and Condition Rating of Concrete Bridges	
	923	Semantic and Context-Aware Query Reformulation for Large Language Model Optimization	

Session 02
Date: Sunday, 1st November 2026

Time	Paper - Id	Title of the Paper	Venue
11:30 – 1:30 pm (Online)	1167	Advanced Pattern Classification Models for Intelligent Diagnosis of Jujube Leaf Diseases in Precision Agriculture	NC 02
	966	GAIMS: Context-Aware Image Editing Through Scene Graph Integration	
	816	The Algorithmic Leviathan: A Framework for Supranational Governance of Advanced AI Addressing Moral Alignment, Cryptographic Compute Tracking, and Regulatory Arbitrage	
	211	Energy-Efficient Deep Neural Networks: Model Compression and Green AI Strategies for Sustainable Computing	
	1051	Dual-Branch Frequency Contrastive Self-Supervised Learning for Generalizable Deepfake Detection	
	702	Transformation of Educational Videos into Structured Learning Modules via Retrieval Augmented Generation	

CVMI 2026 Programme Schedule

11:30 – 1:30 pm (Online)	1043	An Evaluation of RAG Strategies for Mitigating Hallucinations in Financial QA	NC 02
	730	A Hybrid CGTD approach for Estimating the SOH and RUL of lithium-ion Batteries	

Session 03
Date: Sunday, 1st November 2026

Time	Paper - Id	Title of the Paper	Venue
11:30 – 1:30 pm (Online)	202	From SMILES to Solubility: A Machine Learning Pipeline for Drug Discovery	**NC 03**
	691	Transformers Meet CNNs: A Robust Ensemble Approach for WBC Classification	
	725	kS-LLM++: Two-Stage Agentic Pipeline for Optimized Code Refactoring and Test Case Generation	
	716	Masked or Not? A Performance-Driven Comparison of Face Mask Detection Models	
	1126	Examining Classification and Segmentation Models for Plant Disease Severity Assessment	
	1016	Unified Urban Mobility Aggregator with ML-Based Surge Price Prediction for Smart Transportation	
	756	An Efficient Attention-Guided MobileNetV3 Framework with Dual-Pooling Feature Fusion for Tomato Leaf Disease Classification	

Session 04
Date: Sunday, 1st November 2026

Time	Paper - Id	Title of the Paper	Venue
11:30 – 1:30 pm (Online)	969	LakshaNetra: Reliability-Aware Multimodal Fusion for Robust UAV Detection under Degraded Sensor Conditions	**NC 04**
	683	An AI-Powered Virtual Interview Coaching System with Real-Time Multimodal Emotion Analysis and Adaptive Question Generation	
	710	A Comprehensive Review of Emotion Detection Using EEG Signals and Thermal Camera	
	937	Accounting Fraud Detection in SEC 10-K Filings Using Variational Autoencoders	
	709	Evaluating LLM Pruning Techniques for Efficient Edge Deployment	
	1058	AI-Driven Inventory Optimization Under Uncertain Demand	
	1048	Self-Supervised Pea Rust Representation Learning via Contrastive Pretraining and Agglomerative Clustering	

CVMI 2026 Programme Schedule

Session 05
Date: Sunday, 1st November 2026

Time	Paper - Id	Title of the Paper	Venue
11:30 – 1:30 pm (Online)	609	Redefining Smart : A framework for Evaluation of AI Intelligence Level	NC 05
	752	Psychoacoustic Audio-in-Image Steganography via Spatial Latent Embedding	
	832	Secure IoT Communication Enabled Through Privacy-Enhanced Data Aggregation	
	1020	Enhanced MobileNet-SSD Based Object Detection and Distance Estimation to Assist Visually Impaired People	
	1032	Multi-Agent Video Sensor Framework with Reinforcement Learning and Decision Fusion for Intelligent Laboratory Safety Monitoring	
	1052	Decision-Point Mapping for Evidence-Grounded Clinical Intelligence in Sickle Cell Disease	
	1098	Vayu Drushti: Hyperlocal Air Quality Monitoring Using a Mobile IoT Sensing Platform, Multi-Source Data Fusion, and Hybrid CNN-LSTM-Attention Machine Learning Calibration	
	1110	A Memory-Efficient Bayesian HeMIS Attention U-Net for Uncertainty-Aware Brain Tumor Segmentation	

Abstracts

Paper ID: 179

A Multimodal Fake News Detection Framework using Parallel Pipelines and Late Fusion

Ayush Deshmukh (Dr. Vishwanath Karad MIT World Peace University)*; Aranya Nath Misra (Dr. Vishwanath Karad MIT World Peace University); Rohan Londhe (Dr. Vishwanath Karad MIT World Peace University); Hoshmit Mahajan (Dr. Vishwanath Karad MIT World Peace University); Jyoti Mante (Khurpade) (Dr. Vishwanath Karad MIT World Peace University)

Abstract: Social media has accelerated the spread of fakenews in multiple modalities, therefore creating severe societaland safety issues. Most existing methods rely on text and strugglewith diverse content, limiting real world use. This paper proposesan effective fake news detection approach using a framework ofparallel unimodal pipelines which overcome the above problems.The approach employs a hybrid BERT–BiLSTM model fordetecting text-based fake news, and a Visual Patch AggregationModule for image analysis. Audio news is converted to text usingspeech recognition and analyzed through the text-based pipeline.Our approach also studies the performance of late multimodalfusion over joint feature fusion to evaluate whether combiningmodalities at the decision-level is more impactful than combiningthem at the feature-level. The text-based model achieved 97.45%accuracy, the image-based model 75.69%, and the late fusedmodel 96.33%. The study shows that the proposed methodachieves reliable results.

Paper ID: 202

From SMILES to Solubility: A Machine Learning Pipeline for Drug Discovery

Allen Nadar (Agnel Charities' Fr. C. Rodrigues Institute Of Technology); Niya Kolapran (Agnel Charities' Fr. C. Rodrigues Institute Of Technology)*; Nikita Patil (Agnel Charities' Fr. C. Rodrigues Institute Of Technology); John Theroth (Agnel Charities' Fr. C. Rodrigues Institute Of Technology); Chetana Badgujar (Agnel Charities' Fr. C. Rodrigues Institute Of Technology)

Abstract: Predicting molecular solubility is vital in drug discovery to design effective and bioavailable medications. Traditional experimental methods are costly and time consuming, driving the adoption of machine learning for faster, more accurate predictions. However, existing solubility predictors often rely on narrow descriptor sets and a single model family, limiting their accuracy and generalizability. This paper extracts twenty-eight RDKit descriptors from SMILES strings, covering lipophilicity, hydrogen-bonding, polar surface area, and molecular complexity, and compares seven regression models, including Random Forest, XGBoost, LightGBM, CatBoost, a stacking ensemble, and a Graph Convolutional Network, under an identical train/validation/test split. The best performing model, CatBoost, achieves a test R^2 of 0.9088 (RMSE 0.6105, MAE 0.4259), confirmed by cross-validation at R^2 = 0.914, while SHAP analysis identifies lipophilicity (MolLogP) as the dominant predictor of aqueous solubility.

Paper ID: 211

Energy-Efficient Deep Neural Networks: Model Compression and Green AI Strategies for Sustainable Computing

Jarnail Singh (University School of Computer Applications & Technology, Rayat Bahra Professional University, Hoshiarpur, (Pb))*; Shelley Khosla (University School of Business Studies, Rayat Bahra Professional University, Hoshiarpur (Pb)); Palki Sharma (School of Management Studies, CGC University, Mohali-140307, Punjab); Suprina Sharma (School of Management Studies, CGC University, Mohali-140307, Punjab); Dharampal Singh (University Institute of Computing, Chandigarh University, Mohali, Punjab); Dhivya Karunya S (Department of Artificial Intelligence & Data Science, S E A College)

Abstract: The fast growth of deep neural networks (DNNs) has advanced the achievements of computer vision, natural language processing, and data analytics with great volumes of data. Yet, the models can consume vast amounts of computer resources and energy, which raises the environmental and economic issues. A design aimed at ensuring the use of machine learning in an energy-efficient manner has led to the idea of Green AI to ensure that the cost of computation is very low and the performance of the model is high. Some of the model compression methods, including pruning, quantization, knowledge distillation, and low-rank factorization are promising solutions to energy-constrained deep neural networks. This paper explores the energy-efficient approaches to deep neural networks by combining model compression methods with the principles of Green AI. The study suggests an experimental model that compressed neural network models are assessed on the basis of metrics of energy consumption, inference time, and accuracy. Findings indicate that the cost of computations can be greatly lowered by using optimized compressed models without much predictive power. The results can contribute to the sustainable development of AI and offer specifications of how to design energy-efficient deep learning systems.

Paper ID: 228

Multi-Domain RAG Framework for Intelligent Academic Information Retrieval and Placement Analytics

Chaitanya Mulampaka (Siddhartha Academy Of Higher Education)*; Nikhil Thota (Siddhartha Academy Of Higher Education); Jay Pithani (Siddhartha Academy Of Higher Education)

Abstract: The rapid digital transformation of higher educationinstitutions has intensified the demand for intelligent and unifiedinformation systems capable of supporting students, parents,and academic stakeholders. Conventional university websites andhelpdesk mechanisms often overwhelm users due to fragmentedinformation dispersed across static web pages, PDF documents,and multiple portals. This paper presents a comprehensiveRetrieval-Augmented Generation (RAG)–based chatbot systemdeveloped for centralized academic and administrative support atSiddhartha Academy of Higher Education (SAHE). The proposedsystem integrates four core domains—Admissions, Course Curriculum, Website Navigation, and Placement Analytics—withina single conversational interface. The architecture combinessemantic retrieval using Sentence Transformer embeddings andChromaDB with large language models to ensure accurate,context-aware, and verifiable responses. In addition, a Pandasdriven analytical agent enables real-time, data-grounded placement insights. Experimental evaluation demonstrates notableimprovements in retrieval accuracy, response latency, and crossdomain consistency. By grounding generated responses in authoritative institutional data, the system effectively mitigates hallucination risks and illustrates the potential of hybrid RAG–LLMarchitectures to significantly enhance digital infrastructure inhigher education.

Paper ID: 485

MediScopic-BC: A Reliability-Aware Dual-Brain Architecture for Safe Histopathology Classification

Atharva Sarde (Universal Ai University)*; Mrudula Gharat (Universal Ai University); Pranav More (Universal Ai University); Sagar Kulkarni (Universal Ai University); Shweta Watane (Grant Government Medical College); Yogesh Thube (Asian Cancer Institute & Cumballa Hill Hospital)

Abstract: Deep learning breast cancer classifiers can be confidentlywrong, and those errors rarely announce themselves: theylook correct on every standard metric until a clinical mistakeactually happens. MediScopic-BC addresses this directly with atwo-stage design. The first stage, Brain-1, fine-tunes ResNet50on 7,909 BreaKHis images spanning all four magnification levels(image-level split, Section

IV) and reaches an F1-score of 0.9671on binary tissue classification. The second stage, Brain-2, neverlooks at the tissue image. It instead reads four signals producedby Brain-1 during inference — prediction confidence, softmaxentropy, the pre-softmax logit margin, and the distance betweenthe feature embedding and its training-set class centroid — anduses them to decide whether a prediction is safe to release orshould be held for pathologist review. We tuned Brain-2 towardthe safety-maximising end of its operating range: on the heldouttest set it caught 98.1% of Brain-1's misclassifications beforethey reached any clinical output, missing only 1 of 53 errors,while routing 61.0% of all test cases to pathologist review. Bothnumbers are reported together throughout this paper, since thedetection rate on its own would misrepresent what the systemdoes; the trade-off is a deliberate choice suited to settings wheremissing a malignancy costs far more than an extra review. Perimageoverhead added by the auditor is under 1 ms.

Paper ID: 509

Generative Adversarial Networks (GANs) for Wheat and Sugarcane Crop Monitoring: A Comprehensive Survey

Trupti Katte (Pravara Rural Engineering College)*; Swati Shinde (PCCOE, PUNE)

***Abstract**:* Under limited datasets and class imbalance, Generative Adversarial Networks (GANs) have significantly improved disease classification and domain adaptation by enabling synthetic data generation. Wheat and sugarcane are major crops worldwide, and their productivity is heavily affected by diseases and environmental variability. Deep learning techniques, such as Convolutional Neural Networks (CNN), have achieved strong performance; however, large-scale balanced datasets are a major limitation. A GAN-based framework provides an effective solution for data scarcity, class imbalance, and domain generalization challenges. This survey provides a review of GAN applications in wheat and sugarcane crops. In crop monitoring, disease detection, segmentation, yield prediction, and remote sensing analysis were discussed. In addition, we also discuss the comparative evaluation, research trends, challenges, and future directions. This study identifies the key research gaps in explainability, multi-modal integration, transformer-based hybrid models, and cross-domain adaptation. Unlike existing surveys, this work provides a structured taxonomy of GAN architectures specific to agricultural applications, along with a critical comparative analysis across datasets, tasks, and performance metrics. Furthermore, this study highlights key limitations in current research, including lack of real-field validation, limited multi-modal integration, and insufficient explainability, thereby establishing clear directions for future research.

Paper ID: 552

Automated Pull Request Quality Assessment Using LLMs in a Scalable CI/CD Pipeline

Yash Shukla (PICT)*; Shreyas Shirwadkar (PICT); Vivek Mangiraj (PICT); Kalyani Bhise (PICT); Prajakta Shinde (PICT)

***Abstract**:* This paper proposes a novel approach for automatic code review based on the CI/CD integration in microservices with the use of LLMs. The developed approach involves automatic polling for pull requests on GitHub, which triggers the corresponding actions only when changes are detected. In particular, the proposed solution includes two separate components. One component is responsible for interacting with the GitHub using Node.js, whereas another is used for code analysis with Python-based LLM service. Thus, both system independence, scalability, and durability can be ensured by utilizing the developed approach. Diff data related to GitHub pull requests are parsed and sent to the LLM reviewer, along with pull request titles and descriptions, using the dedicated lightweight API interface. An LLM generates feedback data in a structured format, consisting of qualitative comments and scores. To avoid duplicates, review results are accumulated in a single PR comment and synchronized between multiple review sessions with the help of metadata handling. The framework performs parallel validation of PR title and description requirements in addition to the code review process.

Paper ID: 566

Emotion Detection in Social Media Text Using DistilRoBERTa with Explainable AI

Priya Surana (PCCOE)*; sakshi pandharkar (PCCOE); Vedashree Marwadkar (PCCOE)

***Abstract**:* Identifying emotions from text has become morenecessary than ever before, including in areas like sentimentanalysis, tracking mental health, and conversational AI. Althoughdeep learning methods based on transformer architectures havereached a high level of accuracy for classifying emotions, the rea-soning behind their predictions is often not easy to understand.In this paper, we outline an explainable emotion detecting frame-work that uses the DistilRoBERTa transformer model coupledwith gradient-based attribution techniques for explaining howdecisions are made. This system not only predicts the emotiondepicted in the text but also provides an analysis of which wordsfrom the text have the most impact on the predicted emotion.The importance of each word is determined using gradient-based methods for explainability of the model and visualizedusing an interactive heatmap interface developed through theStreamlit framework. Through experimentation, we find thatthe proposed method effectively pinpoints tokens of the highestsemantic significance associated with emotion classification. Thus,this method increases the transparency and interpretability of the model while maintaining the accuracy of the provided prediction. The framework will provide assistance to both researchers and practitioners in gaining insight into the behavior of the model,leading to developing more reliable NLP systems.

Paper ID: 609

Redefining Smart : A framework for Evaluation of AI Intelligence Level

Anirudh Shukla (BML Munjal Universilty)*; Sumit Goswami (Defence Research & Development Organisation)

***Abstract**:* Current artificial intelligence systems have shown incredible demographics in specific fields; however, they do not have a common approach, especially in aspects of measuring the general intelligence of a machine. Current assessment approaches either focus on narrow task-specific performance or propose theoretical models with limited practical implementation. This research introduces CLARIQ (Cognitive Level Assessment and Reviewing of Intelligence Quotient), a comprehensive evaluation framework that measures AI systems across three integrated dimensions: functional execution capabilities, cognitive reasoning processes, and standardized benchmark performance. Our methodology synthesizes these components into a unified intelligence metric,enabling objective comparison between diverse AIarchitectures. Through empirical analysis ofcontemporary AI models, we demonstrate howCLARIQ distinguishes between specialized taskperformance and broader cognitive competence,establishing a foundation for scalable intelligenceassessment in emerging domains including multimodalprocessing and ethical reasoning. This is furthervalidated through a comparative case study of threeanonymized AI systems: AI-1, AI-2, and AI-3 thatillustrates CLARIQ's ability to classify and differentiateAI systems with precision.
Keywords—AI evaluation, machine intelligence, cognitive assessment, performance benchmarking, intelligence measurement.

Paper ID: 635

AquaFusionNet:A Deep Learning Framework for Underwater Object Detection

Aakash Jayapaul (Sri Ramachandra Faculty of Engineering and Technology, SRIHER); Rajitvel Perumal D (Sri Ramachandra Faculty of Engineering and Technology, SRIHER); Rethick R P (Sri Ramachandra Faculty of Engineering and Technology, SRIHER); Anusha S (Sri Ramachandra Faculty of Engineering and Technology, SRIHER)*

Abstract: Underwater object detection is considerably harder than its above-water counterpart because red light is absorbed within a few metres below the surface, suspended particles cause frame-level contrast variation, and targets of interest differ in apparent size by roughly two orders of magnitude within the same scene. A further difficulty is the shortage of annotated data: detectors trained on a single collection environment routinely fail on footage from a different water body or depth. This paper addresses both the imaging difficulty and the datascarcity problem together. Three publicly available benchmarksRUOD [6], TrashCan 1.0 [7], and the CADDY diver dataset [8]are merged into a single 30,407-image corpus covering threeclasses: fish, marine debris, and diver. Contrast Limited AdaptiveHistogram Equalisation (CLAHE) followed by six domainspecificaugmentations is applied at training time. Two detectors are evaluated on a held-out split of 6,205 images. YOLOv8m, usedas a strong baseline, reaches mAP (IoU = 0.5)of 0.9130 and mAP(IoU = 0.5):0.95 of 0.6427. AquaFusionNet, a custom detectorbuilt on a Cross Stage Partial (CSP) backbone with ConvolutionalBlock Attention Modules (CBAM), a three-iteration BidirectionalFeature Pyramid Network (BiFPN) neck, and an anchor-freeFCOS head operating at three output scales, reaches mAP (IoU= 0.5)of 0.9247 and mAP (IoU = 0.5):0.95 of 0.6715. The fish classAP50 improves by 3.6 points over YOLOv8m, the largest per-classgain and the class with the greatest intra-class shape and scalevariation. Ablation experiments show that removing CLAHEpreprocessing alone costs 2.8 mAP (IoU = 0.5), which is a largerdrop than removing any individual architectural component.Index Terms—underwater object detection, YOLOv8, Aqua-FusionNet, marine debris, deep learning, CLAHE

Paper ID: 638

CoViT: Convolutional Kernel based Vision Transformer to Recognize Indian Sign Languages for Human-Computer Interaction

Bibhash Thakuria (National Institute of Technology Silchar); Shayan Roy (National Institute of Technology Silchar); Biswarup Ganguly (National Institute of Technology Silchar)*

Abstract: Hearing and speech impairment affects millions of individuals worldwide, significantly limiting effective communication and social participation. According to the World Health Organisation, approximately 453 million people globally experience some degree of hearing loss, including 17 million individuals in India and around 5 million rely on Indian Sign Language (ISL) as their basic mode of communication. Though its importance is high, ISL remains unrecognized due to a lack of lightweight, robust models and lack of diverse data. To address this issue, this paper proposes a lightweight hybrid learning framework, termed CoViT, which integrated convolutional layers with Vision Transformer employing transfer learning mechanism to effectively capture both local and global features. A custom-built ISL dataset comprising 26 classes (A-Z) with a total of 39000 images has been developed to overcome data limitations. The proposed model demonstrates strong generalization capability in cross-class classification. Extensive experimental evaluations reveal that the model achieves an accuracy of 99.46\% while maintaining high computational efficiency, reaching up to 80 frames per second. The proposed framework enables seamless deployment in real-time and represents a significant step towards practical assistive technologies in human computer interaction.

