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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING (CYBER SECURITY), FACULTY OF ENGINEERING

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**ICERCS'25**

# Certificate

This is to certify that Dr./Mr./Ms. Martin Joel Rathnam from Sri Sairam College of Engineering, Bengaluru has presented a paper entitled Enhanced Cerebral Stroke Onset Classification via a Hybrid 3D ConvNeXt–Transformer with Temporal Cross-Attention and Lightweight Multi-Scale Fusion in 3rd International Conference on Emerging Research in Computational Science ICERCS'25 held on 11th - 13th December 2025 at Karpagam Academy of Higher Education, Coimbatore-641021, Tamil Nadu, India.

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# INTERNATIONAL SCI JOURNAL PUBLICATIONS

**By: Dr.MARTIN JOEL RATHNAM**

**DEPARTMENT OF CSE(IoT & Cyber Security including Blockchain Technology)**

**SRI SAIRAM COLLEGE OF ENGINEERING, ANEKAL, BENGALURU, KARNATAKA, INDIA**

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RESEARCH ARTICLE

# Integration of AI and agent-based modeling for simulating human-ecological systems

**S. Ramkumar[1*], K. Aanandha Saravanan[2], Martin Joel Rathnam[3], M. Revathy[4]**

## Abstract

This study investigates the integration of artificial intelligence (AI) and agent-based modeling (ABM) for simulating human-ecological systems, aiming to enhance our understanding of complex system dynamics and inform evidence-based decision-making in environmental management and policy development. The research methodology combines computational modeling techniques with data visualization approaches to analyze simulation results and performance metrics comprehensively. The simulation of human-ecological systems utilizes Python programming language and the NumPy library to incorporate AI-enhanced decision-making within an ABM framework. Model performance metrics such as accuracy, precision, recall, and F1 score are computed to evaluate the effectiveness of the integrated approach. Additionally, simulation results and performance metrics are visualized using the Matplotlib library to facilitate interpretation and communication of research findings. The results demonstrate the initial spatial distribution of agents within the human-ecological system, the emergence of uniform and localized clusters of agent activity over subsequent simulation steps, and the strengths and weaknesses associated with the integrated AI-ABM approach. Overall, this study contributes to advancing research in environmental science and sustainability by providing insights into the capabilities and limitations of AI-enhanced ABM models for simulating human-ecological systems.

**Keywords:** Artificial intelligence, Agent-based modeling, Human-ecological systems, Simulation modeling, Data visualization, Performance metrics.

## Introduction

The integration of artificial intelligence (AI) with agent-based modeling (ABM) has emerged as a promising approach for simulating complex human-ecological systems, facilitating a deeper understanding of the intricate interactions between human activities and the surrounding environment. Over the past decade, researchers have increasingly recognized the potential of AI techniques, such as machine learning and reinforcement learning, to enhance the capabilities of ABM in capturing the dynamics of human-environment interactions. This literature survey aims to provide a comprehensive overview of recent advancements in the integration of AI and ABM for simulating human-ecological systems, highlighting key findings and contributions from existing studies. The study by (Shults, F. L., *et al.*, 2021) explores the application of machine learning algorithms within ABM frameworks to model land-use changes and their impacts on ecological systems. By incorporating AI techniques, such as support vector machines and random forests, the authors demonstrate the ability to improve the predictive accuracy of ABM models, leading to more realistic simulations of human-environment dynamics. Similarly, the research conducted by (Farahbakhsh, I., *et al.*, 2022) focuses on integrating deep reinforcement learning with ABM to simulate human decision-making processes in the context of environmental management. Through this integration, the authors achieve enhanced agent behavior

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# Threshold Behavior of Bidirectional Sodium Currents in Sinoatrial Node Cells and Modeling Consequences for Pacemaker Dysfunction

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***Keywords:***
*action-potential, sinoatrial-node, hyper-polarization, forward-currents, backward-currents*

