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INTERNATIONAL CONFERENCE ON INTELLECTUAL PROPERTY RIGHTS, RESEARCH AND DEVELOPMENT, AWARDS CEREMONY – 2026 (ICIPRRDAC 2026)

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ICIPRRDAC 2026

CONFERENCE PROCEEDINGS

International Conference on Intellectual Property Rights, Research and Development, Awards Ceremony 2026

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1 December 2026 | Shinawatra University, Thailand (Main Campus)

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*The Organizing Committee of **ICIPRRDAC 2026** expresses heartfelt gratitude to all individuals and organizations whose support, guidance and contributions have made this international conference and awards ceremony a reality.*

Chief Patron, Patron and Conference Chair
We sincerely thank our Chief Patron, Patron and Conference Chair for their visionary leadership, constant encouragement and invaluable guidance.

Keynote Speakers and Resource Person
We are grateful to our Keynote Speakers and Resource Person for sharing their expertise, insightful deliberations and inspiring presentations.

Advisory Board Members
We thank all the National and International Advisory Board Members for their valuable suggestions, continuous support and academic guidance.

Convenors and Conference Staff
We appreciate the Convenors and Conference Staff for their dedication, hard work and meticulous coordination in the successful organization of this event.

Authors and Participants
We extend our sincere thanks to all the Authors and Participants for their active involvement and for contributing their valuable research work, ideas and discussions.

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We acknowledge the support of our Partner Institutions, Collaborating Organizations and Industry Partners for their cooperation and commitment towards the success of ICIPRRDAC 2026.

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We thank our Media Partners for their extensive coverage and for helping to disseminate the conference activities to a wider audience.

All Well-Wishers
We also thank all our well-wishers, colleagues, volunteers and everyone who has directly or indirectly contributed to the success of ICIPRRDAC 2026.

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1 December 2026 | Shinawatra University, Thailand (Main Campus)

PREFACE

The International Conference on Intellectual Property Rights, Research and Development, Awards Ceremony – 2026 **(ICIPRRDAC 2026)** is a premier academic and professional platform that brings together researchers, academicians, industry experts, innovators, policy makers and students from across the globe to deliberate on the evolving dimension of intellectual property, research and innovation for a sustainable future.

In today's knowledge-driven world, Intellectual Property Rights (IPR) play a vital role in transforming creative ideas and research outcomes into real-world solutions. The conference provides an interdisciplinary forum to exchange ideas, share research findings, discuss emerging trends and explore collaborative opportunities in the fields of patents, designs, trademarks, copyrights, technology commercialization, innovation management and research development.

This conference also aims to recognize and honour outstanding contributions through the Awards Ceremony, encouraging young researchers, innovators and institutions to continue their pursuit of excellence. By fostering dialogue between academia, industry and policy makers, **ICIPRRDAC 2026** aspires to create a strong global network for innovation, IPR protection and societal development.

We believe that the deliberations and outcomes of this conference will inspire new ideas, strengthen collaborations and contribute significantly to building a knowledge-based, innovative and sustainable society.

We extend our sincere gratitude to all our distinguished patrons, keynote speakers, resource persons, advisory board members, convenors, conference staff, authors, participants, sponsors and partner institutions for their invaluable support in making **ICIPRRDAC 2026** a remarkable academic event.

"Together for Innovation, Intellectual Property and a Sustainable Future"

GLOBAL COLLABORATION | RESEARCH AND INNOVATION | KNOWLEDGE SHARING | SUSTAINABLE DEVELOPMENT

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Welcome to ICIPRRDAC 2026

INTERNATIONAL CONFERENCE ON INTELLECTUAL PROPERTY RIGHTS, RESEARCH AND DEVELOPMENT, AWARDS CEREMONY – 2026

The **International Conference on Intellectual Property Rights, Research and Development, Awards Ceremony 2026 (ICIPRRDAC 2026)** is a premier global event dedicated to advancing knowledge, innovation, and academic excellence across multiple disciplines. The conference will be held on **27 February 2026** at **Shinawatra University (SIU), Thailand** and is jointly organized by Shinawatra University (Thailand), St. Peter's Institute of Higher Education and Research (SPHIER), Chennai (India), along with the academic partners RAALTECH Publications and NSKD Techno Research & Innovation Solutions, India.