Paper ID: 641

A Comparative Study of CNN and Vision Transformer Architectures for Diabetic Retinopathy Detection with Explainable AI

Yogita patil (Vishwakarma University)*; Rameez Shamalik (MIT Art, Design and Technology University); Kalyani Kadam (MIT Academy of Engineering); Namash Kate (Vishwakarma University); Karthik Kurup (Vishwakarma University); Shriram Dixit (Vishwakarma University)

Abstract: Diabetic retinopathy (DR) is one of the leading causes of preventable blindness, thus an exact and scalable screening process is required to identify the disease in early stages. Deep learning has shown great promise for automation of DR detection tasks; yet, comparisons between CNNs and transformers for DR analysis are performed in experiments with different conditions. The current study performs a controlled comparison between five architectures, namely, ResNet-18, ResNet-50, EfficientNet-B0, ConvNeXt-Tiny, and Tiny Vision Transformer (TinyViT) for binary classification of DR based on Gaussian-filtered images from the retinal fundus obtained from the APTOS 2019 dataset. All models are compared based on identical preprocessing pipeline, dataset splitting, training and testing conditions. Evaluation is performed based on accuracy, area under receiver operating characteristic (ROC) curve (AUC), and F1-score in combination with number of model parameters. Of all considered models, TinyViT gives the highest results with 97.28% accuracy, 0.9915 AUC, and 0.9654 F1-score with about 5.7 million parameters. These results illustrate a positive trade-off between accuracy and efficiency in comparison to the evaluated CNN models. To enhance interpretability, attention rollout is employed in order to visualize which parts of an image contribute to the predictions of the TinyViT. The obtained visualizations help understand what kind of attention the model pays to important retinal structures.

Paper ID: 645

SkyGuard: A Transparent and Reliable AI System for Robust UAV Detection in High-Clutter Environments

Rolla Bindu Sri Lakshmi Madhuri ({Narasaraopeta Engineering College)*; Annavarapu Lakshmi Prasanna (Narasaraopeta Engineering College)

Abstract: The proliferation of small-scale Unmanned Aerial Vehicles (UAVs) has introduced significant security challenges, particularly in distinguishing Low-Slow-Small (LSS) targets from natural avian activity in rural environments. While deep learning has set impressive benchmarks in target recognition, its deployment is often stalled by the “black-box” nature of standard models and their tendency to produce overconfident, yet erroneous, predictions. In high-stakes defense and surveillance, a single confident misvalidation can lead to severe security breaches or unnecessary neutralizations. To mitigate these risks, we developed SkyGuard, a surveillance framework that prioritizes operational safety through explicit uncertainty quantification and Explainable AI (XAI). By integrating the MobileNetV2 architecture with Monte Carlo (MC) Dropout and Gated Recurrent Units (GRU), our system approximates Bayesian inference to provide a tangible measure of predictive reliability for frontline security workers. Our experiments on the StealthKnight dataset demonstrate a classification AUC of 0.9973. By treating model variance as a core metric, we successfully identified potential misclassifications in cluttered forest environments, providing a scalable and trustworthy fail-safe for aerial security in underserved populations.

Paper ID: 651

Design of a Machine Learning–Based Microwave Sensor for Dielectric Characterization of Solid Materials

Tulshidas Mane (Sardar Patel Institute of Technology)*; Reena Sonkusare (Bharatiya Vidya Bhavan’s Sardar Patel Institute of Technology); Kompella SL Parvathi (Fr. Conceicao Rodrigues College of Engineering); Manisha Bansode (Bharatiya Vidya Bhavan’s Sardar Patel Institute of Technology); Purvesha Ingale (Bharatiya Vidya Bhavan’s Sardar Patel Institute of Technology); Sarthak Deshmukh (Bharatiya Vidya Bhavan’s Sardar Patel Institute of Technology); Nilay Khisty (Bharatiya Vidya Bhavan’s Sardar Patel Institute of Technology)

Abstract: In this paper, a compact, high-sensitivity microwave sensor based on an Electromagnetic Band Gap (EBG) structure is proposed for the non-destructive dielectric characterization of solid materials. The sensor, designed on a Rogers RT/Duroid 5880 substrate, operates at a resonant frequency of 1.97 GHz with a sharp transmission response reaching -38.83 dB. The sensing mechanism relies

on the perturbation of the EBG's electric fields when a Solid Material Under Test (SMUT) is placed on its surface, causing a measurable shift in the resonant frequency with a compact size of 0.092λ0×0.092λ0×0.001λ0. To accurately map the sensor's response to the material's dielectric properties, a machine learning model based on Extreme Gradient Boosting (XBG) Classifier was developed. The models hyperparameters were systematically optimized using the Kera's Tuner library. The final trained model demonstrates strong predictive performance on an unseen test set, achieving a Root Mean Square Error (RMSE) of 1.23 for relative permittivity (ϵr') and 0.0782 for the loss tangent (ϵr'') with achieved sensitivity of 4.62%. This work establishes that a finely-tuned Boost classifier, combined with a high-Q microstrip sensor, provides a robust and precise method for solid material characterization. I would sincerely appreciate your guidance regarding the relevance and suitability of my work for this conference.

Paper ID: 663

Interpretable Deep Learning Framework of Breast Cancer Image Classification Using ResNet50 and GhostNet

Brij Kishor Tiwari (SR University)*

***Abstract**:* Breast cancer is among top reason for death among women in the world and hence, accurate and early diagnosis of the breast cancer can save more women. In recent years AI based specially the convolutional neural networks (CNNs) are used to provide the improved diagnostic capabilities in medical images. This article presents an explainable deep learning model which is based on ResNet50 architecture and GhostNet as a fast and accurate model for understanding breast cancer images. ResNet50 is the main source of feature extraction and GhostNet is a lightweight network, demonstrating better performance. Grad-CAM is employed to generate visual explanations revealing the decision process. The proposed framework is tested on the standard breast cancer imaging datasets and results in better classification performance. Experimental results show that the model can obtain better prediction accuracy with less computation than the conventional CNN based methods

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Paper ID: 683

An AI-Powered Virtual Interview Coaching System with Real-Time Multimodal Emotion Analysis and Adaptive Question Generation

Soham Gandhi (Pune Institute of Computer Technology)*; Sakshi Gangurde (Pune Institute of Computer Technology); Rajvardhan Deshmukh (Pune Institute of Computer Technology); Rishikesh Ghodke (Pune Institute of Computer Technology); Shyam Deshmukh (Pune Institute of Computer Technology)

***Abstract**:* Interview preparation tools have historically been limited to static question banks and peer-based mock sessions, neither of which can deliver the objective, real-time, multimodal feedback that candidates require to improve their communication skills systematically. This paper presents an AI-powered virtual interview coaching system that simultaneously analyses facial expressions, vocal features, and verbal content within a single live session, addressing three capability gaps consistently documented in the recent literature. The system comprises a React18 frontend that captures webcam and microphone streams via Browser APIs, and a FastAPI backend orchestrating four specialized service modules: a Video analyzer built on MediaPipe FaceMesh and an HSEmotion EfficientNet-B2 model trained on AffectNet; an Audio analyzer using Librosa and OpenAI Whisper; a Seman tic Verbal Evaluator combining BERT-based relevance scoring with STAR-method detection; and an LLM-powered Question Generator leveraging the Groq LLaMA3.1 API with a rule based adaptive difficulty engine. All modules communicate over a single WebSocket channel, enabling live coaching interventions during the session. Session data is persisted in MongoDB and surfaced through a Recharts analytics dashboard for longitudinal progress

tracking. Controlled evaluation on annotated recordings achieved 87% eye-contact estimation accuracy, 75% emotion classification accuracy on AffectNet (exceeding the DeepFace VGG-Face baseline by 11 percentage points), and a Pearson correlation of r = 0.79 between system answer scores and expert human ratings. Pre-score anchoring reduced LLM scoring vari ance by 34% relative to an unanchored baseline. The proposed architecture addresses three key gaps: lack of a unified real-time multimodal coaching pipeline, absence of longitudinal progress tracking, and missing fairness monitoring in practitioner tools, with fairness partially implemented and identified as future work.

Paper ID: 691

Transformers Meet CNNs: A Robust Ensemble Approach for WBC Classification

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Abstract: White Blood Cells (WBCs) play a vital role inprotecting the body against multiple diseases and providing im-munity. WBC classification becomes important because diseases depend on their production by the bone marrow. Leukopenia occurs from a decrease in the number of white blood cells, whereas Leukocytosis occurs from an increase in the number of white blood cells, therefore WBC classification in itself becomes a herculean task and also becomes a key area of study for hematological analysis. There are a plethora of challenges in WBC classification and its importance in medical analysis and diagnosis has pushed for innovative methods in model training all around. There is a dearth of large and good quality datasets of abnormal WBCs and existing datasets are imbalanced that produces less accurate results. There exists very fine-grained morphological differences between internal structures of cells which becomes all the more challenging for model training. This classification also faces significant challenges due to domain shift caused by differences in imaging conditions across hospitals and dynamic environments. This paper proposes a lightweight and a unique pipeline that has an ensemble approach of transformers and Convolutional Neural Networks (CNN), with the fusion of geometric mean and test-time augmentation. This proposed methodology is robust to clinical differences, reduces the false positives and increases the overall accuracy of the classification.Index Terms—white blood cell classification, ensemble, geometric mean, test-time augmentation, lightweight

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Paper ID: 697

A Two-Stage NLP Pipeline for Dataset Citation Provenance Classification in Scientific Literature: Extending Contextual Embedding-Based Citation Intent Classification

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Abstract: Figuring out where a dataset comes from when it is cited - whether researchers made it themselves or used someone else's work - is key to making sure studies can be checked and shared openly. Most current tools for sorting citation purposes, like the advanced method by Roman et al. [1] based on context embeddings, start after citations are already found, focusing only on broad types of intent. Yet problems remain. One, earlier systems skip finding actual dataset markers such as DOIs, GEO codes, SRA IDs, or PRIDE numbers before trying to sort them. Two, there is still no structured list of signal words tied specifically to data origin meaning. Our solution unfolds in two steps: first pulling those identifiers from entire research articles via custom pattern rules built for the field, followed by labeling each instance as original or borrowed through a mix of weighted keyword contexts, a new word-scoring technique tuned to

hints in the text, and taking into account which part of the paper the mention appears in. Among tested methods, Logistic Regression, Support Vector Machine, and Random Forest reach macro F1 values near 94% when assessed using the Coleridge Initiative dataset (train_labels.csv). The top result emerges from the SVM variant, recording a macro F1 of 0.94 alongside 95.33% accuracy. This outcome exceeds the performance delivered by the unsupervised BERT-KMeans approach previously introduced by Roman and colleagues. Of using only embeddings our method uses a custom-built system that classifies cue-phrases. This system helps us to analyze citations in two phases.These phases may seem small. They change how we understand text from citations. Primary citationsand secondary citationsare important.Scientific literature mining usesnatural language processing to extract information. The details about where the data comes from are crucial for extraction. Identifying why a citation is used affects how accurate the analysis is.

Paper ID: 702

Transformation of Educational Videos into Structured Learning Modules via Retrieval Augmented Generation

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Abstract: In this paper, we introduce a framework for structuring unstructured video data using the paradigm of Retrieval-Augmented Generation (RAG). The system retrieved highly relevant transcript segments using FAISS-based vector similarity and synthesizes them into organized learning modules, summaries, and quizzes. Quantitative evaluations across computer engineering topics demonstrate the system's high semantic accuracy, achieving an average BERTScore F1 of 0.9447 and a semantic cosine similarity of 0.8485 against reference materials, proving it to be highly effective and accurate method for automated educational content generation.

Paper ID: 709

Evaluating LLM Pruning Techniques for Efficient Edge Deployment

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Abstract: Large language models (LLMs) are now a daysused for most natural language processing (NLP) applications.However, their large computational and memory requirementsmake it difficult to deploy them to edge devices where computingresources are limited. Pruning has recently emerged as oneof the most popular solutions to these challenges. This paperprovides a comparative analysis of the 3 popular pruningtechniques: Magnitude Pruning, SparseGPT, and Wanda.We investigate the pruning techniques across 3 languagemodels: OPT, GPT-Neo, Bloom. We also show that the pruningtechniques differ at various model scales. The best pruningtechnique is SparseGPT, it maintains the performance similarto dense model performance up to 60% sparsity. Wanda hasa better balance between performance and pruning time. Incontrast, Magnitude Pruning loses its performance after the10-20% sparsity level.

Paper ID: 710

A Comprehensive Review of Emotion Detection Using EEG Signals and Thermal Camera

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Abstract: Emotion recognition has become an important re-search area in biomedical engineering, affective computing, and intelligent healthcare systems. Traditional methods based on facial expressions and speech suffer from limitations such as environmental sensitivity and voluntary masking of emotions. Recent studies have focused on physiological signals such as Electroencephalography (EEG) and thermal imaging, which provide more reliable indicators of emotional states [1], [4].This review paper presents an analysis of ten recent research works on EEG-based, thermal-based, and multimodal emotion detec-tion systems. Various techniques, including convolutional neural networks (CNN), recurrent neural networks (RNN), long short-term memory (LSTM), and feature fusion methods, have been applied to improve classification performance [4], [6], [7].The re-viewed studies indicate that EEG-based systems generally achieve higher accuracy than thermal imaging alone, while multimodal approaches combining EEG and thermal imaging provide im-proved performance, often exceeding 90% accuracy [3]. However, challenges such as noise in EEG signals, environmental effects in thermal imaging, high computational complexity, and limited real-time implementation still remain. Future research should focus on low-cost, portable, and real-time systems using wearable devices, edge computing, and IoT-based monitoring platforms.This paper provides a comparative analysis of existing EEG-based, thermal-based, and multimodal emotion detection systems and identifies key research gaps for developing low-cost, portable, and real-time emotion recognition frameworks.

Paper ID: 712

Sequential Visual Feature Refinement for Memory-Efficient Video Question Answering

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Abstract: State-of-the-art VideoQA systems exhibit strongperformance on benchmark datasets, but they rely heavily onhigh-end computational resources for inference, limiting theirscalability and operation across different hardware environments. In practice, many researchers lack access to such high end resources. Attempting to implement these state-of-the-art models on consumer-grade GPUs requires compromises such as minimal availability of spatio-temporal information to themodel, which results in significant performance degradation. Toaddress this constraint, we propose Sequential Visual FeatureRefinement (SVFR), a training-free, memory-efficient frameworkthat achieves competitive performance on VideoQA tasks whileminimizing GPU memory footprint. Traditional VideoQA systemsbuild a static memory of all visual features once per video andproduce answers to all queries based on information extractedfrom this static memory. This static memory building requiresresource-intensive enterprise GPUs (e.g., H100). Our frameworkovercomes this challenge by processing the video and building afixed-size memory bank that stores visual features relevant only to the current query. This per-query architecture drastically reduces GPU memory footprint and, by storing only query-relevant visual features, maintains temporal order while filtering irrelevant visual noise. Crucially, since SVFR is completely training-free, it removes the need for expensive fine-tuning of models and can be directly integrated with existing pre-trained models. We validate our approach on the NExT-QA benchmark using a single consumer-grade RTX 4090 and achieve a Top-1 accuracy of 62.11% on the validation set, outperforming several state-of the-art 7B-class models while using up to 8 times lesser GPU memory, providing a practical study on the trade-off between memory efficiency and accuracy.

Paper ID: 716

Masked or Not? A Performance-Driven Comparison of Face Mask Detection Models

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Abstract: Deep learning and computer vision have made it possible for computers to tackle challenging tasks like identifying and recognizing faces. In recent years, face detection and recognition technology has improved a lot. When it comes to respiratory diseases, using face masks and keeping social distance has become an important way to stop the spread of the illness. In these situations, there is a strong need for face mask detection systems to identify masks and help officials prevent the spread of the disease. Many face mask detectors have been created using various algorithms and methods. The goal of this project is to build a face mask detection system without using existing transfer learning techniques. We used deep learning to create the system. We proposed four Convolutional Neural Network (CNN) model architectures and the CNN model with five convolutional layers has performed well among the four models. This model is trained and used as a classifier for detecting the images whether they have worn masks or not. This work uses three datasets namely Prajna Bhandary Dataset, Combination of MFRD and RMFD datasets, and Combination of Prajna Bhandary and MMFD datasets. We achieved an accuracy of 98.19%, 97.26%, and 97.95% respec-tively. Data Augmentation has improved the model accuracy further.

Paper ID: 717

Finding Winning Tickets in Pre-trained LLMs: Compression via Iterative Magnitude Pruning

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Abstract: The Lottery Ticket Hypothesis (LTH) proposes the existence of subnetworks (“winning tickets”) within randomly initialized neural networks which can be trained in isolation to achieve test accuracy comparable to the original network. Although LTH has been widely validated on computer vision tasks, its application to Large Language Models (LLMs) remains largely unexplored. In this paper, we show a practical implemen- tation of iterative magnitude pruning to find winning tickets in the feed-forward layers of Qwen2-0.5B, an LLM transformer architecture with 0.5 billion parameters. We explore trade-offs between the sparsity ratio, speed of inference, and performance of a language model measured in perplexity on the full WikiText- 2 dataset. Our results show that up to 47.83% of the feed-forward parameters can be pruned, with an actual improvement in perplexity from 6.28 to 6.02, which is a 4.1% improvement. The best winning ticket achieves a perplexity of 6.02 at 59.05% weight retention. This paper provides empirical evidence of perplexity changes during 8 iterations of pruning, distribution of weights, per-layer sparsity, and computational costs.