## ABSTRACT

The failure of the sinoatrial (SA) node has been responsible for nearly 2% of deaths in the Indian population that occur without timely medical attention. Action potentials (APs) are generated by the coordinated activity of several hundred thousand tiny, resistively linked cells in the SA node, which is known as the rhythm generator or natural pacemaker of the mammalian heart. This article aims to investigate the variations in the forward and backward sodium currents in sinoatrial node cells of rabbits that affect the generation of action potentials. Specifically, it seeks to understand how reductions in hyperpolarization-activated $Na^+$ currents affect the natural pacemaker's ability to initiate action potentials, and by extension, contribute to cardiac disorders. Sinoatrial node cells from rabbit hearts were modeled as electrically connected (i.e., resistively linked) networks of several hundred thousand cells. A voltage clamp setup was used to vary the conductance of both forward (inward) and backward/outward hyperpolarization-activated sodium currents ($gFNa^+$). Threshold values for these currents were determined by observing whether an action potential (AP) could be generated at different conductance levels. When the conductance $gFNa^+$ dropped below a threshold value of 0.000134, no action potentials were recorded. At subthreshold levels, the sodium current induced in the cells was insufficient to trigger the opening of potassium channels, thereby preventing depolarization beyond the initial resting state. Reductions in the hyperpolarization-activated sodium currents (both forward and backward components) can abolish AP conduction initiated from the SA node in the heart. This threshold-dependent failure highlights a mechanistic basis for natural pacemaker dysfunction and may contribute to cardiac disorders such as bradyarrhythmias, tachyarrhythmias, and tachybrady syndrome, which are associated with reduced $Na^+$ current flow.

# INTERNATIONAL CONFERENCE PUBLICATIONS IN SCOPUS

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# Alzheimer's Disease Segmentation using CNN Neural Wavelet Transform

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***Abstract* - Alzheimer's disease (AD), a prominent subtype of dementia, is a degenerative brain disorder that demands precise, early identification for improving patient care. This work proposes a novel segmentation model that synergistically integrates a Convolutional Neural Network (CNN) with Wavelet Transform for enhanced feature extraction from MRI brain images. Wavelet decomposition captures multi-scale textural and spatial features, which are then input to a custom-designed CNN for robust segmentation. Experiments on benchmark labeled datasets demonstrate that the hybrid approach achieves high segmentation accuracy, with peak metrics reaching up to 97.3% accuracy, 97.1% sensitivity, and 97.2% specificity across AD/Normal Controls and 94.6% accuracy for AD/Mild Cognitive Impairment classification. The model also optimizes for F1 score and outperforms traditional CNN-only frameworks in terms of feature representation and segmentation clarity. Further refinement via morphological operations enhances boundary delineation and model interpretability, while visualization of segmentation maps provides clinical insight. The end-to-end system is optimized for real-world deployment, demonstrating adaptability and the ability to continuously improve as new data becomes available, thus holding promise for widespread clinical and research applications in Alzheimer's disease management.**

***Keywords - Alzheimer's Disease, Segmentation, CNN, Neural Wavelet Transform***

## I. INTRODUCTION

AD is a common neurodegenerative disease that is associated with constant cognitive disability to various degrees, creating a major challenge in human health worldwide, where new methods of diagnostics are required in terms of proper and early detection. Since this has been an urgent call, this paper suggests an all-inclusive system to combine Wavelet Transform with Convolutional Neural Networks (CNNs) to improve the detection of Alzheimer disease in MRI images. Having combined the strengths of Wavelet Transform in the representation of multi-scale features with the hierarchical learning of CNNs, our system is intended to lead to a subtle comprehension of the structural anomalies related with Alzheimer disease. These modules are data loading, pre-processing, feature extraction, model training and integrating the CNN-based segmentation model with Wavelet Transform that are essential components of the pipeline.

Emphasizing adaptability to varying complexities within MRI images, the proposed system aims not only to achieve high accuracy but also to ensure robustness and generalization across diverse datasets. This introduction sets the stage for a thorough exploration of the system's design, implementation, and future prospects in advancing Alzheimer's disease diagnosis.

### *A. Cognitive Assessments*

Cognitive assessments play a predominant place to evaluate individual mental abilities and processes. These assessments are designed to measure various aspects of cognitive functioning, such as memory, attention, problem-solving, and language skills. By providing valuable insights into a person's cognitive strengths and weaknesses, cognitive assessments can aid in a wide range of applications, from diagnosing cognitive disorders like dementia or ADHD to assessing a student's learning potential or an employee's job suitability. The results of these assessments are instrumental in guiding educational, clinical, and professional decisions, making them an indispensable tool for individuals, educators, healthcare professionals, and employers alike. In this introduction, we will explore the significance and uses of cognitive assessments in greater detail.

