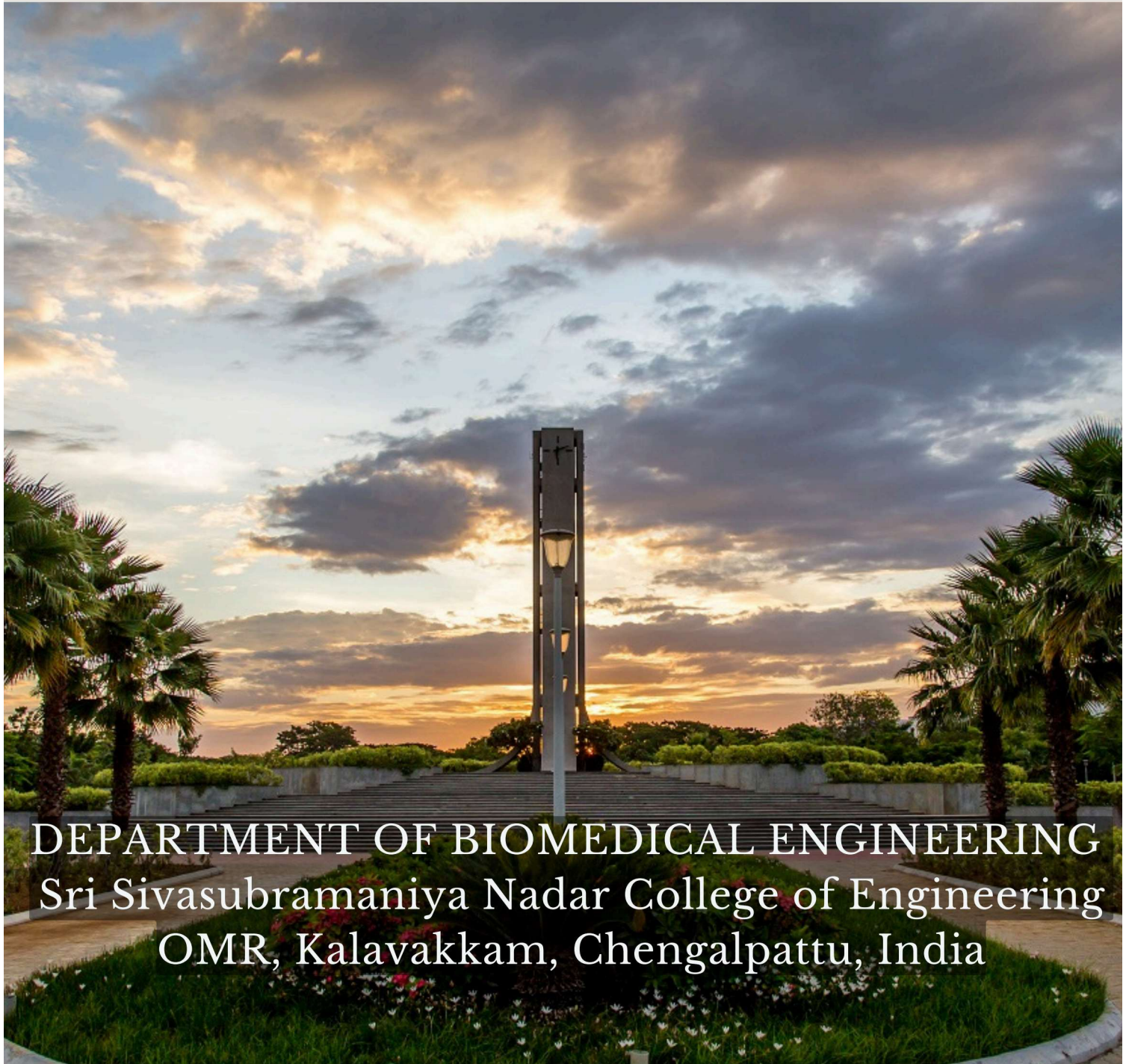


*XII International Conference on BioSignals,
Images and Instrumentation*
March 09-11, 2026



DEPARTMENT OF BIOMEDICAL ENGINEERING
Sri Sivasubramaniya Nadar College of Engineering
OMR, Kalavakkam, Chengalpattu, India

TWELFTH INTERNATIONAL CONFERENCE ON BIOSIGNALS, IMAGES, AND INSTRUMENTATION (ICBSII)

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ISBN: 979-8-3195-4353-0



ISBN - 979-8-3195-4353-0

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ICBSII 2026, SSNCE, CHENNAI, MARCH 09 – 11, 2026



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National
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**Proceedings of the
XII International Conference on
Biosignals, Images and Instrumentation
(ICBSII 2026)**

**Department of Biomedical Engineering
Sri Sivasubramaniya Nadar College of Engineering**

March 09-11, 2026

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From the Patron

Dr. S. Radha

Principal

SSN College of Engineering



It gives me immense pleasure to note that the Department of Biomedical Engineering of our institution, in collaboration with the Centre for Healthcare Technologies, is organizing the Twelfth International Conference on Bio-Signals, Images, and Instrumentation (ICBSII 2026). I am delighted to extend my warm greetings and best wishes to all the participants, researchers, academicians, industry professionals, and students who are part of this prestigious global event.

This conference has been thoughtfully designed to serve the Biomedical Engineering community by fostering collaboration, innovation, and meaningful knowledge exchange. Biomedical Engineering continues to emerge as a dynamic and interdisciplinary domain that integrates engineering principles with medical and life sciences to develop advanced medical devices, intelligent diagnostic systems, precision therapies, and efficient healthcare delivery solutions. Such advancements play a crucial role in addressing global healthcare challenges and improving the quality of life.

The Department of Biomedical Engineering has consistently demonstrated excellence through its strong commitment to academic, research, and professional development activities. The involvement of both faculty and students in multidisciplinary research, industry interactions, and technology-driven learning has strengthened the department's foundation and prepared graduates to meet evolving industrial and societal demands.

ICBSII has evolved over the years into a reputed international platform that brings together scientists, engineers, clinicians, innovators, and researchers from across the world. It provides an excellent opportunity for participants to present their research, exchange ideas, build collaborations, and explore emerging trends in biomedical technologies. I sincerely appreciate the organizing committee for their tireless efforts in bringing distinguished keynote speakers and eminent experts from academia and industry, whose insights will undoubtedly enrich the conference and inspire young researchers.

I congratulate the entire organizing team for their meticulous planning and dedication in conducting this conference. I am confident that ICBSII 2026 will be a great success and will significantly contribute to the advancement of biomedical research, innovation, and global healthcare.

I wish all the delegates a productive, insightful, and memorable conference experience.

With best wishes,
RADHA.S

From the Conference Chair

Dr. A. Kavitha

Professor and Head,
Department of Biomedical Engineering,
SSN College of Engineering



It gives me immense pride and pleasure to extend a warm welcome to all delegates, researchers, academicians, industry professionals, and students to the Twelfth International Conference on Bio-signals, Images, and Instrumentation (ICBSII 2026) organized by the Department of Biomedical Engineering, SSN College of Engineering, Chennai. This prestigious conference, scheduled from 9th to 11th March 2026, continues our long-standing commitment to advancing research and innovation in Biomedical Engineering.

ICBSII has become an emotion and a landmark academic initiative in the technical arena of our department. Since its inception in 2013, the conference has successfully evolved into a globally recognized platform for interdisciplinary collaboration, knowledge exchange, and technological advancement. Each edition has strengthened our vision of bridging healthcare, engineering, and emerging digital technologies to improve patient care and quality of life.

Biomedical engineering plays a transformative role in revolutionizing modern healthcare. The integration of engineering principles with biological and medical sciences has led to groundbreaking developments in biosignal processing, medical imaging, data analytics, prosthetics, wearable devices, and intelligent diagnostic systems. ICBSII 2026 aims to highlight these advancements and provide a dynamic platform for showcasing pioneering research, exchanging innovative ideas, and fostering global collaborations that address real-world healthcare challenges.

One of the major highlights of ICBSII 2026 is the presence of highly distinguished keynote and invited speakers from premier institutions and industry across the world. The conference features eminent experts such as Dr. Erika Ross Ellison, President of IEEE Engineering in Medicine and Biology Society; Dr. Zhong Liang from SingHealth Duke-NUS Cardiovascular Sciences; Dr. Che Wei Lin from National Cheng Kung University, Taiwan; Dr. Romana Schirhagl from UMCG Groningen; and renowned academicians from India including Dr. Uttama Lahiri from IIT Gandhinagar, Dr. Mohanavelu, DEBEL, DRDO, and leading healthcare institutions. Their diverse expertise spanning cardiovascular sciences, nanomedicine, medical imaging, biosensors, rehabilitation engineering, and biomedical instrumentation will provide valuable insights into emerging trends and future directions of healthcare technologies. These keynote sessions are designed to inspire participants, encourage interdisciplinary thinking, and strengthen the link between academia, clinical practice, and industry.

Over the years, ICBSII has successfully fostered innovation through expert talks, technical sessions and workshops. The conference has sparked numerous valuable international partnerships, yielding MoUs for faculty and student exchanges along with joint research efforts. Through ICBSII 2026, we aim to empower young researchers and students with the knowledge, skills, and motivation required to address evolving global healthcare needs.

On behalf of the Department of Biomedical Engineering, I extend my sincere appreciation to all the organizing committee members, reviewers, sponsors, and participants for their dedicated efforts in making this conference a grand success. I am confident that ICBSII 2026 will set new benchmarks in research excellence, innovation, and global collaboration.

Let us come together to explore new frontiers, build meaningful partnerships, and inspire the next generation of biomedical engineers. I warmly welcome you all to ICBSII 2026 – a platform where ideas transform into innovations and aspirations lead to impactful achievements.

Welcome to ICBSII26!



Dr.S.Saranya
Assistant Professor, BME
SSNCE



Dr.J.Subitcha
Assistant Professor, BME
SSNCE



Dr.B.S.Suresh Anand
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The field of biomedical engineering is constantly evolving, and the Twelfth International Conference on Bio-signals, Images, and Instrumentation (ICBSII 2026) provides a unique opportunity to explore the latest research, innovative technologies, and breakthrough discoveries. The exchange of knowledge, ideas, and experiences throughout this conference, will undoubtedly advance our collective understanding and help tackle the most pressing challenges in biology.

This year, we are privileged to host distinguished experts in biomedical engineering. Notably, Dr. Erika Ross Ellison, President, IEEE EMBS USA, and Dr. Zhong Liang from Duke-NUS, Singapore, have consented to be our chief guests for this Twelfth Edition of the conference. Expert lectures covering the niche areas of healthcare are scheduled for this year. Highlights include Dr. Zhong Liang on “The Living Heart in 4D,” Dr. K. Mohanavelu discussing “Combat Biomedical Technologies” and Dr. Chei Wei Lin on Multimodal Neurorehabilitation. We are also excited to hear from Dr. V. B. Narayana Murthy on Contemporary Engineering in Clinical Sciences and Dr. Romana Schirhagl on Diamond-based Quantum sensing for Drug Testing. These sessions, along with many others, promise to inspire and foster collaborations, setting the stage for a transformative conference.

We have received an overwhelming interest from the research community in India and abroad to participate in our conference. With over 300 research articles received, the acceptance rate is limited to approximately 30% to maintain the quality of the presented paper. This was made possible by the rigorous review process conducted by national and international experts in the relevant fields. We are thankful to our sponsors IEEE (technical co-sponsor), Anusandhan National Research Foundation (ANRF), XENS-Galore Systems, XR Panda Canada, and Gentech Marketing, who have supported us with necessary publication and financial support.

We would also like to extend our heartfelt thanks to our colleagues, fellow organizers, committee members, supporting staff, and student volunteers of the Biomedical Engineering department. Their shared responsibilities and teamwork have paved the way for the smooth organization of this prestigious event. We are grateful for the support of SSN institutions for the necessary permissions and support extended in organizing this conference. We would also like to extend our heartfelt thanks to our colleagues who are fellow organizers and committee members, supporting staff, and student volunteers of the Biomedical Engineering department whose shared responsibilities and teamwork have paved the way for a smooth organization of this prestigious event.

We hope this conference will be a rewarding experience for all involved and serve as a catalyst for future collaboration, innovation, and progress in the field of biomedical engineering. We look forward to productive discussions and fruitful networking.

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Keynote Speakers' Profile

Neural Engineering for Stakeholders: From Curiosity to Commercialization

About Speaker

Dr. Erika Ross Ellison obtained her Ph.D. in Neuroscience from the Mayo Clinic Graduate School of Biomedical Sciences, following a B.S. in Biology and Business and an M.S. in Molecular Biology from the University of Denver. She currently serves as the President of the IEEE Engineering in Medicine & Biology Society (EMBS), where she leads a global community of 14,000 bioengineers across nearly 100 countries. In addition to her leadership at EMBS, she is the Founder of Ross Ellison Consulting, advising early-stage neurotechnology companies on clinical, regulatory, and quality strategy. She also applies her expertise as a fractional Chief Clinical & Regulatory Officer for innovative companies such as Neuraworx Medical.



Dr. Erika Ross Ellison
President, IEEE Engineering in
Medicine & Biology Society

Previously, Dr. Ellison was the Vice President of Global Clinical, Regulatory, and Quality at ONWARD Medical, where she successfully guided the company's neuromodulation therapies for spinal cord injury through FDA market authorization in 2024 and CE Mark approval in 2025. Her extensive industry experience includes serving as the Director of Clinical & Applied Research at Abbott, advancing neuromodulation treatments for Parkinson's disease and chronic pain, and as the Neuroscience Director at Cala Health, a Stanford Biodesign-incubated startup, where she helped build the company's digital health architecture and commercialization strategy. Her career began at the Mayo Clinic, where she served as an Assistant Professor of Neurologic Surgery and the Deputy Director of the Surgical Device Innovation Accelerator, focusing on translating clinical needs into surgical device innovations.

ABSTRACT

Neural engineering often begins with a simple question about how the brain works. It becomes something far more complex when that question must survive regulators, investors, clinicians, patients, and markets. In this talk, I reflect on the path from scientific curiosity to commercial reality through the lens of my own journey across academia, startups, global conferences, regulatory strategy, and executive leadership in neurotechnology.

We will explore how ideas evolve from lab prototypes to clinical programs, what changes when a device moves from proof of concept to pivotal trial, and how stakeholder alignment determines whether a technology advances or stalls. I will share lessons learned about evidence generation, risk, reimbursement, global strategy, and the cultural tensions between research ambition and commercial discipline. Neural engineering is not just about signals and stimulation. It is about building systems of trust across scientists, clinicians, patients, regulators, investors, and industry. When we design with all stakeholders in mind from the beginning, we increase the probability that transformative ideas will not only work, but reach the people who need them.

The Living Heart in 4D: From Blood Flow Physics to Clinical Decision Making

About Speaker

Professor Liang Zhong is an Associate Professor at Duke-NUS Medical School and the Department of Biomedical Engineering, National University of Singapore and a Senior clinician-Innovator and Principal Investigator at the National Heart Centre Singapore (NHCS). He serves as Director of the College of Healthcare Engineering (CHE), Co-Director of the Cardiovascular Systems Imaging and Artificial Intelligence (CVS.AI) Lab, and Head of Cardiovascular Bioengineering and Technologies at NHRIS.

His research focuses on cardiovascular imaging, artificial intelligence and machine learning, clinical AI translation, cardiovascular mechanics and physiology, and digital twin technologies. He is also actively involved in the development of international consensus guidelines for 4D flow cardiovascular magnetic resonance (CMR).

Prof Zhong has published over 240 peer-reviewed articles, book chapters, and conference papers in leading international journals, including Nature Reviews Cardiology, The Lancet Regional Health, and Journal of Cardiovascular Magnetic Resonance. As of January 2026, he has an H-index of 41, an i10-index of 131, and more than 6,600 citations and has secured over SGD 50 million in competitive research funding, including SGD 15 million as Principal Investigator, to support interdisciplinary research in cardiovascular engineering and AI-enabled healthcare. Prof Zhong holds leadership roles in professional societies, including IEEE Engineering in Medicine and Biology and the International Society for Magnetic Resonance in Medicine (ISMRM), and serves on multiple international journal editorial and advisory boards.



Dr. Zhong Liang
*Associate Professor,
SingHealth Duke-NUS
Cardiovascular Sciences Academic
Clinical Programme*

ABSTRACT

The human heart is a dynamic pump whose primary role is to move blood efficiently through the body. However, traditional cardiac assessments often focus on structure or simplified functional measures, overlooking the rich information carried by blood flow itself. This talk introduces a new way of understanding the heart by visualising blood motion in four dimensions, three-dimensional space over time, using 4D flow imaging.

We begin with an intuitive overview of heart physiology and the basic physics of blood flow, showing how patterns of filling and ejection reflect both health and disease. The concept of 4D flow imaging is then introduced, illustrating how modern magnetic resonance techniques capture blood movement throughout the beating heart. Beyond visualisation, we explore how blood flow can be quantified to reveal efficiency, direction, and complex flow patterns invisible to conventional tests.

The talk concludes with clinical examples demonstrating how 4D blood flow insights can support diagnosis, risk assessment, and treatment planning in heart failure, valve disease, and congenital heart conditions, linking flow physics to clinical decision-making.

*Multimodal Immersive Neurorehabilitation***About Speaker**

Dr. Che-Wei Lin is a Professor in the Department of Biomedical Engineering at NCKU, holding joint appointments in the Institute of Gerontology, the Institute of Medical Informatics, and the Department of Biotechnology and Bioindustry Sciences. He actively serves in leadership roles within his field, acting as the Secretary General of the Taiwanese Society of Biomedical Engineering (TSBME) and as a board member for the Taiwan Society of Innovative Implantology. His primary research interests focus on artificial intelligence and machine learning-based biomedical signal processing, AI medical wearable device design, and virtual reality medical-based assistive systems.



Dr. Che Wei Lin
Professor, Department of Biomedical Engineering,
National Cheng Kung University,
Taiwan

Dr. Lin is a prolific researcher with an extensive publication record, having authored numerous peer-reviewed articles in international journals such as IEEE Sensors Journal, Expert Systems with Applications, and IEEE Access. He has also been widely recognized for his innovative contributions and excellence in teaching, receiving numerous awards including the Taiwan National Innovation Award in both 2023 and 2024, the NCKU Rising Star Research Award in 2025, and being named an Asia-Pacific Research Networking (APRN) Fellow by the International Federation for Medical and Biological Engineering in 2025. Furthermore, he recently won the SEMBA 2026 Excellent Industrial Potential Award for his project on YOLO-based ECG Edge AI.

ABSTRACT

Stroke remains a leading cause of long-term disability, yet traditional mirror therapy (MT) often lacks the intensity and multisensory engagement required to promote optimal neuroplasticity. This session introduces about a hybrid rehabilitation ecosystem, designed to bridge the gap between visual illusion and proprioceptive feedback. The proposed system integrates virtual reality mirror therapy (VRMT) with distal upper limb robotic assistive devices, specifically a wrist exoskeleton (TIGER) and a soft robotic glove.

We begin by exploring the system's unique closed-loop architecture, which offers synchronized and passive control modes. Unlike traditional setups, this allows the paretic limb to be physically driven by robotic actuators in real-time correspondence with the healthy limb's movements exploring how this integration of visual mirroring with robotic proprioceptive feedback, further augmented by rhythmic auditory and vibrotactile stimulation, enhances the user's sense of agency and embodiment. It concludes with clinical evidence from a study of 30 subjects, highlighting significant improvements in various fine motor tasks, examining the EEG data showing the induction of stronger event-related desynchronization (ERD) in the mu and beta bands than VRMT alone by this hybrid approach, demonstrating a synergistic therapeutic effect, that offers a superior, high-fidelity strategy for restoring motor function in patients with post-stroke hemiplegia.

*Contemporary Engineering in Clinical Sciences****About Speaker***

Prof. Dr. V. B. Narayana Murthy is a distinguished plastic and reconstructive surgeon based in Chennai, India, with extensive expertise in cosmetic surgery, peripheral nerve surgery, and comprehensive diabetic foot management. He began his medical journey at Stanley Medical College in 1977 and completed his MBBS in 1983 with outstanding academic performance, securing a university rank and a gold medal in his final year. In 1990, he was awarded the prestigious Fellowship of the Royal College of Surgeons of Glasgow (FRCS). He further advanced his specialization by obtaining Certification in Plastic Surgery in 1993 from the British Association of Plastic Surgeons and the Royal College of Surgeons of England.



***Prof. Dr. V.B.N. Murthy
M.B.B.S., F.R.C.S.(Glasgow),
Plastic and Reconstructive Surgeon,
Kauvery Hospital***

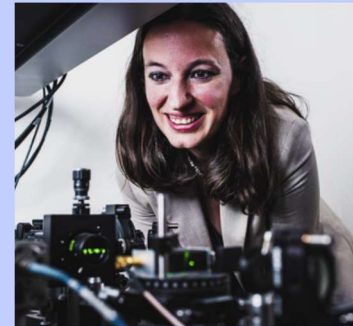
Renowned for his holistic approach to patient care, Prof. Murthy specializes in diabetic foot reconstruction, peripheral nerve surgery, and complex wound management, in addition to aesthetic procedures like rhinoplasty and body contouring. He serves as the Managing Director of NVA Wound Care Pvt Ltd and holds a visiting professorship at IIT Madras, reflecting his commitment to both clinical innovation and education. His contributions to medical science include patents for diabetic footwear and numerous publications in national and international journals. A dedicated philanthropist, he actively participates in medical camps organized by voluntary organizations and holds leadership positions in prestigious bodies such as the Diabetic Foot Society of India.

ABSTRACT

Contemporary engineering is playing a transformative role in advancing clinical sciences through the integration of biomedical instrumentation, artificial intelligence, medical imaging, and real-time physiological monitoring systems. Modern healthcare increasingly relies on data-driven models, embedded sensing technologies, and computational analytics to enhance diagnostic accuracy, treatment personalization, and patient monitoring. Innovations such as wearable devices, deep learning-based clinical decision systems, and smart point-of-care platforms are enabling predictive and preventive healthcare strategies. This session highlights recent technological developments, translational challenges, and the interdisciplinary collaboration required to bridge engineering innovation with clinical application, ultimately improving healthcare accessibility, precision, and outcomes.