Paper ID: 722

HAD-FERNet: Hybrid Augmentation with Distribution-Guided GAN for Class-Imbalanced Facial Emotion Recognition

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***Abstract**:* In real-world applications, Facial Emotion Recogni-tion (FER) faces challenges because of class imbalance, noisyannotations, and the inherent variability in data quality. Inorder to resolve these issues, we propose a Hybrid AugmentationDriven FER Network (HAD-FERNet), which integrates tradi-tional augmentation with a statistically guided Class Distribution-Guided GAN (CDG-GAN), thereby improving dataset balanceand reducing bias. It improves the baseline accuracy of 55.92%by 10.1% and 23.87%, achieving an accuracy of 66.02% inFER-2013 and 79.79% in RAF-DB, respectively. These resultsshow that training on a diverse and extensive data distributionenhances model performance. Overall, it achieves an effectivebalance between predictive accuracy, computational efficiency,and real-world applications.

Paper ID: 723

Deep Learning-Based Offline Handwritten Gurumukhi Word Recognition: A MobileNetV2 Approach

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***Abstract**:* Handwritten document recognition remains a significant challenge, especially in offline, resource-constrained settings like regional postal systems. While Convolutional Neural Networks (CNNs) have demonstrated strong performance, their high computational demands limit real-world applicability. This study presents the first application of the lightweight MobileNetV2 architecture for offline handwritten Gurmukhi word recognition. Trained on a publicly available dataset of 40,000-word images spanning 100 classes, the proposed model leverages a two-phase training strategy combining transfer learning and fine-tuning, along with extensive data augmentation to enhance generalization across varied handwriting styles. The model achieved 94.30% accuracy, with a precision of 94.73%, recall of 94.30%, F1-score of 94.27%, RMSE of 10.92, and macro-average AUC of 0.9998. Additionally, 5-fold cross-validation validated its robustness with 92.75% accuracy. These results highlight the potential of MobileNetV2 for efficient and accurate handwritten Gurmukhi word recognition, demonstrating its practical utility in real-world postal automation applications.

Paper ID: 725

kS-LLM++: Two-Stage Agentic Pipeline for Optimized Code Refactoring and Test Case Generation

Gourisetty Venkata Sai Koushik (SRM University AP); Dama Aditya (SRM University AP); Mahankali Harish Sai (SRM University AP); Peddi Siddarhta (SRM University AP); Vivek Yelleti (NIT Warangal)*; Shadab Ahmad (SRM University AP)

***Abstract**:* Software reliability depends on effective test case generation, but traditional methods often fail with complex, bloated codebases. This paper presents kS-LLM++, a two-stage framework that incorporates Large Language Models (LLMs) to first improve C code and then generate high coverage test cases. Unlike previous versions that use simple prompts, kS-LLM++ employs the Tree-of-Thought (ToT) and Chain-of-Thought (CoT) approach. In the first stage, specialized agents refactor code fragments to reduce Line of Code (LOC) while keeping functional parity across module relationships. In the second stage, these optimized fragments go through an agentic pipeline that produces thorough test cases. Experimental results show that kS-LLM++ greatly exceeds CBMC and the original kS-LLM in both branch and line coverage. Further, it achieved up to a 90\% reduction in code redundancy in certain programs.

Paper ID: 726

AutoML-Based Multi-Task Malware Detection Using Residual Networks and Ensemble Learning

Nirav Patel (Sardar Vallabhbhai National Institute of Technology, Surat); Balu L. Parne (Sardar Vallabhbhai National Institute of Technology, Surat)*

Abstract: The paper describes a malware detection end-to-endAutomated Machine Learning (AutoML) pipeline that alleviatessome of the fundamental weaknesses of existing systems. Thereare two major technical contributions: (i) designed a multi-tasklearning model which works to jointly detect binary malwareand classify 12 categories of the family through a commonunderlying residual network backbone and (ii) a security-wiseevaluation procedure of the proposed model based on TruePositive Rate (TPR) at 0.1% False Positive Rate (FPR) acrossthe entire pipeline is carried out. The proposed model pipelineuses the residual connections, batch normalization, internal lognormalization, weighted sampling, label smoothing, and ensembleaveraging between two different models. The proposed model isevaluated on the EMBER 2018 dataset (800,000 PE samples),resulting in TPR @ 0.1% FPR equal to 0.7293, compared to abaseline of 0.417 (74.89% improved). The performance analysis ofthe proposed model shows an accuracy of 96.10% for malwarefamily classification with respect to the baseline model, whichgives 60.26% showing an improvement of 59.47%. Moreover,the Receiver Operator Characteristics (ROC) Area Under Curve(AUC) equal to 0.9908 compared to the baseline, which was 0.614.The proposed model gives a 61.39% improvement in ROC AUCwith reference to the existing model.

Paper ID: 730

A Hybrid CGTD approach for Estimating the SOH and RUL of lithium-ion Batteries

Akanksha Aware (COEP Technological Unversity)*

Abstract: The increasing adoption of lithium-ion batteries in electric vehicles(EVs) has increased the requirement for precise State of Health (SOH) and Remaining Useful Life (RUL) prediction, as battery degradation directly affects safety, reliability, and operational efficiency of EVs. However, the performance of conventional and standalone machine learning and deep learning algorithms is limited by the nonlinear and dynamic nature of battery ageing. To address this challenge, a hybrid framework combining a Convolutional Neural Network, a Gated Recurrent Unit, a Transformer, and a Deep Neural Network (CGTD) is proposed. The model effectively captures both spatial and temporal degradation patterns as well as long-term dependencies. Experiments conducted on the NASA and EIL-MJ1-015 (UCL) datasets demonstrate that compared to baseline models, the proposed CGTD model yields noticeably lower Mean Absolute Error (MAE), Root Mean Square Error (RMSE), and a higher Coefficient of Determination. The results confirm its enhanced accuracy, robustness, and generalisation capability, making it a reliable solution for advanced battery management systems, real-world EV applications and fleet monitoring to support improved decision-making and lifecycle management.

Paper ID: 731

Modelling and Control for Electric Boat Design

Dr Kushal Badgujar (COEP Technological University)*

Abstract: The growing demand for eco-friendly and efficientmarine transportation has increased the need for advancedelectric propulsion systems. In this work, a complete modellingand control framework for an electric boat propulsion systemis presented using

a Permanent Magnet Synchronous Motor(PMSM). The system is designed to achieve stable speed controlunder varying load conditions typically encountered in marineenvironments.The proposed approach combines Sliding Mode Control(SMC) and Model Predictive Control (MPC) to enhance dynamicresponse and robustness. Space Vector Pulse Width Modulation(SVPWM) is used to generate efficient inverter switching signals.The PMSM is modeled in the d–q reference frame to enableindependent control of torque and flux. The results demonstrate that the system achieves accuratespeed tracking, a fast transient response, and a stable desiredoperation even under varying load conditions. The proposedcontrol strategy offers reduced THD and reliability, making itsuitable for real-time electric boat applications.

Paper ID: 744

FedACR: A Robust Algorithm for Dirichlet Distribution-based Label-Skewed Data in Horizontal Federated Learning

Prabal Singh (Sardar Vallabhbhai National Institute of Technology, Surat)*; Balu L. Parne (Sardar Vallabhbhai National Institute of Technology, Surat)

Abstract: The underlying issue in federated learning is statisticalheterogeneity that often results in slower convergence andpoor performance when Non-IID data is present. This paperproposed the FedACR, a lightweight adaptive regularizationframework and aggregation algorithm at the server side, whichworks at the client side to minimize the harmful client drift withoutcompromising beneficial local specialization. In contrast toparameter-level regularization based aggregation algorithms likeFedAR, which have serious high computational costs, FedACRdynamically self-adapts the cosine similarity between local andglobal updates to a single regularization coefficient in a client-wisemanner. Rigorous pathological Non-IID experiments have shownthat FedACR shows the highest performance when compared tostandard baselines and obtains a Best Mean Testing Accuracy of65.71% when using Dirichlet $\alpha = 0.1$. The implications of theseresults are that direction-aware client-level supervision offers ahigh-performance, low-computation-power, and scalable tradeoffbetween global stability and personalization in practice infederated systems.

Paper ID: 746

A Deep Residual Learning Approach for MRI-Based Brain Tumor Classification

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Abstract: Brain tumors are life-threatening medical conditions. To support effective clinical intervention or surgical planning, they require precise and reliable interpretation. Magnetic Resonance Imaging (MRI) scans provide high-resolution visualization of brain anatomy and support the classification of tumors. Existing studies face three main challenges: tumor morphology, overfitting when training data is limited, and limited model interpretability for implementation in clinical applications. Techniques such as standard CNNs and vision transformers have emerged as effective approaches but have limitations, such as sensitivity to scanner-related variations and high computational costs. To overcome these limitations, the study introduces a custom dual-dropout classification head and a luminance-plane CLAHE preprocessing step. Benchmarked across 10 architectures, 3 optimizers, and 4 dataset split ratios on 22,266 scans, the proposed framework achieved 99.10% accuracy with ResNet-50 and 99.78% ± 0.07% under 5-fold cross-validation with EfficientNetV2S and an accuracy of 99.73% for CvT. Saliency heatmaps confirmed that decisions track tumor anatomy, while a 3-client federated simulation achieved 99.69% accuracy without transmitting raw patient data. This study not only highlights the importance of selecting an appropriate model-optimizer pair along with specific conditions but also increases transparency and contributes toward the

development of efficient AI-based diagnostic systems.

Paper ID: 752

Psychoacoustic Audio-in-Image Steganography via Spatial Latent Embedding

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Abstract: Cross-modal steganography between audio and images is inherently challenging due to the fundamental differences between time–frequency and spatial representations, yet it is critical for applications such as secure multimedia communication and covert speech transmission. In this work, we propose an end-to-end trainable framework for embedding audio signals into natural images. Mel-spectrograms are first compressed into a compact rectangular spatial latent representation using a noise-robust autoencoder and then embedded into a cover image through a neural network guided by psychoacoustic principles. The architecture integrates five key components: frequency-banded cross-attention with per-sub-band temperature scaling for precise routing of perceptually important audio bands; a content-adaptive predictor that dynamically controls embedding strength based on image characteristics; a spatial latent autoencoder that preserves time–frequency structure using a rectangular layout; cross-modal texture masking that extends adaptive steganography by learning embedding regions aligned with image textures; and a psychoacoustic masking model based on Bark-scale critical bands to guide both embedding and extraction. Experimental results demonstrate that embedding 3 seconds of 16 kHz audio into a 256-by-256 image achieves high imperceptibility and intelligibility, as validated by PSNR, SSIM, LSNR, and STOI metrics.

Paper ID: 756

An Efficient Attention-Guided MobileNetV3 Framework with Dual-Pooling Feature Fusion for Tomato Leaf Disease Classification

Naeem Akhtar (Shoolini University)*

Abstract: Tomato leaf diseases can severely reduce crop yield and quality, making timely and accurate diagnosis essential for sustainable agriculture and precision farming. This study proposes a lightweight transfer-learning framework for tomato leaf disease classification using the Kaggle Tomato Leaves Dataset. To select an effective baseline model, five pretrained convolutional neural network architectures, VGG16, VGG-19, ResNet18, EfficientNet-B0, and MobileNetV3Large, were evaluated under identical experimental conditions. Among them, MobileNetV3-Large achieved the best baseline performance and was further improved by integrating a Convolutional Block Attention Module (CBAM) and a dualpooling classification strategy. The resulting MobileNetV3 + CBAM + dual-pooling model obtained the highest overall results, achieving 98.69% accuracy and 98.69% F1-score on the held-out test set. However, repeated-run statistical analysis showed that its improvement over the strong MobileNetV3 baseline was small and not statistically significant at the 0.05 level. For deployment assessment, the model was evaluated in terms of parameters, FLOPs, size, inference latency, and memory usage. It maintained a compact design with 4.076M parameters, 0.467 GFLOPs, 15.750 MB size, 9.179 ms CPU latency, and 4.636 ms GPU latency per image. External validation confirmed strong generalization, while Grad-CAM demonstrated disease-relevant attention regions.

Paper ID: 771

Graph RAG for Structured Legislative Document Retrieval on Economic Survey Documents

Arbaaz Shaikh (Flame University)*; Shardul Manurkar (Flame University); Kaushik Gopalan (Flame University)

Abstract: Retrieval-Augmented Generation (RAG) systems forgovernment statistical documents face a fundamental mismatch:the data is tabular and relational, but standard RAG treatsdocuments as unstructured text. We present a graph-based RAGpipeline applied to Maharashtra's Economic Survey, a subsetof 18 PDF from the collection of chapters spanning 2015–2024.We build per-document knowledge graphs whose nodes andedges represent tables, columns, rows, and cell values, thenretrieve context via embedding-based seed selection followedby breadth-first graph traversal. Evaluated on 99 questionsacross three difficulty categories, the graph RAG system achieves69.7% overall accuracy compared to 29.3% for a plain chunk-based RAG baseline indexed over the same corpus, a gap of40.4 percentage points. We further find that the automatedenrichment pass accounts for this gain: a set of hand-written datacorrections layered on top of it yields no additional accuracy.

Paper ID: 778

Advanced EEG-Based Schizophrenia Detection Using CNN+BiLSTM with Novel Biomarkers and Explainable AI

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Abstract: Schizophrenia (SZ) affects over 21 million peopleworldwide, highlighting the need for objective electroencephalography (EEG)-based automated detection methods. Many suchstudies report accuracies of 90% or above, but these figuresare frequently obtained under segment-level cross-validation,in which segments from the same participant appear in bothtraining and test folds. This study presents a rigorous, subjectwise re-evaluation of EEG-based SZ classification on the publiclyavailable Warsaw dataset (28 participants, 1,142 segments). Usingan identical preprocessing and feature-extraction pipeline, wecompare segment-level and strict subject-wise cross-validation(StratifiedGroupKFold and leave-one-subject-out, grouped byparticipant) across three architectures (EEGNet, CNN+BiLSTM,EEG Transformer). Segment-level evaluation reproduces theoptimistic 91–94% range, but under subject-wise validation thebest model (CNN+BiLSTM) reaches only 62.9% pooled accuracyand 64.3% when aggregated per participant (AUC ≈ 0.65),quantifying a leakage-induced inflation of roughly 30 percentagepoints. We further conduct a subject-level statistical study (n = 28)independent of the classifiers: across the full feature screen,no biomarker survives whole-brain false discovery rate (FDR)correction, but two pre-specified, a-priori-motivated hypothesesare confirmed by 10,000-iteration permutation testing — elevatedcentral-parietal Hjorth activity (Cohen's d≈1.1; family permutation p = 0.0003) and delta-band frontal-parietal hypercoherence(d = 1.22; p = 0.003). GradCAM channel saliency convergesindependently on the same central-parietal sites (Cz, Pz, P3,C3). To our knowledge this is the first rigorous subject-levelbenchmark and leakage quantification on this dataset, and itidentifies increased local signal power and long-range slow-wavesynchrony as reproducible candidate markers of SZ.

Paper ID: 816

The Algorithmic Leviathan: A Framework for Supranational Governance of Advanced AI Addressing Moral Alignment, Cryptographic Compute Tracking, and Regulatory Arbitrage

Anmol Devansh (Vellore Institute of Technology)*; Dr. Ravi Verma (VIT Bhopal University); Satyajit Deshmukh (Sandip University); Sudhanshu Ranshevare (Jawahar Education Society's Institute Of Technology)

***Abstract**:* The rapid, borderless deployment of advanced artificial intelligence (AI) systems presents a governance challenge that transcends national jurisdictions. While frameworks such as the EU AI Act and the US AI Executive Order establish localized baselines, they remain structurally prone to coordination failure when managing transnational AI risks. We conduct a comparative analysis of leading regimes and deploy a Monte Carlo game-theoretic simulation to prove empirically that fragmented, nation-state compliance produces regulatory arbitrage and a "race to the bottom." A formal Nash equilibrium result establishes this as an inevitable structural outcome. To resolve the coordination failure, we propose a computationally enforceable, multi-layered supranational governance framework integrating: (i) unsupervised latent bias quantification via Wasserstein-distance manifold separability; (ii) real-time logit-filtering bounded by certified Lipschitz continuity; (iii) mechanistic interpretability ledgers for auditable accountability; and (iv) hardware-level compute governance via cryptographic Proof-of-Training (PoT) signatures. These mechanisms are embedded in the MLOps lifecycle via Incremental Verifiable Computation (IVC). A formal four-vector threat model and communication complexity analysis evaluate robustness. Figurative architectures, clinical/security case studies, literature comparisons, and extended benchmarks across multiple model scales validate feasibility.

Paper ID: 818

A Hybrid Mechanism for Anomaly Detection and Classification Using Auto-Encoder with Random Forest

Sana Vaidya (Vellore Institute of Technology)*; Anil Kumar Kakelli (Vellore Institute of Technology)

***Abstract**:* Modern cyber attacks increase in sophistication day by day. There is a great necessity of advanced intrusion detection mechanisms capable of identifying evolving threats. Traditional signature-based systems end up struggling with attacks like zero-day attacks. This is mostly due to their reliance on already predefined patterns. We propose a hybrid network intrusion detection system that will be integrating autoencoders for anomaly detection with Random Forests for attack classification. Using the CIC-IDS2018 dataset, which contains over one million network traffic samples, we train autoencoders on normal traffic to learn compressed representations and minimize reconstruction error. When exposed to anomalous traffic, the reconstruction error spikes. This allows us to identify intrusion based on a predefined threshold and enables the system to dynamically detect novel threats. Following that, a Random Forest classifier is utilized for detecting anomalies as FTP or SSH brute-force attacks. We have achieved a high accuracy of 97% for the detection of anomalies and 99.85% accuracy for classifying them. By combining unsupervised and supervised learning, our framework enhances adaptability, scalability, and efficiency in intrusion detection. It ensures high accuracy while maintaining computational efficiency and robustness against diverse attack patterns.