THE CONFERENCE AIMS TO:

- Promote awareness and understanding of Intellectual Property Rights and their role in research and innovation.
- Provide a platform for presenting high-quality research across various domains.
- Facilitate international academic collaboration and MoU partnerships.
- Encourage innovation, entrepreneurship and start-ups.
- Recognize outstanding research contributions.

HIGHLIGHTS OF THE CONFERENCE

- Multiple Colleges
- Global Perspective
- Over 30+ Professional Options
- Modern Facilities

"Innovation today, a better tomorrow for a sustainable world."

A GLOBAL PLATFORM BRINGING TOGETHER RESEARCHERS, INNOVATORS, INDUSTRY EXPERTS AND ACADEMIC LEADERS.



February 26th to March 2nd, 2026 | **Hybrid Mode** | **Online** | **Offline**

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About Shinawatra University

A GLOBAL UNIVERSITY WITH ASIAN EXCELLENCE



Shinawatra University (SIU) in Thailand is a well-known university established by former Thai Prime Minister Thaksin Shinawatra with the approval of the Thai Ministry of Education in 1999. As an outstanding political leader and advocate for education in Thailand, Thaksin Shinawatra is committed to building SIU into Asia's top international chemical hub.

SIU has multiple colleges, offering over 30 professional options including education, management, medicine, nursing, psychology, information resource management, as well as art and design. The teaching team of the school mainly comes from elites and academic leaders in various industries, providing students with rich academic content and practical opportunities.

SIU is based in Asia and has a global perspective. Through close cooperation with over 150 well-known universities worldwide, SIU provides students with rich practical exchange and learning opportunities. We firmly believe that the ultimate mission of education is to cultivate talents with lifelong learning abilities and adapt to the needs of social development, contribute to the progress and development of global society, and will make unremitting efforts to this end.

Key Highlights

- **Established in 1999** by former Thai Prime Minister Thaksin Shinawatra
- **Over 30 Professional Options** across diverse disciplines
- **Global Perspective** Collaboration with 150+ well-known universities worldwide
- **Expert Faculty Team** Elites and academic leaders from various industries
- **Modern Facilities** State-of-the-art infrastructure and beautiful campus environment

Quality Education | **International Collaboration** | **Research and Innovation** | **Lifelong Learning Opportunities**

Join us at **ICIPRRDAC 2026** to gain insights into IPR processes, network with industry leaders, and take your research to the next level.

SHINAWATRA UNIVERSITY
FOSTERING INNOVATION

St. PETER'S
INSTITUTE OF HIGHER EDUCATION AND RESEARCH

ABOUT ST. PETER'S INSTITUTE OF HIGHER EDUCATION AND RESEARCH



SPHIER is a Deemed to be University under section 3 of UGC Act, 1956 since 2008. The institution was previously known as St. Peter's Engineering College which was established in the year 1993. It is one of the India's leading Institute, with students from all over the country.

The institution continuously strives to focus on imparting quality technical education and introducing innovative programmes leading to Research and Development for sustainable growth.

The institution offers Engineering, Technology, Architecture, Management Studies, Science and Humanities programmes approved by UGC and AICTE.

KEY FEATURES

Deemed to be University
Under section 3 of UGC Act, 1956 since 2008

Established in 1993
Previously known as St. Peter's Engineering College

Students from across India
One of the leading institutions in India

Focus on Research & Development
Imparting quality education with innovative programmes

Approved Programmes
Engineering, Technology, Architecture, Management Studies, Science and Humanities approved by UGC and AICTE

PROGRAMMES OFFERED

- Engineering
- Technology
- Architecture
- Management Studies
- Science
- Humanities
- and more innovative programmes

OUR VISION

To impart quality education, promote innovation, and foster research and development for sustainable growth and to create future-ready global citizens.