### *B. Image Classification*

In the era of digitalization, when the visual amount of information that we get is overwhelming our mental capabilities of perception and analysis tools, the technology of

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# Renal Stone Picture and Values for the Identification of Chronic Renal Illness

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***Abstract*—This study seeks to respond to the growing incidence of kidney stones by creating an AI-based solution for accurate detection and complete functional assessment. Through the use of Convolutional Neural Networks (CNNs), specifically the VGG16 model, the system scans CT images to identify renal stones with high accuracy. In addition to stone detection, it assesses key renal parameters like urinary tract obstruction and tissue perfusion. The methodology involves data curation, preprocessing, and model training, ensuring robustness across diverse patient cases. Performance metrics such as sensitivity, specificity, and precision validate the model's reliability. This research contributes to nephrology by integrating deep learning with medical imaging, enabling early diagnosis and improved patient outcomes. The system incorporates explainable AI techniques to provide insights into the decision-making process, aiding clinical interpretability. Real-world validation is conducted using a diverse dataset, ensuring generalizability across different demographics. This approach aims to support radiologists by offering a rapid, automated tool for comprehensive kidney function analysis.***

***Keywords*—Kidney Stones, Deep Learning, Convolutional Neural Networks, Medical Imaging, AI in Healthcare.***

## I. INTRODUCTION

Urinary stones, also known as kidney stones, are a major global health issue, impacting a large percentage of the population. In the United States alone, about 600,000 people are diagnosed every year, and in India, almost 12% of the population is affected. The increasing incidence of urinary stones puts a huge burden on healthcare systems globally, making it imperative to develop innovative diagnostic tools. Kidney stone formation is a polyfactorial process that is influenced by genetic predisposition, dietary factors, dehydration, and metabolic disorders. Left undiagnosed or untreated, kidney stones can cause severe complications such as chronic kidney disease (CKD), urinary tract infections, and renal failure. The conventional methods of diagnosis involving X-rays, ultrasounds, and computed tomography (CT) scans involve manual interpretation by radiologists, which is prone to inconsistency and delay in diagnosis. Furthermore, such traditional procedures may not identify tiny or less radiopaque stones, which complicates patient treatment further.

Recent developments in deep learning, specifically through the use of Convolutional Neural Networks (CNNs), have presented new opportunities for improving diagnostic precision and speed in nephrology. CNN algorithms are exceptionally capable of interpreting sophisticated patterns in medical imaging data and provide unprecedented promise for high-accuracy detection of kidney stones. Such models can also facilitate automation of feature extraction, training on complex nuances from medical images that may pass undetected to human inspectors. In addition to simply detecting stones, such algorithms also support in-depth functional analysis, centring on parameters like the size, location, and effect on renal function.

Furthermore, deep learning models offer the advantage of scalability and consistency in diagnostic workflows. Unlike traditional radiological assessments, AI-driven models ensure uniformity in evaluations, minimizing inter-observer variability. The implementation of CNNs in nephrology enables faster and more reliable diagnosis, allowing clinicians to focus on personalized treatment strategies for patients. The integration of AI into kidney stone detection not only reduces diagnostic time but also enhances the accuracy of treatment planning, improving patient outcomes.

This study highlights the imperative of precise and timely detection of kidney stones, especially in India, where as much as 50% of cases threaten serious kidney failure. With the high rate of recurrence of kidney stones, early detection is vital to avoid complications. By incorporating CNN algorithms.

# UGC – PUBLICATIONS

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# Non-Invasive Measurement of Stress Levels in Knee Using IOT

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## ABSTRACT

As Knee replacement surgery has become widely prevalent with a high success rate in the short to medium term. However, over the long term, implant degradation may occur due to wear and tear. To address this issue, a potential solution involves using a PIC controller to monitor and compare pressure levels, displayed on an LCD. This system employs a load cell to detect stress, which causes changes in inductance. Additionally, Internet of Things (IoT) technology, through wireless connectivity such as Bluetooth, is integrated with an Android mobile app for continuous monitoring of knee pain based on the weight applied.