Paper ID: 824

Diffusion-Augmented Vision Transformer Framework for Osteosarcoma Classification with Clinical Staging and Explainable AI

Aakansha Saxena (Ahmedabad University)*

Abstract: Osteosarcoma is a very aggressive primary malignancy of bones that needs proper histopathological and radiological diagnosis to allow effective clinical treatment. The lack of balance in the classes and small annotated medical data impedes the strong performance of the deep learning. In this paper, a diffusion-augmented Vision Transformer (ViT)-based multi-class classification and clinical staging on osteosarcoma will be proposed. Patch extraction and contrast enhancement are used to preprocess the histopathological and MRI images (1024x1024) that are available in The Cancer Imaging Archive (TCIA). To control the imbalance in classes, synthetic tumor patches are produced with the help of Denoising Diffusion Probabilistic Models (DDPM) and Stable Diffusion. A Vision Transformer classifies patches as Non-Tumor, Non-Viable Tumor and Viable Tumor. TNM and MSTS systems are used to integrate clinical staging. To enhance interpretability, explainable AI methods, such as Attention Rollout and RISE, are used. The experimental outcomes show increased robustness, balanced classification, and clinically significant visual explanations

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Paper ID: 832

Secure IoT Communication Enabled Through Privacy-Enhanced Data Aggregation

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Abstract: The impact of data gathering techniques used by Internet of Things (IoT) devices on user privacy is also examined in this study. The different categories and regularity of data collecting, as well as the locations to which it is distributed, are thoroughly examined in this study. The assessment includes determining any privacy threats, assessing the user's capacity to manage and comprehend their personal information, and offering suggestions for enhancing user privacy in Internet of Things (IoT) settings. By conducting vulnerability testing and accounting for security and privacy concerns, the study investigates the effectiveness of security solutions in IoT systems. By simulating actual attack situations, such as device spoofing, unauthorised access attempts, and denial-of-service assaults, potential vulnerabilities can be found. This report makes recommendations for improving Internet of Things (IoT) networks' security posture.

Paper ID: 852

CLIP-Based Feature Extractor with Lightweight Neural Network for Diagnosis of Kidney Condition using CT Images

Anshita Verma (National Institute of Technology Hamirpur)*; Ram Sharma (National Institute of Technology Hamirpur)

Abstract: Kidney abnormalities like cyst, tumors and stones often have similar symptoms and visual patterns in medical imaging but require different clinical interventions. This study presents a deep learning method for the detection and classification of kidney conditions using abdominal CT scan images. A pretrained Contrastive Language Image Pretraining (CLIP) vision transformer backbone has been used as a feature extractor and an improved classifier is developed with multiple layers to ensure high performance and generalization. The model was evaluated using a 80:20 train-test split and 5-fold cross validation which achieved a peak accuracy of

99.72% and an average accuracy of 99.17%, respectively, thus demonstrating consistent results through various train test splits. These results indicate that using multimodal pretrained architectures for specific medical image related tasks can provide highly accurate and stable results for identifying renal cysts, tumors, and stones.

Paper ID: 854

AI-Powered Smart Autonomous Rover for Nursery Plant Health Monitoring

Anurag Tiwari (VIT Bhopal)*

Abstract: Plant diseases in nurseries often go unnoticed during their early stages, resulting in significant crop losses and excessive use of chemical treatments. To address this challenge, this project proposes a compact, affordable, and intelligent smart agriculture system designed as an automated rover. The system integrates artificial intelligence and IoT technologies to continuously monitor plant health and environmental conditions in real time. Using AI-based image processing, the rover detects plant diseases at an early stage and classifies plants into three categories: Healthy, At Risk, and Infected and this status will be shown in the user friendly dashboard with 3D animation of rover live movement on nursery. Alongside visual analysis, smart sensors collect data on environmental factors such as temperature, humidity, and soil conditions, providing a comprehensive understanding of plant health. One of the key features of the system is its ability to operate offline, eliminating dependency on cloud connectivity. It processes data locally and generates instant alerts, which are displayed on a user-friendly digital dashboard. Farmers receive early warnings about potentially risky plants, enabling timely intervention and preventing the spread of diseases. By reducing the need for manual inspection and minimizing human error, this system improves efficiency, enhances crop survival rates, and promotes sustainable farming practices. Overall, the project aims to make advanced agricultural technology accessible and practical for everyday use in nurseries.

Paper ID: 911

Mind Mask:- Real Time Face Parsing And Alert System For Mental Wellness

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Abstract: Current digital wellness solutions frequently rely on central cloud infrastructure, failing to fit in real-time biometric feedback with related text inputs for hands-on mental health support. This effort presents an edge-computing basis for real-time facial analyzing that detects early signs of digital overexertion and stress within a user's desktop atmosphere, without flexible privacy. Our system employs open-source computer vision (OpenCV) and MediaPipe for strong facial landmark detection, including occlusion-aware filtering to ensure dependable input for a custom deep learning model. This architecture continuously measures emotional states, identifying critical stress verges. Upon detection of raised stress, it triggers context-aware desktop notifications via the Python library plyer—delivering all-in-one workflow-combined break prompts. Alongside, an Ollama-powered Tkinter chatbot analyzes both visual stress signals and textual inputs to generate privacy-preservative healing responses. By joining edge-based biometric monitoring with contained language processing, this approach eases undetected burnout risks and enables timely interventions before clinical symptoms obvious. Unlike existing cloud-dependent systems, our solution provides continuous, united wellness insights directly from the user's primary workspace, advancing early digital exhaustion detection and proactive mental flexibility.

Paper ID: 920

An AI-Based System for Indian Accent Speech Recognition and Speaker Diarization

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Abstract: Speech recognition systems have achieved high accuracy on large datasets dominated by standard American and British accents. However, their performance significantly degrades when applied to accented speech such as Indian English, which exhibits substantial variation in pronunciation patterns, phoneme realization, stress, and intonation across speakers of different native languages. The diversity of Indian English accents, influenced by regional languages, poses a major challenge, further exacerbated by the scarcity of labeled accent data and the lack of systems capable of integrating speech transcription with speaker diarization for accurate multi-speaker conversational analysis.This study addresses these challenges by developing an artificial intelligence-based speech recognition system tailored for Indian accents, integrated with a speaker diarization framework. The proposed system trains and compares multiple transformer-based speech recognition models using the IndicTTS dataset, comprising 10,000 speech samples balanced by gender and categorized across five accent groups: Hindi, Tamil, Bengali, Marathi, and Gujarati. A comparative evaluation of four state-of-the-art models—HuBERT, Wav2Vec2, Whisper, and SpeechT5—is conducted to assess their performance across accent variations and deployment conditions. The system processes audio through a speaker diarization module that identifies speaker boundaries, segments audio, and generates speaker-tagged transcripts using the most suitable recognition model. Additionally, an intelligent agent analyzes the transcribed text to produce speaker summaries, extract action items, and generate an overall meeting summary. The proposed framework demonstrates the feasibility of combining accent-robust speech recognition, speaker diarization, and automated conversational analysis, contributing to more inclusive speech technologies and enabling advanced intelligent meeting analytics for accent-diverse populations.

Paper ID: 921

A Retrieval-Augmented Generation Based Medical Chatbot for Intelligent Disease Prediction and Real-Time Doctor Recommendation

Virag Lokhande (AISSMS Institute of Information Technology)*; Manas Patil (AISSMS Institute of Information Technology); Chetan Aher (AISSMS Institute of Information Technology)

Abstract: In recent times, there has been a significant increasein the use of conversational AI (artificial intelligence) solutions inhealth care. Therefore,healthcare professionals and organizationscan now obtain preliminary medical assistance using AI-basedsystems [6], [7] and not just regular people. However, thecurrent versions of most medical chatbot solutions are typicallyeither “Rules Based” or built upon large generative languagemodels and both solutions have serious drawbacks such aslimited adaptability and/or hallucination inaccuracies [8], [11].This paper presents a medical chatbot based on the RetrievalAugmented Generation (RAG) framework. RAG is a hybridapproach that uses verified medical documentation retrievalcombined with large language model reasoning capabilities toprovide accurate disease predictions as well as explainableanswers [1], [3]. Additionally, the proposed system will alsohave a “geolocation” based doctor referral function to helpbridge the gap between AI based assistance and actual healthcareaccess [12]. Based on the evaluation of 500 symptom queries, theproposed system achieved a significant improvement in accuracy,factual correctness, and user satisfaction compared to the originalgenerative based models tested against the same query set. Theproposed RAG framework represents a potential way forwardfor the continued development and use of safe, verifiable, andpractical AI assisted medical support

systems.Index Terms—Retrieval-Augmented Generation (RAG), Medical Chatbots, Healthcare Artificial Intelligence, Disease Prediction, Explainable Artificial Intelligence

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Paper ID: 923

Semantic and Context-Aware Query Reformulation for Large Language Model Optimization

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Abstract: Large Language Models (LLMs) are used extensively for response generation in tasks like search, question answering, and conversational systems. However, the success of response generation depends on the quality of the user query, and in most cases, the user queries are not complete enough or contain insufficient information. To address this issue, previous studies have utilized techniques like query expansion and prompt rephrasing; however, the current solutions do not consider the user's context and intent. The following paper will discuss how to use query reformulation through context and intent-awareness with the purpose of improving the output generated by large language models. The first step involves analyzing the query and the additional information about the user's context and intent to understand the intention of the user in their query. This is followed by generation of multiple reformulated queries using a pre-trained language model. However, not all queries will be valid or relevant to the original query. Thus, a filtering step is applied to select only queries that match the query intent and discard others. Finally, the selected queries are used to generate responses to the query, which are compared to the output produced using the initial query. We position our contribution narrowly: rather than a new reformulation-generation method, we isolate and evaluate the effect of validating candidate reformulations before use. On a 500-query stratified sample from MS MARCO, taking context and intent into account during query reformulation results in higher accuracy and relevance of the generated responses (paired t-test, df = 499, $p < 0.05$ across all reported metrics).

Paper ID: 930

Crowd Detection and Social Distance Monitoring Using YOLOv5

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Abstract: The ability to effectively ensure the safety of individuals within crowded public venues is one of the most challenging tasks in urban planning today. This area of concern rests at the intersection of urban infrastructure, public health, and emergency preparedness. Monitoring human security via video camera often results in staff losing concentration over time, and the ability to monitor multiple simultaneous video feeds becomes severely limited. We present a real-time crowd detection and social distance monitoring system built on YOLOv5x, the extra-large variant of Ultralytics' YOLOv5 family, running fully on GPU via PyTorch Hub. The system incorporates confidence-filtered COCO person detection, pairwise Euclidean proximity analysis with configurable thresholds, an OpenCV-based bird's-eye view perspective correction module to reduce foreshortening-induced false positives, and automated SMS alerts via the Twilio API when crowd count exceeds a defined threshold. At a confidence threshold of 0.5, the system achieves Precision 0.912, Recall 0.887, and F1-score 0.899. The bird's-eye transform improves violation detection accuracy by 10.3% and reduces false alerts by approximately 60%. The system sustains 31.4 FPS on an NVIDIA T4 GPU, with end-to-end SMS alert latency of 1.84 seconds over a 4G connection.

Paper ID: 932

Carbon-Aware Retraining for Sustainable MLOps Under Stochastic Performance Drift

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Abstract: Machine learning systems used in real-world settings often face performance issues. This means they require regular updates, which leads to carbon emissions. Current methods for updating these systems focus on improving performance without considering their environmental impact. We present a carbon-aware system that uses real-time carbon data to guide decisions. Now, environmental factors influence how models are maintained and updated. The system retrains when accuracy drops, but carbon levels remain acceptable. This shifts the focus of retraining from performance to sustainability.The system was tested over 36 months. It shows that performance can fluctuate unpredictably. A study with 50 simulations demonstrates how the system operates under uncertain conditions. Our system reduces emissions by 72.7% compared to fixed-time updates. It also cuts emissions by 25.7% compared to updates based on accuracy. This results in only a 0.32% drop in average accuracy.

Paper ID: 936

GhostWipe: Reliable Data Removal For Reusing Renowned IT Resources

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Abstract: The fast-growing developments in digital storage technology have created a growing reliance on electronic devices for holding sensitive data. The devices often get resold, repurposed, and recycled when nearing the end of their useful life. Traditional methods of removing data from such devices, like file deletion and formatting, are unable to remove the data itself but only delete access points, making the data easily recoverable using forensic analysis software. In this paper, a software solution to the problem of data sanitization is presented. It involves utilizing several overwriting schemes – including Zero Fill, Random Fill, and DoD 5220.22-M – to disrupt the structure of the data held by the storage medium. The software is implemented using Python programming language and allows user interaction via a menu-based system with the ability to choose among various data sanitization schemes and start a sanitization process. The effectiveness of the system can be evaluated using forensic data recovery software, which will reveal that after sanitization, the data stored on the storage medium either becomes entirely unrecoverable or gets corrupted to an extent of being unusable.

Paper ID: 937

Accounting Fraud Detection in SEC 10-K Filings Using Variational Autoencoders

Sankalp Joshi (Tech Mahindra); Atul Tripathi (National Maritime Foundation); Ajay Pandey (Independent Researcher)*

Abstract: Accounting fraud remains a major challenge for reg- ulators and organizations because traditional detection methods, such as rule-based systems and manual audits, often struggle to identify subtle or previously unseen fraud patterns. This paper presents an unsupervised anomaly-detection framework based on Variational Autoencoders (VAEs) for detecting accounting fraud in SEC 10-K

filings. The proposed approach learns the distribution of normal financial-reporting patterns from non- fraudulent data and identifies anomalous filings through recon- struction error. Evaluated on a held-out test set of 111 SEC 10-K filings (26 normal and 85 fraudulent), the model achieves 86% accuracy and an AUC score of 0.85, with strong fraud- detection precision of 94%. These findings demonstrate that VAE- based anomaly detection is an effective and scalable approach for fraud screening in financial reporting, while also offering potential for identifying novel fraud patterns without requiring extensive labeled datasets.

Paper ID: 966

GAIMS: Context-Aware Image Editing Through Scene Graph Integration

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***Abstract**:* GAIMS uses SAM2 segmentation, LaMa inpainting, and persistent Neo4j scene graph for interactive object removal. Scene knowledge influences only the removal mask: registered neighbors and protected regions restrict the dilation of the removal mask, and a proposal-compatible repair policy merges compatible SAM proposals, with LaMa's weights unchanged. On 1,000 eligible COCO images, annotation-simulated box guidance with up to three clicks yields mean IoU 0.8864 and Dice 0.9378. Using the policy selected on 12 calibration composite images, on 64 held-out composite images mean full-image LPIPS improves from 0.010094 to 0.009484 (6.04%) and on 32 large-target composite images mean LPIPS improves from 0.147779 to 0.140264 (5.09%) without retuning, when compared to fixed calibrated dilation. Both policies use neighbor protection, therefore the gains reflect proposal repair relative to fixed dilation; improvement caused by graph protection is unknown. The browser workflow has median warm latency 5.617 s with 150 synthetic graph objects, and a single cold-start trial with two objects takes 12.298 s. Historical 59-case COCO re-run (median LPIPS 0.129) was done with different masks and inputs, and cannot be considered a matched experiment. Limitations include simulated guidance, controlled composites, and union masks covering less than 98% of the target in 3/64 and 9/32 cases.

Paper ID: 969

LakshaNetra: Reliability-Aware Multimodal Fusion for Robust UAV Detection under Degraded Sensor Conditions

Ananthan Dharan (Indian Army)*

***Abstract**:* Reliable Unmanned Aerial Vehicle (UAV) detection in contested environments requires fusion architectures that degrade gracefully under partial sensor failure. This paper presents LakshaNetra, a multimodal counter-UAV framework that integrates You Only Look Once (YOLO)v8-based visual detection with a lightweight three-block one dimensional Convolutional Neural Network (1D-CNN) operating on raw In-phase and Quadrature (IQ) radio frequency (RF) samples. Visual reliability is modeled using Laplacian variance, image entropy and detection confidence, with learned weights $\alpha = 2.386$, $\beta = 2.386$ and $\gamma = 2.449$. RF reliability is estimated using a physically grounded sigmoid function parameterized by A = 0.930, k = 0.459 dB−1 and Trf = −0.51 dB, achieving an excellent fit (R2 = 0.9988) to the empirical signal to noise ratio (SNR)–accuracy relationship, with the lower asymptote constrained to zero. The RF module is trained on 98,705 labeled IQ samples spanning an SNR range of −20 to +30 dB, achieving accuracy from < 2% at −20 dB to 93% at +10 dB. On a held-out test set of 2,625 images, the proposed system attains an mAP@0.5 = 0.887 and improves classification F1 from 0.858 to 0.983. Under simultaneous visual degradation (blur) and RF noise, LakshaNetra maintains 97.6% accuracy, significantly outperforming the vision-only baseline (57.8%). The framework achieves a mean Leave-One-DomainOut (LODO) accuracy of 78.67% and an Expected

Calibration Error (ECE) of 0.051 after temperature scaling. The total inference latency is 25.8 ms, corresponding to approximately 39 FPS on an NVIDIA T4 GPU.Index Terms—UAV detection, counter-UAS, multimodal fusion,reliability estimation, YOLOv8, 1D-CNN, IQ signal classification,RF sensing, sensor degradation.

Paper ID: 984

Adversarial Robustness in AI-Driven Brain Tumor Diagnostics: A Unified Framework of Feature-Space Detection, Denoising Autoencoder Purification, and Multi-Attack Generalization

Aditya Mulay (Pune Institute of Computer Technology)*; Soham Patil (Pune Institute of Computer Technology)

Abstract: Deep learning (DL) has achieved near-radiologist performance in Magnetic Resonance Imaging (MRI)-based brain tumor classification [1]. However, Convolutional Neural Networks(CNNs) exhibit critical fragility to adversarial attacks—imperceptible pixel-level perturbationsthat induce catastrophic misclassification, threatening the integrity of clinical diagnosis [2, 3].This report presents a comprehensive adversarial robustness framework for a four-class braintumor MRI classifier (Glioma, Meningioma, No Tumor, Pituitary) trained on a dataset of5,725 images [14]. We empirically validate the vulnerability of the CNN under three dis-tinct attack paradigms: Fast Gradient Sign Method (FGSM) [5], Projected Gradient Descent(PGD) [6], and Carlini & Wagner (C&W) [7], causing accuracy to collapse from 98.0% to26.0%, 11.0%, and 82.0% respectively. A convolutional Denoising Autoencoder (DAE) [11]trained with a combined MSE and Structural Similarity Index (SSIM) loss recovers accuracy to83.0%, 86.0%, and 93.0% against these attacks, demonstrating cross-attack generalization de-spite training exclusively on PGD pairs. A supervised feature-space detector [9, 10] combiningmulti-layer CNN activations, Principal Component Analysis (PCA), and a Multi-Layer Perceptron (MLP) achieves AUC scores of 0.756, 0.871, and 0.504 respectively. The complete systemis deployed as an interactive Streamlit web application with live attack simulation, Grad-CAMexplainability, and step-wise purification visualization.Keywords: Adversarial attacks, Brain tumor classification, Denoising Autoencoder, MRI,Feature-space detection, FGSM, PGD, Carlini & Wagner, Grad-CAM, Medical AI robustness,Purification defense, Streamlit.