UGC
Approved Programmes

AICTE
Approved Programmes

DEEMED TO BE UNIVERSITY
SINCE 2008

SHINAWATRA UNIVERSITY
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INSTITUTE OF HIGHER EDUCATION AND RESEARCH

Objectives and Scope

INTERNATIONAL CONFERENCE ON
INTELLECTUAL PROPERTY RIGHTS, RESEARCH AND DEVELOPMENT, AWARDS CEREMONY – 2026 (ICIPRRDAC 2026)

Objectives

- Promote awareness and understanding of Intellectual Property Rights and their role in research and innovation.
- Provide a platform for presenting high-quality research across various domains.
- Facilitate international academic collaboration and MoU partnerships.
- Encourage innovation, entrepreneurship and start-ups.
- Recognize outstanding research contributions and innovations.
- Build a global network of researchers, industry experts, policymakers and academic leaders.

Scope

The conference invites original research papers, case studies, innovations and industry experiences related to, but not limited to, the following areas:

01 Intellectual Property Rights and Patent Law
02 Research and Development
03 Engineering and Technology
04 Computer Science and Information Technology
05 Management Studies
06 Science and Humanities
07 Innovation and Entrepreneurship
08 Artificial Intelligence and Emerging Technologies
09 Sustainable Development
10 Education and Social Sciences
11 Interdisciplinary Research
12 Industry – Academia Collaboration

From Ideas to Impact
Through IPR, Research and Innovation

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CONFERENCE THEMES

INTERNATIONAL CONFERENCE ON INTELLECTUAL PROPERTY RIGHTS, RESEARCH AND DEVELOPMENT, AWARDS CEREMONY – 2026 (ICIPRRDAC 2026)

Papers are invited **(but not limited to)** the following themes:

01 Intellectual Property Rights and Patent Law

02 Research and Development

03 Engineering and Technology

04 Computer Science and Information Technology

05 Management Studies

06 Science and Humanities

07 Innovation and Entrepreneurship

08 Artificial Intelligence and Emerging Technologies

09 Sustainable Development

10 Education and Social Sciences

11 Interdisciplinary Research

12 Industry – Academia Collaboration

"Exploring Research, Innovation and Intellectual Property for a Sustainable Global Future"

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CONFERENCE FEATURES AND REGISTRATION

CONFERENCE FEATURES

- Registered papers containing novelty features may be processed as **patent or design applications.**
- Accepted papers are to be published as conference proceedings with **ISBN and DOI.**
- **E-certificates** are provided to participants.
- High-standard articles may be considered for **SCI- and Scopus-indexed journals** at an additional cost.
- Paper submission is through **iciprrdac2026thailand@gmail.com**

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- Conference Registration

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ARTICLE SUBMISSION GUIDELINES

1. Abstract should not exceed **500 words.**
2. Abstract should contain **5–6 keywords.**
3. Authors are expected to follow **APA guidelines.**
4. The selected **sub-theme** must be mentioned with the abstract and full paper.
5. **References** should be cited at the end of the paper.
6. Presentation may be **individual or in a group.**
7. The presentation schedule is to be provided **two days before the conference.**
8. Correspondence is to be sent to the registered author using the **Article ID.**
9. Certificates are provided on the basis of **presented or participated status.**
10. The **best paper** in each track is selected by a panel of experts.

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Abhyas: A Reasoning-Enhanced LangChain-Orchestrated LLM NLP Framework with Explainable Intelligence for Adaptive Examination and AI Proctoring

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***Abstract*— Online tests have come to constitute a fundamental aspect of up-to-date education as they allow flexible and scaled evaluation. Nevertheless over 70 percent of current existing examination systems are still using manual question systems, strict assessment systems and minimal feedback features which have increased administrative burden and decreased learner involvement. These limitations must be addressed to come up with smart and trusted digital assessment systems. In this paper, I introduce Abhyas which is an AI powered examination management system that aims at automating the entire assessment life cycle. The system permits instructors to upload study content in different formats, such as PDF files, scanned tests as well as presence of image based display of the question. Abhyas uses the combination of Optical Character Recognition (OCR), Natural Language Processing (NLP), and transformer-based deep learning models to extract and formatted multiple-choice and descriptive questions, making an average extraction rate of over 95. The text classification module composed of the deep learning tool is able to map the extracted questions to the topics in the syllabus with more than 92 percent accuracy, which makes it possible to analyze the questions according to the topic and carry out assessments equally. Assessments created are presented by an interactive online exam application with automatic grading, scheduling, and remote proctoring with the use of AI. The detection of behavioral abnormality at the time of examination has a precision of about 90%. Experimental test proves that Abhyas saves the administrative work by approximately 60 per cent. and helps creating exams with three times more speed as with traditional approaches. In general, Abhyas is a part of a clear, effective, and intelligent digital assessment environment that is compatible with smart education purposes.**