*Diamond based quantum sensing for drug testing***About Speaker**

Prof. Dr. Romana Schirhagl is a Professor in the Department of Biomedical Engineering at the University of Groningen and the University Medical Center Groningen, who is internationally recognized for her pioneering work in diamond-based biosensing, nano-magnetic resonance imaging, and quantum sensing technologies for advanced biomedical diagnostics. She obtained her PhD with distinction from the University of Vienna, where she studied both chemistry and biology extensively. She subsequently held advanced postdoctoral positions at Stanford University and at ETH Zurich. In 2014, she successfully started her own group at Groningen University as a tenure-track assistant professor and was promoted to Full Professor in 2021. To commercialize her highly innovative quantum sensing equipment, Romana founded the spin-off company **QTsense** in 2024.



Dr. Romana Schirhagl
Professor, Department of Biomedical Engineering
University of Groningen &
University Medical Center Groningen

Prof. Schirhagl has received over 20 million EUR in research funding, securing prestigious recognitions including the ERC Starting, Consolidator, and Proof of Concept Grants, alongside the Dutch VIDI, ASPASIA, and Schmidt Futures Program grants. Her research bridges physics, chemistry, and biomedical engineering, with strong emphasis on translating diamond-based quantum sensing technologies into clinical and biomedical applications. In addition to her research leadership, she is deeply involved in education at the University of Groningen and has served as Coordinator for the MSc courses Biomedical Instrumentation I and II since 2018 and as Lecturer and Course Developer for Surface Characterisation and Microscopy and Imaging.

ABSTRACT

Free radical generation plays a key role in the mechanisms of action of many different drugs. Additionally, free radical generation offers a powerful biomarker to quantify the drug efficacy. However, free radicals are difficult to measure since they are short lived and reactive.

Diamond based quantum sensing offers a possible solution to this problem. We have demonstrated recently that we can predict which drugs might work in clinical samples. Here we can either measure stress responses [] (as for instance caused by anti-cancer drugs or anti-biotics) or reduction of oxidative stress [] (as caused by anti-inflammatory drugs, certain inhibitors or anti-oxidants). Figure 1 shows an example where we tested synovial fluid from rheumatoid arthritis and osteoarthritis patients[]. We can clearly differentiate the two groups which differ in their responsiveness to Piroxicam. Such ex-vivo measurements can be used for diagnostic purposes, to predict the effectiveness of a drug or to elucidate its mechanism of action. In my talk I will show different examples of how quantum sensing can be used in drug development.

Smart Platform to offer Evidence-based Personalized Support for Healthy and Independent Living at Private Spaces

About Speaker

Dr. Nagarajan Ganapathy is an Assistant Professor in the Department of Biomedical Engineering at the Indian Institute of Technology (IIT) Hyderabad and a leading researcher in clinical artificial intelligence and healthcare informatics, directing the Medical Informatics & Digital Health (MINDH) Lab at IIT Hyderabad. His primary research interests encompass a wide array of cutting-edge technologies, including deep learning, affective computing, the Internet of Medical Things (IoMT), and the development of wearable and smart sensors. Beyond his core academic and research duties, Dr. Ganapathy is highly engaged in global academic initiatives, serving as a DAAD (German Academic Exchange Service) Research Ambassador to foster Indo-German academic collaborations, and acting as the Department Faculty Advisor for International Relations at IIT Hyderabad.



Dr. Nagarajan Ganapathy
Assistant Professor,
Department of Biomedical
Engineering,
IIT Hyderabad

Dr. Ganapathy has made significant contributions to biomedical signal and image analytics, particularly in emotion recognition and affective computing, using multiscale deep convolutional neural networks and physiological signals like electrodermal activity (EDA), ECG, and EEG. His recent pioneering work focuses on edge analytics and contactless monitoring, creating robust machine learning frameworks for real-world healthcare applications such as radar-based elderly fall detection, camera-based driver stress state monitoring, and automated sleep apnea detection. He possesses an extensive publication record in esteemed international journals, including IEEE Transactions on Instrumentation and Measurement, Expert Systems with Applications, and Sensors. Committed to translating clinical AI into practical healthcare solutions, his research continually bridges the gap between complex big data analytics and accessible, intelligent medical diagnostics.

ABSTRACT

The session aims to explain about a Smart Platform that integrates multimodal sensing, artificial intelligence (AI), and behavioural analytics to promote evidence-based personalised support for healthy and independent living within private spaces. By leveraging wearable and ambient sensors, the platform will continuously monitor physiological, behavioural, and environmental parameters to detect early deviations in health and daily activity patterns. Advanced AI-driven decision models will generate individualised feedback and adaptive interventions to enhance physical, mental, and emotional well-being. The system will also employ privacy-preserving data fusion and context-aware algorithms to ensure secure, unobtrusive, and user-centric operation. Designed for scalability, this intelligent ecosystem supports diverse populations such as older adults, individuals with chronic conditions, and those in rehabilitation, ultimately fostering preventive healthcare, autonomy, and quality of life in everyday living environments.

Bridging Minds: Tech for Neuro-Inclusive Learning

About Speaker

Ms. Harleen Ahluwalia is the Head of the Department for Special Education Needs (SEN) at Shiv Nadar School, where she leads initiatives in inclusive education and specialized learner support. With a strong commitment to fostering accessibility and equity in school environments, Ms. Ahluwalia champions practices that enable diverse learners—including those with varying cognitive, social, and developmental needs—to thrive academically and socially. She has moderated thought leadership discussions on inclusive schooling, sharing insights on bridging policy and practice to cultivate emotionally safe and supportive educational spaces for all students.

Her expertise lies in designing inclusive frameworks, capacity building for educators, and advocating for learner-centred strategies that promote participation and achievement. Ms. Ahluwalia's work reflects a deep commitment to advancing educational equity through innovation, collaboration, and evidence-based practice.



*Ms. Harleen Ahluwalia
Head of the Department,
Special Education Needs,
Shiv Nadar School.*

ABSTRACT

Neuro-inclusive learning recognizes the diversity of cognitive processing styles and seeks to create equitable educational environments for learners with varied neurological profiles. Advances in educational technology, artificial intelligence, assistive systems, and adaptive learning platforms are transforming how institutions support students with autism spectrum conditions, ADHD, dyslexia, sensory processing differences, and other learning variations.

This session explores how emerging technologies—such as AI-driven personalized learning systems, speech-to-text and text-to-speech tools, immersive virtual environments, real-time attention monitoring, and data-informed intervention frameworks—can bridge gaps in accessibility and engagement. Emphasis will be placed on designing learner-centered digital ecosystems that integrate Universal Design for Learning (UDL) principles, promote cognitive flexibility, and enhance academic participation.

The discussion will also address ethical considerations, data privacy, educator training, and the importance of interdisciplinary collaboration between technologists, clinicians, and special educators. By leveraging thoughtful technological innovation, neuro-inclusive learning environments can move beyond accommodation toward empowerment—enabling every learner to thrive according to their unique strengths.

Witnessing Power of Physiology-sensitive Computing in Diagnostics, Rehabilitation and Affective State Estimation

About Speaker

Dr. Uttama Lahiri is an Associate Professor in the Department of Electrical Engineering at the Indian Institute of Technology Gandhinagar who received her Ph.D. from Vanderbilt University and her M.Tech. She has gained over a decade of industrial experience in data handling, signal acquisition, signal processing, and hardware-software interfacing, which continues to inform her translational research. Her research focuses on automated rehabilitation technologies for movement disorders, development of intelligent diagnostic tools, and Virtual Reality based Human computer Interaction for healthcare applications. She works extensively on sensory integration using eye-tracking and physiology-based modeling techniques to design adaptive neurorehabilitation systems for stroke, Parkinson's disease, and other neurological conditions.



Dr. Uttama Lahiri
Associate Professor
Department of Electrical
Engineering,
Indian Institute of Technology,
Gandhinagar

Dr. Ganapathy has made significant contributions to biomedical signal and image analytics, particularly in emotion recognition and affective computing, using multiscale deep convolutional neural networks and physiological signals like electrodermal activity (EDA), ECG, and EEG. His recent pioneering work focuses on edge analytics and contactless monitoring, creating robust machine learning frameworks for real-world healthcare applications such as radar-based elderly fall detection, camera-based driver stress state monitoring, and automated sleep apnea detection. He possesses an extensive publication record in esteemed international journals, including IEEE Transactions on Instrumentation and Measurement, Expert Systems with Applications, and Sensors. Committed to translating clinical AI into practical healthcare solutions, his research continually bridges the gap between complex big data analytics and accessible, intelligent medical diagnostics.

ABSTRACT

Computing augmented with Physiology has gained prominence in rehabilitation, diagnostics, affective computing and a host of other applications. With the inclusion of Artificial Intelligence and Signal Processing, Human Computer Interaction (HCI) has become more powerful and has been potent to establish seamless connectivity between 'human' and the 'computing world'.

The talk will highlight some of the applications of such computing related to rehabilitation, diagnostics and affective state estimation along with sharing some of the interesting research findings. With regard to rehabilitation, the talk will address how deficits in standing balance and gait can be benefited by use of Physiology-sensitive computing. With regard to diagnostics, the talk will present the work carried out on wearables. Finally, with regard to affective state estimation, the talk will present research exploring the use of gaze tracking to estimate one's cognitive state.

Combat Biomedical Technologies

About Speaker

Dr. K. Mohanavelu is a distinguished scientist currently serving as Scientist 'G' and Associate Director at the Defence Bioengineering and Electromedical Laboratory (DEBEL), a premier laboratory under the Defence Research and Development Organisation (DRDO) in Bengaluru. In his leadership capacity at DEBEL, he spearheads critical initiatives in the indigenization of biomedical technologies for the armed forces, focusing on life support systems, soldier performance augmentation, and advanced medical instrumentation. He plays a pivotal role in bridging the gap between clinical requirements and engineering solutions, overseeing the development of cutting-edge technologies that enhance the operational efficiency and safety of defense personnel.



Dr. K Mohanavelu
Scientist G &
Associate director,
DEBEL, DRDO

Dr. Mohanavelu obtained his M.Tech in Biomedical Engineering from the Indian Institute of Technology (IIT) Madras, following a B.E. in Instrumentation and Control from the University of Madras. Since joining DRDO in 2002, he has made significant contributions to the field of military physiology and bioengineering. His research interests are extensive, spanning wearable physiological monitoring, telemedicine, and cognitive workload analysis for fighter pilots. Notably, he has been instrumental in the development of the "Smart Vest" for remote health monitoring and the "PEARL" passive augmentative exoskeleton, designed to reduce musculoskeletal load for soldiers operating in difficult terrains. He is also an active contributor to the academic community, with numerous publications in reputed journals such as the Defence Science Journal and Biomedical Signal Processing and Control.

ABSTRACT

Combat biomedical technologies represent a critical intersection of engineering, medicine, and defense science aimed at improving survivability and rapid medical response in battlefield environments. Advances in portable diagnostic systems, wearable physiological monitoring devices, hemorrhage control technologies, telemedicine platforms, and AI-driven triage tools are transforming combat casualty care. Modern solutions focus on real-time health monitoring, autonomous decision support, lightweight life-support systems, and rapid evacuation coordination under resource-constrained conditions. This session highlights emerging innovations, translational challenges, and the role of interdisciplinary research in enhancing trauma management, resilience, and operational readiness in military healthcare systems.

AI in remote patient monitoring

About Speaker

Arvind Srinivas is a prominent leader in the medical technology industry, currently serving as the Vice President of Sales & Marketing for Aesculap, a division of B. Braun (BBRAUN). In this executive capacity, he is responsible for driving the commercial strategy, market presence, and growth initiatives for Aesculap's specialized medical and surgical solutions. Throughout his career, Srinivas has demonstrated a strong focus on navigating complex healthcare markets, enhancing clinical user experiences, and bridging the gap between advanced medical device technologies and the healthcare professionals who rely on them. His leadership focuses on building sustainable, value-driven partnerships that improve both procedural efficacy and patient outcomes.



Arvind Srinivas
Vice President,
Sales & Marketing (Aesculap),
BBRAUN

Prior to his current role at B. Braun, Srinivas served as the General Manager and Business Head of Ultrasound at Philips India, where he led the ultrasound business across the entire Indian subcontinent. During his tenure, he successfully spearheaded market penetration strategies across diverse clinical avenues, including cardiology, radiology, and obstetrics and gynecology (OB/GYN). Recognizing the growing demand for accessible healthcare infrastructure, he significantly expanded the direct salesforce to address the needs of clinicians and standalone clinics, particularly in Tier 2 and Tier 3 cities. He also successfully championed the growth of point-of-care (POC) diagnostic systems in the Indian market, facilitating strategic collaborations to ensure specialized medical technologies reach the clinicians who need them most.

ABSTRACT

Artificial Intelligence (AI) is transforming remote patient monitoring by enabling continuous, real-time assessment of physiological parameters outside traditional clinical settings. By integrating wearable sensors, Internet of Things (IoT) devices, and cloud-based analytics, AI-driven systems can process large volumes of biosignal and health data to detect anomalies, predict disease progression, and support early clinical intervention. Advanced machine learning and deep learning models enhance the accuracy of pattern recognition in signals such as ECG, PPG, blood glucose levels, and respiratory data, facilitating personalized and preventive healthcare. AI-powered remote monitoring not only reduces hospital readmissions and healthcare costs but also improves patient engagement and accessibility, particularly in rural and underserved populations. As healthcare increasingly shifts toward data-driven and decentralized models, AI-enabled remote monitoring stands as a critical enabler of proactive, efficient, and patient-centric care.

Human Digital Twins The Future of Movement, Performance & Rehabilitation

About Speaker

Mr. Vijay Dhamodharan, with over five years of dedication to sports performance and exercise physiology, has a journey driven by a passion for optimizing athletic potential and health outcomes. At the Sports Development Authority of Tamil Nadu, his role as a consultant has enabled him to combine cutting-edge research methods with practical training strategies, significantly enhancing athlete performance and program efficacy.



*Mr. Vijay Dhamodharan,
Channel Manager,
Xsens - South Asia*

Their expertise in biomechanics and kinesiology, complemented by hands-on experience as a certified personal trainer, enables a comprehensive and data-driven approach to performance enhancement. By bridging academic research with the real-world demands of high-performance sports, the speaker has contributed to building structured, scientifically grounded training ecosystems.

Committed to advancing the standards of sports science and athlete development, the speaker continues to promote innovation, performance optimization, and evidence-informed practice in competitive sports environments.

ABSTRACT

Human Digital Twins (HDTs) represent a transformative frontier in movement science, sports performance, and rehabilitation engineering. By creating dynamic, data-driven virtual replicas of individuals, HDTs integrate biomechanical modeling, wearable sensor data, medical imaging, and artificial intelligence to simulate, monitor, and optimize human movement in real time.

This session explores how digital twin frameworks enable precise performance analysis, injury risk prediction, personalized training adaptation, and rehabilitation planning. Through the fusion of motion capture systems, musculoskeletal modeling, physiological monitoring, and predictive analytics, clinicians and performance scientists can move from reactive treatment to proactive and preventive strategies.

Applications span elite sports performance optimization, post-surgical recovery modeling, neuromuscular disorder management, and remote rehabilitation through cloud-connected platforms. The talk will also address technical challenges, including model fidelity, multimodal data integration, computational scalability, privacy considerations, and clinical validation protocols.

By bridging biomechanics, computational intelligence, and translational healthcare, human digital twins are poised to redefine how we understand, enhance, and restore human movement—ushering in a new era of precision performance and personalized rehabilitation.

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TRACK 1

Attention-Enhanced CNN–BiLSTM Model for Emotion Classification from PPG Signals

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Abstract:

Emotion detection is of utmost significance in health care, human-computer interaction, and personalized systems, as it allows for improved tracking of mental health, adaptive user interfaces, and real-time stress level identification. Photo plethysmography (PPG) is a non-invasive and efficient method of registering changes in physiology that are accompanied by emotional states. The current work is interested in emotion analysis from PPG traces through the extraction of time domain features and frequency-domain features, such as heart rate variability (HRV), pulse amplitude, and spectral power. A hybrid framework has been developed, utilizing threshold based rules initially for primary labeling, followed by the use of deep models for refining classification precision. Experimental works were performed using the BIDMC dataset, where the proposed methodology achieved up to 92% accuracy, indicating the potential of PPG-based emotion recognition in real-time and wearable technologies.

Keywords: Emotion recognition, PPG signals, Deep learning, Hybrid approach, CNN–BiLSTM, Attention mechanism.

RSA-Enhanced Adaptive Noise Cancellation with Multi-Verse Optimizer for Robust ECG Signal Denoising and Classification

Aravinth J, Sidhiksha T S

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Abstract:

Electrocardiogram (ECG) signals are widely used in medical diagnosis to study electrical activity of the heart. However, ECG data are sensitive to a variety of noise sources during acquisition, including baseline wander, white Gaussian noise (WGN), artifacts of muscle activity, and power line interference (PLI). These noises distort the original signal and decrease the effectiveness of later analysis. Noise cancellation methods will improve the quality of the signal by removing unnecessary parts and increasing signal to noise ratio. This facilitates more precise analysis and enhances the performance of algorithms for anomaly detection and classification. This study provides a hybrid approach of combining Multi-Verse Optimizer (MVO)-based feature selection with an RSA-enhanced Adaptive Noise Cancellation (RSA-ANC) method. Multi-Objective Optimization (MVO) is applied to select features retaining key ECG characteristics while simultaneously suppressing noise levels, whereas the RSA ANC system is applied for efficient denoising functions. Experimental results show that the proposed system outperforms existing state-of-the-art ECG noise reduction methods as well as standalone MVO. After the denoising step, the system efficiently classifies arrhythmias (ARR) and Normal Sinus Rhythm (NSR) signals, and it shows potential for reliable clinical decision-making assistance.

Keywords: Electrocardiogram (ECG), Noise cancellation, Adaptive Noise Cancellation (ANC), Multi-Verse Optimizer (MVO), RSA algorithm, Signal-to-Noise Ratio (SNR).

Cascaded Adaptive Filtering of ECG Signals via Dual-Stage MFO–Jaya Optimization

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Abstract:

This paper suggests an effective method for the enhancement of Electrocardiogram (ECG) signals using an adaptive filtering technique with the objective of removing noise artifacts. ECG signals are often affected by baseline wander (BW), powerline interference (PLI), muscle artifacts (MA), electrode motion (EM), and additive white Gaussian noise (AWGN) artifacts, which conceal the diagnostic information. In order to solve this problem, we suggest a cascaded Adaptive Noise Cancellation (ANC) system, where each stage is tasked with a particular type of noise. The system uses adaptive Infinite Impulse Response (IIR) filters in series to successively denoise ECG signals. To achieve optimal results, a two-step optimization strategy is adopted. First, the Moth-Flame Optimization (MFO) technique is employed to determine the cutoff values, which enable the removal of initial noise. Subsequent to this, the Jaya Optimization algorithm optimizes filter parameters according to the properties of individual noise components targeted. Serial denoising phases reduce baseline wander, electrode motion artifacts, muscle artifacts, powerline interference, and AWGN. ECG signal validation on the MIT-BIH Arrhythmia Database shows massive improvements in signal clarity, drastic MSE reductions, and noise artifact suppression. The proposed framework achieves a minimum MSE of 0.002 and a maximum SNR of 17.0 dB, corresponding to an approximately 82% error reduction accuracy and improved signal quality compared to conventional optimization approaches. The cascaded and optimized adaptive filtering scheme proposed here ensures a robust solution for the enhancement of ECG signal with high potential for clinical diagnostics and ongoing cardiac monitoring systems.

Keywords: Electrocardiogram (ECG), Noise cancellation, Adaptive Noise Cancellation (ANC), Moth-Flame Optimization (MFO), Jaya Optimization, Mean Squared Error (MSE), Signal to-Noise Ratio (SNR), Signal Enhancement.

Stress Detection using Physiological Signals and Machine Learning

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Abstract:

Stress is a critical physiological and psychological condition that, if left undetected, could result in severe health complications, namely cardiovascular disorders, depression, cognitive impairment, reduced productivity. Advancements in wearable sensing technologies and artificial intelligence have enabled continuous monitoring of stress related physiological changes, making automated stress detection more practical and reliable. This paper offers comprehensive review of machine learning (ML) and deep learning (DL) approaches utilized for stress prediction using biomarkers, namely Electrocardiogram (ECG), Galvanic Skin Response (GSR), Respiration Rate, Heart Rate Variability (HRV), multimodal sensor data. A generalised methodological pipeline is proposed, which includes physiological signal acquisition, feature extraction, preprocessing in time and frequency domains, classification utilizing intelligent models such as Random Forests (RF), Support Vector Machines (SVM), Convolutional Neural Networks (CNN), Long Short Term Memory (LSTM) networks. Literature studies demonstrate that performance of stress detection systems significantly relies on quality of physiological data, feature representation, and model architecture. The review also highlights recent advancements, including photoplethysmography-based stress analysis, transfer learning, and hybrid fusion models that improve robustness in real world conditions. This work provides insights into state-of-the art (SOTA) techniques, existing limitations, upcoming research opportunities to facilitate development of efficient real-time stress monitoring systems for personalised healthcare and well being enhancement.

Keywords: Stress Detection, ECG, Wearable Sensors, HRV, Machine Learning, Deep Learning.