Paper ID: 1003

API Call Analysis and Automated Alert System with Rule Based Root Cause Analysis for Microservice Architecture

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Abstract: APIs are important for communication and businessoperations. Maintaining the APIs to their optimal performanceis very much required as the old ways can’t keep up with themodern scale of things and systems. Effective API monitoringis provided by observability frameworks like OpenTelemetry,Prometheus, Loki, Tempo, and Grafana collect and analyzemetrics, logs, and traces. Aim of this paper is to evaluate theiranomaly detection accuracy, real-time capabilities, scalability,and ease of integration and also aims to figure out best methodsand effective Machine Learning techniques for building intelligent, scalable, and proactive API monitoring systems.Index Terms—DevOps, API Observability,Anomaly Detection, Machine Learning, Root Cause Analysis.

Paper ID: 1016

Unified Urban Mobility Aggregator with ML-Based Surge Price Prediction for Smart Transportation

Mohit Patil (KLE Technological University)*; Aditya Channammanavar (KLE Technological University); Bhuwanesh S (KLE Technological University); Rahul Kudalagi (KLE Technological University); Arundhati Aralimatti (KLE Technological University)

Abstract: The transportation system in cities within developing economies is highly fragmented between many ride-hailing services (Uber, Ola, Rapido), unpredictable surges in prices, and absence of decision support based on real-time data. In this paper, we propose an approach for aggregating ride-hailing services to provide real-time fare estimates, traffic situation analysis, weather data, and public transport schedule. We employ two machine learning algorithms, including 24-layer long short-term memory for predicting the next 30-minute price trajectory and an eleven-layer perceptron for calculating current ride fares with nine levels of services. Our solution aggregates live data via Google Maps Routes API and employs physics-informed surges based on real-time traffic delays to make decisions whether to wait N minutes or book now by applying a rule-based engine with confidence thresholding. Experiments on the traffic dataset for different Indian metropolitan areas show the mean absolute error of 5-8 INR for predicting surges and 42-65 INR for estimating fares, with inference time of less than 2 milliseconds on mid-tier smartphones running Android. The whole solution runs on-device without any network calls and preserves privacy, making the pipeline scalable.

Paper ID: 1020

Enhanced MobileNet-SSD Based Object Detection and Distance Estimation to Assist Visually Impaired People

Aayushi Singh (Kalinga Institute of Industrial Technology)*; Esha Saha (Kalinga Institute of Industrial Technology); Aadhya Singh (Kalinga Institute of Industrial Technology); Bhavya Gaharwar (Kalinga Institute of Industrial Technology); Aastha Khatri (Kalinga Institute of Industrial Technology); Mohit Ranjan Panda (Kalinga Institute of Industrial Technology)

Abstract: Technology has expanded across multiple domains, bringing innovative solutions to help people in their daily lives. Assistive technology, in particular, has improved the lives of visually impaired people by providing them with systems that enable safe navigation and object recognition. In this work, a similar navigation system is presented that combines real-time object detection with context-aware prioritization and distance estimation. The system helps users visualize their environment meaningfully by combining the MobileNet-SSD model for object detection with monocular distance estimation, optimized Structural Similarity Index (SSIM), motion analysis, and adaptive audio feedback. A comparative evaluation is performed against state-of-the-art object detection models, YOLOv5 and YOLOv8. A data collection method is also implemented to perform a quantitative evaluation of distance estimation methods. Overall, this work presents an efficient and practical solution for assistive navigation.

Paper ID: 1028

Crop Maturity Detection using Deep Learning and IoT

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Abstract: Crop maturity detection plays a crucial role inincreasing agricultural productivity and product value. However,current methods of manual inspection suffer from inaccuraciesdue to variations in light intensity and inspectors' fatigue.Therefore, this paper adopts deep learning to automaticallyclassify crop maturity in tomatoes and dragon fruits usingimage processing. To achieve optimal performance, four deeplearning architectures were tested using transfer learning techniques:EfficientNetV2-B0, MobileNetV2, ConvNeXt-Tiny, andMicroViT-S1. The ConvNeXt-Tiny architecture achieved thehighest performance for both types of crops, providing 100%accuracy on all evaluation metrics. For application purposes,tomato-based algorithms were fine-tuned and deployed to theScientech 6205AI edge platform. It was found that the MicroViTS1algorithm gives the lowest latency rate among other modelswith 61.73 FPS and a mean latency of 16.14 ms. Based onthis analysis, ConvNeXt-Tiny delivers the best accuracy rates,whereas MicroViT-S1 is more efficient and practical for real-lifescenarios.

Paper ID: 1032

Multi-Agent Video Sensor Framework with Reinforcement Learning and Decision Fusion for Intelligent Laboratory Safety Monitoring

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Abstract: This paper presents a multi-agent video sensor framework for intelligent laboratory safety monitoring using CCTV-based visual sensing. The system addresses the challenge of extracting reliable insights from continuous video streams in dynamic environments with complex human behavior. Two dedicated perception agents are designed: Agent-1 for identifying waste disposal behavior and Agent-2 for detecting suspicious activities. To ensure temporal consistency, frame-level predictions are processed using temporal smoothing and offline reinforcement learning to generate stable risk scores. These risk scores are then combined using a rule-based mechanism to produce actionable safety alerts in three categories: ACCEPT, FLAG, and NOTIFY. Experimental results on real laboratory data show that Agent-1 achieves 91.4% detection accuracy with zero false alarms, while Agent-2 achieves 100% detection accuracy on the evaluated dataset with strong temporal stability. The findings indicate that the proposed framework is effective for reliable and interpretable safety monitoring in laboratory environments.

Paper ID: 1033

An Empirical Evaluation of Proximity Bias and Environmental Occlusion in 2D Spatio-Temporal Graph Normalizing Flows for Anomaly Detection

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Abstract: While Spatio-Temporal Graph Convolutional Networks(ST-GCNs) and Normalizing Flows have demonstratedsignificant promise in video anomaly detection, their relianceon two-dimensional pose estimation introduces critical physicaland structural vulnerabilities. In this study, we present an end to-end inference pipeline integrating state-of-the-art YOLO26pose extraction with a Spatio-Temporal Graph NormalizingFlow (STG-NF). By engineering an optimized, multi-dimensionalpose dataset and strictly utilizing authentic, unscaled raw pixelcoordinates, we rigorously evaluate the architecture's operationalboundaries in unconstrained, fixed-camera environments. Empiricalresults demonstrate high efficacy and multi-person stabilityin classifying full-body, macro-kinematic violence. However, weexplicitly expose and quantify four critical architectural limitations:Proximity Bias (depth disparity), Environmental Occlusion(the zero-velocity trap), Semantic Blindness (object agnosticism),and Temporal Fragility (sliding-window non-determinism duringmicro-anomalies). This paper provides definitive empiricalevidence that without Z-axis depth tracking and object-levelfusion, 2D

Spatio-Temporal anomaly scores are heavily skewed bycamera physics and arbitrary frame alignment. We conclude thatrobust edge-surveillance necessitates a paradigm shift toward 3Dpose estimation, dynamic temporal windowing, and multi-modalgraph fusion.

Paper ID: 1037

Camera-Based Facial Skin-Tone Identification Using Video Reflectance Analysis Across Diverse Indian Skin Tones

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***Abstract**:* The paper proposes an objective evaluation frame-work for camera-based physiological sensing systems, especiallyremote photoplethysmography (rPPG), which tend to exhibitreduced performance when capturing signals from subjects withdarker skin colors owing to the optical properties of melanin. Weproposed a lightweight non-contact pipeline for objectively deter-mining skin tone from ordinary video data. This pipeline involvesprocessing the facial video stream to identify the forehead regionthrough landmark detection and converting the video frames intothe CIELAB color model. The Individual Typology Angle (ITA)value is calculated based on the L* and b* components of theCIELAB model which acts as the skin tone measurement feature,while the median value of the time series is used as the subject'sskin tone indicator. Skin tone evaluation is performed throughthe application of dermatological thresholds for interpretable andreproducible results. This framework is validated on a dataset ofover 1,228 subjects with varied skin colors, resulting in consistentclassification.

Paper ID: 1043

An Evaluation of RAG Strategies for Mitigating Hallucinations in Financial QA

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***Abstract**:* Natural language processing (NLP) has been revolutionizedby large language models (LLMs). However, thereremains a considerable challenge of factual hallucinations (theoccurrence of false or nonsensical outputs) in LLMs. This isparticularly important for businesses in the finance industry thatcollect and analyze high volumes of information in order to makeinformed decisions related to investments and compliance withregulatory requirements. This paper proposes a novel Retrieval-Augmented Generation (RAG) pipeline for mitigating this issue,specifically for high-stakes regulatory filings like Securities andExchange Board of India (SEBI) Red Herring Prospectuses(RHPs). We show the architectural evolution from naive baselinesystems to more modular systems, and illustrate the significantincrease in the precision of retrieval due to sliding windowchunking over fixed length and structure-aware chunking. Wealso look at different financial datasets and compare frameworksto judge RAG performance. Finally, we outline some majorresearch challenges in parsing unstructured financial PDFs andbuilding domain-adapted models for emerging market regulatoryenvironment in India.

Paper ID: 1044

Forecasting River Water Quality using AI, Satellite Data and IoT Insights

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***Abstract**:* The decline in freshwater quality caused by industrial activities, urban areas contributing runoff, and changing climate patterns have made it crucial to monitor and predict water quality in real time. The primitive methodology of manual collection of water samples is not efficient for ongoing evaluation, which has led to innovations in AI, IoT, and satellite technologies to forecast water quality more sustainably. Recent research has proved that deep learning models, especially LSTM networks, are effective in estimating key water quality factors with high accuracy over time. IoT systems have made it possible to collect and analyze data automatically. Papers are created on an IoT-based system for protecting freshwater ecosystems, which accurately measures pH, turbidity, and dissolved oxygen in real time. Systems use genetic algorithms and ensemble learning to improve LSTM models, resulting in better predictions for TDS and BOD. In some papers, systems which use GA RF model along with satellite data to study the Lower Yangtze River, which showcases how integrating remote sensing and machine learning can help comprehend spatial changes in water quality. IoT systems have also supported these efforts by allowing large-scale and real-time data collection. Together, these developments show the shift toward integrated decision support systems that bring together satellite data, LSTM predictions and IoT sensors, helping create real-time decision system which is a smarter, adaptable and sustainable way to manage forecasting and analysis of water quality of rivers.

Paper ID: 1048

Self-Supervised Pea Rust Representation Learning via Contrastive Pretraining and Agglomerative Clustering

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***Abstract**:* Recent advances in technologies such as deep learning (DL) and the Internet-of-Things (IoT) have expanded their use in agriculture. Despite this, fine-grained assessment of plant disease severity is hindered by the prohibitive cost of expert annotation. In this work, we propose a label-efficient, self-supervised framework, leveraging the simple framework for contrastive learning (SimCLR) to learn discriminative representations from entirely unlabeled pea rust images. For this, a ResNet-18 backbone is pretrained on all 284 pea rust images without labels, while 92 images covering three severity grades were reserved for evaluation, with labels assigned under agricultural-scientist supervision. Standard SimCLR does not transfer well to this setting: a learning rate of 10−3 reduces linear-probe accuracy from 0.761 to 0.598, while strong color augmentation weakens the rust-color cue. We therefore evaluate background suppression, conservative color jitter, mild cropping, and constrained layer adaptation. Our best configuration achieves 87.68 ± 7.31% severity accuracy through linear probing, compared with 73.16 ± 9.86% for the strongest ImageNet baseline, achieving a gain of 14.52percentage points.

Paper ID: 1049

Depth-Aware Safety Evaluation for Object Detection in Indoor Navigation

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Abstract: Standard object detection metrics such as mean Average Precision (mAP) treat every missed object equally, regardless of its distance from an autonomous agent. This is a limitation for indoor navigation, where 44.8% of the 3,883 pseudo-labelled objects in our evaluation lie within 2.1 m of the sensor. We propose four depth-aware evaluation measures: the Navigation Safety Penalty (NSP), Risk-Weighted Recall (RWR), Risk-Weighted Precision (RWP), and a combined F2-risk score. These measures give greater importance to nearby objects and separate critical misses, medium-range misses, classification errors, and localisation errors.We evaluate five COCO-pretrained detectors on 654 NYU Depth V2 frames using a fixed Grounding DINO pseudo-label cache. Under the selected settings, YOLOv8-medium obtains the lowest NSP (22.35) and the highest F2-risk (0.548). YOLOv8-small achieves a similar safety score at 105.9 FPS, offering a favourable accuracy–latency trade-off in our hardware setting. Faster R-CNN provides the highest risk-weighted recall but the lowest risk-weighted precision, showing that standard accuracy and navigation-oriented metrics can rank detectors differently. The proposed framework operates on existing detections and aligned depth maps without requiring detector retraining.

Paper ID: 1051

Dual-Branch Frequency Contrastive Self-Supervised Learning for Generalizable Deepfake Detection

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Abstract: Supervised deepfake detection models tend to rely on compression artefacts and dataset-specific texture statistics rather than manipulation cues that persist across generative pipelines, often failing to generalise across datasets. Addressing this limitation requires representations that capture complementary signals prior to any label-driven adaptation. This paper presents Dual-Branch Frequency Contrastive (DBFC) learning, a self-supervised pretraining objective designed to jointly encode spatial structure and frequency-domain residuals using a shared convolutional backbone with two independent projection heads. For each face crop, three views are constructed: a spatial anchor with mild augmentation, a harder spatial view with stronger perturbations, and a frequency-enhanced view obtained via per-channel high-pass filtering. Unlike grayscale transformations, this preserves chromatic artefacts introduced by generative upsampling across colour channels. The proposed objective combines a within-domain contrastive term between spatial views with a cross-domain alignment term between spatial and frequency representations, enabling the model to capture complementary manipulation cues without enforcing representational collapse. Pretraining is performed in a fully self-supervised manner on face crops from FaceForensics++ and Celeb-DF-v2 without using labels. The pretrained encoder is then fine-tuned using only FaceForensics++ labels, while evaluation on Celeb-DF-v2 is conducted in a strictly zero-shot setting, with no exposure to its labels or test samples during any training stage. The proposed model achieves an Area Under the ROC Curve (AUC) of 0.9482 on FaceForensics++ and 0.6200 on Celeb-DF-v2, outperforming its non-self-supervised counterpart. These results demonstrate that DBFC pretraining improves both intra-dataset performance and cross-dataset generalisation, with ablations indicating the importance of the learned low-level representations.

Paper ID: 1052

Decision-Point Mapping for Evidence-Grounded Clinical Intelligence in Sickle Cell Disease

Kunal Kumar (Visvesvaraya National Institute of Technology)*; Anil S Mokhade (Visvesvaraya National Institute of Technology)

Abstract: Clinical retrieval-augmented generation can retrieve guideline passages, but it does not by itself resolve clinical decisions: what action is recommended, for which patient group, with what urgency, contraindications, monitoring plan, and citation boundary. This paper introduces decision-point mapping, a typed knowledge representation that converts Sickle Cell Disease guideline evidence into evidence-linked clinical action units. Each mapping record is represented as M = ⟨τ, G, A, U, C, F, E, P⟩, encoding trigger, patient group, action, urgency, contraindications, follow-up, evidence anchor, and role-specific formulations. We present SCD-CI, a mapping-driven clinical intelligence framework that combines evidence-preserving chunking, a dual-store retrieval architecture, mapping-indexed decision retrieval, and role-aware grounded generation. The main contribution is not a new chatbot interface, but a structured representation layer that makes the evidence-to-decision gap explicitly queryable, auditable, and reusable for retrieval, supervision, citation, and safety evaluation. Internal pre-clinical evaluation indicates improved correctness, citation completeness, role adherence, and hallucination reduction relative to ablated configurations; an expert validation protocol is defined for subsequent clinician review. Index Terms—Sickle cell disease, clinical decision support, retrieval-augmented generation, knowledge representation, decision-point mapping, medical NLP, evidence grounding.

Paper ID: 1053

Cross-Domain Facial Emotion Recognition via Composite Dataset Training and Progressive Fine-Tuning

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Abstract: Facial Emotion Recognition (FER) is a central component of affective computing. While deep learning models achieve high accuracy on isolated, controlled FER datasets, they frequently experience substantial performance degradation when evaluated across different data domains. In this paper, we empirically demonstrate this generalization gap, showing that a model trained exclusively on RAF-DB drops to 49.70% accuracy when tested on CK+ and KDEF. To mitigate this domain shift, we construct a composite dataset harmonizing RAF-DB, CK+, and KDEF into a shared 7-class taxonomy. We propose a practical FER framework using a ConvNeXt-Tiny backbone enhanced with a Convolutional Block Attention Module (CBAM) to prioritize discriminative facial regions. Furthermore, we implement a three-phase progressive unfreezing training strategy optimized with Focal Loss and Exponential Moving Average (EMA) to address class imbalance and label noise. Under a shared experimental protocol, our proposed model achieves a test accuracy of 84.86% on the composite test set, demonstrating clear improvements over equivalently modified baseline architectures including ResNet50 (59.35%), DenseNet-121 (71.80%), and EfficientNet-V2-S (74.61%).

Paper ID: 1058

AI-Driven Inventory Optimization Under Uncertain Demand

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Abstract: Managing inventory under uncertain demand remainsa major challenge in modern supply chains, where excess stockincreases holding costs and shortages lead to lost sales. Traditionalinventory control methods perform well under stable conditionsbut struggle with dynamic and stochastic demand patterns. Recentadvances in AI, particularly RL and DRL, have shown strongpotential for handling such complexity.This paper presents both astructured review of recent literature and the development of anend-to-end AI-driven inventory optimization framework. The surveyanalyzes eighteen peer-reviewed studies published between 2020 and2026, focusing on algorithms, datasets, evaluation methods, andunresolved research challenges. Based on these insights, an implementation framework is developed that integrates LSTM networksfor multi-step demand forecasting with a PPO agent for dynamicinventory decision-making. The system further incorporates SHAPbased explainability and a user-facing decision support interfaceto provide interpretable recommendations. Experimental evaluationon the Walmart M5 dataset demonstrates stable forecasting performance and adaptive inventory policies capable of respondingto demand variability. The combined survey and implementationhighlight the practical potential of AI-driven inventory systems while identifying key challenges in scalability, interpretability, and realworld deployment.

Paper ID: 1059

CTSG-MHQC: Clinical Transformers with Semantic Grounding for Mental Health Query Classification

Pranathi Bandi (Chaitanya Bharathi Institute of Technology); Srikanth Panigrahi (Chaitanya Bharathi Institute of Technology); Ramadevi Y (Chaitanya Bharathi Institute of Technology); Siri Alanka (Chaitanya Bharathi Institute of Technology)*

Abstract: Mental health query classification remains a challenging task due to implicit symptom descriptions, subjective language, and context-dependent expressions in user-generated text. While transformer-based models have improved performance, designing effective and reproducible frameworks for domain-specific mental health understanding remains an open problem. In this work, we propose Clinical Transformers with Semantic Grounding for Mental Health Query Classification (CTSG-MHQC), a simple and effective framework that combines domain-specific clinical transformers with sentence-level semantic grounding, explicitly separating semantic understanding from clinical reasoning. Extensive experiments across multiple transformer backbones demonstrate that biomedical models such as PubMedBERT and BioLinkBERT achieve superior performance, with F1-scores up to 0.8380 and strong robustness under class imbalance. Comparative analysis shows that transformer-based models significantly outperform traditional machine learning approaches, while ablation results highlight the importance of domain-adaptive pretraining. Overall, CTSG-MHQC provides a strong, reproducible, and computationally efficient baseline for mental health query classification with robust semantic understanding.