**Keywords:** IOT, Keypad, LCD, LCD PIC Controller, Load Cell.

## 1 Introduction

Knee pain is a common issue that affects many people, with various factors contributing to its development. It can either be referred pain or pain directly related to the knee joint. A sedentary lifestyle and certain work environments can contribute to knee pain, as reduced physical activity weakens the muscles around the knee. This, in turn, can affect blood circulation and lead to painful conditions. In this system, the primary objective is to assess the condition of the knee and determine whether the pain is treatable. A keypad is used to input the person's weight, while a load cell measures the stress on the leg. The controller then compares the weight data from the keypad with the stress readings from the load cell and provides an accurate assessment of the knee's condition, which is displayed on an LCD screen.

## 2 Recent Works

A prospective randomized study was conducted to investigate whether a design modification in the articular surface geometry of the Optetrak total knee prosthesis—intended to enhance joint conformity and further reduce polyethylene stress—affected implant survival, especially with the all-polyethylene version. The study included 47 patients undergoing bilateral simultaneous total knee arthroplasty, who were randomly assigned to receive a polyethylene tibial component and followed for an average of 11.6 years.

In the monitoring system, the affected knee is subjected to pressure on a load cell, chosen for its high coupling coefficient and sensitivity to stress. Thin 25 μm ribbons were cut into rectangular strips (48 mm × 7 mm), with four strips stacked and bonded using epoxy resin to

# Efficient Scheduling Techniques for Performance Enhancement in Networks

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**Abstract**: In this work, a study on a novel Multiple- Input, Multiple-Output (MIMO) technique called Multiple Packet Transmission (MPT), with which the sender can send more than one packet to two distinct users simultaneously. Traditionally, in wireless networks, it is assumed that one device can send a data packet to only one receiving device at a given time. However, this restriction is no longer true if the sender has more than one antenna, by processing the data according to the channel state, the sender can send distinct packets to distinct users simultaneously. Problems related to MPT are seen and provided solutions. Here the problem of sending out buffered packets in minimum time is being formalized as finding a maximum matching algorithm. Since maximum matching algorithms are relatively complex and may not meet the speed of real-time applications, packet scheduling techniques from some algorithms like the Dijkstra's algorithm, the Linear Time ¾ Maximum Matching algorithm and Edmond's blossom algorithm are considered to enhance the downlink transmission, thereby improving the overall performance in wireless networks by using MPT. In this work the main concern is how to enhance the downlink performance in the wireless networks using the simultaneous behavior of multiple packet transmission. During the course of doing this paper, it becomes possible to learn Java functionalities by understanding the working of profiling java tools, features of wireless networks and implementing these algorithms.

**Keywords***:* MPT-Multiple Packet Transmission, Packet transmission techniques, Downlink performance.

# I. INTRODUCTION

Wireless access networks have been widely used in recent years when compared to the wired networks because wireless access networks are easier to install and use. Due to the tremendous practical interests, much research effort has been devoted to wireless access networks as great improvements have been achieved by adopting newer and faster signal processing techniques, for example, the data rate in 802.11 Wireless Local Area Network (WLAN) has increased from 1Mbps in the early version of 802.11b to 54 Mbps in the new 802.11a WLAN. It has been noted that in addition to increasing the point to point capacity, new signal processing techniques have made other novel transmission schemes possible, that greatly improve the performance in wireless networks. A wireless LAN is usually composed of an Access Point (AP), which is connected to the wired network and several users communicate with the AP through wireless channels. In wireless LANs, the most common type of traffic is the downlink traffic that is, the flow of packets from the AP to the users, when the users are browsing the Internet and downloading data. In today's wireless LANs, the AP can send one packet to one user at a time. However, if the AP has more than antenna and if MPT is used, then the AP can send two packets to two different users simultaneously whenever possible the throughput of the downlink increases. MPT is feasible for the downlink because it is not very difficult to equip the AP with two antennas in fact, many wireless routers today have two antennas. Another advantage of MPT that makes it very commercially appealing is that, although MPT needs a new hardware at the sender, it does not need any new hardware at the receiver. This means that to use MPT in a wireless LAN, the AP can be replaced and simple software protocols can be upgraded in the user devices without having to change their wireless cards therefore incurring minimum cost.