Keywords*—*Artificial Intelligence; Online Examination System; Automated Question Extraction; Optical Character Recognition (OCR); Natural Language Processing; Transformer Models; Deep Learning; Syllabus Mapping; Automated Assessment; Remote Proctoring

I. INTRODUCTION

The high growth rate of online learning has greatly altered the process of assessment design, administration, and scoring. Online tests have become another viable alternative to paper-based tests, which is scalable and flexible, and therefore allows institutions to access large and spatially versatile populations of learners. Recent global upheavals have further enhanced the enhanced uptake of online assessment platforms, supported by the necessity to have reliable, secure and effective digital examination systems, coupled with the fact that much of the current online examination systems still use manual systems to input questions, predetermined assessment templates, and minimal automation. The teachers are often asked to type or shape the questions in the reprinted question papers, PDF files or scan pictures. This is lengthy, subject to error, which raises the burden on administration and constrains the flexibility that is demanded by contemporary and outcome-driven education. In addition, several platforms offer little analytical feedback and hence they are less effective in facilitating the alignment of the curriculum and the performance of learners.

Most recently, with new developments in Artificial Intelligence (AI) specifically in the domain of Optical Character Recognition (OCR), Natural Language Processing (NLP), and deep learning, new challenges toward automating educational processes can be confronted. The transformer-based language models have shown high ability to comprehend, organize and categorize textual data across a variety of fields. In the context of assessment systems, the techniques can help to minimize manual work and enhance accuracy, as well as provide the opportunity to analyze the content of examinations intelligently. Nevertheless, such practices are still not widely adopted in a single and a practical management of examinations. Another significant challenge in online examinations is to ensure that academic integrity is achieved. Some modern methods of proctoring are sometimes intrusive, join resource-consuming, or cannot be applied at scale. Even though AIs-based remote proctoring technologies have enjoyed popularity, most current tools are more concerned with surveillance and do not provide a smooth way to combine testing development and assessment. This has necessitated holistic solution to unite the automated assessment generation, intelligent analysis and secure delivery of examination.

To cope with them, the paper, Abhyas, an AI-based examination management system, aimed at automating the process of assessment end-to-end. Abhyas allows instructors to post the content of examinations in various formats such as PDF files, scanned files and image based screenshots. The framework uses the transformer based deep learning models, OCR and NLP, to extract and structure multiple choice questions as well as descriptive questions in an automatic fashion. Moreover, egocentrically a deep learning based classification module is used to map extracted questions with syllabus topics, making it possible to design assessments balanced and analyze them by topic. The examinations generated are distributed with the help of the interactive online platform that incorporates automated grading, time management, and AI-proctoring remote exams.

The main achievements of this work are as follows:

1) the architecture of a question acquisition and format pipeline on heterogeneous document formats, automated;

2) building of deep learning-based syllabus mapping tool of analysis in assessment by topic;

3) integration of online test enclosure and AI-supported proctoring and analytics.

Experimental findings reveal that Abhyas will cut down administrative work load and speed up examining creating processes without compromising the accuracy and reliability of the results obtained.

I. LITERATURE REVIEW

Sharma et al suggested an online test design that facilitates automatic grading and time based tests in enhancing scalability on academic tests. The system was mainly objective-based and based on manually prepared question banks and was not as flexible to mass preparation of examinations and reusing of content [1].

Patel et al published an automated evaluation management system which used Optical Character Recognition (OCR) to scan and digitize question papers. Post processing of the extracted text with rule based methods to format the questions to be given online was carried out. The solution minimized manual data input, but the performance of the solution also depended on document quality and did not understand the semantics of questions [2].

The article by Kumar et al. provided a Natural Language Processing (NLP)-based question classification and difficulty estimation mechanism. The research used the conventional machine learning classifiers using hand-coded linguistic features to map the questions to pre-existing topics. Although the model worked well on structured datasets, it showed a lower rate of accuracy on the unstructured data or image-based examination materials [3].