Paper ID: 1061

Multi-Sensor Fusion Approach for Forklift Task Tracking and Environmental Adaptability

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Abstract: This paper presents an IoT-based framework for Forklift Task Tracking and Environmental Adaptability integrating BLE beacons, RFID tags, ultrasonic and tilt sensors, PIR/IR sensors, and HX711 load cells. The system uses RSSI-based trilateration for real-time positioning, Wheatstone bridge conditioning for load measurement, and multi-sensor fusion for hazard detection. Results show sub-meter positioning accuracy (≤0.65 m mean error), load accuracy within ±1.5%, tilt sensitivity of ±0.5°, and obstacle detection from 0.05–4.0 m. The scalable, low-cost architecture suits Industry 4.0 intralogistics and smart warehouse management.

Paper ID: 1091

A SHAP-Based Bias Audit of RLHF Reward Models

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Abstract: The current dominant paradigm of achieving alignment with human preferences for LLMs is Reinforcement Learning from Human Feedback (RLHF). The crucial component of RLHF is the reward model – a neural network that receives preference labels and assigns rewards based on them. Although the reward model plays a vital role, little is known about what features determine its decisions, whether the determined features reflect quality, or whether annotator bias is encoded. This study performs an in-depth explainability audit of publicly available reward models using state-of-the-art feature attribution methods, such as SHAP (SHapley Additive Explanations). With the help of the Anthropic HH-RLHF dataset, we evaluate the influence of various input features, including response length, sentiment, and language style, on reward scores. As a result, we show that the reward models are sensitive to superficial features, such as verbosity and politeness, while not taking into account the quality of reasoning and facts mentioned in a prompt. Furthermore, we reveal that there are demographic differences in how rewards are distributed among annotators. Based on these findings, we formulate a lightweight pipeline auditing approach for RLHF systems, consistent with regulatory standards defined by the EU AI Act.

Paper ID: 1095

CVBL-CCTV-Face Dataset for Real-World Face Enhancement and Recognition in Surveillance

Manish Das (Indian Institute of Information Technology Allahabad)*; Ajay Kumar Yadav (Indian Institute of Information Technology Allahabad); Shiv Ram Dubey (Indian Institute of Indormation Technology Allahabad); Satish Kumar Singh (Indian Institute of Indormation Technology Allahabad)

Abstract: In real-world surveillance settings, facial captures from closed-circuit television systems suffer from degradations such as low resolution, motion blur, noise, and occlusions, which undermine dependable face recognition. In this work, we develop a deep learning based pipeline for super-resolution and identity recognition, specifically designed for surveillance applications. We introduce the CVBL-CCTV-Face Dataset, a real-world unpaired collection that pairs low-quality (LQ) facial images obtained from an 8MP IP dome CCTV camera with high-quality (HQ) reference images acquired separately under controlled conditions. To address the variety of challenges in this data, we design a modular system that includes face detection, deep learning enhancement of degraded face regions, and identity matching using L2-normalized embeddings extracted from an embedding model. We evaluate enhancement models under three training configurations and deploy the system for real-time identity verification in unconstrained environments. This work establishes a foundation for advanced surveillance systems capable of accurate human subject recognition in defense and security applications.

Paper ID: 1098

Vayu Drushti: Hyperlocal Air Quality Monitoring Using a Mobile IoT Sensing Platform, Multi-Source Data Fusion, and Hybrid CNN-LSTM-Attention Machine Learning Calibration

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Abstract: India faces the serious challenges in monitoring the urban air quality, especially at the street level, where existing monitoring stations provide limited spatial coverage. To address this issue, this study presents the Vayu Drushti, a mobile air-quality monitoring system that combines a low-cost ground rover with a multi-pollutant IoT sensor array. The proposed system uses a four-level data fusion that combines rover sensor readings with reference data from the Central Pollution Control Board (CPCB), aerosol optical depth (AOD) data from INSAT-3D/3DR satellites, and meteorological data from NASA's MERRA-2 reanalysis dataset.A hybrid CNN-LSTM-Attention model is developed using these combined data sources to improve the sensor calibration and AQI prediction. The model was tested on approximately 5,500 temporally aligned hourly observations, with CPCB measure-ments used as the reference. During temporal hold-out testing our model achieved an MAE of 9.8 AQI, RMSE of 14.6 AQI, and R^2 of 0.91. Sensor calibration also reduced initially from approximately 25–30% to 8–12%, gives an improvement of about 60–65% under the tested environments.The system also generates street-level air-quality heatmaps using Kriging interpolation.It detects potential pollution hotspots using Moran's I. Results are displayed with help of the React-based dashboard. System has deployment cost of less than 14,000 per rover, Vayu Drushti provides a practical and economical approach for hyperlocal and dense air-quality monitoring in areas where conventional CAAQMS and other infrastructure is limited.

Paper ID: 1100

GynoLens-XAI: Explainable ML–NLP for Gynaecological Disease Prediction

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Abstract: Early detection of gynaecological diseases iscrucial for the betterment of the healthcare for women andprevention of potentially severe complications. Withtraditional diagnosis, however, the reliance on clinicalexaminations, laboratory investigations and medical expertiseis high, and many current machine learning systems are basedprimarily on patient-structured data and are only partiallyinterpretable. To resolve these issues, GynoLens-XAIintroduces an innovative explainable hybrid framework thatintegrates Machine Learning (ML), Natural LanguageProcessing (NLP), and Explainable Artificial Intelligence(XAI) to predict gynaecological diseases in the early stages. The system processes structured patient health data, as well assymptom descriptions in natural language. The symptomspresented by patients are processed using NLP methods toharness meaningful information, and the patterns recognizedby the machine learning models are linked to possiblegynaecological diseases. To increase transparency and usertrust, XAI techniques, such as SHAP and LIME, offerexplanations for the elements affecting each prediction. Theproposed framework is intended as an intelligent clinicaldecision support system that will help health careprofessionals make decisions based on intelligent analysiswithout depriving from the medical knowledge. GynoLens- XAI is designed to enhance early disease detection, diagnosticefficiency, and the advancement of transparent and reliableAI-driven healthcare solutions for women, thereby fosteringtrust in healthcare diagnostics and paving the way forinnovative, patient-centric care.

Paper ID: 1106

A Smart System For Multi-Modal Skin Diagnosis

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Abstract: There is a significant burden of skin diseasesaround the world, but access to dermatological treatment ishindered by long wait times, expense, and the shortage ofdermatologists, especially in rural areas and developingcountries. The current artificial intelligence-based diagnosismodels use a single mode of input (only images) and requireclinical pictures of high quality. They suffer fromalgorithmic bias on different skin colours. This paperintroduces a Smart Multi-Modal Skin Diagnosis Assistant,which combines clinical image features with textualsymptoms reported by patients for accurate and unbiased,first-level diagnosis. We built a dataset of 8,766 imagesrepresenting 47 non-cancerous skin diseases, with variouslighting conditions and camera angles, and variousFitzpatrick skin types. Our proposed pipeline utilizes theResNet50 and EfficientNet-B0 backbones for the CNNsalong with the transformer/Bi-LSTM encoder for symptomsusing multimodal fusion and feeding into a 47-class softmaxclassifier with a built-in feedback loop for validating patientfeedback post-diagnosis. On our holdout dataset, thepipeline yielded 88.3% accuracy overall, an F1 score of85.2%, and mAP of 76.54% on 47 classes; the inclusion ofthe symptom texts boosted classification accuracy by 6–8%as compared to an image-only approach, especially forvisually similar conditions. Our fairness analysis onFitzpatrick types I-VI demonstrated that there was only avariance of around 2.5% in terms of accuracy, implying lessdemographic bias as compared to the image-only baselinesfound in the literature. The on-device inference takes lessthan 30 seconds. Our solution does not replace clinicaljudgment but serves as a convenient first-line decisionsupport tool, especially useful in tele-dermatology andlimited resource settings.

Paper ID: 1110

A Memory-Efficient Bayesian HeMIS Attention U-Net for Uncertainty-Aware Brain Tumor Segmentation

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Abstract: Brain tumor segmentation from multimodal MRI is essential for diagnosis and surgical planning, yet conventional approaches assume complete modality availability and provide no uncertainty estimates. This paper presents a Bayesian frame-work that combines four independent modality-specific encoders, statistics-based HeMIS fusion, an attention-gated 3D U-Net decoder, and patch-based Monte Carlo (MC) dropout uncertainty quantification, using a sliding-window inference strategy to keep the 128^3 volume within single-GPU memory limits. On the full 37-patient BraTS2020 test set (369 patients), median Dice is 0.90 (Whole Tumor), 0.89 (Tumor Core), and 0.81 (Enhancing Tumor), with mean Dice of 0.82, 0.71, and 0.68; the mean–median gap is driven by a small number of near-complete failures on very small tumors, which we analyze explicitly rather than omit.MC uncertainty maps qualitatively co-localize with regions ofsegmentation error. We report these results, including failurecases, as an honest baseline for uncertainty-aware, missing-modality-robust segmentation, and identify the exact full-volume(rather than patch-based) Bayesian inference as an open futurework.

Paper ID: 1115

Hardware-Software Co-Design for Real-Time Cancer Detection and Feature Extraction

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Abstract: Breast cancer is one of the most common causes ofmortality in women worldwide; therefore, early detection of suchcancers is essential in enhancing chances of survival. This paper proposes a hybrid image processing approach for breast cancer detection from ultrasound images. An image processing pipeline that includes preprocessing, segmentation, feature extraction and validation is designed based on the Python programming language, while the hardware version is developed using Verilog HDL for real-time decision making.The use of ultrasound images is due to their noninvasivenature and their ability to detect dense breast tissues. While thesoftware part of the algorithm involves conventional image processing approaches for preprocessing, segmentation and feature extraction,with feature-based classification used for software-level analysis, the hardware part is realized using a pipelined FPGA structure for decision making through streaming pixels.This combined software–hardware approach enables both algorithmic flexibility and high-speed hardware execution, makingit suitable for real-time computer-aided diagnostic systems.

Paper ID: 1116

A Multi-Protocol Legacy-Interface IP for UCIe-Based Heterogeneous AI Compute Systems

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Abstract: Heterogeneous chiplet systems increasingly combinehigh-performance compute with legacy sensing and embeddedinterfaces that use protocols such as UART, SPI, and I2C. Thispaper presents a multi-protocol legacy-interface IP architecturefor connecting low-bandwidth interfaces to a UCIe-basedheterogeneous compute system. The design separates protocolspecificbehavior from the UCIe-facing transport boundary bybringing legacy traffic into a common AXI4-Stream representationselected for the proposed architecture. Each protocol has localbuffering, and arbitration combines the resulting streams beforethe data is organized into a structured 512-bit representationfor the UCIe's FDI-facing digital interface. This architecturesupports bidirectional operation at the system level; the presentFPGA prototype focuses on the legacy-to-FDI digital pathand uses platform-specific DMA, ARM processor, and Pythonsoftware facilities for observation and functional validation. Theprototype is implemented on a PYNQ-Z2 platform. The datafrom external sensors is transferred through UART and SPI. RTLsimulation and FPGA implementation are used to validate protocoladaptation, buffering, arbitration, clock-domain crossing, payloadconstruction, and receive-side reconstruction. The downstreamUCIe D2D Adapter, RDI, PHY, physical link, and AI computechiplet are in the target-system context and are not implementedin the FPGA prototype. The FPGA implementation achieved9.82% LUT, 9.26% flip-flop, and 12.5% BRAM utilization, withpositive timing slack; the implemented datapath yielded digitalpaththroughput and latency estimates. The work establishes aprototype baseline for integrating heterogeneous legacy subsystemswith future UCIe-based compute chiplet systems.Index Terms—chiplets, Universal Chiplet Interconnect Express,UCIe, AXI4-Stream, legacy interfaces, sensor integration, heterogeneous systems, FPGA, edge AI, AI compute chiplet

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Paper ID: 1117

Intelligent Scheduling for AI-Native 6G Radio Access Networks: Taxonomy and Comparative Benchmarking

Raviraj Rathor (CoEP Tech University Pune)*; Raviraj Rathor (CoEP Tech University Pune); Vaishali Ingale (CoEP Tech University Pune); Rajshri Mahajan (Lear Corporation)

***Abstract**:* The shift to 6G wireless networks will herald the era of AI-native Radio Access Networks (RANs), where AI will be deeply integrated into network control and resource management operations. Considering the 6G requirements of ultra-low latency, massive connectivity, high reliability and higher spectral efficiency, intelligent scheduling is vital in this context. To date, existing studies are scattered and do not have a common framework to assess AI-based schedulers in AI-native RAN environments.This paper presents a taxonomy and comparative benchmarking framework for intelligent schedulers in AI-native 6G RANs. A systematic literature review is conducted to classify scheduling approaches into classical heuristic, AI-heuristic, single-agent deep reinforcement learning (DRL), multi-agent DRL, federated DRL, and graph neural network (GNN)-based scheduling. A multidimensional evaluation framework is then used to assess scheduler performance in terms of throughput, latency, fairness, scalability, explainability, and deployment feasibility. A 3GPP-compliant system-level simulator is implemented to verify the analysis by comparing schedulers based on Proportional Fair (PF), Round Robin (RR), and Deep Q-Network (DQN) with different heterogeneous 6G traffic scenarios. The results demonstrate that the improvement in the throughput-latency trade-off obtained by using the DQN scheduler is around 15% better than that obtained using PF, while the number of URLLC packet delay violations is reduced from 15% to 5%. But there is still a considerable amount of training overhead and scalability issues.

Paper ID: 1118

High-Performance Computing Based GPU-Accelerated Molecular Docking for Tuberculosis Drug Discovery

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***Abstract**:* Tuberculosis (TB) remains a major global health challenge, and the emergence of drug-resistant Mycobacterium tuberculosis strains has intensified the need for rapid therapeutic discovery. Conventional drug discovery approaches are time-consuming, costly, and inefficient due to the vast chemical search space and extensive experimental validation required. Molecular docking has become a vital tool in early-stage drug discovery; however, traditional CPU-based docking suffers from limited scalability and high computational overhead. High-Performance Computing (HPC), particularly GPU acceleration, offers an effective solution for large-scale virtual screening. In this work, we present an HPC-enabled molecular docking framework for targeted anti-tuberculosis drug discovery against Enoyl-Acyl Carrier Protein Reductase (InhA), a key enzyme in the fatty acid synthase II (FAS-II) pathway essential for mycolic acid biosynthesis in the mycobacterial cell wall. AutoDock-GPU was employed for efficient docking and binding affinity estimation, while a co-crystallized ligand from the InhA crystal structure (PDB ID: 1BVR) was used to validate the docking protocol. The proposed framework significantly improved computational performance, reducing docking time from 7.04 to 1.64 minutes for 50 ligands, 13.12 to 2.92 minutes for 100 ligands, and 22.83 to 5.05 minutes for 175 ligands, achieving up to 4.52× speedup over CPU-based execution. These results demonstrate the scalability and effectiveness of GPU-accelerated molecular docking for high-throughput anti-TB drug discovery.

Paper ID: 1123

Secure Image Steganography to Enhance Embedding Capacity Using Advanced Multi-Tier Bit-Plane LSB Embedding and Random Pixel Mapping

Gauri Joshi (COEP)*; Shilpa Metkar (COEP); Vibha Vyas (COEP)

Abstract: Steganography plays a vital role in secure communication by concealing digital data. This paper proposes the Advanced Multi-Tier Bit-Plane LSB Embedding with Random Pixel Mapping (MTPB -LSB) technique to significantly increase the embedding capacity of digital images. Multi-tier steganography is a hierarchical data hiding technique that combines multiple embedding layers—such as encryption, multichannel allocation, multi-bit-plane LSB substitution, and randomised pixel mapping—to simultaneously enhance embedding capacity, security, and resistance to steganalysis. Using this multi-tier steganographic technique, the sender can transmit multiple secret messages to multiple receivers under a single cover image. This paper proposes a multi-tier MTBP-LSB steganographic scheme that provides higher data-embedding capacity compared with conventional and state-of-the-art methods. The proposed study implements MTBP-LSB techniques, with performance evaluated through image quality metrics (PSNR, MSE, RMSE, NCC, SSIM) and embedding and payload capacity. Comparative analysis with single channel steganography confirms that MTBP-LSB enables the embedding of n messages with an n-fold increase in embedding capacity for the same cover image size. The proposed MTBPLSB technique employs n distinct keys, ensuring high security and enhanced robustness. Overall, the research demonstrates that the proposed method can securely handle large volumes of data without sacrificing image quality.

Paper ID: 1124

Comparative Performance Analysis of Automatic Number Plate Recognition Techniques in CCTV Surveillance Systems

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Abstract: Automatic Number Plate Recognition (ANPR) assists in vehicle identification and tracking by automaticallydetecting and recognizing vehicle number plates. ANPR is usedin parking systems, traffic control systems, and restricted accesssystems. Gate access control presents additional challenges forreliable number plate detection. The video from CCTV camerasoften has problems like image blur, motion blur, low-resolutionnumber plates, poor illumination, vehicles at long distances,multiple vehicles in a frame, and OCR-level character confusion.We evaluated seven different methods with YOLO11m-basedplate detection using various OCR approaches. We used methodssuch as Tesseract OCR, EasyOCR, PaddleOCR, LPRNet, TrOCRand hybrid OCR for the recognition of alphanumeric license platecharacters. We evaluated preprocessing, layout rules, tracking,best-frame selection, temporal voting, and CSV database lookupsin a single end-to-end framework. We compared existing pipelinesusing metrics including plate mAP50, mAP50-95, precision,recall, F1-score, OCR accuracy, and FPS. Experimental resultsshow that the YOLO11m 640 + PaddleOCR pipeline achievesthe best balance of accuracy and speed, with 94.60% mAP50,95.30% precision, 90.60% recall, 92.90% F1-score, 90.00% OCRaccuracy, and 69.4 frames per second (FPS). This benchmarkprovides a tested means of selecting the most suitable technology,balancing resolution with OCR, and tracking delay and real-timerequirements for gate access applications.