Investigation of EEGNet and its variants for ADHD Detection: Joint Spatial, Temporal, and Frequency Domain Learning

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Abstract:

Early and reliable detection of Attention Deficit Hyperactivity Disorder (ADHD) through EEG analysis holds much promise for developing objective and accessible neurodiagnostics. However, the conventional EEG-based ADHD detection approaches usually process the spatial, temporal, and frequency information separately, which leads to fragmented representations and limit the model's ability to learn representations from EEG data. In the study, we propose an end-to-end ADHD detection framework that uses EEGNet and modified EEGNet which are both compact convolutional networks used to classify different EEG-based brain computer interface applications. The model learns frequency, temporal and spatial domain representations together which enables the model to extract EEG patterns which reflect ADHD related neural activity. To avoid data leakage and evaluate the model's performance, the dataset was evaluated using subject-wise splitting through Group K Fold cross validation. The model achieved an accuracy of 97% when it was evaluated using sample-wise splitting. However, this setup introduces data leakage due to overlap of subject specific EEG characteristics across training and testing sets. These results highlight EEGNet as an efficient approach for ADHD detection from EEG signals.

Keywords: ADHD, EEG, EEGNet, Spatiotemporal Analysis, Data Leakage.

A Multiclass Framework for Epileptic Seizure Phase Classification Based on EEG Analysis

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Abstract:

Early and reliable detection of Attention Deficit Hyperactivity Disorder (ADHD) through EEG analysis holds much promise for developing objective and accessible neurodiagnostics. However, the conventional EEG-based ADHD detection approaches usually process the spatial, temporal, and frequency information separately, which leads to fragmented representations and limit the model's ability to learn representations from EEG data. In the study, we propose an end-to-end ADHD detection framework that uses EEGNet and modified EEGNet which are both compact convolutional networks used to classify different EEG-based brain computer interface applications. The model learns frequency, temporal and spatial domain representations together which enables the model to extract EEG patterns which reflect ADHD related neural activity. To avoid data leakage and evaluate the model's performance, the dataset was evaluated using subject-wise splitting through Group K Fold cross validation. The model achieved an accuracy of 97% when it was evaluated using sample-wise splitting. However, this setup introduces data leakage due to overlap of subject specific EEG characteristics across training and testing sets. These results highlight EEGNet as an efficient approach for ADHD detection from EEG signals.

Keywords: ADHD, EEG, EEGNet, Spatiotemporal Analysis, Data Leakage.

A Study Based on the Approximate Entropy Extracted from the Lower Limbs' sEMG Signal on Gait Analysis

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Abstract:

Understanding muscle activation patterns and their complexities is essential for improving prosthetic designs and clinical applications. In this study, a comparative analysis was conducted to investigate lower limb muscle activation patterns during level walking (LW), stair ascent (SA), and stair descent (SD) using surface electromyography (sEMG). Data were collected from six muscles: rectus femoris (RF), vastus lateralis (VL), semitendinosus (SEM), gastrocnemius medialis (GM), gastrocnemius lateralis (GL), and tibialis anterior (TA) during these activities. Approximate Entropy (ApEn) analysis of surface electromyography (sEMG) signals to quantify the neuromuscular complexity and motor control strategies during the transition from LW to stair climbing. Nonlinear analysis of sEMG signals reveals that LW is characterized by low, stable complexity (GM Mean 0.0160), reflecting rhythmic automation. Conversely, the transition to SA triggers a significant surge in signal entropy, with the RF Mean increasing by 64% (from 0.0169 to 0.0278) to manage concentric power demands. During stair descent, sustained high complexity in the TA (Mean 0.0229) and RF highlights a reactive, feedback-heavy eccentric braking strategy required for impact absorption and balance. Therefore, the proposed methodology can be used for analyzing sEMG signals in clinical and engineering applications.

Keywords: Surface Electromyography, Gait Transitions, Gait analysis, Approximate Entropy.

Signet: A Low-Cost Prosthetic Glove for Deaf and Mute Patients

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Abstract:

The impairment substantially inhibits real-time communication. Communication for the Deaf & Mute, particularly when interactions with people who are not proficient in sign language. Conventional methods refer to manual signing or written notes. may require the receiver to have specific knowledge in advance and may slow Down communication. This paper proposes a low-cost assistive communication glove for translating predefined hand gestures Using capacitive touch sensors with an Arduino Nano, translate it into text. The proposed system identifies seven defined microcontrollers. touch combinations and displays the corresponding messages in real time using a 16×2 I2C type LCD module. The glove is Light, compact, and engineered to be easy to handle with minimal training. Experimental evaluation was carried out in a controlled indoor conditions with multiple user trials. The system attained 96% average gesture recognition accuracy with a mean less than one second, as it is the expected response time. The results seem to show that the glove proposed is able to supply reliable and constant performance Being practical, cost-effective, and easy to use, Mance, Communication aid used by speech-impaired individuals on a day-to-day basis.

Keywords: Assistive communication system, smart glove, capacitive touch sensors, Arduino Nano, gesture recognition, embedded system, deaf and mute individuals.

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TRACK 2

Early Prediction of Diabetes Mellitus Using Supervised Machine Learning Techniques

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Abstract:

Diabetes Mellitus now receives major recognition as a gigantic metabolic disorder that, in fact, almost threatens the world in terms of public health. International statistics indicated that recently this condition tends to show continuous increases in prevalence, thus emphasizing the need for innovative prediction and prevention mechanisms. This ailment is characterized as an abnormal accumulation of elevated glucose levels in the circulatory system, possibly causing several metabolic complications, symptoms such as increased urination, increased thirst, and increased hunger. Three major classifications of this ailment exist: Diabetes of Type 1 Mellitus, Diabetes of Type 2 Mellitus, and Gestational Diabetes Mellitus (GDM). The scalable development of data-driven technologies holds machine learning in good stead to analyze complex health data and discover hidden relationships for predicting the onset of such diseases at an early stage. This paper assesses a variety of supervised learning techniques and compares them to find out which one is most suitable for diabetes prediction. Approximately algorithms like Random Forest (RF), Decision Tree (DT), Naïve Bayes (NB), Support Vector Machine (SVM), and Extreme Gradient Boosting (XG Boost) could be applied for their analyses according to their prediction performance. From the experimental results, it was established that the XG Boost model had the greatest accuracy of about 96%, followed by Random Forest with 94%, thus validating both models as being robust and demonstrating strong capability in early and accurate diagnosis of these diabetic conditions.

Keywords: Early Diabetes Prediction; supervision-based machine learning framework; Random Forest Classifier; Decision Tree Algorithm; XGBoost Framework; Naïve Bayes' Classifier.

Interpretable Diabetic Foot Ulcer Classification through EfficientNet Architectures with Grad-CAM

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Abstract:

Diabetic Foot Ulcer (DFU) is a serious complication of diabetes and affects millions worldwide. It results in amputation if left undiagnosed and untreated. Conventional clinical diagnosis is based on mere visual examination, which is prone to subjectivity and inter-observer variability. This work presents a computer-aided diagnosis system using EfficientNet architectures (B0–B3) for detection and visualization in DFU images. These models have been trained using a curated openly available dataset consisting of 543 normal and 512 ulcerated skin patches with extensive data augmentation, transfer learning, and the proposed custom classification head as techniques to enhance performance for binary classification. Model evaluation includes predictive metrics such as accuracy, precision, recall, and F1 score with computational metrics like FLOPs, parameters count, and inference time, giving a complete picture of accuracy and efficiency. Interpretability is enhanced through Grad-CAM visualizations, highlighting clinically relevant areas that influence the model's decisions. Experimental results showed that EfficientNet B3 yielded the highest test accuracy of 99.37% with near-perfect precision, recall, and F1-score of 0.994. Among lighter variants, EfficientNet-B0 and B2 obtained competitive accuracy (98.74%) with very low computational costs and were thus suitable for resource-constrained deployment, whereas EfficientNet-B1 obtained 98.11% accuracy with a balanced performance but moderately higher inference latency. This study also illustrates how EfficientNet-based models can be used to achieve accurate, efficient, and interpretable detection of DFUs.

Keywords: Diabetic Foot Ulcer (DFU), Computer-Aided Diagnosis, Deep Learning, EfficientNet, Medical Image Classification, transfer learning

Integration of Handcrafted Features with Deep Learning Model for Automated Grading of Cervical Histopathological Images

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Abstract:

Cervical cancer develops through progressive stages of cervical intraepithelial neoplasia (CIN), making accurate CIN grading essential for early detection and clinical diagnosis. Though many deep learning based solutions are proposed for detection and diagnosis, during the routine practice, the pathologist searches for the morphological changes including size, shape, arrangement of cells for decision making. The proposed work presents a computationally efficient framework for grading CIN based on interpretable, handcrafted features extracted from the whole slide images (WSIs) that align with the diagnostic cues assessed by the pathologists. Specifically, morphological and textural feature descriptors were extracted from the WSI patches, followed by characterization using XGBoost, Random Forest, and DL classifiers. This work presents a comparable performance with low computing complexity for the CIN classification task compared to end-to-end deep learning approaches.

Keywords: cervical intraepithelial neoplasia, handcrafted features, histopathology, classification, whole slide images .

Federated Machine Learning Approach for Multi-Protocol IoT Intrusion Detection for Healthcare

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Abstract:

This paper aims to present an Adaptive Federated Multi-Protocol Intrusion Detection System (AFM-IDS) to protect Internet of Things (IoT) environments which is used in many smart healthcare systems through a privacy-preserving and decentralised learning approach. Unlike conventional intrusion detection systems, instead of depending on centralised data and focusing on a single protocol, AFM-IDS uses Federated Learning (FL). This enables collaborative model development across heterogeneous IoT nodes or clients. A publicly available dataset, "ACI-IoT-2023", was preprocessed and distributed among multiple virtual devices for federated training. Each device trained a local neural network on protocol-specific traffic and sent encrypted model parameters to a central server for aggregation. The global model was evaluated with accuracy, precision, recall and F1-score metrics. AFM-IDS provides low latency, scalability and robust detection. Hence, this is a practical and adaptable framework for healthcare systems, which nowadays are very crucial to be handled with proper and safe usage.

Keywords: Internet of Things (IoT), Intrusion Detection System (IDS), Federated Learning (FL), Privacy Preservation, Multi-Protocol Networks, Machine Learning, Healthcare

Mitigating Optimism Bias in Fast Antimicrobial Susceptibility Testing via Imbalance-Aware Kernel KNN and SMOTE-NC

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Abstract:

The fast emergence of multidrug resistance (MDR) *Pseudomonas aeruginosa* imposes a serious challenge to medical outcomes universally, necessitating a move away from traditional antimicrobial susceptibility testing (AST) system that normally take 48-72 hours to complete. While ML offers an inspiring alternative for a very fast susceptibility prediction most current models suffer from “optimism bias” due to their inefficiency to effectively handle severe class imbalance and missed type medical data. In this research we propose an imbalance-aware diagnostic pipeline utilizing SMOTE-NC based synthetic oversampling for minority classes and a kernel based K-Nearest Neighbor (KNN) model with nonlinear BRF weighting. Also including advanced feature engineering calculations such as age stratification and a composite infection severity score, the model efficiently captures drug-specific resistance patterns for five very high priority antibiotics available in medical. Experimental outcomes demonstrate the model’s durable performance, achieving a maximum accuracy of 77.59% and a Matthews correlation coefficient (MCC) of 0.5518 for gentamicin. Specifically, this framework reveals an average inference time of less than 10 milliseconds. Setting up its clear appropriateness for real-time, point-of-care applications in resource-constrained medical settings.

Keywords: Antibiotic resistance; Class imbalance; SMOTE-NC; Computational efficiency; *Pseudomonas aeruginosa*.

AI-Driven Impact Analysis of Clinical Parameters influencing Menopause

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Abstract:

Menopause, a critical transition in a woman's life, is associated with diverse symptoms. Most existing studies focus on the analysis of menopause severity based on a single or specific factor only. Interrelationship study between the influencing factors and severity of menopause remains under explored. This study explores the impact of various clinical parameters on menopause severity using a data-driven approach to improve clinical understanding, interpretability and management. By analyzing key clinical parameters— including symptoms, hormonal levels, diagnostic, demographic parameters—this research identifies the most contributing features that influence the severity of menopause. The workflow involves data preprocessing, feature selection and validation. Initially the data is cleaned, and data imbalance is addressed using Synthetic Minority Over-sampling Technique. To facilitate the identification of key factors, feature selection techniques are integrated with machine learning techniques like Support Vector Machines (SVM), K-Nearest Neighbors (KNN), Random Forest, and XGBoost. Model evaluation and hyperparameter tuning help to make reliable identification of the impactful features. The identified clinical features include- Systolic Blood Pressure, Estrogen, Free Triiodothyronine, Triglycerides, Free Thyroxine, Progesterone, Age, Follicle Stimulating Hormone, Prolactin and Body Mass Index whose significance was validated through statistical analyses and clinical evidence. This approach serves as a clinical decision support system aiding tailored treatment and management of menopause severity.

Keywords: Menopause, clinical informatics, Machine Learning, Decision support, Impactful features

Prognosys: A Unified Multi-Modal Framework for Heterogeneous Disease Prediction and Context Aware Patient Education

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Abstract:

The contemporary digital health landscape is characterized by fragmentation, forcing patients to navigate a disconnected ecosystem of single-purpose applications. This "siloe" architectural paradigm imposes a significant cognitive burden on users and impedes the transition from reactive to proactive care. This paper introduces Prognosys, a unified, cross-platform framework designed to democratize access to predictive healthcare. We propose a novel modular API routing architecture that services both a responsive web interface and a native mobile application. The system integrates three heterogeneous diagnostic pipelines: a Hybrid Cardiovascular Risk Engine (combining Random Forest with a clinical rule based scoring algorithm), an EfficientNet-B0 Convolutional Neural Network (CNN) for detecting structural brain anomalies (tumors) as predictive biomarkers for epilepsy, and a VGG16 CNN for retinal fundus screening to predict glaucoma. Leveraging native mobile capabilities, the system facilitates direct image capture and upload. Furthermore, we integrate a Generative AI module, encased in a rigorous safety wrapper, to provide context-aware patient education. Experimental results demonstrate robust diagnostic performance—achieving accuracies of 94.0% for the Brain module, 92.1% for the Eye module, and 88.5% for the Heart module. Usability validation via the System Usability Scale (SUS) yielded a score of 85.3, confirming the efficacy of the modern "Glassmorphism" interface.

Keywords: Multi-Modal AI, Mobile Health (mHealth), EfficientNet, VGG16, Clinical Decision Support, Medical Image Analysis.

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TRACK 3

Electrochemical Characterization of ZnO–Graphene Hybrid Electrodes Functionalized with Cysteine and 3-Aminophenylboronic Acid for Non-Enzymatic Sensing Applications

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Abstract:

This work presents the electrochemical characterization of graphene oxide (GO), reduced graphene oxide (rGO), and ZnO–graphene hybrid electrodes functionalized with L-cysteine and 3-aminophenylboronic acid (APBA). The study focuses on understanding how sequential surface modification influences charge-transfer kinetics using cyclic voltammetry (CV) and differential pulse voltammetry (DPV) in a 5 mM $[\text{Fe}(\text{CN})_6]^{3-/4-}$ + 0.1 M KCl electrolyte. Results show a systematic enhancement in redox current and reduction in peak-to-peak separation (ΔE_p) from GO–Cys–APBA to ZnO rGO–Cys–APBA, confirming improved conductivity and electroactive surface area. The ZnO–rGO–Cys–APBA electrode exhibited the highest current response ($I_{pa} = 0.401$ mA) and lowest ΔE_p (66 mV), attributed to synergistic effects between ZnO and rGO. Although direct glucose oxidation was not detected, the observed redox reversibility establishes this hybrid system as a promising platform for future non-enzymatic biosensing applications.

Keywords: Graphene oxide (GO), reduced graphene oxide (rGO), zinc oxide (ZnO), cysteine, 3-aminophenylboronic acid (APBA), electrochemical characterization, non-enzymatic glucose sensing.

DeepSight: AI Driven Navigation Assistance for the Visually Impaired

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Abstract:

Independent mobility remains challenging for visually impaired individuals, especially in dynamic environments where conventional aids lack semantic understanding. Deep Sight is a lightweight, monocular-vision-based navigation system that combines YOLOv8 object detection with Lite-Mono depth estimation to provide real-time obstacle awareness from a single RGB camera. The fused outputs enable metric distance estimation using calibrated intrinsics and ground-plane geometry. A wearable Raspberry Pi Zero 2 W streams frames to a remote GPU-based server, achieving up to 20 FPS. These spatial audio cues of distance and direction provide intuitive feedback for non-visual navigation. Extensive experiments in both indoor and outdoor environments ensure low latency, reliable detection, and practical usability, toward an accessible, low-cost assistive solution.

Keywords: Visual navigation, assistive technology, depth estimation, object detection, audio feedback, YOLO, Lite-Mono.

Optimal Sensor Placement for Fall Detection: A Dual-Sensor Framework with Multi-Mode Motion Analysis

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Abstract:

Reliable fall detection remains a fundamentally unsolved challenge in wearable safety systems due to the complex biomechanics of human impact events and the difficulty of separating falls from high-variance normal walking patterns. This work introduces and experimentally validates a fall-detection algorithm that was developed, which leverages dynamic acceleration-magnitude profiling and adaptive thresholding for real-time impact characterization. To rigorously assess the algorithm's biomechanical sensitivity, we employed high-precision Xsens MTw Awinda IMUs as a reference instrumentation system. Quantitative evaluation using various features demonstrates a clear dominance of central torso placements, with hip and navel yielding the strongest fall signatures and earliest impact localization. The results provide high-fidelity experimental validation of the proposed algorithm and decisively establish torso-mounted sensing as the optimal configuration for robust, real-time fall detection architectures.

Keywords: Fall detection, inertial sensing, impact biomechanics, acceleration-magnitude profiling, adaptive thresholding, signal to-noise ratio

Hybrid Posture Monitoring System Using Computer Vision and Sensor-Based Analysis

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Abstract:

Prolonged improper sitting posture is one of the leading ergonomic issues associated with musculoskeletal disorders and improper spinal alignment. Early identification and constant correction are critical towards ensuring proper spinal alignment and alleviating fatigue. For this purpose, this paper proposes a hybrid posture analysis system that utilizes both force-based sensing and computer vision. The proposed work will make use of force-sensitive resistor sensors connected to an ESP32 microcontroller for identifying pressure variations in seating positions, in addition to a vision module utilizing a webcam and OpenCV with MediaPipe Pose for identifying improper upper limb sitting posture positions such as slouching and neck bending. The solutions derived from these approaches will be processed using a Python programming language setup. The future scope of this work will incorporate an intelligent posture predictor with cloud analysis support.

Keywords: ESP32, Force-Sensitive Resistor (FSR), OpenCV, MediaPipe Pose, ergonomics.

A Novel Wideband, Compact Flexible Microstrip Grid Array Antenna for Wearable Application

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Abstract:

A compact and flexible 1×4 rectangular grid- array antenna is presented for next-generation millimeter- wave 5G communication systems. The antenna is imple- mented on a flexible PDMS substrate with an overall size of 55 × 30 × 1 mmt, providing excellent mechanical compliance for wearable and conformal applications. The dielectric constant of PDMS, calculated from its material properties, supports stable wideband performance with low electromagnetic loss. The proposed grid-loaded rectangular radiating structure enhances the effective current path and achieves multiresonant behaviour across a wide frequency region. Simulation results demonstrate a peak gain of 12.6 dBi and a broad impedance bandwidth extending from 4 GHz to 8.4 GHz, making the antenna suitable for mid band and sub-6 GHz 5G platforms. With its lightweight construction, high gain, wideband capability, and structural flexibility, the antenna is well suited for wearable communication devices and emerging IoT-based flexible electronic systems.

Keywords: Flexible antenna, PDMS substrate, Rectangu- lar grid array, 5G communication, High- gain antenna.

Non-invasive Optical Signature Based Hemoglobin Measurement in Neonates

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Abstract:

In neonatal intensive care units (NICUs), hemoglobin (Hb) concentration is measured for several clinical purposes like anemia detection, evaluation of hemolytic diseases and assessment of oxygen delivery. However, in current clinical practice, invasive blood-based methods are used to find Hb values. In contrast, this study presents a non-invasive optical signature approach for estimating neonatal hemoglobin concentration using diffuse reflectance spectroscopic system. Spectral data are acquired from the heel of neonates and the relevant wavelength signatures associated with hemoglobin absorption are utilized to estimate Hb values. The proposed method is then clinically validated against reference laboratory values. The correlation value of 0.91 and mean bias of -0.01 g/dL, with a high proportion (86%) of samples within ± 1.0 g/dL error are observed. These findings indicate that optical signature-based method provides a reliable and non-invasive means of hemoglobin assessment in neonates without any blood prick.

Keywords: hemoglobin, newborns, anemia, optical signature, non-invasive, point-of-care.

Design and Development of a Smart Augmented Reality Vision Glass Usage in Healthcare Monitoring, Enhanced Learning and Navigation Purpose

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Abstract:

The Smart AR Vision Glass is a low cost and portable wearable Augmented Reality (AR) device based on NodeMCU (ESP8266) technology, which can be applied in health care, primary education, and navigation support. The proposed Smart AR Vision Glass design integrates biomedical sensors for the measurement of SpO₂, blood glucose level, body temperature, and blood pressure, with vital signs information presented using an OLED-based head-up display for continuous and unobtrusive hospital monitoring. In an educational environment, the proposed Smart AR Vision Glass design enhances learning by presenting interactive visual information to primary school children. For delivery and mobility service providers, the proposed Smart AR Vision Glass design offers real-time navigation support using wireless connectivity and smartphone integration. The proposed design emphasizes energy efficiency, portability, and seamless IoT communication. Experimental results confirm the accuracy of sensor data, robust wireless communication, and clear visual information display. The Smart AR Vision Glass is a scalable and affordable wearable AR platform for diverse real-world applications.