# INTERNATIONAL SCI JOURNAL PUBLICATIONS

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**2026**

# IoT-Based Remote Health Monitoring and Alert System for Tribal Communities: Architecture, Optimization Modelling, and Statistical Evaluation

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***Abstract:*** *Access to quality healthcare remains a critical challenge for tribal communities, arising from geographic isolation, inadequate infrastructure, and socioeconomic barriers. This paper presents an IoT-based Remote Health Monitoring and Alert System (IoT-RHMAS) specifically designed for resource-constrained tribal environments, incorporating two original analytical contributions absent from prior work. First, a Communication Protocol Optimization Model (CPOM) is formulated as a constrained multi-objective minimization problem that dynamically selects the optimal wireless protocol (BLE, LoRa, or GSM) by minimizing a weighted composite objective function over energy consumption, latency, and channel reliability. Second, a Weighted Adaptive Management Model (WAMM) optimizes duty-cycle scheduling through dynamic programming to maximize operational uptime within the solar energy budget. The anomaly detection subsystem employs a statistically validated Isolation Forest framework with empirical hyperparameter selection via cross-validated grid search, achieving a precision of 94.8%, recall of 92.3%, and F1-score of 93.5% — superior to both rule-based and standalone ML baselines. Bland-Altman agreement analysis confirms sensor accuracy within clinically acceptable limits (mean bias < 0.6 bpm). Alert latency analysis demonstrates that 95% of BLE alerts are delivered within the 3-second clinical threshold. These validated analytical models and empirical results substantiate IoT-RHMAS as a rigorously grounded, cost-effective (USD 28-35/node), and inclusive healthcare platform for underserved indigenous populations.*

**Keywords: IoT; Tribal Healthcare; Remote Health Monitoring; Isolation Forest; Multi-Objective Optimization; Communication Protocol Selection; Duty-Cycle Scheduling; Statistical Validation; Wearable Sensors; mHealth.**

## 1. INTRODUCTION

Access to reliable healthcare remains one of the most persistent challenges confronting tribal and remote communities globally. Geographic isolation, limited infrastructure, and socioeconomic barriers create a compounding disadvantage resulting in delayed diagnoses, chronic disease progression, and preventable mortality. In India alone, tribal populations constitute approximately 8.6% of the national population (Census, 2011), yet remain profoundly underserved by the formal healthcare system.

The Internet of Things (IoT) has emerged as a transformative paradigm with significant potential to redress such inequities through continuous health monitoring and remote diagnostic capabilities. IoT-enabled health systems leverage sensor networks and communication infrastructure to collect, process, and transmit physiological data—including heart rate, blood oxygen saturation ($SpO_2$), and body temperature—enabling proactive healthcare management where conventional access is limited [1], [2].

Critically, however, the preponderance of existing IoT health monitoring systems lacks formal analytical models governing key operational decisions—specifically, which wireless communication protocol to deploy given varying channel conditions, and how to schedule sensor sampling given a finite solar energy budget. These omissions are not merely academic: in tribal environments where connectivity is intermittent and energy is scarce, ad hoc protocol and duty-cycle decisions directly degrade system reliability and patient safety. This paper addresses both gaps through original optimization and statistical contributions.

# UGC – PUBLICATIONS

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# Efficient Scheduling Techniques for Performance Enhancement in Networks

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**Abstract**: In this work, a study on a novel Multiple- Input, Multiple-Output (MIMO) technique called Multiple Packet Transmission (MPT), with which the sender can send more than one packet to two distinct users simultaneously. Traditionally, in wireless networks, it is assumed that one device can send a data packet to only one receiving device at a given time. However, this restriction is no longer true if the sender has more than one antenna, by processing the data according to the channel state, the sender can send distinct packets to distinct users simultaneously. Problems related to MPT are seen and provided solutions. Here the problem of sending out buffered packets in minimum time is being formalized as finding a maximum matching algorithm. Since maximum matching algorithms are relatively complex and may not meet the speed of real-time applications, packet scheduling techniques from some algorithms like the Dijkstra's algorithm, the Linear Time ¾ Maximum Matching algorithm and Edmond's blossom algorithm are considered to enhance the downlink transmission, thereby improving the overall performance in wireless networks by using MPT. In this work the main concern is how to enhance the downlink performance in the wireless networks using the simultaneous behavior of multiple packet transmission. During the course of doing this paper, it becomes possible to learn Java functionalities by understanding the working of profiling java tools, features of wireless networks and implementing these algorithms.

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# I. INTRODUCTION

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