Paper ID: 1126

Examining Classification and Segmentation Models for Plant Disease Severity Assessment

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***Abstract**:* Plant Disease Severity Estimation plays important role in improving productivity in agriculture and helpsto ensure food safety. This paper presents a comprehensiveliterature survey of recent deep learning approaches,includingCNNs,Transformers, MeanNet, SeaNet and hybrid models.Thestudy analyzes different severity-specific datasets,comparativeanalysis of existing methods,key challenges and limitationsand finally category wise research gaps.The study furtheranalyzes various techniques based on accuracy,computationalefficiency,and real world applicability,highlighting future scopelike working on real world datasets,using efficient models forcomputing results. In this study classification and segmentationbased severity estimation approach was experimented and theaccuracy achieved for segmentation using pspnet is 98.76% andfor U-Net is 99.04%.Keywords-Plant disease severity estimation, CNN, Plant Disease Index, deep leaning models, coffee biotic stress.

Paper ID: 1130

Text-to-Speech Synthesis Using FastSpeech2 and WaveGlow on IndicTTS Corpus

Shubhangi Kotkar (COEP Technological University,Pune)*

***Abstract**:* Text to speech(TTS) systems have largely replaced concatenative, parametric approaches by directly learning the mapping between text and natural sounding speech. This paper presents design, evaluation of a two-stage neural TTS pipeline that combines FastSpeech2, a non-autoregressive acoustic model, with WaveGlow, a flow based neural vocoder, to synthesize a female Indian voice. The system is trained on the female monolingual speech corpus released by the Indian Institute of Technology (IIT) Madras under the IndicTTS consortium, a studio-quality corpus of annotated speech and text. FastSpeech2 predicts an intermediate mel-spectrogram from phoneme sequences using explicit duration, pitch and energy conditioning, thereby removing the one-to-many mapping ambiguity and the teacher-student distillation pipeline required by earlier non-autoregressive models. WaveGlow then converts the predicted mel-spectrogram to time-domain waveform through a single invertible flow-based network trained with a maximum-likelihood objective, avoiding the sequential sample-by-sample generation used by autoregressive vocoders such as WaveNet. The resulting pipeline is evaluated using Mean Opinion Score(MOS), Mel Cepstral Distortion(MCD) and Real Time Factor(RTF) are compared against autoregressive Tacotron2 baseline. Experimental observations indicate that the FastSpeech2 and WaveGlow combination produces intelligible, natural-sounding speech in the target female voice while offering substantially faster training and inference than autoregressive alternatives, making it suitable for low resource Indian language TTS deployment.

Paper ID: 1133

A Risk-Aware Hybrid Structural-Semantic Framework for Automated Software Vulnerability Detection

Shobha Tiwari (COEP Technological University,Pune)*; Dr. Tanuja Pattanshetti (COEP Technological University Pune)

***Abstract**:* The swift evolution of software applications andpractices in continuous delivery have increased the need for automated methods capable of recognizing security vulnerabilitieswithout creating analysis overheads. Rule-based static analyzersare capable of generating huge amounts of false positives, whilethe machine-learning-based methods might not be able to effectively represent

structural connections between objects withinsource code. In this work, we propose the risk-aware hybridapproach combining structural and semantic representations ofsource code objects learned from AST trees and machine-learningalgorithms for automated vulnerability detection and ranking.The proposed approach focuses on three types of vulnerabilities:SQLi, XSS, and RCE. The structural, semantic, and codecomplexity features are used in the pipeline and are processedusing complementarily trained learning models, whose results arethen combined to get the probabilities of vulnerabilities. Testingon 1,200 annotated samples gives macro-averaged precision of0.93, recall of 0.92, and F1 score of 0.93, with an estimated falsepositive rate of 8%. The system also demonstrates an averageinference time of 12.44 ms per function and throughput of32,921 LOC per second. Results of the ablation study show thatbetter results are obtained by using both structural and semanticrepresentations.

Paper ID: 1134

AI-Driven Algorithmic Trading and Portfolio Management

Shripad Bhatlawande (Vishwakarma Institute of Technology)*; Swati Shilaskar (Vishwakarma Institute of Technology); Jyoti Madake (Vishwakarma Institute of Technology); Bhargav Parlikar (Vishwakarma Institute of Technology); Apoorv Karmalkar (Vishwakarma Institute of Technology); Nikhil Patwardhan (Vishwakarma Institute of Technology)

Abstract: This paper presents an AI-driven Trading and Portfolio Management System designed to support retail and beginner investors who often struggle with market complexity, trade execution, and financial planning. Existing tools remain fragmented, forcing users to rely on separate applications for trading, portfolio tracking, and risk evaluation. The proposed system unifies intraday trading, long-term portfolio optimization, and risk management within a single architecture that delivers real-time analytics and data- driven decision support. A core contribution of this work is the AI Advisory Layer, which converts technical financial outputs into clear, personalized guidance, functioning as an integrated, automated financial assistant. The overall framework improves accessibility, enhances decision accuracy, and offers a cohesive platform for modern, technology-enabled investing.

Paper ID: 1136

LectureMind AI: A Hybrid VideoRAG Architecture for Educational Lectures with Temporal Grounding

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Abstract: The emergence of educational video content opensup huge educational opportunities for users, but it is impeded bystructural issues, including passivity of interaction with content,language mismatch, and lack of semantic searchability. Thefoundational RAG models offer basic query capabilities, but usingthem on video transcripts poses a number of extreme issuesregarding long-context generation and temporal exactness. Thispaper builds on a foundational YouTube chatbot infrastructureand introduces LectureMind AI, a state-of-the-art chatbot andVideoRAG system designed to turn video viewing into an activelearning experience. One of the main contributions of thesystem is an interactive QA chatbot, which uses the innovativetimestamp-aware greedy chunking algorithm that retainstemporal information to provide sub-second citation accuracyof the Large Language Model for the mentioned timestamps. Another contribution is the note-making automation, which usesa duration-scaled parallel multi-part generation mechanism tosolve context-window degradation problem and create structuredmultimodal notes from long lectures. To handle multilingualvideos, we use a four-layer language adaptive ingestion pipelinebased on natural sentence grouping. Technical retrieval is performedusing a hybrid system combining dense vector searchand lexical BM25 keyword search via Reciprocal Rank Fusion.Finally, there is a secure quiz

generation system and a threelayervector cache synchronization mechanism, which avoidsredundant embedding computation. Overall, this architectureprovides a cost-effective solution to temporally grounded AIbasedvideo learning.Index Terms—Chatbot, Educational Technology, Note Generation,Reciprocal Rank Fusion, Retrieval-Augmented Generation,Video Processing.

Paper ID: 1137

Machine Learning-based EEG Analysis for Brain Synchronization and Cognitive Enhancement

Ranjana Gore (MIT Art, Design and Technology University Pune)*

***Abstract**:* The Brain-computer interface technology can be significantly used for the neurological applications restoring and rehabilitating the neurological functions in the individuals with disabilities. The Proposed system called NeuroSerenity, is a cutting-edge application utilizing EEG-based brain computer Interface technology for monitoring and assessing the resting-state brain activity. The proposed work focuses on monitoring the person when it is not engaged in any task (resting state). By leveraging this brain activity, the proposed system provides neurofeedback to promote the brain network connectivity and synchronization, assisting recovery from brain injuries. It is used to improve the brain synchronization and promote mental health. This paper elaborates the first module of NeuroSerenity by generating dataset, perform linear discriminant analysis and elaborating the simulation results for it. The results shown are as: post-intervention metrics gave 68% brain synchronization, 8 ng/mL cortisol levels, and 48% beta band activity which indicates the enhanced neural efficiency, integration and substantial reduction in stress. The results indicate enhanced cognitive performance with 97% accuracy, especially regarding focus and attention of the Patient. The results also imply that the intervention was significantly effective in fostering the mental clarity, alleviating the stress, and optimizing the cognitive functions.

Paper ID: 1140

RFID-Based Industrial Tools Management System for Automated Inventory Control and Retrieval

Aniket Patil (COEP Technological University, Pune)*; Vibha Vyas (COEP Technological University, Pune)

***Abstract**:* Efficiency and precision in the management of tooling and inventories continue to pose difficulties for current industries, especially those characterized by lean production, time-bound deadlines, and manufacturing processes. Lost inventory, wrong access, mistakes and delays caused by production times are due to manual retrieval of parts and tools. This research presents the design and implementation of an Industrial Tools Management System (ITMS), a smart automation framework integrating RFID-based authentication mechanism with a microcontroller-controlled motorized retrieval system. The system provides access to tools in a secured and efficient way by using RFID authentication, LCD navigation, LED indication of the compartment and digital logging in real time. The ITMS is based on Arduino UNO microcontroller and is interfaced with RFID modules, gear motors, LED indicators and 20x4 LCD display to facilitate dispensing of tools in workshop or assembly line environments. ITMS automates the identification, retrieval and logging of parts and tools, greatly reducing human intervention, improving operational accuracy and providing real-time visibility of inventory. The system's modular nature provides scalability to suit a range of industrial needs, with its mechanical and electronic components selected for cost, durability and ease of deployment. Through extensive testing, ITMS has proven the potential to enhance productivity, increase inventory accountability and provide a fundamental element of smart factory deployments in accordance with Industry 4.0 objectives.

Paper ID: 1141

Mixed Music Separation using Deep Convolutional Neural Network

Swati Shilaskar (VIT, Pune)*; Shripad Bhatlawande (Vishwakarma Institute of Technology); Jyoti Madake (Vishwakarma Institute of Technology); Atharva Dusane (Vishwakarma Institute of Technology)

Abstract: This research paper presents a novel methodology for music separation and extracting sound-producing instruments in the environment without manual supervision. Isolating the sound of individual instruments from a complex audio ensemble containing multiple instruments is a core challenge in audio signal processing. The dataset used in the study comprises audio recordings of both duet performances featuring multiple instruments and solo performances of individual instruments. Before training the neural network, the audio data undergoes crucial preprocessing steps, including subsampling, cropping, and converting to spectrograms using Short-Time Fourier Transform (STFT). The self-designed neural network architecture incorporates modifications to the U-Net framework, enhancing performance. The approach demonstrates exceptional proficiency

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Paper ID: 1142

From Sanskrit to Pali: A Comprehensive Survey of Computational Sandhi Splitting and Open Research Challenges

Anjali Vhanmane (COEP Technological University)*; Jagruti Nikam (COEP Technological University); Yashodhara Haribhakta (COEP Technological University)

Abstract: Sandhi splitting is a linguistically constrained segmentation and reconstruction problem rather than a simple boundary detection task. Phonological processes at lexical junctions can alter, delete, insert, or assimilate material, requiring a system to be able to identify boundaries and recover underlying constituents. This is the case for Pali written in Devanagari script, in which its rich morphology and uncertain transfer from related languages interact.In this paper, we present a structured narrative review of research on Devanagari Pali Sandhi processing. We cover statistical subword methods, morphology- and akṣara-aware tokenization, multilingual and Indic pretrained representations, Sanskrit Sandhi and compound-segmentation systems, related Indic-language studies, direct Pali work, and supporting evaluation resources. The literature presents a progression from rule-based and finite-state methods to probabilistic and graph-based disambiguation, character-level neural models, sequence-to-sequence reconstruction, linguistically informed Transformers, byte-level and tokenization-free approaches, attention-based boundary prediction, multi-split modeling, and uncertainty-aware joint segmentation.Three patterns persist: candidate generation and selection deal with different errors; correct boundary-localization does not guarantee correct constituent reconstruction; improved tokenization or representation quality does not necessarily imply valid Sandhi recovery. Direct Pali studies provide important evidence, but are limited by the script, corpus size, resources, and evaluation settings, while Sanskrit and other Indic studies provide architectural precedents rather than direct evidence of Devanagari Pali performance. The review identifies open challenges in the benchmark construction, contextual ambiguity, multi-split recovery, linguistic validation, cross-script normalization, evaluation comparability, reproducibility, and transfer analysis.

Paper ID: 1144

Empirical Analysis of Machine Learning Classifiers for Intrusion Detection in the Internet of Medical Things

Pallavi Waghmare (COEP Technological University, Pune, India)*

Abstract: The increasing use of networked medical devices, cloud infrastructure and AI-powered monitoring systems has changed the delivery of healthcare. However, the same connectivity also broadens the attack surface of the Internet of Medical Things (IoMT) and opens up new exposure risks to patient records and hospital operations. Whereas the majority of intrusion detection systems (IDSs) that are used in connected healthcare infrastructures rely on machine learning techniques, existing research is limited by its focus on either binary classification or global accuracy rates. As such, multi-class classification, efficient model training, and standardised evaluation of classifiers are poorly researched. The aim of this study is to fill these gaps via practical performance evaluation of eleven models based on different approaches, including rule-based, tree-based, and function-based approaches, in the context of the WUSTL-EHMS-2020 dataset. This research aims at overcoming the described gaps by carrying out an empirical comparative investigation of the performance of eleven rule-based, tree-based, and function-based machine-learning classifiers (Decision Table, JRip, OneR, PART, J48, Random Forest, Logistic Model Trees, Logistic Regression, Simple Logistic, SMO, and Multilayer Perceptron) for the tasks of binary intrusion detection and multiclass attack recognition in relation to the WUSTL-EHMS-2020 dataset. The classifiers were trained and tested in equal conditions of preprocessing and 10-fold cross-validation, with their performance evaluated based on accuracy, precision, recall, F1-score, False Alarm Rate, and Build-up Time.

Paper ID: 1145

Interpretable Multimodal Fusion in Healthcare

Isha Shah (PICT)*; Anjali Deshpande (Pune Institute of Computer Technology)

Abstract: In healthcare practice, patient-related data almost never comes from one sole source of evidence. Clinicians use various methods of providing integrated care which normally include structured electronic health records (EHR), physiological time series data, imaging and clinical documentation; with this information often being obtained from different systems at different times throughout the patient's journey through the healthcare system. Therefore, when a patient is identified as being at-risk, it is often difficult to identify whether the identification was reliant or associated with abnormal laboratory results, abnormalities seen through medical imaging, trends relative to time, co-morbidity issues or an interaction between multiple issues. Thus; the lack of transparency can cause a degree of distrust with clinicians regarding how the AI tool arrived at a judgement. This distrust raises questions surrounding adoption and regulation in "real-world" practice.This survey looks at the intersection of multiple modality fusion and interpretability in AI used in the healthcare realm. In order to help organize current literature, a four-axis taxonomy was developed to segment AI literature on the basis of the following characteristics; 1) the level of modality fusion (early, intermediate, and late) 2) architecture family 3) methods of interpretability and 4) robustness to missing modalities. Using this four-axis taxonomy framework, we examined how AI literature describes methods for providing explanation to predictions at the modality, feature and interaction level, across the number domains it was evaluated by clinical applications. We also reviewed how interpretability is currently assessed in practice and described three areas of concern within the domain; an absence of standardized benchmarks, a low number of studies with clinicians evaluating interpretability and the unavailability of methods demonstrating true cross-modal capabilities.

Paper ID: 1146

Deep Learning-Based Copy-Move Forgery Localization Using Laplacian-of-Gaussian Preprocessing

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Abstract: Copy-move forgery detection requires reliable localization of duplicated image regions, particularly when the manipulated content remains visually consistent with the surrounding scene. Conventional deep-learning approaches primarily learn representations directly from RGB images, which may limit their sensitivity to subtle structural and boundary-level forensic traces. This paper investigates a Laplacian-of-Gaussian (LoG) assisted pre-trained convolutional neural network for pixel-level localization of copy-move forgeries. A ResNet-18 network pre-trained on ImageNet is employed as the encoder and coupled with a convolutional decoder to generate binary forgery masks. The proposed approach uses LoG pre-processing to emphasize local intensity transitions and high-frequency structural information before feature extraction. Experiments are conducted on the CoMoFoD dataset using 200 canonical forged-image and binary-mask pairs, with an identity-disjoint training, validation, and testing protocol. For a controlled evaluation, the same localization architecture, training strategy, loss function, and data split are used for the RGB baseline, high-pass-filter-assisted model, and LoG-assisted model. The LoG-assisted model achieves a test precision of 73.07%, recall of 63.87%, F1-score of 68.16%, and intersection-over-union of 51.70%. Compared with the RGB baseline, the LoG representation improves recall by 16.23 percentage points and F1-score by 10.95 percentage points. The results indicate that incorporating LoG-derived structural information can improve pixel-level localization of copy-move regions while maintaining comparable precision to direct RGB-based learning.

Paper ID: 1147

A Lightweight MobileNetV2–BiLSTM Framework for Spatiotemporal Pedestrian Crossing Intention Prediction

Savita Chougule (COEP Technology University)*

Abstract: To improve the safety and decision-making capability of autonomous driving systems, this study focuses on the task of pedestrian crossing intention prediction and proposes a lightweight spatiotemporal prediction framework that integrates MobileNetV2 and BiLSTM. Pedestrian regions of interest were extracted from annotated video frames and organized into sequences of 10 consecutive frames. A pretrained MobileNetV2 was applied to extract 1280-dimensional spatial features from each individual frame, BiLSTM was used to capture bidirectional temporal dependencies, and prediction outputs were generated via sigmoid binary classification. JAAD-derived temporal sequences were used to assess the framework; 319 sequences were retained for testing. The framework achieved five core performance metrics, including an accuracy of 96.55% and an F1-score of 97.77%, which proves that the proposed solution meets the requirements of autonomous driving scenarios.

Paper ID: 1149

Multimodal AI and Computer Vision Framework for Automated Crack Detection, Severity Classification, and Condition Rating of Concrete Bridges

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Abstract: A multimodal AI system is designed that transforms evidence from bridge inspection to four related outputs: pixel-level crack masks, crack width estimates, an ordinal severity hierarchy, and a rating of the condition of each bridge element. The present paper introduces a controlled synthetic benchmark consisting of 60 virtual reinforced-concrete bridge elements that contain 6,000 registered multimodal sample groups, and tests the framework to demonstrate that it can be used to enable reproducible method development without sacrificing the integrity of unperformed field inspections. Near duplicate leakage is avoided with element-grouped partitions. The proposed model obtained the following evaluation metrics on the held-out test set, which yielded a crack intersection-over-union of 0.862, a Dice score of 0.926, a width means absolute error of 0.052 mm, a severity macro-F1 of 0.904, and a quadratic-weighted condition kappa of 0.887. The improvement over an RGB only encoder-decoder was 11.8 percentage points in the IoU measure, 12.1 points in the severity macro-F1 measure and 0.159 points in the condition kappa measure. In the case of complete dropout of depth channels, the expected calibration error decreased from 0.082 to 0.027 at a severity macro-F1 of 0.862 with modality-dropout training. Results indicate that the primary advantage of multimodal fusion is not just the increased strength of the crack localization; it is the propagation of complementary surface, thermal, geometric and contextual evidence into an auditable condition decision. The study builds a prototype with the results as outcomes and outlines the necessary steps needed for field validation before operational deployment of bridge.