Keywords: Augmented Reality (AR), Smart Vision Glass, Wearable Devices, Internet of Things (IoT), Biomedical Sensors, Health Monitoring, Enhanced Learning, NodeMCU (ESP8266), Head-Up Display, Wireless Communication, Navigation Assistance

Benchmarking Flex, FSR, and IMU Sensors for Wearable Posture Monitoring Using Deep Learning

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Abstract:

Chronic back pain and musculoskeletal diseases are significantly exacerbated by poor posture, especially in sedentary people. Although wearable posture monitoring systems provide a useful option for ongoing evaluation and early correction, current systems use a variety of sensing modalities without a common framework for determining which sensor is best for precise and long-term posture measurement. Three widely used sensors for wearable posture assessment, Flex sensors, Force Sensitive Resistors (FSRs), and Inertial Measurement Units (IMUs), are compared in this study. To allow for simultaneous data collection, every sensor was combined into a single wearable belt and positioned in the same way. The gold-standard reference for measuring joint angles was a goniometer. During controlled activities like sitting, and forward bending, a real-time dataset was gathered from 250 people, including those with normal posture and those with problems linked to posture. Four deep learning models, Long Short-Term Memory (LSTM), Bidirectional LSTM (BiLSTM), Transformer, and BiLSTM with sensor fusion, were used to simulate the nonlinear and temporal features of posture inputs. By comparing sensor outputs with goniometer readings, performance was assessed using Mean Absolute Error (MAE), Root Mean Square Error (RMSE), and temporal stability. IMUs are the most dependable option for wearable posture management belts because the results show that IMU-based measurements consistently achieve greater accuracy, robustness, and stability across models and posture scenarios.

Keywords: Wearable Posture Monitoring, Sensor Benchmarking, Flex Sensor, IMU, Deep Learning, Goniometer, Biomedical Signal Processing

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TRACK 4

Automated Cardiovascular Risk Assessment Using Retinal Fundus Photography and Deep Learning Models

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Abstract:

Cardiovascular illnesses are the major causes of death in the world and therefore are predictors of risk both early and accurately. Recent developments in deep-learning methods have made it possible for automatic detection of the complex patterns that are often ignored in manual quantification of medical images. Here, we present the deep learning approach that directly predicts cardiovascular risk indices from retinal eye images. The framework has been built on a large dataset comprising 287,421 retinal images and validated on two independent datasets of 13,032 and 1,000 images, respectively. Experimental performance of the model reliably predicted some major cardiovascular parameters: age to within ± 5.28 years, gender with an AUC of .98, smoking behavior with an AUC of .77, HbA1c to within $\pm 2.37\%$, and systolic blood pressure to within ± 12.32 mmHg. In addition, the proposed system has achieved an area under the curve (AUC) of 0.75 for predicting major adverse cardiac events (MACE). Attention map visualizations revealed the differing contributions of various retinal areas, such as the optic disc and vascular structures, across prediction tasks. Taken together, these findings show the potential of deep learning combined with retinal imaging as a non-invasive marker to assess cardiovascular health.

Keywords: Deep Learning, Retinal Fundus Images, Cardiovascular Risk Factors, Convolutional Neural Network (CNN), UK Biobank, EyePACS

A Lightweight Deep Learning Model for Non-Invasive Bilirubin Grading by Multi-colour Space Images and Metadata Fusion

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Abstract:

Neonatal bilirubin assessment typically relies on an invasive blood test, which is restricted by continuous monitoring and early detection in limited-resource environments. This work proposed an automated, non-invasive bilirubin grading using a deep learning model, which combined multi-colour space neonate image features and metadata fusion. The non bilirubin and bilirubin neonate images were pre-processed to extract RGB, HSV, YCbCr, Lab, and grayscale features. These extracted features were then utilized to generate pseudo-labels for three bilirubin severity grades through K-means clustering. The proposed framework, combined with a lightweight MobileNet CNN model and trained independently with Adam and AdamW optimizers to evaluate their performance. The MobileNet model with Adam and AdamW optimizers achieved 97% and 98% accuracy, respectively. However, AdamW performed smoother decision boundaries and reduced misclassification at grades 0 and 1. These results indicate that the proposed model is feasible as cost-effective, and clinically beneficial way to monitor the neonate bilirubin level in real-time, especially in limited resource areas.

Keywords: Bilirubin, MobileNet model, K-means clusters, Adam and AdamW optimizers, colour space features.

YOLOv12-Driven Pancreatic Segmentation and Disease Diagnosis in Computed Tomography

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Abstract:

Primary pancreatic pathologies, including pancreatic adenocarcinoma and pancreatitis, are notoriously difficult to diagnose in their early stages due to subtle clinical presentations and overlapping features in computed tomography (CT) images. Manual segmentation and lesion identification are both time-intensive and subject to inter-observer variability. Current computational methods do not adequately integrate rapid localization with diagnostic categorization into a clinically applicable system. This research introduces a deep learning architecture founded on YOLOv12 for the concurrent localization of the pancreas and disease diagnosis. The proposed approach uses a tailored detection head together with optimized anchor parameters and an effective preprocessing solution that implements adaptive contrast enhancement, grayscale conversion, and specific data augmentation methods. The model demonstrated high precision in detecting pancreatic cancers and exhibited moderate success in identifying pancreatitis, based on the evaluation of 3,266 annotated CT slices. The system supports near real-time inference capabilities, functioning as a clinical decision-support tool that effectively scales while enhancing diagnostic performance and decreasing radiologist workflow time.

Keywords: Deep learning, YOLOv12, Pancreatic segmentation, Disease detection, Computed tomography, Medical image analysis.

Feature-Based Retinal Image Analysis for Diabetic Retinopathy Detection using Optical Coherence Tomography Angiography and Fundus Imaging Techniques

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Abstract:

Diabetic retinopathy (DR) is one of the major causes of preventable blindness and timely detection is essential. Manual screening is time-consuming and subjective. This work presents an AI-based system for retinal vessel and lesion features analysis and severity grading of Diabetic Retinopathy using Fundus images and detection of Retinal Neovascularisation (RNV) using Optical Coherence Tomography Angiography (OCTA). The IDRiD and DRIVE datasets were used for fundus analysis. Images were preprocessed with green channel extraction, Contrast Limited Adaptive Histogram Equalisation (CLAHE) and gamma correction. A two-stage segmentation pipeline was employed namely: U-Net for vessel extraction and a fine-tuned U-Net with ResNet-50 encoder for detecting lesions. The predicted masks when compared with the ground truths, achieved Dice scores of 0.81 for vessels and 0.74 for lesions. Vascular and lesion features were then extracted and classified using XGBoost, achieving an accuracy of 95.5%. For OCTA, TUH dataset and DRAC 2022 dataset were used. Vessel segmentation using Full-Resolution Network (FRNet) achieved a Dice score of 0.801. Vascular biomarkers were computed from the segmented vessel masks. A modified U-Net was used for the detection of RNV. The proposed multimodal framework has the capacity to facilitate large-scale screening by reducing the need for subjective grading, particularly in resource limited areas.

Keywords: Diabetic Retinopathy, OCTA, Fundus Imaging, Lesion Segmentation, Severity Grading

Optimal Temporal Window Selection for 3D CNN-Based VFSS Swallowing Phase Classification

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Abstract:

The Videofluoroscopic Swallowing Study (VFSS) is the gold standard for assessing swallowing. The swallowing process has three phases: oral, pharyngeal, and esophageal. Identifying these swallowing phases is essential for dysphagia assessment, but this process is currently done manually by clinicians, which is time-consuming and prone to inter-rater variability. This study proposes a deep learning framework for automatic detection of swallowing phases for VFSS video analysis. In this study, the VFSS sequences are pre-processed into fixed-length clips and are trained and validated using three 3D Convolutional Neural Network (3D CNN) models: 3D ResNet 18, Mixed Convolution 3D (MC3), and R2plus1D-18. Each model is trained under two settings: (i). with pretrained weights, (ii). without pretrained weights and with various temporal lengths ranging from 2 frames to 9 frames per window. A patient-wise 5-fold validation is performed to prevent data leakage across subjects and to verify the model's performance. The best models from 5-fold validation with the best average validation accuracy are used to build a decision-making model using soft voting based on class probability. The R2plus1D-18 model with a temporal length of 4 frames per window has the best performance with validation accuracy, precision, and f1-score of 95.46%, 95.4%, 95.2%, respectively. The proposed system can provide accurate and automated swallowing phase classification, which has the potential to reduce subjectivity and time consumption and can also assist clinicians in VFSS analysis.

Keywords: Video fluoroscopic Swallowing Study, Swallowing phase classification, Dysphagia, Deep learning, 3D CNN.

Simulation Study of Data Skew in Federated Learning for Tuberculosis Detection

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Abstract:

Deep learning (DL) plays a major role in the automation area, from robotics to the medical field. However, it suffers from two issues, one is the need for a huge amount of data, and the other is explainability. Though the DL models failed to give explanations, the recent explainable algorithms provide detailed explanations, and hence DL can be used for automation. In the medical field, it is impossible to get more data due to the restrictions imposed by regulatory standards. The objective of this paper is to reduce the dependency of the number of medical images required for the DL network training using Federated Learning in order to increase the accuracy. This work simulates collaborative work on the same DL model environment by generating multiple clients with data dissimilarity among them, and also investigates the impact of multiple data dissimilarities, such as the number of data available with each client and machine-dependent data dissimilarity. The results of sample size skew illustrate that the proposed FL framework achieves a global accuracy of up to 95.39% within 2 communication rounds, closely approaching the centralized model accuracy of 98.7%, while maintaining consistent performance across additional rounds. With an increasing number of clients with equal or unequal datasets, the accuracy is 97%, which is the same as independently using the dataset with the same model. As it increases the privacy of the dataset and the model developer owns their model, the FL DL technique will rule the future in the field of diagnostic tool automation.

Keywords: Federated Learning, Deep learning, medical images, data skew, device skew

Overcoming Data Scarcity in Retinal Lesion Segmentation via Instance Injection and Multi-Scale Ensembling

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Abstract:

Automated segmentation of retinal lesions is a pre requisite for the early diagnosis of Diabetic Retinopathy (DR). However, the development of robust models is hindered by the extreme scarcity of pixel-wise annotations and the severe class imbalance between structural features and minute pathologies. In this work, we propose a data-efficient framework that improves upon the standard Swin-UNet architecture. We introduce a Coordinate-Attention Fusion module to recover spatial information lost during downsampling and implement a novel training pipeline integrating Copy-Paste Instance Injection and Multi-Scale Zoom Augmentation. To ensure statistical robustness, we employ a 5-Fold Cross-Validation Ensemble. Benchmarking against a standard ResNet34 U-Net baseline on the IDRiD dataset, our method demonstrates superior convergence. While the baseline suffers from oversegmentation (Mean IoU: 0.2346), our proposed framework achieves a Mean IoU of 0.3606, representing a 53.7% relative improvement. Notably, we achieve state-of-the-art recovery of challenging Soft Exudates (IoU 0.58 vs. Baseline 0.12).

Keywords: Diabetic Retinopathy, Swin Transformer, Coordinate Attention, Copy-Paste Augmentation, Medical Image Segmentation, Ensemble Learning.

Non-Invasive Hemoglobin Estimation Using Subungual Vascular Tissue Images via Machine Learning Regression Models

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Abstract:

The level of hemoglobin is a vital clinical indicator applied in treating and monitoring different health conditions, such as anemia and blood disorders. Conventional means of measurement. Hemoglobin requires invasive blood tests, which may not be comfortable and cannot be used in regular or large scale screening. It is a non-invasive approach is introduced in this paper. The measurement of hemoglobin using nailbed images and machine learning regression models. Nailbed images are examined to derive colour and intensity features of different color spaces. Training and training are then done using these features. Run a few regression models, including Linear Regression, Ridge Regression, Lasso Regression, Support Vector Regression, and XGBoost. The efficacy of every model is measured based on accuracy estimates. Experimental results indicate that the XGBoost regressor is the best. The proposed approach is cost-effective, readily available, and simple non invasive screening of hemoglobin, which may be used in mobile and smartphone-based health care systems.

Keywords: Non-invasive Hemoglobin measurement, nailbed imaging, regression models, machine learning, diagnosis, nailbed imaging, medical image analysis, medical image analysis

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TRACK 5

Real-Time Stress Detection and Analysis Using Biopotential Sensors

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Abstract:

Stress is an important factor that affects human health across several dimensions. Various studies have shown that elevated stress levels significantly increase the risk of cardiovascular and psychological disorders. Heart activity, body temperature, skin conductance are some of the physiological signals that are reliable for monitoring stress levels. Among these, the key parameters such as GSR, ECG, and skin temperature are connected with the physiological changes that are inducing stress. In this project, the proposed work is to develop a real-time stress detection and analysis system using biopotential sensors by combining multiple sensors together to identify whether a person is stressed or not. The GSR, ECG, and temperature signals are acquired simultaneously at a time using an Arduino Uno microcontroller that converts the raw sensor values into meaningful physiological data. These data are further sent to MATLAB for preprocessing, visualization and feature extraction. Various individuals at rest and at stress conditions are collected and analyzed through various activities for GSR, ECG and temperature responses. HR, HRV, temperature change and GSR variability features are extracted to identify the stress patterns. Stress and non-stress conditions are identified using threshold-based feature classification. Compared to the traditional single-sensor approaches, this multi-sensor setup improves the stress assessment by jointly analyzing GSR, ECG and temperature signals. The system provides a non-invasive, low-cost solution for stress monitoring in real-time and demonstrates potential applicability in academic stress evaluation, mental health screening, and general wellness monitoring, supporting early identification of stress-related physiological changes.

Keywords: Mental health monitoring, Electrocardiogram, Stress Detection, Galvanic Skin Response, threshold-based classification.

Fabrication and Invitro Evaluation of Gentamicin Sulphate-PLA Filaments for Antibacterial Applications

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Abstract:

Gentamicin Sulphate (GS) is a broad-spectrum antibiotic primarily used to treat infections caused by gram negative bacteria and few gram-positive bacteria. Its effectiveness across a wide range of bacteria, combined with its affordability, makes it a widely chosen antibacterial drug. Poly Lactic Acid (PLA) is a popular biodegradable thermoplastic polymer. Due to its excellent biocompatibility, ease of processing, and suitability in tissue engineering, drug delivery, and 3D printing, combining GS with PLA presents a promising strategy for controlled and sustained drug release systems. This study involved the extrusion of GS-PLA composite filaments. Also, the drug eluted from the extruded composite filament in PBS was quantified using three approaches. The drug (GS) was initially adhered to the surface of the polymer pellets. The filaments were fabricated from drug-coated polymer pellets using a single-screw extruder. The extruded drug-polymer composite filaments were then evaluated for in vitro drug release in phosphate-buffered saline (PBS) over a period of five days by studying absorbance of Ninhydrin-GS, o-phthalaldehyde-GS, and mercaptoethanol o-phthalaldehyde GS. Additionally, Minimum Inhibitory Concentration (MIC) tests were performed to evaluate antibacterial efficiency. The drug release study and MIC study were also performed on control PLA filaments. MIC tests confirmed that the GS released from the composite filaments maintained its antibacterial activity. Control experiments with uncoated PLA filaments helped verify that the antibacterial effects were due to the drug itself, supporting the potential of this composite approach. Out of the three methods used for quantifying drug release, the mercaptoethanol o-phthalaldehyde-GS method was able to quantify the drug release efficiently. Extruding drug polymer composites into filament form is promising, as it enables direct fabrication of customized, drug-eluting structures with 3D printing techniques, opening new possibilities for biomedical devices aimed at controlled and sustained drug delivery.

Keywords: Gentamicin Sulphate (GS), Poly Lactic Acid (PLA), Minimum Inhibitory Concentration (MIC), Antibacterial drug, Extrusion

Real-Time Hand-Gesture Interface for Coordinated Swarm Robotics in Rehabilitation and Medical Assistance

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Abstract:

This paper presents a real-time human–swarm interaction that allows control of multiple robots using dual-hand gesture recognition. The system integrates OpenCV for video processing with MediaPipe’s lightweight landmark extraction to achieve robust gesture tracking without any need of complex preprocessing or heavy computational resources. A key novelty of this work is the dual-hand control architecture: the left hand selects an individual robot (R1–R5) which maps to the finger count, while the right hand issues directional commands such as forward, backward, left, and right. A full-hand gesture enables decentralized swarm formation which allows all robots to converge toward a selected agent within a bounded 30×30 simulation environment. This technique was evaluated over a 95-second continuous run, processing more than 1700 frames by showing real-time responsiveness which suits for interactive applications. Gesture-command accuracy stayed stable across dynamic lighting and moderate occlusion and also it ensured the robustness of the method in a non-ideal environment. Overall, the proposed work provides an effectively connects human gestures and multi-robot coordination, which offers strong potential for extension into physical robot platforms, hospital-assistive robotics, immersive AR/VR interfaces, and real-time applications such as search and rescue.

Keywords: Hand gesture recognition, Real-time systems, Computer vision, Deep learning, Human–computer interaction, Swarm robotics, Gesture-based control, Medical Assistance.

CQD-Loaded HA-PBA/PVA Hydrogel Patch for ROS-Responsive Cellulitis Monitoring

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Abstract:

Cellulitis is an acute bacterial infection caused by *Streptococcus pyogenes* and *Staphylococcus aureus* that affects the deeper layers of the skin mainly the dermis and subcutaneous tissue. The inflammation triggers the release reactive oxygen species (ROS) in elevated levels by immune cell. Current diagnostic methods rely heavily on clinical observations and systemic antibiotics, which are often slow, non-specific, and leads to abscess formation. To overcome this limitation carbon quantum dots (CQD) Embedded hydrogel patch was developed that delivers an anti-oxidant and continuously monitor the infection environment. HA-PBA/PVA Hydrogel were prepared and incorporated with CQDs. The morphology and presence of functional groups were examined using SEM and FTIR, which revealed the porous network arrangement of the hydrogel. CQD loaded patches decomposed more slowly than unloaded hydrogels due to denser cross-linking connections, as evidenced by swelling and degradation studies. CQDs enabled real-time monitoring of cellulitis-related oxidative stress by ROS triggered fluorescence changes, which were measured using H_2O_2 -responsive fluorescence assays. CQD loaded hydrogel patch therapeutic efficacy was further validated by antibacterial tests against *Staphylococcus aureus*, which showed a considerable inhibitory action. Compared to standard wound dressings, the CQD-embedded PVA-PBA hydrogel patch may provide a multifunctional platform that combines antibacterial activity, and continuous optical monitoring for efficient cellulitis management.

Keywords: Cellulitis, carbon quantum dots, HA-PBA/PVA hydrogel, ROS, antibacterial activity.

Quantitative Electrochemical Detection of Paracetamol using 3D Printed Electrodes

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Abstract:

The study presents the design, fabrication and electrochemical detection of paracetamol using 3D-printed conductive electrodes. Thermoplastic composite Acrylonitrile Butadiene Styrene (ABS) reinforced with a Carbon Black (CB) filament was used to fabricate the working, reference and counter electrodes using Fused Deposition Modelling (FDM) technique. Paracetamol drug is commonly used as analgesic and antipyretic in pharmaceutical tablet formulations. The electrochemical technique - Differential Pulse Voltammetry (DPV) is used for the detection of analytes (drugs). Well-defined and sharp oxidation peaks were observed at lower concentrations (1.5 to 12.5 $\mu\text{g/ml}$), while at higher concentrations (25 to 100 $\mu\text{g/ml}$), the peak current stabilized. A 3D printed sensor displayed two linear calibration ranges for its response. A low-concentration range showed a high value of sensitivity, which is linked to the high rate of electron transfer at the active sites. Additionally, the high concentration region showed low sensitivity, resulting from saturation of the active sites of electrodes by the oxidized forms of paracetamol. This work highlights the possibilities offered by 3D-printed conductive polymer electrodes. Such electrodes are low-cost, customizable and eco-friendly alternatives to traditional electrochemical sensing electrodes. The lower concentration sensing capability reported in this work aims towards the improvement of pharmaceutical quality control and point-of care diagnostics.

Keywords: 3D printing, conductive ABS, carbon black, paracetamol detection, electrochemical sensor. differential pulse voltammetry,

Estimation of skin surface voltage distribution due to stenosed brachial artery using numerical technique

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Abstract:

Electrical bioimpedance is a non-invasive diagnostic technique that exploits the electrical properties of biological tissues to an applied sinusoidal current. Various tissue composition contributes to different impedance distribution inside tissues. This method is used to detect changes in tissues due to pathological conditions. Atherosclerosis is a vascular disease that causes stenosis due to plaque deposition and impedes blood flow. This causes ischemia and induces stroke. In this study, impedance changes in the upper arm caused by the plaque formation in the brachial artery are investigated. A numerical model of the upper arm with appropriate tissue electrical properties is developed, and a physiologically safe sinusoidal current is applied. The resulting surface voltage and impedance distributions are analyzed and compared with a healthy model. The results indicate that plaque presence produces change in the voltage distribution near artery and distinct surface voltage change in the stenosis region when compared with non-stenosis region, thus demonstrating the potential of bioimpedance analysis for peripheral artery assessment.

Keywords: Atherosclerosis, Bioimpedance, Brachial artery, Numerical modelling, COMSOL.

High Performance Slotted Rectangular Textile UWB Antenna with Modified CPW Configuration for WBAN Applications

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Abstract:

This work describes a small Ultra-Wideband (UWB) antenna constructed on a cotton fabric substrate for usage in wearable and body-centric wireless systems. To enhance impedance characteristics and bandwidth, the antenna uses a redesigned radiating patch with square, semicircular, and rectangular parts as well as carefully positioned horizontal and vertical slots. To enable flexible integration on textile materials, a CPW-fed architecture is used. With a reflection coefficient of less than -10 dB, the optimized construction achieves a broad operating range from 3 GHz to 10.8 GHz. The design retains radiation efficiency beyond 81 % and offers stable gain levels between 2.5 and 3.4 dB despite its small dimension of $17 \times 17 \times 1 \text{ mm}^3$. These findings demonstrate the antenna's applicability for wearable and implanted WBAN applications, when wideband performance, comfort, and compactness are significant.

Keywords: Rectangular patch, WBAN applications, flexible antenna, Ultrawide Band

Development of a Low-Cost Laser Speckle Imaging System for Tissue Perfusion Assessment

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Abstract:

Currently, the assessment of burn depth still relies on the traditional method of visual inspection, which is subjective and not sufficiently accurate. Since blood perfusion is closely linked to burn severity, this paper aims to assess blood flow as a more objective method for evaluating burn depth. It outlines a Laser Speckle Contrast Imaging (LSCI) technique for real-time blood flow monitoring. The system used a laser with a wavelength of 650 nm, a digital microscope, and spatial LSCI analysis to generate perfusion maps. Validation involved controlled blood flow changes in healthy volunteers aged 20 to 22 years using a blood pressure cuff. The results, represented in the graph, clearly show differences between low and high perfusion levels, indicating effective detection of blood flow changes. The mean Kt in no cuff pressure is 0.0624, and the mean Kt in occluded pressure is 0.0642. Similarly, mean Ks at no cuff pressure is 0.055 and at occluded pressure is 0.05423. This paper demonstrates the potential of an affordable, portable LSCI system to objectively evaluate burn depth.

Keywords: Laser Speckle Contrast Imaging (LSCI), Burn depth assessment, Spatial Speckle C

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TRACK 6

Speech-Driven Adaptive Learning Support for Autism Spectrum Disorder

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Abstract:

This paper describes the design and implementation of a Personalized Learning Support System which utilizes speech signal analysis to measure and facilitate student engagement in Autism Spectrum Disorder (ASD) students during learning activities. The system utilized a pre recorded audio data from publicly available GitHub repository and then extraction of acoustic features like energy, entropy, brightness, and formants which were analyzed using machine learning algorithms. The engagement being measured was modeled using Support Vector Machine (SVM) and Random Forest (RF) algorithms. The inclusion of an industry-integrated adaptive threshold based rule set allowed for an instantaneous and relevant feedback. Using this engagement-related monitoring system also allowed for privacy control; In particular, all raw audio recordings were permanently deleted from the system after processing and only the computed audio features were retained. Data collected from the Github resource consists of participants with the autism spectrum in highly structured educational environments validates that it is possible to use speech to measure engagement that can lead to highly accurate classification and could support the instructor to adjust their teaching in real-time for dynamic lesson and session management. The proposed system achieves upto 91.2% accuracy using an SVM classifier and 89.6% accuracy in RF classifier. In summary, speech signal analysis is a valid and unobtrusive method of detecting and measuring engagement to support personalized learning interventions for ASD learners in both secure and community-based educational environments

Keywords: Autism Spectrum Disorder, adaptive learning, engagement detection, speech features, machine learning, personalized education

Facial EMG controlled Wheelchair – a Simulated Mobility Assistance for Quadriplegia

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Abstract:

Quadriplegia is a severe form of paralysis that affects the motor functions, causing problems in ability to move independently. Traditional manual and electric wheel chair failed to meet the specific need of people with quadriplegia, requiring developments for quadriplegia patient. Facial EMG based mobilization device for quadriplegia that helps the individual with mobility assistance on their own, highlighting the importance of finding a new solution for the patient. This paper focuses on Facial EMG acquisition, signal processing and feature extraction using wavelet. Facial EMG signals are acquired and given as input for filtering process. These processed signals are then used as input functions for the simulation in Simulink, which include components such as PID controller, torque, torque source, shaft and common gear assembly. This paper aims to create a simulated model for a fully operational and independent control wheel chair that could improve the quality of life for quadriplegic patient using facial EMG as input. This paper aims to provide a simpler and more effective method for controlling movement and to demonstrate the capacity to transform the use of technological advancement in restoration.

Keywords: Electromyography, wavelet detection, assistive technology, rehabilitation engineering, signal processing, simulation model

A Multi-Stage Comparative Evaluation of Classical Machine Learning, Boosting Models and Unsupervised Clustering for EEG-Based Seizure Analysis

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Abstract:

Epileptic seizure analysis based on electroencephalography (EEG) has traditionally been carried out by employing supervised learning methods using predefined clinical labels. These methods, although very effective in classifying, have the inherent assumption that the epileptic brain activity can be separated into distinct and stable states over time. In this paper, we question that assumption by proposing a single analytical framework that combines supervised classification, comparative model evaluation, and unsupervised state discovery for characterizing intrinsic EEG dynamics. The study uses the Bonn EEG dataset across all the work pipelines to maintain proper methodological consistency and comparability. In the supervised context, time-frequency features from wavelet decomposition were first used to assess several learning models, which proves the existence of discriminative seizure-related patterns. Additional comparative analyses look at the robustness of the models under identical feature representations. Moreover, a brain activity clustering technique is proposed as a label-free analysis method for the unlabelled EEG data which does not need clinical annotations. Dimensionality reduction and clustering techniques were used to extract stable EEG states, with internal validation indices being used as a guide to select the best state partitions. The agreement of the supervised labels with the discovered state space based on post-hoc mapping was only partial and there was a significant overlap as well which in turn indicates the presence of transitional and heterogeneous brain states that neither of the two techniques can capture. The combined findings suggest that rather than being a binary phenomenon, epileptic EEG activity is more appropriately characterized as a structured continuum of states. This paper combines the strengths of both supervised performance and unsupervised interpretability to give a comprehensive view of using EEG for epilepsy analysis and emphasize the worth of state-space modeling in enhancing reliable and clinically relevant EEG interpretation. All the supervised assessments were performed at the window level with stratified cross-validation and several random initializations to confirm the results' reliability.

Keywords: EEG, seizure detection, preprocessing, boosting models, clustering, wavelet features.

Manual vs Deep Learning Feature Extraction in Biomedical Signals: A Comparative Study Arvind

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Abstract:

In the state-of-the-art methods used in BCI Based on tasks, Manual features overwhelm the number of available self learned features used to classify or perform tasks, and are Often left less talked about and researched. Thus, this paper aims to Provide a comprehensive and comparative review of the standard methods used to classify a MI(Motor Imagery) task done using BCI Competition IV 2a dataset, which has been widely used for the MI task classification. This paper focuses on The significance and impact of the extracted features on accuracy and explainability, both subject-wise and generalized to all subjects One of the current challenges that exists is the cross-subject variability among the subjects, which reduces the performance of the models, as shown in this work. In this paper, the features extracted for comparison are Filter Bank Common Spatial Pattern (FBCSP) and EEGNet, and the models used to classify them are Support Vector Machine (SVM), and use SHAP to explain features that affect the target results. The results show that the FBCSP achieves better subject-specific accuracy, whereas EEGNet demonstrates stronger robustness across subjects. These findings highlight the trade-off between interpretability and generalization and provide useful insights for designing reliable MI-based BCI systems.

Keywords: Motor Imagery, Machine Learning, EEGNet, FBCSP, Feature Extraction

Fatigue Detection From Frontal EEG Signals Using a CNN– BiGRU Attention Framework For Wearable Monitoring

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Abstract:

During prolonged tasks, mental exhaustion significantly impairs cognitive function and safety. Although EEG-based fatigue detection has achieved promising outcomes, the majority of existing solutions are based on bulky and costly clinical-grade systems, which are not suitable for practical applications. This work proposes a novel lightweight CNN-BiGRU attention mechanism-based deep learning architecture for the detection of mental fatigue using low-dimensional frontal EEG spectral features, such as band power ratios, theta, alpha, and beta. Both long-term temporal fatigue patterns and short-term spectral dynamics can be modelled using the suggested method. Experimental results on the SEED-VIG dataset show high accuracy in classification tasks, which confirms the effectiveness of the proposed method using reduced electrode topologies. Moreover, a low-cost wearable EEG system design is introduced as a feasibility platform for future real-time fatigue detection applications.

Tamil Dysarthric Speech Data Collection: Challenges and Constraints

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Abstract:

Speech data collection is crucial for advancing speech technologies and depends on factors such as environmental noise, recording equipment, and the speaker's ability to provide sustained intelligible speech. Typically, speakers provide at least 20-30 minutes of data in one session for building any speaker-independent speech recognition system. However, for individuals with cerebral palsy and dysarthria, a motor speech disorder, this process is complicated by speech inconsistencies, fatigue, and physical limitations, making it time-intensive and challenging. This paper examines the methodologies, procedures, and challenges faced in creating the SSN TDSC (Tamil Dysarthric Speech Corpus), the only dysarthric speech corpus in Tamil. This study highlights patient-related variability, ethical considerations, and transcription difficulties. Strategies to address these challenges are discussed, offering practical insights for future speech data collection in low-resource and clinical areas.

Keywords: Dysarthria, Cerebral Palsy, Speech Data Collection, Speech recognition systems, Low-Resource Languages

Advanced Surface EMG Analysis of Biceps and Triceps Activation Across Performance Levels During a Prolonged Forearm Plank

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Abstract:

Surface electromyography (sEMG) is a common tool for the evaluation of neuromuscular activation and endurance during sustained tasks, which apply to upper limb rehabilitation. In our current study, the muscles of activation that were studied were the biceps brachii and triceps brachii, when the participants were engaged in a sustained forearm plank exercise of different degrees of proficiency. There were thirteen healthy participants who were considered novice, intermediate or advanced depending on their plank-hold durations. The surface electromyography (sEMG) data collection and analysis were done with a BIOPAC MP45 system and then processed in MATLAB, where root-mean-square (RMS) amplitude was chosen as the most significant measure. Unpaired ANOVA and Kruskal Wallis tests showed statistically no significant relationship between the mean RMS value, yet the effect-size analysis showed a big range of variation among the performance levels. Correlation coefficients between trials were moderate, while trial-by-trial RMS amplitude trends suggested fatigue-related compensatory activation in novice participants and stable activation in advanced participants. These results show that metrics of variability and fatigue-related changes are useful for gaining practical insight into sustained isometric neuromuscular performance, independent of statistical significance. All signal processing and feature extraction were performed using MATLAB R2024b (MathWorks, USA). Variability, trial to trial consistency and fatigue related activation are focused on the study as opposed to relying on single-trial amplitude alone.

Keywords: Biceps Brachii, Isometric Exercise, Neuromuscular Fatigue, Rehabilitation, Surface Electromyography (sEMG), Triceps Brachii, Upper Extremity.

Piezoelectric Energy Harvesting Platform for Low Power Wearable Vital Signal Monitoring

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Abstract:

Wearable health monitoring systems enable continuous observation of physiological parameters but are often constrained by battery dependency, frequent recharging, and limited operational lifetime. To overcome these challenges, this paper presents a piezoelectric energy harvesting system for a self powered vital signal monitoring application. The proposed system utilizes piezoelectric materials to harvest electrical energy from human motion, enabling sustainable power generation during daily activities. The harvested energy is conditioned through rectification, voltage boosting, and energy storage circuits to deliver a regulated power supply suitable for low-power biomedical sensors. The system demonstrates reliable operation under motion-based energy input, reducing dependence on conventional batteries. Experimental and simulation results validate the feasibility of the proposed piezoelectric energy harvesting approach for sustainable and long-term wearable healthcare applications.

Keywords: Piezoelectric energy harvesting, wearable healthcare, self-powered system, human motion, vital signal monitoring

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ICBSII 2026, SSNCE, CHENNAI, MARCH 09 – 11, 2026

TRACK 7

Early Detection of Dyslexia Based on the Analysis of Handwritten Images

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Abstract:

Learning disabilities often go undetected during the early developmental stages making it complex for treatment procedures thereby impacting academic performance and self- esteem. The objective of this work is to design and develop a handwriting-based tool for early detection of learning disabilities by leveraging machine learning techniques and also to classify the condition based on the severity levels. As a first step, the character-level detection is done using a dataset consisting of characters with the help of techniques namely, Random Forest, Support Vector Machine (SVM), and MobileNetV2. Secondly, sentence-level detection was performed using a different dataset based on a hybrid model of MobileNetV2+Bi-LSTM architecture. The classification showed promising results on character level recognition wherein Random Forest and SVM gave accuracies of 90% and 82%, respectively, for 2 classes, Normal and Reversal characters, and the MobileNetV2 for 3 classes, Normal, Reversal, Corrected gave an accuracy of about 86%. The classification of dyslexic and non-dyslexic categories based on handwritten sentences using the hybrid model of MobileNetV2+Bi-LSTM architecture gave an accuracy of 94%. As an additional step, the developed algorithm classifies the dyslexic condition based on severity levels as low, mild, moderate, and severe. The models have been tested on real data obtained from dyslexic children. This research brings together a solution to fill the lacuna in early dyslexia screening by focusing on handwritten images' analysis thereby providing an easy way for meaningful assessment.

Keywords: Learning disabilities, Dyslexia, Machine learning, early detection, Classification, handwritten images, Bi-LSTM.

Adaptive Multi-Agent Tutoring for Personalized Learning

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Abstract:

Many e-learning platforms today are static and don't respond to students' emotions or real-time understanding. The solution to this problem is to develop an adaptive virtual robotic tutor that personalizes learning using a multi-agent AI system. This virtual robot's "brain" combines voice, text, and face recognition through a multimodal Large language model (LLM). This pedagogical tool can detect students' emotional states and learning gaps, offer personalized explanations, generate new practice problems, evaluate responses, and give empathetic feedback—all in a smooth, continuous cycle. The system runs locally with Ollama, making it private, free, and AMTPL (Adaptive Multi-Agent Tutoring for Personalized Learning) introduces a new approach to smart tutoring by blending Affective computing, Agent-based LLMs, and Virtual robotics for tailored, human-like learning experiences. The performance metrics such as System Accuracy, System Latency, Resource Usage and Education Impact of the proposed AMTPL model are compared with existing VTPIM and the proposed model is observed to perform well with these metric.

Keywords: Adaptive tutoring, Multi-Agent Systems, Personalized Learning, Affective Computing, Robotic Tutor, Large Language Models (LLMs), LLM Agents, Ollama. s.

A Machine Learning–Driven Ensemble and Optimization Approach for Cervical Cancer Classification

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Abstract:

The importance and early detection of cervical cancer remain vital for the improvement and extension of patient life outcomes and clinical interventions. This study proposes a systematic machine learning framework for cervical cancer classification using leakage-free preprocessing, RFECV based feature selection, and meta-heuristic-based hyperparameter tuning and ensemble learning methods. The study also tests an 80:20 split for data splitting and uses a technique called SMOTE ENN for handling imbalanced classes, but only on the training set to reject data leakage. The study tests various machine learning classifiers, including SVM, RF, and XGBoost, and uses Genetic Algorithm and Particle Swarm Optimization for hyperparameter tuning. Random Forest achieved the highest accuracy of 97.52%, demonstrating strong sensitivity and balanced classification performance, while the others performed well and yielded promising results and most accurate outcomes, making it stable and robust against imbalanced and leakage-free results. In addition, the ensemble learning methods, such as the stacking method, were used to further enhance the detection performance, reducing the number of false negatives and increasing the stability of the predictions made. In order to accurately evaluate the performance of the models, accuracy, precision, specificity, sensitivity, F1 Score, and confusion matrix analysis were used on the models. From the results, the effectiveness of the proposed framework in giving a robust method for the prediction of cervical cancer was clear.

Keywords: Cervical cancer, machine learning, ensemble learning, SMOTE-ENN, hyperparameter optimization.

Automated Breast Cancer Diagnosis from Ultrasound Using Vision-Eagle Attention

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Abstract:

Breast cancer has always been one of the most significant causes of deaths in the female population across the world with early and precise diagnosis being a major factor in increasing the survival chances. Ultrasound imaging is popular in the detection of breast lesions, but detection by hand is difficult because of speckle noise, low contrast, and large intra class variability. In this paper, the authors suggest a new deep learning model that incorporates EfficientNetV2L with a Vision Eagle-Attention (VEA) system to classify cancer in the breast using automated systems. The attention module proposed fuses global contextual awareness with channel and spatial feature refinement in order to boost discriminative representation of ultrasound images. There was an experiment on the BUSI breast ultrasound dataset which had benign, malignant and normal classes. The experiments were done on the BUSI data that had benign, malignant, and normal classes. The proposed model had a general classification accuracy of 92% with high rates of evaluation indicated by high rates of precision, recall and F1-score of all the classes. The findings show that it converges stably, has high ROC property, and enhances generalization. The suggested EfficientNetV2L-VEA framework has a potential to be an effective computer-aided diagnosis system that can be used to detect breast cancer in the initial stage and reliably.

Keywords: Breast Cancer, Ultrasound Imaging, Efficient NetV2L, Attention Mechanism, Deep Learning, Medical Image Classification

Menstrual Health Monitoring and Prediction System Using Machine Learning

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Abstract:

Women's reproductive health depends on tracking their menstrual health, but the majority of tracking apps are calendar-based and lack predictive intelligence. In this paper, we introduce DateIncoming, a machine learning-based intelligent menstrual health tracking system that offers health risk analysis, symptom forecasts, and personalized predictions. Three domain-specific models are combined in the system: a weighted statistical approach with 86% accuracy for predicting cycles, a multi-output symptom prediction model with 82% accuracy for pain, flow, mood, and energy symptoms, and a condition risk indication model with 73% accuracy for various menstrual health conditions. The system is built with a secure backend, an interactive user interface, and Google Calendar integration. The app offers personalized recommendations, menstrual anomaly alerts, and next-day symptom forecasts.

Keywords: menstrual health, machine learning, Random Forest, cycle prediction, symptom forecasting, health risk assessment, women's health, PCOS detection

Explainable Deep Ensemble Learning for Intervention-Aware Cardiac Risk Prediction

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Abstract:

An intervention-alert deep ensemble structure for smoking consumption forecast and heart failure threat representation is presented by this work. By combining an Echo State Network (ESN) and a GoogleNet-aroused one-dimensional convolutional architecture through an AlexNet-oriented meta learner, a Probabilistic Blending Model (PBM) is evolved. Powerful preprocessing is applied that encompasses standardization of median–interquartile range, variable selection using Random Forest, and Borderline-SMOTE for group balancing which guarantee elasticity to anomalies and bias in data. For preserving efficiency of computation, the blended structure attains a region under the Area Under Curve (AUC) of 0.885 that overperforms separate standalone learners. Shapley Additive exPlanations (SHAP)-based explainability is utilized to strengthen openness which offers both global attribute significance and row-level explainability. A Unified Decision Network (UDN) is projected to increase static classification into actionable risk modeling. The UDN combines PBM-derived smoking confidence as an endogenic behavioral signal and executes regression-based assessment of future cardiac risk. Improved metrics of AUC curve of 0.977, precision of 0.877, and F1-score of 0.877 is portrayed by observational validation as compared to PBM. Regression testing achieved metrics such as the MAE of 0.078, RMSE of 0.110, and R² of 0.898. On an average, cessation of smoking decreases the 12 month cardiac risk by 31.46% approximately. Dose–response examination validates monotonic risk elimination with diminishing smoking rate in which the population-level projections emphasize great collective health advantages. Counterfactual reasoning represents least attribute adjustments proficient of alleviating forecasted risk additionally. The suggested structure combines ensemble learning, explainable artificial intelligence, ambiguity modeling, and behavioral interference simulation into an integrated architecture suitable for extensible help of public health.

Keywords: Smoking behavior, heart disease threat, deep ensemble learning, explainable AI, SHAP, intervention modeling, counterfactual reasoning

An Explainable Representation-Level Attention Fusion Network for Smoking Status Prediction

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Abstract:

Smoking stays as the dominant evitable reasons of worldwide disorders such as cardiovascular, pulmonary, and oncology. Initial detection of smoking habits from systematic medical limits is significant for protective involvement; Despite that, such detection works are complicated by the imbalance of class, non-linear feature contact and restricted interpretability of conventional systems of deep learning. This study put forward a two-stage deep ensemble framework improved with a unique Depiction-Level Attention Fusion Network for exact and interpretable smoking status detection. First of all, a Probabilistic Blending Model is executed with the help of the Echo State Network and a 1D GoogleNet framework as base learners, succeeded by an AlexNet-based stacking meta-learner. Robust scaling, Random Forest feature selection, and Borderline-SMOTE balancing are utilized to enhance selective knowledge. Although the PBM attains a strong detective performance (ROC-AUC = 0.855277), its decision-making is restricted to probability-level fusion. To tackle this constraint, an attention-based representation fusion mechanism is introduced that merges intermediate embeddings extracted from ESN and GoogleNet before final categorization. The attention layer strongly weighs latent depictions, allowing adaptive feature emphasis and improvised nonlinear modeling. The proposed attention fusion model reaches exceptional performance which is proved by experimental valuation with ROC-AUC of 0.862935, PR-AUC of 0.839491, Accuracy of 0.784633, and the lowest Brier score of 0.146613, outperforming individual base models and the PBM. In addition, a lightweight NLP integration layer allowss risk alerts, hidden smoker identification, and conversational medical interpretation. The proposed framework connects deep learning, ensemble optimization, and clinical explainability, supplying an expandable and illustratable decision-support tool for quick smoking risk detection in systems of healthcare.

Keywords: Smoking, detection, ESN, GoogleNet, AlexNet, Attention Fusion Network, NLP, Probabilistic Blending Model.

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ICBSII 2026, SSNCE, CHENNAI, MARCH 09 – 11, 2026

TRACK 8

Deep Learning-based Classification of Human Embryo Developmental Stages from Time-Lapse Imaging

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Abstract:

Although IVF success rates have remained inconsistent and largely reliant on subjective morphological embryo evaluation, time-lapse imaging technology emerged with prospects for objective morphokinetic analysis based on embryo developmental stage evaluation. Analyzing morphokinetics with time-lapse imaging technology in this study aims to automate embryo development stage assessment into 15 distinct morphokinetic phases using computer vision algorithms on time-lapse imaging videos. The proposed deep learning model is based on a ResNet-50 neural network serving as a vision embedding model pre-trained on an image recognition dataset called ImageNet, focusing on spatial image representation based on individual image frames rather than vision based solely on image elements. The model accuracy in classifying embryo developmental phases using a transform model focused on self-attention analysis is tested with a class weighted focal loss function to cope with class imbalance in a standard IVF embryo developmental stage assessment dataset with a total of 704 embryo developmental phases labeled in a publicly accessible online competition. The individual model performance accuracy in assessing embryo developmental phases can be measured by accuracy of 0.6359 and balanced accuracy of 0.5359. The individual model performance can be measured by macro-average metrics including precision of 0.5315, recall of 0.5359, and F1-score of 0.5273 with Cohen's Kappa statistic of 0.5955 with a level of being in moderate agreement. The model performance in assessing embryo developmental phases in early frequently observed phases such as tPNa with F1-score of 0.9004 and receiver operating characteristic curve accuracy of 0.9924, showing better performance in frequently observed developmental phases.