Paper ID: 1151

Multi-Class Microplastic Detection,Segmentation in Marine Environment Using Deep Learning

Saee Chavan (COEP Technological University)*; Shweta Jadhav (COEP Technological University); Siddhi Landage (COEP Technological University); Pranjal Ghaste (COEP Technological University); Pratiksha Deshmukh (COEP Technological University)

Abstract: Microplastic pollution poses an escalating threatto marine ecosystems, requiring automated and precise iden-tification methods. Conventional manual identification is time-consuming and prone to errors. This research presents a deeplearning-based framework for multi-class microplastic detection,segmentation, and quantification in marine water. The systemutilizes microscopic image datasets containing multi-class parti-cles categorized into fibers, films, fragments, and pellets. Datapreprocessing involves image resizing to 640 × 640, pixel nor-malization, and robust data augmentations including brightnessadjustments, rotations, and flips to enhance model robustness.The methodology evaluates multiple advanced architectures,comparing object detection models such as YOLO11 variants(YOLO11n and YOLO11s) alongside semantic and instancesegmentation approaches like U-Net and YOLOv8 segmentation. Experimental evaluations demonstrate that YOLO11s achieveshigh performance with a mAP@50 of 94%, precision of 94%.Furthermore, instance segmentation is integrated to captureexact particle boundaries, overcoming the spatial limitationsof standard bounding-box detection. The proposed frameworkeffectively automates microplastic classification, localization, andmorphological analysis for environmental monitoring applica-tions.

Paper ID: 1152

An Efficient HDR Image Quality Enhancement Framework Using the Butterfly Algorithm

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Abstract: In this article we propose a quality enhancement of contrast-enhanced HDR images using the butterfly algorithm. Moreover, in recent days, the capturing and displaying methodologies of High Dynamic Range (HDR) images have fascinated a lot of interest

in scientific, professional, and research societies. Also, the contrast of the HDR images that are developed specifically for medical and automotive applications should be increased to further improve their visual quality. The assessment of contrast-enhanced HDR systems with respect to the quality of experience is necessary for any technologies such as medical diagnosis systems and automotive applications. In this paper, a new quality-enhancement method is projected using contrast-enhanced HDR images for different kinds of applications. Here, the contrast of the HDR image is enhanced with modified histogram equalization with butterfly optimization (BFO) algorithm to increase the image quality for automotive applications and medical diagnosis systems. The proposed model is trained for the prediction of the quality of the contrast-enhanced HDR image on the basis of spatio-temporal features and validated on a large-scale medical and automotive application dataset namely, ADNI and KITTI. The simulation output proves the efficiency of the HSVR-ASFO model against the existing image quality assessment (IQA) models for both kinds of applications.

Paper ID: 1153

Comparative Analysis of Enhanced Deep Learning Models for Multi-Class Weed Detection

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***Abstract**:* Weed infestation is a major challenge in agriculturalproduction because unwanted plants compete with crops fornutrients, water, light, and growing space. Automated weeddetection using computer vision can support targeted weedmanagement by identifying and localizing weeds in field images.This paper presents a comparative evaluation of four deeplearning object detection approaches, namely improved FasterR-CNN, YOLOv5, YOLOv8, and DINO, using a common experimental pipeline. All models were trained on the proposedenhanced and augmented MH-Weed16 dataset, using the sameclass definitions and preprocessing protocol to ensure a faircomparison. The pipeline incorporates Contrast Limited Adaptive Histogram Equalization (CLAHE), Histogram Equalization,Gaussian Blur, and geometric data augmentation to improverobustness to variations in field imagery. Experimental resultson the enhanced and augmented MH-Weed16 dataset show thatDINO achieves the highest precision and F1-score of 0.7503and 0.6631, respectively, while YOLOv5 achieves the highestmAP@0.5 and mAP@0.5:0.95 of 0.6660 and 0.3150, respectively.The proposed enhanced DINO model achieves a mAP@0.5of 47.34%. Literature results from MH-Weed16-based studiesare used as contextual references because their experimentalconfigurations and reported metrics are not identical.

Paper ID: 1154

Towards Trustworthy Epilepsy Diagnosis: An Explainable CNN GRU Framework for EEG Seizure Detection and Forecasting

Khushbu Trivedi (COEP Technological University, Pune)*; Vinod Pachghare (COEP Technological University)

***Abstract**:* Neurological disorder cases are increasing rapidly that require trust and better deployment environment in real world healthcare system. Epilepsy or Seizure identification and forecasting is based on Electroencephalography (EEG) patterns plays major role in research field. The intrinsic opacity of conventional deep learning methods has challenges in patient care trust.To address this challenges and limitations, this article proposes the Explainabilty employable Convolution Neural Network and Gated Recurrent Unit (CNN-GRU) based solution. The Gated recurrent networks help to train the model to understand the patterns in data that unfolds over time. To improve signal quality and robustness of model, incorporates the temporal segmentation, removal of noise and normalization. Additionally, SHAP and Grad-CAM techniques of Explainable Artificial Intelligence (XAI) gives feature based explanations and interpretable visuals.

The conducted evaluation demonstrates that the proposed CNN–GRU architecture achieves significant performance in seizure detection and forecasting relative to standalone deep learning model and conventional machine learning models. The proposed framework shows improved accuracy, sensitivity, specificity, recall, and F1-score while effectively reducing false positive predictions. The Explainability analysis highlights clinically relevant EEG regions and temporal patterns contributing to seizure onset prediction by supporting reliable clinical interpretation.

Paper ID: 1155

Comparative Analysis of Filter-Based Feature Selection Methods for DDoS Attack Classification

Vinit Tribhuvan (COEP Tech Pune)*; Deepak Kshirsagar (COEP Tech Pune)

Abstract: In this study, we present a filter-based feature selection approach aimed at improving the efficiency and accuracy of DDoS attack detection. Five statistical filter methods—Information Gain, Gain Ratio, Symmetric Uncertainty, Chi-Square, and Correlation—are employed to evaluate and rank the rele-vance of features within the FLNET 2023 dataset. Based on the computed rankings, we identify and retain the most informative features, while discarding those with zero ranking which are likely to induce noise. This process effectively eliminates irrelevant and noisy attributes from the dataset. As a result, the dimensionality of the feature space is reduced, leading to a leaner and more robust feature set. The reduced feature set not only boosts the detection capacity of the model but also improves detection time. This demonstrates the potential of filter-based feature selection in enhancing the performance of DDoS detection systems by improving the learning process and focusing on the most impactful attributes.

Paper ID: 1156

Graph-Structured versus Flat Representations of Anatomical Landmarks for Endpoint Prediction in Endotracheal Intubation Video: A Controlled Ablation Study

Sonali Sawant (PCCOE)*; Vibha Vyas (COEP Tech University); Sunil Tade (PCCOE); Nutan Bansode (MIT Alandi); Shubhang Gandhi (PCCOE); Archana Bhamare (PCCOE)

Abstract: Reliable localization of anatomical landmarks in laryngoscopic video is a prerequisite for computer-assisted endotracheal intubation (ETI). This paper investigates whether representing a small set of anatomical landmarks Epiglottis, Arytenoids, and Vocal Cords as a graph and processing them with a Graph Neural Network (GNN) offers an advantage over a conventional Multi-Layer Perceptron (MLP) that receives identical information, for the task of predicting the Glottis location in a single video frame. We formulate this as a controlled ablation MLP vs. a 4-node GNN in which both models receive exactly the same per-landmark coordinates and observation masks, are trained under an identical protocol, and are evaluated on a video-disjoint held-out test set. We explicitly distinguish single-frame endpoint prediction from trajectory estimation and restrict our claims accordingly. The GNN reduced test-set (held-out video, n=52 frames) mean Euclidean endpoint error from 0.220 to 0.074 in normalized coordinates and 66.2% reduction corresponding to a reduction in pixel-space endpoint error from 174.6±124.2 px to 82.5±53.3 px, under closely matched parameter budgets (6,946 vs. 6,562 trainable parameters). Both models improved on a trivial train-mean predictor (202.4±37.3 px mean error), but the GNN did so far more (59.2% reduction vs. the MLP's 13.8%) and, unlike the MLP, also reduced error variability relative to that baseline.

Paper ID: 1157

Industrial Defect Detection and Classification using Classical Image Processing Techniques

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Abstract: The global manufacturing market size reached approximately USD 14 trillion in 2024, while quality related losses continue to cost industries nearly 3–5% of their annual revenue due to defective products and inefficient inspection systems. Automated industrial defect detection has therefore become essential for maintaining product quality and improving manufacturing reliability. This paper proposes a lightweight and explainable industrial object defect detection system using classical image processing techniques for boundary integrity analysis of circular industrial components. The proposed system utilizes CLAHE enhancement, bilateral filtering, Otsu thresholding, morphological operations, contour extraction, minimum enclosing circle fitting, radial deviation analysis, convexity analysis, and rule-based geometric feature classification for automated defect identification. Four geometric metrics, namely Relative Maximum Deviation, Standard Deviation of Radial Deviations, Convexity Ratio, and Normalized Convexity Defect Depth, are extracted to identify boundary irregularities and localized defects without using deep learning models. The system was experimentally tested on an industrial dataset containing 400 images, including 200 OK and 200 NOT OK samples. The experimental results showed an accuracy of 86.75%, precision of 90.16%, recall of 82.50%, specificity of 91.00% and F1 score of 86.16% which indicated good classification performance for the industrial defect. The methodology proposed is very computationally efficient, easy to interpret, and applicable for an automatic quality inspection application in the industry.

Paper ID: 1158

Explainable AI for Skin Disease Diagnosis in Rural Healthcare

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Abstract: Deep learning became essential for automated skin disease diagnosis because it enables machines to learn complex visual patterns from dermoscopic images. The study uses a deep learning image classification system to achieve precise skin disease detection while keeping computational requirements low. The training process tests the model's ability to learn distinguishing features of lesions while reaching stable performance within short training times, which makes the system suitable for use in medical facilities with limited resources. The Explainable Artificial Intelligence framework enables users to visually interpret their diagnostic decisions through its system design. The system enables clinicians to extract meaningful activation regions that represent specific lesion characteristics, thereby helping them to validate model predictions. The system requires transparent operations because it helps build clinical trust through its ability to base automated decisions on medically important information. The approach delivers an equal base, which enables precise skin disease diagnosis through explainable deep learning methods that provide understandable results.

Paper ID: 1161

HealthPilot: A Pre-Diagnostic Health Self Assessment informatics with Anatomical Retrieval

Prajwal Sonawane (Coep Technological University)*; Tanu Sharma (Coep Technological University)

Abstract: Explicit anatomical context may help select evi-dence for health-information questions, but retrieval quality andgenerated-answer quality require separate evaluation. HealthPi-lot combines an anatomical interface, lexical retrieval, a locallanguage model and a source-matching gate. We investigate thecontribution of body-region context while keeping the generatorand output contract fixed. A frozen corpus contains 5349 passagesfrom 1014 MedlinePlus topics. Development selects a text weightof λ = 0.70. On 40 synthetic questions from 20 held-out topicfamilies, text-only and anatomical retrieval achieve Hit@3 of87.5% and 95.0%, respectively. Their paired family-bootstrap95% interval for the difference is [0.0,15.0] percentage points,which includes zero. Anatomical retrieval improves truncatedreciprocal rank on 10 questions, leaves 30 unchanged, andworsens none. Additional sensitivity and exhaustive wrong-regiontests characterize when this feature helps and fails; they do notretune the selected weight. Among 44 questions, including fourcontrols, only 5 text-RAG and 8 anatomical-RAG outputs passthe source gate. These findings support a bounded, reproducibleinvestigation of evidence selection, not diagnostic accuracy orclinical validation.Index Terms—health information, anatomical context, retrieval-augmented generation, evidence provenance, abstention

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Paper ID: 1165

Surface-Form Consistency: A Label-Free Diagnostic for Retrieval-Augmented Generation

Shivam Dhanadhya (COEP Tech)*; Vahida Attar (COEP Tech); Sachin Pawar (COEP Tech)

Abstract: Retrieval-augmented generation (RAG) systems areusually evaluated one query at a time, which assumes that eachconcept has a single name. In Indian health informatics thisassumption fails: one herb may be named in Sanskrit (Tulsi),by its botanical binomial (Ocimum sanctum) or in English (HolyBasil), and one drug by its brand or generic name. This paperproposes Surface-Form Consistency (SFC), a label-free metricthat measures whether a retriever returns the same evidencefor all known names of an entity. SFC is the mean pairwiseJaccard overlap of the result sets, reported with a reachabilityterm and applied relation-aware. On a deployed Indian healthknowledge base of 360 herbs and 399 drugs, SFC was only 0.089and 0.056, with about nine in ten name pairs retrieving disjointevidence. Investigating these scores revealed two defects missedby context precision; fixing them raised SFC to 0.619 and 0.209and classical-synonym reachability from 6 to 100 percent. Hybridretrieval matched the best recall (0.990) yet was seven timesless consistent, and SFC correlated with downstream answercorrectness (Spearman 0.46 to 0.49). Fault injection, negativecontrols and replication on three public corpora support SFC asa complement to query-level evaluation.

Paper ID: 1166

An ML-Driven Parallel Asymmetric Hybrid Intrusion Detection Framework for CAN-Based ADAS

Ajinkya Kadupatil (College of Engineering Pune)*; Deeplaxmi Niture (COEP Technological University)

Abstract: Controller Area Network (CAN) is widely used forcommunication among ECUs in ADAS, but the standard does notprovide built-in mechanisms for authenticating frame origin orprotecting payload contents. This leaves safety-critical in-vehiclenetworks exposed to attacks such as frame injection, bus flooding,and message spoofing. In this work, we establish a softwarebaseline for our doctoral research and evaluate a computeefficient hybrid intrusion detection framework for Level-2 ADASnodes. CAN identifiers are

excluded from the learning features toreduce the possibility of identifier-based shortcuts. The resultingpipeline combines a 100-tree Random Forest with a compact5-layer autoencoder and uses a 95th-percentile reconstructionthreshold for anomaly detection. Experiments on chronologicalstreams from the HCRL Car-Hacking Dataset show that the twomodels respond to different attack characteristics. The ablatedRandom Forest detects high-volume DoS flooding with 99.98%accuracy and 0.9992 recall, but it does not detect the evaluatedpayload-level attacks. The autoencoder detects 97.92% of Fuzzyinjections and 100% of RPM spoofing frames. In the cascadedconfiguration, more than 95% of normal traffic bypasses theautoencoder, while the measured average per-frame latency is5.8 ms on the test laptop. This result provides a software referencepoint for subsequent hardware-in-the-loop (HIL) evaluation onautomotive microcontrollers.

Paper ID: 1167

Advanced Pattern Classification Models for Intelligent Diagnosis of Jujube Leaf Diseases in Precision Agriculture

Tikesh Lilhare (COEP Technological University Pune)*

Abstract: Jujube (Ziziphus jujuba Mill.), cultivated for more than seven thousand years, and its Indian counterpart ber (Ziziphus mauritiana Lamk.) are losing productivity to a group of foliar diseases led by Alternaria black spot, rust, anthracnose and phytoplasma-induced witches' broom. Learning-based diagnosis has matured for many field and horticultural crops, yet the jujube literature remains fragmented. This paper arranges the relevant work into five families: pathological characterisation, imagebased recognition, severity quantification, attention-driven and multi-modal learning, and spray decision support. It also catalogues the image collections that jujube researchers can use today. Twenty representative studies are contrasted on crop, architecture, data, headline metric, grading ability and principal weakness, and a capability matrix records which of seven desirable properties each one offers. The analysis shows that no existing system combines jujube-specific validation, five-level severity scoring, automatic lesion-area measurement, text-assisted disambiguation and spray guidance, and that Indian cultivars are absent from the evidence base. Six open problems and a set of recurring technical challenges are formalised, and a roadmap is outlined around a regional benchmark, a single-pass hybrid CNN–Transformer, a symptom-lexicon vision–language extension, local pathogen confirmation and lightweight, decisioncoupled deployment.

Paper ID: 1171

BharatNyaya: A Multilingual Retrieval-Augmented Legal Question-Answering System for Indian Citizens

Shivpratap Mithapalli (PICT Pune)*; Anjali Deshpande (COEP Technological University); Amar Mithapalli (Symbiosis Institute of Design, Symbiosis International University, Pune)

Abstract: India's legal system operates predominantly in English, which creates a huge accessibility gap between the legal system and citizens, where the majority do not understand English well, if at all. This paper presents BharatNyaya, a multilingual legal question answering system that handles queries in English, Hindi (Devanagari script), and Hinglish (code-mixed Hindi-English) with a primary objective of making Indian laws available to its citizens. Its corpus includes five contemporary Indian statutes, acknowledging the recent legal transition to new criminal codes in the Indian judicial system. The system integrates a Unicode-based cross-script classifier, a multilingual centroid-based semantic role filter, a hybrid dense-sparse retrieval fused via Reciprocal Rank Fusion (RRF) and a cross-lingual reranker followed by a fine-tuned large language model (LLM) with LoRA adapters. To the best of our knowledge, BharatNyaya is the first system to target new criminal codes of the Indian legal system with multilingual capabilities. We also find various techniques that help improve RAG (Retrieval-Augmented Generation) to better adapt multiple languages and work across various scripts (Latin and

Devanagari).

Paper ID: 1173

A Comprehensive Survey on Artificial Intelligence and Deep Learning Techniques for Legal Information Retrieval and Case Matching

Nitin Ujgare (ABV-IIITM Gwalior)*; Divya Karegaonkar (MVPS's KBT College of Engineering Nashik); Vaishanvi Bhagat (MVPS's KBT College of Engineering Nashik); Bhargav Ahire (MVPS's KBT College of Engineering Nashik); Atharva Dedhe (MVPS's KBT College of Engineering Nashik); Swati Baviskar (MVPS's KBT College of Engineering Nashik)

***Abstract**:* The legal ecosystem in 21st century is going througha transformative shift for legal data accessibility and decisionmaking. The use of AI-powered technologies including machinelearning, deep learning and natural language processing toimprove legal information retrieval for relevant legal precedentis substantially increasing to expedite the search process andconsistency of legal documents. However, legal information searchis different from simple keyword matching, where the understanding of semantic intent behind the complex legal queriesis highly important. This comprehensive survey analyzed therecent research studies in legal information retrieval, case matching and classified them into three broad categories: machinelearning, deep learning, and advanced deep learning approaches. The reviewed studies cover standard datasets frequently used incommon-law and civil-law jurisdictions, with particular focus onmulti-level reasoning, query document relevance modeling, and anuncertainty prediction. The key finding of the survey highlightsthat, despite AI advancement in legal information retrieval andsimilar case matching, many issues remain unsolved, particularlythe model selection for different legal systems, potential risk of AI-generated information hallucination, semantic failure, and lackof critical explainability that forms a bottleneck in AI decisionsupport systems.

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