Keywords: Time-lapse Embryo Imaging, Morphokinetic Stage Classification, Human Embryo Development, Deep Learning, ResNet-50, Transformer-based Classifier

Segmentation Of Plasmodium Falciparum Infected Cell in Blood Smear Images using Optimized U-Net

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Abstract:

Malaria is a major global health concern, contributing to significant illness and mortality across many regions of the world. Every year a millions of cases reported, early detection and accurate diagnosis are critical for effective disease control and timely treatment. Malaria diagnosis has been regarded as the gold standard of the manual microscopic analysis of the blood smears. The manual microscopic examination of blood smears has been considered as the gold standard for malaria diagnosis. The identification of infected cell using microscope is highly challenging during mass screening in rural areas. Hence, the identification of infected cells in blood smear images requires the efficient computer assisted system. In this study, the camera was used to capture the images of the thin blood smear of Plasmodium Falciparum in microscope after staining the slides. The quality of collected blood smear images was enhanced by Histogram Equalization (HE) techniques. Further, the Honey Badger Optimization based U Net (HBA-UNet) was developed to segment the infected cells in thin blood smear images of Plasmodium Falciparum species. The performance of the developed segmentation model is compared with existing deep learning models such as Mobilenet, Efficientnet, and UNet. The results demonstrated that the dice coefficient of HBA based U Net model attains higher (96.07%) when compared to the deep learning models. Similarly, recall, precision, accuracy and IOU of HBA based UNet model achieves 90.93%, 91.26%, 98.77% and 91.24% respectively, which are higher when compared to the other deep learning models. This finding reveals that the HBA-UNet model is efficient and accurate segmentation of Plasmodium Falciparum infected cell in the thin blood smear images.

Keywords: Malaria, Honey Badger Optimization, UNet, Plasmodium Falciparum, Segmentation

Autism Spectrum Disorder Detection using Facial Asymmetry and Optimized Feature Selection Methods

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Abstract:

Autism Spectrum Disorder (ASD) is a condition that affects verbal communication abilities, behavior patterns, and social interaction skills. Early identification of the disorder is crucial for effective intervention. This study presents a machine learning-based ASD identification system using facial asymmetry analysis. The facial images were pre-processed, the Haar Cascade classifier was utilized for facial regions detection, and MediaPipe Face Mesh was utilized for extraction of 68-point, left-side, and right-side landmarks. Capturing asymmetry patterns involved the calculation of Euclidean distances between corresponding landmark pairs, which were then used as classification features. SVM and AdaBoost were evaluated using baseline and optimized feature sets. RFE with SVM and AdaBoost, along with BPBO-optimized SVM, improved feature discrimination. RFE-SVM achieved the highest accuracy of 82.50% with standard facial landmarks, while BPBO-SVM performed best for unilateral landmarks, achieving 82.08% for left facial landmarks and 81.16% for right facial landmarks. These outcomes show that facial asymmetry can serve as a simple and clear tool for screening ASD.

Keywords: Autism spectrum disorder (ASD); Facial Asymmetry; Facial Landmark Detection; Euclidean Distance Features; RFE with SVM; RFE with AdaBoost; BPBO-SVM Classification.

A Hybrid Inception - Transformer Based Framework For Classification and Severity Grading of Respiratory Diseases

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Abstract:

Respiratory diseases like COVID-19, Pneumonia, and Tuberculosis often exhibit overlapping radiographic characteristics, making accurate diagnosis and severity assessment from chest X-ray images a difficult task. A complete deep learning-based pipeline for automated respiratory disease classification and severity grading utilising chest X-ray images is presented in this work. The proposed pipeline integrates image enhancement, lung segmentation, deep feature extraction, multi-class classification, and disease-specific severity assessment. While deep learning-based segmentation algorithms are used to identify lung regions and concentrate on disease-relevant areas, contrast enhancement strategies are quantitatively assessed to improve image quality before analysis. Deep representations are extracted from both whole-lung and segmented-lung images using convolutional neural network backbones, followed by classification through standalone and hybrid learning strategies. Among the assessed methods, a transformer-based hybrid model based on Inception V1 feature representations performs the best. Severity grading is further performed using clinically inspired scoring strategies to assess disease progression. The outcomes of the experiment shows that the suggested framework achieves a maximum multi-class classification accuracy of 97.9%, supporting reliable and clinically meaningful automated analysis of chest X-ray scans for respiratory diagnosis of a medical condition and severity assessment

Deepbone IRV2: A Hybrid Inception-ResNet-V2 Architecture for Knee Osteoarthritis Grading and Surgical Recommendation

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Abstract:

Knee osteoarthritis (KOA) should be assessed accurately by a radiologist to make decisions on clinical procedures. Conventionally, Kellgren-Lawrence (KL) grading system has been employed to evaluate the radiological images and it resulted in observer variations. Hence there arises automated methodologies for assessing KOA. This study presents Deepbone Inception-ResNet V2 (IRV2), a deep learning convolutional neural network (CNN) architecture by hybridizing Inception and ResNet architecture. It has been designed to automate KOA classification and deliver surgical recommendations. The proposed model shows improved capability in detecting minute pathological features such as joint space narrowing and subchondral sclerosis that are often missed by traditional networks. The model was trained on a large knee X-ray dataset using transfer learning, with fine-tuning applied to adjust the network for musculoskeletal image analysis. Apart from binary or multi- class grading, an integrated decision-support layer correlates KL-grade predictions with biomechanical thresholds to propose tailored surgical pathways, from conservative management to total knee arthroplasty (TKA). The proposed Deepbone IRV2 achieves a classification accuracy of 96.7%, which outperforms other CNN based approaches. The proposed framework combines the orthopedic clinical knowledge with computer vision-based analysis, which results in reliable diagnosis, effective patient-centered treatment planning, and improves clinical management of degenerative joint diseases.

Keywords: Knee Osteoarthritis (KOA), Inception, ResNet, KOA Grading, Surgical Recommendation, Medical Image Analysis, Hybrid Learning

EfficientNet-B0 Based Multi-Class Kidney Abnormality Classification from CT Images Using Transfer Learning

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Abstract:

CT scans while evaluating manually consumes a lot of time that motivates the necessity for computer assisted diagnosis systems which are reliable. Kidney abnormalities such as cysts, stone and tumor are diagnosed in advance by the use of computerized analysis of CT images. A deep learning based multi-class classification framework for the detection of kidney abnormality is presented by this work with the help of CT images. The proposed lightweight, convolutional neural network architecture can be called as EfficientNet-B0 used along with transfer learning to categorize CT images into four groups as normal kidney, cyst, stone, and tumor. Metrics such as accuracy, precision, recall, and F1-score were used for performance assessment. The model is worked with a publicly available CT Kidney dataset with an overall accuracy of 84.02% which shown a strong performance for the classes of cyst and tumor and at the same time providing importance to the challenges of class imbalance and visual resemblance present in stone classification. From the results, the practical applicability of EfficientNet-based models for the multi class classification of kidney abnormalities is discovered.

Keywords: Detection of kidney abnormalities, Deep learning, EfficientNet-B0, CT image, Classification of medical images.

Hybrid CNN–Transformer U-Net for Breast Ultrasound Tumor Segmentation using Combined Dice and Binary Cross- Entropy Loss

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Abstract:

Accurate outlining of tumor edges in breast ultrasound images remains difficult due to speckle noise, low contrast, and irregular lesion morphology. To address these limitations, this paper proposes a Hybrid CNN–Transformer U Net architecture for automated breast tumor segmentation. The proposed framework integrates convolutional feature extraction for local spatial representation with transformer based self-attention mechanisms to capture long-range contextual dependencies. A symmetric encoder–decoder structure with skip connections is employed to preserve fine grained spatial details during reconstruction. To reduce the class imbalance that exists in the medical image segmentation, a hybrid loss is used, which is a combination of Binary Cross Entropy (BCE) and Dice loss, which allows stable training and directly increases the region overlap. Training on grayscale ultrasound images with ground truth masks is based on an 80%20% training validation split. As shown by experimental assessment, proposed architecture can attain a Dice coefficient of 0.91, Intersection over Union (IoU) of 0.86, pixel-wise accuracy of 94.3% and a convergence validation loss of 0.18. Transformer-based contextual modeling combined with the hierarchical fusion of features of U-Net shows a significant improvement in the ability to delineate boundaries. The suggested approach offers a powerful and computationally powerful segmentation model, which makes it feasible to obtain credible computer-aided diagnosis in breast cancer evaluation.

Keywords: Deep Learning, U-Net, Ultrasound Imaging, Breast Cancer, Image Segmentation.

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ICBSII 2026, SSNCE, CHENNAI, MARCH 09 – 11, 2026

TRACK 9

Multimodal Control Approaches for Below Elbow Prosthetic Hand Movement

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Abstract:

The increasing prevalence of below elbow amputations underscores the need for prosthetic solutions that are functional, affordable, and adaptable. This proposed work presents the development of a smart prosthetic hand featuring three distinct control modalities (i)The Android application, developed using MIT App Inventor, offers a gesture-based wireless interface. (ii)The IR-sensor-based glove captures finger flexion to drive corresponding motor actions, (iii)The voice control system, utilizing the Voice Recognition Module V3, enables predefined movements through speech commands. A 3D-printed prosthetic hand, actuated by servo motors and managed by an embedded microcontroller, serves as the test platform. To evaluate and compare the effectiveness of each control modality, performance metrics such as movement accuracy, joint angle precision, and grip pressure are measured using IMU sensors, a goniometer, and tactile sensors. This comparative study aims to identify the most suitable control method, contributing to the advancement of low cost, customizable prosthetic solutions for below elbow amputees in both clinical and underserved settings.

Keywords:Prosthetic hand, Multi-modal control, Mobile app, Wearable glove, Voice recognition, IR sensors, IMU sensor, Goniometer, Tactile sensor .

Design and Development of a Smart Wrist Band for Remote Rehabilitation and Vital Sign Monitoring

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Abstract:

This work proposes the design and development of a smart rehabilitation band that integrates biosensors with advanced features, wireless communication, and therapeutic assistance. The proposed system includes a blood pressure sensor with the ability to measure systolic, diastolic, and pulse values in real time, therefore allowing for continuous monitoring of a patient's vital signs. A Global System for Mobile Communication module is used for sending automated alerts in cases of physiological abnormalities to the healthcare provider for immediate medical response. An OLED display on the wearable facilitates the live visualisation of health parameters directly by the user, therefore fostering better user engagement and motivating patients toward their rehabilitation process. The therapeutic mode in the smart band leads patients through exercises of wrist movements that are vital for physical Janne Chetan Department of Biomedical Engineering, School of Bio and Chemical Engineering, Sathyabama Institute of Science and Technology, Chennai, India chetanjanne2002@gmail.com Raghupathi Prahala Department of Biomedical Engineering, School of Bio and Chemical Engineering, Sathyabama Institute of Science and Technology, Chennai, India prahalaraghupathi@gmail.com The WHO estimates that in India alone, approximately 65 million people live with some form of disability, many of whom require long-term rehabilitation services. While national initiatives exist, such as the Rehabilitation Council of India and the National Programme for Prevention and Control of Cancer, Diabetes, Cardiovascular Diseases and Stroke, the efforts are still inadequate to ensure continuous, patient centred rehabilitation support, especially in remote and underserved areas [2]. recovery. The architecture includes an Arduino Nano (Atmega328P) that will handle the operation of sensors and motors, and the ESP32 module that will provide wireless connectivity for seamless wireless transmission of data. This architecture uses a two-controller system to enable efficient sharing of tasks and ensure reliable communication with external monitoring platforms. The proposed smart band combines continuous physiological monitoring, real-time alerts, and interactive rehabilitation assistance to offer a comprehensive solution for post-surgical recovery. It is particularly useful in remote or underserved areas where frequent clinical visits are difficult, thus enhancing access and efficiency of rehabilitation services. Monitoring blood pressure is a safety and risk-reduction feature, particularly for stroke patients and older adults undergoing unsupervised rehabilitation at home.

Keywords :Smart band, rehabilitation, wearable technology, blood pressure sensor, OLED display, GSM alert system.

Engaging Breathing Therapy System with Real Time Feedback and Performance Tracking

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Abstract:

An interactive breathing exercise system addresses insomnia, anxiety, and speech difficulties by combining pressure-based respiration detection with game driven user feedback. The platform features real-time monitoring using an MPX5010DP sensor, hygienic hardware suitable for repeated use, and structured exercises such as 4-7-8 and Box Breathing. Performance feedback, automated scoring, and data recording are integrated to support regular practice and measurable progress in therapeutic and wellness settings. The system achieved a breath phase detection accuracy of 96%, with timing error within ± 0.11 seconds, and demonstrated consistent improvement in breathing control across 15 days of user testing.

Keywords : Breathing exercise, biofeedback, MPX5010DP sensor, gamified therapy, adaptive threshold.

Stridesync: A Multisensory Framework for Movement Monitoring and Response

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Abstract:

Accurate monitoring of biomechanical parameters with precision is essential in rehabilitation and mobility training to facilitate effective recovery, prevent reinjuries. Conventional walkers primarily provide mechanical support and lack the ability to yield quantify posture, grip stability, or gait coordination. Therefore, the development of the smart walker system, Stridesync, is designed to enhance rehabilitation through real-time sensing and feedback. The system integrates force sensors mounted on the walker handles, with an accelerometer module to monitor variations in motion and assess the stability of an individual's locomotion. A haptic unit provides feedback in the form of vibration to the user when walking assistance is active and a deviation in posture or an imbalance occurs. Governed by a microcontroller that processes sensor data and transmits the output both visually and tactually via a digital display interface for therapist's evaluation, this prototype continuously monitors biomechanical changes, effectively corrects posture, and facilitates safe movement training. Therefore, the Smart Walker constitutes an economical, sensor-enabled rehabilitative assistive device.

Keywords : accelerometer, force sensors, haptic feedback, microcontroller-based system, and rehabilitation device.

Urea Estimation Based on Dilute Species Transport Dynamics in Micro Device

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Abstract:

Sweat is a biological fluid containing many analyte that could serve to identify related pathological conditions. In this way, any elevation in sweat urea could be an indication of disease related to liver or kidney or even diabetes. Since sweat collection poses few challenges, any measurement done with micro quantity of sweat would be useful. In this aspect attempted here is to design a micro device that could estimate urea concentration with 20 L of input. The device has three chambers for storage, reaction and collection. The input fed in the collection chamber passess through reaction unit producing different species of ions. Finally they are accumulated in collection chamber. On execution of the model, ammonia ion concentration is estimated for two different urea concentration in the input. As per stoichiometry, the amount of ammonium ion liberation is two times of urea with an error of $3\pm0.5\%$

Keywords :urea sensor, ammonium ion, urease, surface reaction

Design Optimization of a Dual-Cuff Supraglottic Airway for Enhanced Seal Performance

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Abstract:

Supraglottic airway devices (SADs) are essential for maintaining the prolonged efficacy of a consistent airway, which is influenced by structural robustness and flow resistance, by preventing gastric reflux. Conventional (SADs) offer modest advancements in sealing dynamics, but they are limited by their inability to regulate downstream pressure and ensure proper sealing to prevent regurgitation. A previously designed external channel dual-cuff SAD enhanced sealing, but its disproportionate geometry induced displacement in stress-strain concentration and disruption of airflow. A remodelled dual-cuff airway tube with an integrated gastric drainage channel (Design2) was evaluated through a computational analysis to compare the performance of the our previous design external-channel dual-cuff (Design1) and conventional SADs. The integrated channel model depicted significantly enhanced operational implications in functional outcomes, with almost an 85 % reduction in peak pressure and 73% reduction in unstable laminar flow. Substantially, a 70 % reduction in peak stress with improved uniform distribution of loads was observed compared to the external gastric channel dual-cuff approach. If implemented practically, these outcomes can help produce a significantly more resilient and clinically adaptive airway pathway. The outcomes depict that the revised geometry yields substantial improvements in mechanical endurance.

Keywords : Supraglottic airway devices (SADs), dual cuff airway tube, External- gastric channel, Integrated gastric channel.

A Biomedical IoT Device for Continuous Monitoring and Prevention of Pressure Ulcers in Bedridden Patient

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Abstract:

In long-term patient care environments, pressure ulcers are one of the most common yet preventable complications, especially for immobile patients who cannot communicate their discomfort. This paper presents an IoT-based intelligent monitoring system designed to support proactive pressure ulcer prevention through continuous and non-intrusive patient observation. The proposed system features a new multi-parameter monitoring approach that combines pressure distribution, patient posture, physiological signals, and skin microclimate conditions to assess risk in real time. Unlike traditional systems that depend on single-parameter thresholds or periodic manual checks, the system uses time-based risk validation and multi-sensor fusion to identify lasting high-risk conditions while reducing false alarms. It analyzes prolonged immobility, abnormal pressure patterns, adverse temperature and humidity levels, and physiological changes together to produce a unified risk assessment. If significant risk continues beyond set durations, alerts are automatically generated and sent through local and remote communication modules, allowing for prompt caregiver intervention even without direct supervision. Experimental evaluation shows reliable real-time performance and better alert accuracy. The proposed system changes reactive care into a proactive, data-driven prevention framework, improving patient safety, comfort, and caregiver efficiency in hospitals and long-term care settings.

Keywords :Pressure ulcer prevention, IoT-based patient monitoring, biomedical sensors, long-term patient care, remote health monitoring, alert systems.

Design of a Sensor-Assisted Five-Bar Finger Rehabilitation Device

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Abstract:

Finger rehabilitation plays an important role in restoring hand function following neurological and musculoskeletal impairments, yet conventional therapy methods often lack repeatability and objective performance feedback. This paper presents the design and experimental evaluation of a compact finger rehabilitation device that supports adaptive active-assist therapy. The system is based on a five-bar linkage mechanism fabricated using thermoplastic polyurethane (TPU) to achieve physiologically aligned finger flexion extension while maintaining comfort and mechanical simplicity. The device integrates multiple sensing modalities, including inertial measurement, surface electromyography, force sensing, and galvanic skin response monitoring, to enable closed-loop control and safe operation. Experimental validation was conducted on healthy volunteers using a structured rehabilitation protocol. The results demonstrate stable motion repeatability, controlled finger movement within a physiological range. To address these challenges, various robotic and wearable rehabilitation devices have been proposed. However, many existing systems are bulky, expensive, or mechanically complex, limiting their accessibility and long-term usability. Soft robotic gloves improve comfort but often suffer from limited force control and motion repeatability, whereas rigid exoskeletons may restrict natural finger motion and cause discomfort during prolonged use. These limitations highlight the need for a compact, mechanically simple, and user friendly finger rehabilitation device capable of delivering repeatable motion while providing quantitative feedback, range, and reliable sensor-driven adjustment of assistance based on user effort and comfort. Compared to manual finger exercises, the proposed device provides improved motion consistency and quantitative control while maintaining comparable comfort levels. The use of widely available components and standard fabrication methods enables easy replication and integration by other researchers, making the system a practical platform for future rehabilitation studies and clinical evaluation.

Keywords : Finger Mobility Rehabilitation, Five-Bar Linkage Mechanism, Thermoplastic Polyurethane (TPU), 3D Printing, Servo Motor Actuation, Inertial Measurement Unit (IMU), Electromyography (EMG), Galvanic Skin Response (GSR)Active assist, Wearable rehabilitation device.

Design and Development of a Low-Cost Static Plantar Load Measurement Platform for Diabetic Foot Risk Screening

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Abstract:

Diabetic foot ulcer (DFU) is a major complication of diabetes mellitus. It is often followed by abnormal plantar force distribution combined with loss of sensation (neuropathy). The risk of ulcer formation and lower limb amputations can be reduced by early identification of high-force regions. However, available plantar assessment systems are limited to specialized clinical settings and are often expensive. This paper presents the development of a low-cost static plantar load measurement platform intended for preliminary diabetic foot ulcer screening. The proposed system uses force-sensitive resistors (FSRs) integrated into a foot platform to acquire the distribution of plantar force while standing. Data acquisition is carried out using an ESP32 microcontroller with signal conditioning and an external Hemadarshini.R.S BME Department Rajalakshmi Engineering College Chennai, India 220301032@rajalakshmi.edu.in environments as the existing systems are expensive, bulky, and restricted to specialized clinical or urban settings. There is a clear need for affordable and simple systems that can support preliminary screening and monitoring of plantar force abnormalities. analog-to-digital converter. Real-time data visualization and data logging are enabled using a graphical user interface. To establish the relationship between applied force and sensor output, calibration is performed using known static loads. Although the current prototype is restricted to static measurements, it is a cost-effective and accessible solution for preliminary diabetic foot risk screening. Dynamic analysis and large-scale clinical validation can be included in future work.

Keywords : Plantar force, diabetic foot ulcer, static force assessment, force-sensitive resistor, low-cost biomedical device, risk screening.

DS2P: Digital Speech Screening Platform Differentiating Post-stroke and Healthy Individuals Paromita

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Abstract:

Stroke poses a major global health challenge coupled with deficits in phonological processing and motor dysfunction, impairing comprehension, reading, and production of language. Speech specialists use pen-and-paper based tools for quantifying such deficits. Though powerful, these methods suffer from the need for multiple one-on-one sessions and access to clinical resources, which is problematic in countries like India having limited healthcare resources and low doctor-to-patient ratio. To face this challenge, researchers have been focusing on digitized screening tools that can quantify one's speech signal in terms of time and frequency domain features. Existing digitized screening platforms quantify speech in various languages, e.g., English, Dutch etc. but no work has been reported in Hindi. Languages vary in phonological structures, affecting the choice of feature set used to quantify a speech signal. This problem aggravates in the case of anomalous speech signals acquired from post-stroke individuals, making generalization of digitized screening difficult across languages. No work has been reported based on the use of speech signals of words spoken in the Hindi language (official language of India) for digitized screening of post stroke and healthy speech. Motivated by this, we have developed a digitized screening platform (DS2P) that analyzes speech signals corresponding to words spoken in Hindi, followed by extracting distinctive time and frequency-domain features and screening post-stroke individuals from their healthy counterparts. Results of our study with 14 post-stroke and 13 healthy participants showed the potential of DS2P to screen post-stroke participants with an accuracy of ~83% and to distinguish them from their healthy counterparts using a combination of time- and frequency-domain features.

Keywords : Spectral Centroid, Power Spectral Density, Signal Kurtosis, Formants, Zero Crossings Rate, Signal Intensity

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ICBSII 2026, SSNCE, CHENNAI, MARCH 09 – 11, 2026

TRACK 10

Deep Learning Approach for EEG Cognitive Load Detection

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Abstract:

EEG provides a non-invasive trustworthy way of analyzing human brain activity and inferring cognitive load. In this paper, we propose a hybrid CNN-LSTM-based framework for the classification of cognitive load levels using EEG signals collected from Arithmetic and Stroop paradigms. The model has successfully modeled both spatial and temporal dependencies of multichannel EEG data through convolutional and recurrent layers, respectively. In this work, the EEG data were preprocessed with band-pass filtering, normalization, and epoching over 8 active electrodes (Fp1, Fp2, F7, F3, FZ, F4, F8, and C2). Experimental evaluation showed that the accuracy is 89.88%, precision is 88.8%, recall is 89.88%, and F1-score is 88.89%, outperforming traditional methods like SVM and shallow CNN baselines published in previous papers. The AUC value of 0.797 and robust EEG channel correlations between frontal and central electrodes are representative of similar cognitive load patterns across task conditions. These outcomes validate the feasibility of the CNN-LSTM architecture for real-time cognitive load tracking, human-computer interaction enhancement, and neuro-ergonomic evaluation.

Keywords : EEG signal processing, cognitive load classification; CNN–LSTM, deep learning; Stroop, Arithmetic, neuroergonomics.

MediScribe AI - Intelligent Digital Prescription Tool

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Abstract:

The project focuses on the development of an intelligent digital prescription system designed to assist doctors in generating accurate and paperless prescriptions. It explores the integration of AI-driven transcription and automation in healthcare documentation. The main problem addressed is the manual effort and errors involved in traditional handwritten prescriptions, which can lead to miscommunication and data loss in medical records. This research aims to improve prescription accuracy, enhance record management and promote faster communication between doctors and patients. It also seeks to fill the gap in existing systems by applying advanced AI language models for real-time medical transcription. The methodology involves capturing the uploaded prescription text, extracting key details using Gemini AI and converting them into a formatted digital prescription stored securely in the cloud and shared with patients through SMS. The system ensures faster data handling, improved accuracy and reduced manual workload for healthcare professionals. The proposed solution promotes digital healthcare transformation and enhances the reliability of prescription management systems.

Keywords:Digital Prescription, Artificial Intelligence (AI), Gemini AI, Optical Character Recognition (OCR), Cloud Database, Healthcare Automation.

Optimal Feature Selection for Muscle-Dependent Fatigue Detection Using Surface EMG

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Abstract:

Muscle fatigue refers to the decline in a muscle's ability to generate force during sustained or repeated activity and directly affects movement performance, coordination, and functional capacity. Objective assessment of fatigue is important in clinical evaluation, rehabilitation, ergonomics, and athletic training, where fatigue progression influences performance degradation and injury risk. However, accurate detection of muscle fatigue from surface electromyography (sEMG) remains challenging due to signal non-stationarity, inter-subject variability, and the muscle-specific nature of neuromuscular adaptation. Many existing EMG-based fatigue studies rely on large, generic feature sets often with limited physiological interpretability and reduced generalisability across subjects. To address these limitations, this work presents a unified framework for extracting physiologically meaningful fatigue markers from the Vastus Lateralis (VL) and Tibialis Anterior (TA) during sustained isometric contractions. Surface EMG recordings were obtained from participants during sustained isometric lower-limb tasks, and fatigue-related signal characteristics were systematically analysed using a physiology-informed validation strategy. The resulting muscle-specific signatures revealed clear mechanistic differences: VL fatigue was characterised by amplitude elevations, whereas TA fatigue exhibited spectral compression and reduced complexity. These validated features were further assessed under Leave-One-Subject-Out cross-validation using multiple classifiers, demonstrating robust subject-independent discrimination of fresh and fatigued states. The proposed framework provides a physiologically grounded, interpretable, and data-efficient foundation for automated lower-limb fatigue monitoring.

Keywords: Muscle fatigue, surface electromyography, fatigue assessment, muscle-specific analysis, lower-limb muscles.

Single-Channel sEMG-Based Wrist Gesture Recognition for Gamified Rehabilitation Interfaces

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Abstract:

Surface electromyography (sEMG) is commonly used to recognize wrist gestures in human-computer interaction and assistive applications. In this work, a single-channel sEMG based gesture classification approach is presented using Support Vector Machine(SVM), Random Forest, and Neural Network models. The study focuses on designing lightweight models that are suitable for deployment in edge-oriented environments. A signal processing pipeline was developed to extract 16 time and frequency-domain features from Flexor Carpi Radialis muscle signals for classifying four hand gestures: rest, flexion, radial deviation, and pronation. The study combines laboratory recorded signals with an online dataset and applies standard preprocessing techniques. Among the evaluated models, Random Forest achieved the highest classification accuracy of 79.79%. To demonstrate application-level usability, the classified gestures were integrated into a rehabilitation-oriented interactive game interface, where pre-recorded sEMG signals were streamed sequentially to simulate real-time interaction and validate gesture to-action mapping.

Keywords: surface electromyography, gesture recognition, single-channel sEMG, embedded machine learning, biomedical signal processing, gamified rehabilitation interface

Dual Age Estimation Framework Using PINN and Modified AlexNet with Grad-CAM Visualization: A Deep Learning Approach for Chronological and Biological(Apparent) Age Prediction

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Abstract:

Age estimation on the face has gained more relevance in healthcare, biometrics as well as human-computer interaction. The dual-AlexNet architecture learns parallel deep learning approximations that differentiate chronological age (calendar age) and biological indicators of physiological aging on parallel deep learning frameworks trained with fine-grained age annotations. Physics-Informed Neural Network (PINN) constraints are incorporated into the training loss to enforce biological plausibility of age predictions. Although the majority of available systems look at the chronological age; an increasing understanding is that biological age as a measure of physiological aging and not the time elapsed is of greater benefit in clinical decision-making. Our proposed dual-stream deep learning architecture concurrently predicts chronological and biological age based on faces. Two parallel variants of the AlexNet architecture are employed with the modification to age classification using discrete values (one as discrete) and predicting the biological age using weighted probability averaging (the other). In order to increase clinical trust and interpretability, we combine Gradient weighted Class Activation Mapping (Grad-CAM) visualization that identifies age-relevant parts of the face. The framework supports various age label formats by doing intelligent parsing and offers a REST API that can be production ready to enable easy integration with healthcare systems.

Keywords: Age estimation, biological age, deep learning, AlexNet, Grad-CAM, explainable AI, facial analysis

Real-Time Prosthetic Hand Control Using Forearm EMG Signals

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Abstract:

The current project is aimed at creating a prosthetic arm that can be controlled using electromyography (EMG) signals generated by the muscular activity of the user's forearm. The system employs a Muscle Sensor V3 to acquire EMG signals, which are processed using an Arduino microcontroller. In addition to EMG sensing, an ADXL accelerometer is used to capture wrist motion and orientation, while a force-sensitive resistor (FSR) is incorporated to measure grip pressure during object interaction. These multimodal sensor signals are interpreted by the Arduino and translated into appropriate actuation commands for servo motors that drive a 3D-printed robotic hand. The prosthetic mimics natural hand movements, such that muscle contraction results in hand closing, while muscle relaxation leads to hand opening, enabling an intuitive and mirrored control mechanism. The system provides a non-invasive and user friendly interface for individuals with upper-limb amputations. By integrating EMG, motion, and pressure sensing with open source hardware and 3D printing, the proposed solution remains low-cost and suitable for low-resource environments and educational applications. Overall, the project demonstrates the feasibility of developing an effective, affordable, and real-time myoelectric prosthetic hand using embedded systems to enhance assistive technology for physically disabled individuals. It highlights how embedded systems have the potential to transform the real-world to assist physically disabled people.

Keywords: Electromyography (EMG}, Prosthetic Hand, Real Time Control, Arduino, Muscle Sensor, Embedded Systems, Servo Motors, Assistive Technology, Myoelectric Control, 3D Printing.

Sentence-level Silent Speech Classification using sEMG scalogram features and SVM

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Abstract:

This paper proposes a silent speech recognition framework based on scalogram-derived features extracted from surface electromyography (sEMG) signals. Surface electromyography (sEMG) is employed as the sensing modality, with a six-channel electrode configuration positioned over key articulatory muscle regions to capture muscle activation patterns associated with speech production. The proposed approach enables the development of silent speech interfaces, allowing users to convey messages without producing audible speech. Scalogram images generated via Continuous Wavelet Transform (CWT) of the sEMG signals serve as input features to a Support Vector Machine (SVM) classifier for sentence-level recognition across 50 sentence classes. While spectrograms are commonly used for audio signal visualization and classification, this study instead explores the use of scalograms for EMG signal analysis. The mapping accuracy between individual scalogram images and their associated sentences is evaluated and analyzed to assess the effectiveness of the proposed method. The proposed system achieves a classification accuracy of 80.00%, with precision, recall, and F1-score of 79.36%, 80.01%, and 79.66% respectively, demonstrating the viability of scalogram-based sEMG features for sentence-level silent speech recognition.

Keywords: Multi-channel EMG signal processing, Scalogram Analysis, Support Vector Machine, Assistive-communication technologies.

Multi-Class Lung and Colon Cancers Classification using Transfer Learning Approach

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Abstract:

Accurate and early recognition of lung and colorectal cancers is essential for improving survival rates. These cancers are leading causes of cancer-related mortality worldwide. Although image analysis with manual evaluation by pathologists is time-consuming, subjective, and prone to variability. This study proposes an automated deep learning pipeline using transfer learning with the EfficientNetB3 architecture for robust cancer classification. The framework begins with data acquisition, followed by augmentation, including resizing images to $224 \times 224 \times 3$, normalization, and dataset balancing to enhance generalization. Two models were developed: a custom Convolutional Neural Network (CNN) and a transfer learning model based on EfficientNetB3 pre-trained on ImageNet. The system classifies images into five categories: normal colon tissue, colon adenocarcinoma, normal lung tissue, lung adenocarcinoma, and lung squamous cell carcinoma. Performance was evaluated using accuracy, precision, recall, and F1-score. Experimental results show that EfficientNetB3 achieved over 99% test accuracy, outperforming the custom CNN and demonstrating strong generalization with minimal misclassification.

Keywords: Lung Cancer, Colon Cancer, Histopathology, Deep Learning, Transfer Learning, EfficientNetB3, Medical Image Classification

An Efficient Low Power Design of Multiplierless Discrete Cosine Transform

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Abstract:

An effective low-power multiplierless Discrete Cosine Transform (DCT) architecture by using merely addition and subtraction instead of power-hungry multiplication processes is presented in this paper. The suggested architecture drastically lowers computing complexity. The DCT design uses optimized arithmetic units to achieve low power consumption and area efficiency. Because it uses fewer adders and subtractors, the multiplierless 8-point DCT structure is appropriate for error tolerant image processing applications. Power consumption, delay, and power-delay product (PDP) are used to assess the architecture. Using an 8×8 block-based method, the suggested DCT is applied for image compression, and simulation results demonstrate significant reduction in power and area while maintaining acceptable performance. The suggested design is ideal for low-power multimedia and medical image processing applications because of these properties.

Keywords: Discrete Cosine Transform (DCT), Multiplierless Architecture, Low-Power Design, Image Compression, Approximate Computing

Temporal CAT-based Data Fusion for IoMT System

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Abstract:

IoMT (Internet of Medical Things) is purely real time series data operation where the temporal information plays the major role. Data fusion mechanisms represent a patient's complete information in a unique way that makes the prediction easier. But a patient's diagnosis always depends on their previous investigation and records, which need to be fused, and a decision has to be made based on that. Thus, the proposed work involves the temporal Cross Attention Fusion mechanism for unified representation of patient information using the current and last updated information. The proposed work utilizes the benefit of the Long Short-Term Memory (LSTM) based Variational Autoencoder (VAE) for obtaining meaningful information from the patient multi modal data. These features are then combined and fused along with the previously recorded patient information, that shown 96.2% fusion effectiveness using the HER, Imaging and Sensor modalities dataset. The contribution for fusion is accounted for maximum by the image modality where the temporal-based fusion provided a balanced contribution by EHR and Sensor data.

Keywords: IoMT, Healthcare, Sustainable, Temporal, Data Fusion

Regression-Based Noninvasive Haemoglobin Prediction from Eye Conjunctiva Images

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Abstract:

Anemia diagnosis typically requires invasive blood testing, which may not be accessible in low-resource settings. This study proposes a noninvasive machine learning framework for predicting haemoglobin levels using eye conjunctiva images. Conjunctiva localization was performed using a YOLO-based detection model, followed by precise segmentation using the Segment Anything Model to isolate the region of interest. The segmented images were resized and normalized prior to analysis. Feature extraction focused on vascular density and color-related parameters associated with haemoglobin concentration. Three regression models, namely Random Forest, Neural Network, and an Attention-based model, were implemented for haemoglobin prediction. Model performance was evaluated using R^2 score and error-based metrics. Among the three evaluated models, the Attention based approach achieved superior haemoglobin prediction performance by effectively leveraging the extracted vascular and color features. The proposed framework provides an accurate and scalable solution for non-invasive anemia screening in resource-constrained healthcare settings.

Keywords: Anemia, Haemoglobin prediction, Noninvasive diagnosis, Machine learning, Conjunctiva images.

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ICBSII 2026, SSNCE, CHENNAI, MARCH 09 – 11, 2026

TRACK 11

Development and Validation of a Multichannel fNIRS System for Cognitive Load Assessment

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Abstract:

The assessment of cognitive load is crucial in understanding how individuals interact with cognitively demanding tasks such as learning, problem-solving, or gaming. Functional Near-Infrared Spectroscopy (fNIRS) provides hemodynamic signals qualitatively from the prefrontal cortex, offering a window into the neural correlates of cognitive workload. In this study, the design, development, and validation of a four-channel fNIRS system are presented to obtain objective, real-time insights into brain activity. The objective of cognitive load assessment has to be met with rigorous validation of the developed system. Hence, the fNIRS system is subject to validation using different strategies. The system features a multi-distance channel configuration, wireless data acquisition, and signal processing. Validation of the developed system has been done in a bright light environment, a dark environment and through a physiological test such as the arterial occlusion test. The dark and ambient light tests related results reveal consistent and expected trends. The same follows for the arterial occlusion test as well. The outcomes of this research are a testament to the usage of the developed system for the assessment of cognitive workload and user- centered design strategies in domains such as education, gaming, and neuroergonomics.

Keywords:fNIRS system, validation, wireless data acquisition, arterial occlusion validation, Cognitive Load Assessment.

Embedded AI System Continuous Surveillance for Neurofibromatosis Using Wearable BioImpedance and Nerve Signal Sensors

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Abstract:

Neurofibromatosis is a progressive neurological disorder that requires continuous observation to detect subtle changes in nerve and tissue characteristics at an early stage. The risks of neurofibromatosis range from cosmetic and functional impairments to potential malignant transformation of tumors, emphasizing the importance of timely diagnosis and intervention. Early identification of neurofibromatosis-related changes is crucial to prevent long-term complications and improve patient quality of life. This work proposes a wearable and non-invasive monitoring approach that focuses on tracking physiological variations over time and interpreting these patterns to assess potential risk levels. The proposed approach emphasizes intelligent signal interpretation and real-time assessment to support early abnormality identification without revealing underlying implementation details. Clinically meaningful outputs are provided to assist healthcare professionals in long-term monitoring and timely intervention, while prioritizing portability, patient comfort, and practical usability in everyday clinical environments.

Keywords:Neurofibromatosis monitoring, AD5933 bio impedance measurement, AD620 nerve-signal acquisition, ESP32 data processing, TinyML-based classification, Wearable biomedical device, Wireless result transmission.

An fNIRS – Enabled Memory Game Device

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Abstract:

Memory and attention related issues are becoming a widespread problem among students and older adults, which prompts the necessity to find convenient and efficient methods of contributing to cognitive wellness. In this paper, a Memory Game Device is proposed, and this device combines interactive gameplay with real time monitoring of brain activity. The device will make memory exercises more interesting at varying degrees of difficulty using visual, audio and touch cues such as colored LEDs, a small display and a buzzer. The system displays the brain activity by monitoring alterations in blood oxygen in the brain using fNIRS to reveal the extent to which the brain is engaged in play. The game runs on ESP32 microcontroller, where data is collected and transmitted on wireless. The scores and fNIRS data are stored in a database and represented on a web dashboard, where the users can analyze their performance, time, and get feedback dedicated to their health. This system is cheap and portable compared to traditional brain monitoring such as EEG and MRI and as such, this system can be used on a daily or classroom basis. This device assists in cognitive enhancement and educational research by utilizing memory training, actual brain monitoring, and personalized feedback.

Keywords:functional Near-Infrared Spectroscopy, Memory Game, prefrontal cortex, cognitive Task, Hemodynamics

Neuromuscular Fatigue Detection Using Hybrid Machine Learning Classifier

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Abstract:

Humans exhibit reduced muscle strength and motor skills due to neuromuscular fatigue which results in lower operational capacity and higher chances of sustaining injuries during rehabilitation and clinical evaluation and athletic performance training. The objective study of neuromuscular fatigue requires methods that can accurately identify the intricate and dynamic physiological signals which exhibit non-static behavior. It Introduces a machine learning system which combines different techniques to identify NMF through the analysis of synchronized EEG and EMG data. It mainly used complete system to process EEG-EMG data which involved multiple subjects and different channels to study upper-limb movement activities through five steps which included signal preprocessing and feature extraction and dimensionality reduction and classification. The two hybrid models tested in this study included Support Vector Machine with Principal Component Analysis (SVM-PCA) and Support Vector Machine with Convolutional Neural Network (SVM-CNN) which used the CNN as a tool for automatic feature extraction. The evaluated system performance with different participant group sizes who ranged from two to five people to see how the system worked with different levels of participant differences. The SVM-CNN model showed better generalization capabilities and consistent performance across different participant groups although both models achieved strong accuracy after parameter optimization work. The SVM-CNN model achieved superior performance in detecting fatigue during class imbalance situations which became more severe when dealing with larger groups of subjects. The findings show that deep feature learning combined with traditional classifiers creates more durable machine learning systems which can identify fatigue more effectively, making it possible to use this method for NMF detection in rehabilitation monitoring and occupational health assessment and sports science.

Keywords: Neuromuscular Fatigue, EEG-EMG Signal Processing, Hybrid Machine Learning, SVM-CNN Classifier, Rehabilitation Engineering, Fatigue Detection.

Design and implementation of multichannel EMG-based control of bionic arm

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Abstract:

Upper limb amputation results in functional impairment which brings psychological stress to affected people. This can be overcome by activating an external device such as bionic arm with the employment of signals acquired from residual muscles. Hence this paper presents the design and implementation of a multichannel EMG-based control system for bionic arm to achieve robust and real-time user centered recognition. The proposed system acquires surface EMG signals from three forearm muscles namely Flexor Carpi Radialis, Extensor Carpi Ulnaris, and Brachioradialis corresponding to grasping, releasing, and stabilization functions. The acquired signals are amplified, filtered, and processed using a moving average window and multichannel threshold-based algorithm implemented on an ESP32 microcontroller. The bionic arm that is used as an external device contains 7 servo motors fixed for various functions. These motors enable smooth and responsive arm movements with low latency of about 30ms. Prolonged time of usage may result in fatigue, and to enhance this, a hybrid architecture incorporating voice-based commands has also been integrated. Additionally, the microcontroller is capable of transferring real-time data to a IoT dashboard for remote monitoring and tele-rehabilitation. The evaluation results shows that the system provide improved accuracy, reduced false triggering and latency within acceptable limits. Hence the proposed frameworks provide a better, low-cost device for real-time control applications.

Keywords: Multichannel EMG, Upper-limb Prosthetics, ESP32, IoT Tele-rehabilitation, Voice Control, Flexor Carpi Radialis, Biomedical Engineering, Low-cost Bionics.

Design and Implementation of a Low-Noise Signal Acquisition System for Small Animal Physiological Monitoring

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Abstract:

Accurate acquisition of physiological signals such as ECG, blood pressure, and temperature is critical in small animal biomedical studies. Analog monitor circuits are normally prone to problems such as signal degradation, motion artifacts, and environmental noise, which affect the quality of the acquired data. The objective of this research work is to develop a wearable signal acquisition circuit that ensures accurate and trustworthy physiological acquisition of small animals. The proposed circuit includes an instrumentation amplifier designed using INA333 with high common-mode rejection and low noise. The amplifier output is followed by high-pass and low-pass filters for efficient signal processing. The processed signals are then converted to digital form using an analog-to-digital converter (ADC) for analysis. The circuit is simulated and developed using Multisim software with a focus on gain maximization, power optimization, and noise reduction. This design will help improve the clarity of signals with integrity and address significant problems in biomedical signal acquisition and therefore will be suitable for continuous monitoring.

Keywords: ECG, Instrumentation Amplifier, Signal Conditioning, Physiological Monitoring

Hybrid Power Reduction Techniques for Low Power Arithmetic Units in Portable Biomedical Instrumentation

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Abstract:

This paper proposes a hybrid low-power design for Binary Coded Decimal (BCD) adders, which consists of a combination of three techniques: power gating, clock gating and multi-Vdd architectures. BCD adders are known to finance, commerce, and embedded systems; in this metric is a critical requirement for efficiency in power utilization. The method reduces the static and dynamic power at a fine level. Power gating helps to cut off the leakage current by isolation idle blocks with a sleep transistor. Clock gating, which accesses clock pulses in inactivated units, reduces dynamic consumption. Multi-VDD allows the sub-blocks to be with different supply voltages according to their performance requirements to further increase the efficiency without sacrificing any function. Collectively, these techniques guard against the powerful and effective control of power across the adder. Simulations indicate that the total power and energy-delay-product is reduced to a much lower level with the hybrid design compared to the conventional BCD adders without optimizations. It would save up to 70% power in appropriate configurations and therefore be used in low-power VLSI applications and Bio-medical instruments.

Keywords: EEG emotion recognition, deep learning, emotion classification, Bi-LSTM.

Pupil Detection and Tracking in Recorded Footage with Respect to Auditory Stimuli

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Abstract:

Researchers can learn a lot about a person's cognitive workload, autonomic nervous system activity, and overall brain function by keeping track of how the pupil expands and contracts. However, the commercial tools that are usually used to keep track of these metrics depend on expensive proprietary hardware, which makes it hard for a lot of researchers to get to them. To solve this money problem, we made Pupilometer // Pro, an inexpensive, all-software app that can get very accurate pupil measurements from regular infrared video recordings. The method uses a simple night vision camera to record the video, which is then analysed later using the OpenCV library. Our custom computer vision algorithm successfully isolates the pupil across changing lighting conditions by running the video frames through a specific pipeline. This includes changing the images to greyscale, setting adaptive thresholds, filtering contours, making morphological changes, and finally drawing an ellipse around the edge of the pupil. The algorithm keeps its region of interest up to date so that it can keep a steady lock on the eye while it moves. Then, a built-in calibration protocol changes the raw digital pixel data into real-world millimetre sizes. The program also has automated tools for removing blinks, cutting down on data noise, making visual graphs, and giving full statistics. We tested the software's performance by exposing three test subjects to different sounds. The app was able to accurately track the expected pupil dilations caused by the sounds, which proved its overall accuracy. This framework is a very good, low-cost alternative to high-end eye-trackers, especially for scientific studies that don't need real-time analysis.

Keywords: Pupil Detection, Infrared Eye Tracking, Computer Vision, OpenCV, Pupil Diameter Estimation, Image Processing, Neurological Analysis

Preliminary Results with a Hardware Setup for Testing Ankle Actuation Strategies for Lower Limb Exoskeletons

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Abstract:

Ankle push-off plays a critical role in human walking by injecting mechanical energy during late stance, and hence can be very important in lower-limb exoskeleton design for rehabilitation and metabolic assistance. However, systematic evaluation of ankle actuation strategies directly on human subjects is challenging due to neuromuscular variability and whole-body coupling effects. In this work, we present preliminary results from a planar three-link hardware testbed developed to experimentally investigate ankle push-off strategies under controlled mechanical conditions. The platform enables pneumatic ankle push-off while independently regulating torso stabilization and swing leg motion. Experimental results demonstrate that push-off magnitude directly influences stance angular velocity and step progression, while coordinated torso stabilization ensures that the torso remain upright through out the step. Furthermore, accurate foot placement can be achieved through active regulation following push-off, though increased dynamic coupling leads to higher control effort. The proposed hardware framework provides a repeatable environment for evaluating ankle assistance strategies and offers insights relevant to the design of rehabilitation oriented lower-limb exoskeletons.

Keywords: Exoskeleton, Ankle Actuation, Push-Off, Rehabilitation Robotics, Foot Placement Control

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ICBSII 2026, SSNCE, CHENNAI, MARCH 09 – 11, 2026

TRACK 12

Drift-aware Explainable Boosting Machine for Interpretable heart disease prediction across diverse clinical population

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Abstract:

Artificial Intelligence (AI) models used in healthcare systems often experience degradation in their performance when the characteristics of patient data shift over time, known as concept drift. This means the model used for medical diagnosis performs well during the training phase, but the accuracy degrades when it sees temporal or distributional changes in incoming data or shifts suddenly. International regulatory bodies such as FDA and MHRA increasingly stress the need for AI systems that not only produce accurate predictions, but also be transparent and explainable to the clinicians for interpretability. The existing heart disease prediction systems lack mechanisms to detect drift. Addressing this gap, we propose a drift-aware interpretable framework using an explainable boosting machine (EBM), rather than a new classifier, addressing regulatory needs and making it suitable for reliable long-term clinical use. This system is trained using the Cleveland database collected from the UCI Heart Disease dataset and evaluated under three complementary scenarios: (i) predictive system testing on held-out Cleveland samples, (ii) cross-population testing on a Hungary database, (iii) testing under a simulated drift by adding controlled noise to physiological attributes to measure the drift occurring within the clinics or hospitals. The baseline performance achieved an accuracy of 86% and AUC of 0.944 when tested for in distribution performance. Meanwhile, cross-population testing showed a decline in accuracy of 78% and AUC of 86% explaining the domain shift. Quantification of drift severity is done using the population stability index (PSI), revealing major drift for physiological variables which alerts the clinicians for reconstructing the model. This work prioritizes deployment effectiveness over individual-group performance and also the framework demonstrates that even highly accurate systems can become unreliable and thus provides an interpretable, clinical & practically deployable solution.

Keywords : Concept drift, Explainable Boosting Machine, population stability index, model interpretability, drift detection, clinical drift analysis.

An Automated ML-Based Framework for Predicting Mutation-Induced Drug Resistance via ESMFold and Molecular Docking

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Abstract:

Mutations in the genome that lead to drug resistance are major problem in treating cancer. The study proposes an automated computer pipeline that does in silico docking to figure out how mutations affect binding to drugs. The workflow integrates modules like Biopython, PubChemPy, and the ESMFold API. They use it to model the EGFR protein, specifically the wild type version NP_005219.2, and then the L858R mutant variant. With AutoDock Vina for the molecular docking, it showed a reduction in how stable the binding is for Gefitinib when in mutant form when compared to the wild type. But the predictions from it still need future experiments to validate them, to confirm they work in actual clinical situations.

Keywords : Bioinformatics, Machine Learning, Molecular Docking, EGFR, Drug Resistance, ESMFold

Hybrid Multilevel Thresholding for Skull Base Tumor Segmentation and Classification Using an Improved YOLOv8s Model

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Abstract:

The very early and precise identification of skull base tumors is key to better prognosis and treatment planning. In that complex anatomic area, tumors present diagnostic issues due to their variable presentation and proximity to critical neural and vascular structures. Current manual methods for segmentation and classification from MR and CT scans are time-intensive, subjective, and observer-dependent. Automated methods exist but still struggle with poor boundary definition, distinguishing tumor from adjacent healthy tissue, and boundary and performance discrepancies with different imaging and tumor types. These poor performance boundary discrepancies lead to diagnostic delays and poor patient outcomes. To overcome these obstacles, we introduce a fully automated, hybrid framework that integrates classical image analysis and deep learning. Using Multi-Otsu thresholding for accurate tumor region segmentation, we optimize precision before classification. The derived segments are then processed by a tuned medical-grade YOLOv8s augmented with attention layers and structural enhancements to better capture fine tumor details. On a large skull base tumor dataset, the model achieved strong results ($mAP@50 = 0.8362$, $mAP@50-95 = 0.6499$, classification accuracy = 99.41%), proving efficient and clinically compatible. This work contributes an accurate, stand-alone, and computationally efficient tool to assist radiologists and neurosurgeons in rapid, reliable skull base tumor diagnosis, supporting timely and precise clinical management.

Keywords: Skull base tumor, multilevel thresholding, YOLOv8s, medical image segmentation, tumor classification, magnetic resonance imaging (MRI)

Skin Cancer Segmentation and Classification Using Multi-Task Deep Learning with EfficientNet and Feature Pyramid Network

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Abstract:

Accurately examining dermoscopic images is essential for spotting melanoma and other skin conditions at an early stage, yet most deep-learning systems still handle segmentation, feature detection, and disease classification as if they were unrelated tasks. Treating them separately often leads to repeated computation and weaker generalization. In this work, a single multi-task framework is introduced to manage all three tasks at once. It relies on an EfficientNet backbone to extract shared representations, a U-Net–style decoder that delineates the boundaries of lesions, a lightweight multi-label feature detection branch that identifies key dermoscopic structures, and a classification head that differentiates melanoma from nevus and seborrheic keratosis. Since the ISIC 2017 dataset is severely imbalanced, especially for melanoma, a dynamic oversampling strategy with continuous augmentation was included to give the minority classes more variation without touching the actual dataset. Over several experiments, the system maintained stable and well-rounded performance. Achieved 84% accuracy during the validation phase and a macro F1-score of 0.8058, while on the final test set, the accuracy settled to 75.8% with a macro F1 score of 0.6990. The segmentation branch turned out to be quite reliable, maintaining Dice scores above 0.83, while the feature detection head hovered around a mean F1-score of 0.60. These confirm that the system indeed processes both the overall lesion shape and the finer internal details. From these results, it appears that sharing feature representations across tasks leads to better stability and generalization of performance. In this respect, this framework sets a very good basis for further improvements toward clinical decision support and automated skin analysis.

Keywords: Multi-task learning, dermoscopic analysis, melanoma detection, deep learning, image segmentation.

AI-ENHANCED CENTRALIZED PATIENT DATA SYSTEM WITH BIOMETRIC VERIFICATION

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Abstract:

This study offers a new approach for developing a secure health data access system by integrating both an AI based centralized patient data management system and a fingerprint biometric authentication system. The system proposed in this paper uses a new authentication technique that combines two different authentication techniques together, namely ORB descriptors and minutiae-based fingerprints, using a feature-level hybrid fusion technique before sending the information to the CNN classifier. The system was designed to be scalable, secure, and perform real-time authentication using secure and encrypted communication channels and developing the CNN on a microservices architecture. The SOCOFing Fingerprint dataset was used to test the system using cross-validation against a baseline SVM classifier. The CNN performed better than the SVM classifier on all metrics of average authentication accuracy (94.0%), Precision (94.95%), Recall (98.95%), and F1-score (96.91%). Moreover, the CNN demonstrated low authentication times (between 280 365 ms) and low false acceptance and false rejection rates, which confirms that the CNN is effective for secure authorization of transactions in real-time in the healthcare domain. These findings offer proof of the efficacy and efficiency of the new hybrid biometric approach developed for use in centralized medical data management systems.

Keywords: Authentication, Biometric, Fingerprint, Healthcare, Patient, System, Convolutional Neural Network, Support Vector Machine, Artificial intelligence

A Hybrid Deep Learning Framework For Early- Stage Alzheimers Disease Classification From Neuro-Imaging Biomarkers

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Abstract:

This is because early detection of Alzheimer disease (AD) is necessary to ensure cognitive deterioration is slowed, and timely therapeutic interventions. This paper will report an implementation of a hybrid deep learning architecture based on Vision Transformer (ViT), Deep Belief Network (DBN), Long Short-Term Memory (LSTM), and Deep Q-Network (DQN) to improve the classification of Alzheimer at earlier stages through the use of MRI-based neuro-imaging biomarkers. ViT is effective at extracting spatial patterns, DBN is able to generate hierarchical feature representations, and LSTMs capture progression in time, whereas DQN optimizes the choice of features and decision-making strategies by use of reinforcement learning. The unified architecture capitalizes on the complementary modeling advantages to enhance the diagnostic strength and interpretability. Based on benchmark neuro-imaging datasets, experimental analysis shows that there are huge improvements in classification accuracy, sensitivity and specificity of the conventional models. The suggested system offers a scalable, smart diagnostics tool that will be able to help clinicians to identify the early Alzheimer and make medical diagnosis-based decisions.

Keywords: Alzheimer's Disease, Vision Transformer, Deep Belief Network, LSTM, Reinforcement Learning, Neuro-imaging, MRI Classification.

Confidence-Aware and Explainable Deep Learning for Ovarian Cancer Subtype and Risk Mapping

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Abstract:

Ovarian cancer is one of the most aggressive gynecological malignancies and this is mainly attributed to late diagnosis, recurrence and strong histopathological heterogeneity. Accurate detection of ovarian cancer subtypes important in determining the treatment plans and enhancing patient survival. Traditional diagnostic procedures rely on manual histopathological examination, which is subjective, time-consuming and prone to inter-observer variability, inspiring the process of adopting automated and effective computer-aided diagnostic systems. In this paper, the authors suggest a Confidence-Aware and Explainable Deep Learning model that can be used to classify ovarian cancer subtypes and map risks based on histopathological images automatically. A tuned EfficientNet-B0 model is used and compared with MobileNetV2, a lightweight baseline model. The framework combines the entropy-based confidence estimation and explainable artificial intelligence (XAI) through Grad-CAM to increase the reliability and interpretability of predictions. The experimental findings indicate that the proposed model has a validation accuracy of 91.01% with test-time augmentation (TTA), outperforming the baseline while providing higher transparency and clinical applicability of computational pathology.

Keywords: Ovarian cancer, EfficientNet-B0, MobileNetV2, deep learning, subtype classification, confidence-aware, explainable AI, Grad-CAM, histopathology, risk mapping.

Skin Cancer Prediction using Deep CNN based Feature Fusion Model

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Abstract:

Skin cancer is one of the most prevalent types of cancer in the world, and improving clinical outcomes and minimizing death rates relies significantly on early and precise detection. Recent advancements in deep learning have demonstrated great promise for automated skin lesion diagnosis however, the ability of the algorithm to capture a variety of discriminative signals may be constrained by the use of a single architecture. In this study, we employ several modern convolutional neural network (CNN) architectures to propose a feature-level fusion framework for the classification of skin cancer. EfficientNetB3, InceptionV3, and DenseNet121 are used as independent feature extractors in the proposed approach. At first, each model is assessed individually with classification accuracies of 94.19%, 97.2%, 95.5%, and 96.5%, respectively. A hybrid fusion model is created by combining deep features obtained from EfficientNetB3 and DenseNet121 at the feature level in order to make use of complementing feature representations. For the final prediction, the entire integrated classification layer receives the fused feature representation. With an accuracy of 98.84% and better feature robustness and generalization, experimental data show that the suggested fusion technique effectively improves discriminative capabilities. The outcomes underline the possibilities of multi- model feature fusion for creating accurate computer-aided skin cancer diagnosis systems and highlight how well it incorporates a variety of skin lesion features.

Keywords: Skin cancer classification, feature-level fusion, deep learning, convolutional neural networks, skin lesion analysis, medical image classification.

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ICBSII 2026, SSNCE, CHENNAI, MARCH 09 – 11, 2026

TRACK 13

Predicting Scoliosis Progression Using Long Short Term Memory Networks

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Abstract:

Scoliosis describes a deformity of spinal curvature, and predicting progression of scoliosis may help provide early intervention, facilitate planning for treatment delivery, and allow for monitoring of outcomes for patients. Predicting scoliosis has been an underexplored area of research. Standard approaches to predicting scoliosis progression struggle to effectively account for the complex and dynamic structure and patterns in the data. This study aims to develop a Long Short-Term Memory (LSTM) based prediction model for scoliosis progression that leverages sequential patient data and temporal patterns to produce more accurate predictions, ultimately supporting faster and more informed clinical decision-making. This study evaluates the predictive performance of several machine learning models for Cobb angle prediction in scoliosis, with particular emphasis on comparing LSTM, Gradient Boosting Regressor (GBR), Support Vector Machine (SVM), and Artificial Neural Network (ANN) models. Results presented in this study show that LSTM outperformed all other models, with the lowest mean absolute error (MAE) of 0.93, and highest Test R^2 of 0.52 showing greater accuracy and ability to explain more variance in the predictions made with this model. Alternatively, ANN shows poor performance with a Test R^2 of - 8.15. The MSE and R^2 distributions also show that LSTM is more robust than the other models, as exhibited by lower error values found tightly clustered, and more positive R^2 values exhibited closest to the higher concentrations. In 5-Fold Cross Validation, LSTM shows consistency with a CV R^2 of 0.45 while ANN shows larger variances in error values and even negative R^2 values. Overall, these results demonstrate the superiority of LSTM in predicting the Cobb angle in terms of accuracy, consistency, and generalization to both test and CV data.

Keywords : scoliosis, prediction, temporal, accuracy, Cobb angle

Constitutional Challenges in AI-Driven Public Health Emergency Management in India

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Abstract:

The speed at which AI is being applied for managing public health emergencies has been studied, particularly for surveillance, predictive modelling, and automatic triage. There were many examples of AI based emergency responses developed and implemented in India for the purpose of responding to the COVID-19 pandemic under emergency laws. These emergency responses allowed states to quickly respond to an emergency situation by providing them with greater capability, but also raised numerous constitutional issues related to privacy, equity, due process, and democracy. The purpose of this article is to provide a conceptual analysis of the role of AI in public health governance, using the framework of the constitution. This study will be done through the lens of Indian case law, international standards for human rights, and comparative regulations used in other countries to identify deficiencies in the legislative protection, institutional oversight, and public participation in the development and implementation of AI systems. This study provides a rights-based approach to governance grounded in the constitutional principles of legality, proportionality, and accountability to ensure that the application of AI during emergencies does not compromise the value of democracy.

Keywords : artificial intelligence (AI), public health emergency, constitutional law, privacy, data protection, fundamental rights, algorithmic governance, surveillance.

In Silico Biomedical Analysis of Marine Phlorotannins as Potential DPP-4 Inhibitors for Diabetes Management

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Abstract:

Dipeptidyl peptidase-4 (DPP-4) is a significant target enzyme for treating type-2 diabetes mellitus because it modulates incretin activity. While several synthetic DPP-4 inhibitors are already commercially available, research is currently focusing on developing inhibitors derived from natural sources. Marine phlorotannins are unique phenolic compounds with potential anti-diabetic effects, but their interaction with DPP-4 remains unclear. In the current study, molecular docking was carried out to predict interaction of marine phlorotannins with human DPP-4. Our results demonstrated that polyphenolic flavonoids, especially phlorotannins, have higher affinity for binding with DPP-4, and one of the ligands, phlorofucofuroeckol A, displayed the highest binding affinity among all ligands studied. Ligand interaction with residue(s) in the catalytic site and substrate binding site highlighted the importance of these sites for docking of phlorotannins with DPP-4. In conclusion, our results suggest that marine phlorotannins are a valuable source of DPP-4 inhibitors and the structure of a polyphenolic compound plays an important role in stabilizing the interaction with the enzyme.

Keywords : DPP-4 inhibition; Marine phlorotannins; Molecular docking; Type 2 diabetes mellitus; AutoDock Vina; Polyphenols; Enzyme–ligand interactions; In silico drug discovery

A Two-Stage CNN-TTS Framework for Sign Language to Emotion Aware Speech Translation

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Abstract:

Bridging the communication gap between hearing impaired individuals and non-signers remains a persistent challenge. This work presents a software-based framework that converts hand gestures into emotion-aware speech using a two stage pipeline. In the first stage, a Convolutional Neural Network (CNN) classifies sign language gestures into corresponding alphabets. Image preprocessing techniques are applied to improve robustness under varying conditions. In the second stage, the generated text is transformed into speech while incorporating emotional context inferred from the text itself. Edge Text-to Speech (Edge TTS) is used for neural voice generation, and Sound eXchange (SoX) is employed to adjust pitch, tempo, and intensity to reflect emotional tone. The integrated system produces intelligible and expressive speech output, offering a practical assistive communication solution with potential for future expansion into continuous sentence translation and multilingual support.

Keywords: Text to Speech, Deep Learning, Convolutional Neural Network, Gesture Classification, Sign Language Translation, Emotion Aware Speech, Human Computer Interaction



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PROCEEDINGS OF THE TWELFTH INTERNATIONAL CONFERENCE ON BIOSIGNALS, IMAGES, AND INSTRUMENTATION MARCH 09 - 11, 2026



Biomedical Engineering continues to evolve as a transformative discipline that seamlessly integrates medicine and Engineering to develop innovative, technology-driven solutions for complex healthcare challenges. The Twelfth International Conference on Biosignals, Images, and Instrumentation (ICBSII-2026) builds upon this strong interdisciplinary foundation, further strengthening its role as a global forum for advancing biomedical research and translational healthcare technologies.

The event is hosted by the Department of Biomedical Engineering at SSN College of Engineering, a department established in 2005 with a strong commitment to excellence in biomedical technology, instrumentation, and imaging research. The conference continues its mission of bringing together researchers, academicians, clinicians, industry experts, and students to present cutting-edge research findings and foster meaningful scientific dialogue in areas including Biosignal Processing, Medical Imaging, Biomedical Instrumentation, artificial intelligence in healthcare, Wearable Systems, Robotics in Medicine, and emerging healthcare technologies. This prestigious event is the result of the vision and dedication of the management, faculty, and students of the Department of Biomedical Engineering, SSN College of Engineering, in association with the Centre for Healthcare Technologies—a multidisciplinary R&D center committed to driving advancements in healthcare innovation.

The department's global research engagement is reflected through collaborations with internationally reputed institutions such as the Medical Device Innovation Centre at National Cheng Kung University, Birmingham City University, Drexel University, and University of Bologna. These partnerships strengthen joint research programs, collaborative publications, student mobility initiatives, and technology transfer activities.

At the national and clinical interface, the department sustains strong partnerships with leading healthcare institutions and industries, including Rela Hospitals, Kauvery Hospitals, Sri Ramachandra Medical College, Perfint Healthcare, and the National Institute for Empowerment of Persons with Multiple Disabilities. These collaborations enable clinical validation of prototypes, translational research projects, and real-time deployment of biomedical innovations.

The department is also actively supported by major funding agencies such as HCL Healthcare, the Science and Engineering Research Board, Life Sciences Research Board, and the Defense Research and Development Organization, which facilitate research addressing critical challenges in diagnostics, therapeutic technologies, assistive systems, and digital healthcare ecosystems.

ICBSII-2026 continues the distinguished legacy of the ICBSII conference series, which has successfully hosted eleven international editions and established itself as a premier platform for interdisciplinary biomedical research. With a growing international footprint, participation from global experts, keynote addresses by distinguished speakers, and strong IEEE technical backing, ICBSII-2026 is poised to further elevate its academic and research impact.



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