Zhang et al. suggested one of the text classification systems transformer-based and applied to educational texts. The model used contextual information by exploiting self-attention mechanisms to support its classification and it outperformed the traditional deep learning models in terms of classification accuracy. Nevertheless, the framework was tested on its own and not as part of an entire examination generation or delivery system [4].

Rao et al. designed the AI-powered remote proctoring machinery on facial recognition and behavioral analysis to identify unusual behaviors by a remote examiner during online exams. The technology was very accurate in detecting suspicious activity but was a self-monitoring system not coordinated to create examination or evaluation pipelines [5].

Singh et al. have detailed a document based online assessment system which offers the means of importing questions in a PDF file automatically. The framework used simple rules of extraction with pattern matching rules to extract text and identify boundaries of questions using OCR. But on the other hand, the system made the manual work easier; it however had difficulties in laying down a complex document structure and semantic interpretation to correctly structure the question [6].

The model of document analysis during educational content proposed by Li et al. was based on deep learning. They had used a hybrid method that coupled both convolutional neural networks and recurrent layers to process the scanned education materials to obtain structured information. Although the model demonstrates better extraction accuracy than the conventional OCR pipelines, it was not fine-tuned to carry out tasks related to examination like question categorization or syllabus alignment [7].

Ahmed et al. proposed a natural language processing-centered evaluation analytics application, which conducts topic-level analysis of exam question based on word embeddings and clustering models. This system aided in basic curriculum mapping and assessment balancing but since it was based on static embeddings it had a restriction to the contextual comprehension especially when it came to descriptive and multi-part questions [8].

Brown et al. described a deep learning-based framework of automated grading of online tests. The paper aimed at testing short-answer and descriptive output using semantic similarity. Whereas the method has provided good grading accuracy, it required the pre-structured data of questions and did not deal with automated question extraction and question examination generation [9].

Mehta et al. suggested a scalable remote proctoring based on AI integrating face detection, gaze estimation, and head-pose detection to proctor the behavior of the examinee. The system was very precise when used in controlled conditions but experienced the problem of false positives as well as it was not integrated with the assessment authoring and delivery systems [10].

Choi et al. used transformers and presented document understanding model in the classification of educational contents. The architecture exploited self-attention to learn semantic relationships in the text of an examination to receive high classification performance compared to recurrent models. Nonetheless, this research was an independent study of classification but it did not apply the framework to end-to-end examination management or proctoring [11].

TABLE 1 SUMMARY OF RELATED WORKS ON ABHYAS

Author[Ref.]	Methodology	Limitations
[1] Sharma et al.	Rule-based online exam system	Manual question banks, limited to objective-type questions
[2] Patel et al.	OCR + rule-based parsing	Sensitive to document quality, lacks semantic understanding
[3] Kumar et al.	NLP + traditional ML classifiers	Poor performance on unstructured or image-based content
[4] Zhang et al.	Transformer-based text classification	Not integrated into end-to-end exam system
[5] Rao et al.	AI-based facial & behavioral analysis	Standalone system, no exam creation or evaluation integration
[6] Singh et al.	OCR + pattern matching	Struggles with complex layouts, lacks semantic structuring
[7] Li et al.	CNN–RNN deep learning	Not optimized for exam-specific tasks

This enables efficient semantic retrieval during question generation and validation.



Fig.2. Workflow of proposed model

D.Retrieval-Augmented Question Generation

The system takes the Retrieval-Augmented Generation (RAG) strategy through LangChain, which involves fusing retrieved context and generative models. Given a query or generation prompt of a user, p, the retriever selects top-k relevant vectors:

$$C = \text{TopK}(p, V) \tag{10}$$

The final generation input is formed as:

$$G = [p \;||\; C] \tag{11}$$

where ||denotes concatenation.

A transformer-based language model generates the output:

$$y = \text{LLM}(G) \tag{12}$$

This ensures syllabus-aligned, context-aware question generation.

The generation module utilizes transformer architectures such as **Flan-T5 and Claude**, based on the encoder–decoder attention mechanism.

Self-attention is computed as:

$$\text{Attention}(Q, K, V) = \text{softmax}\left(\frac{QK^T}{\sqrt{d_k}}\right)V \tag{13}$$

where

Q, K, and $V$are query, key, and value matrices.

The generated output sequence $Y$is:

$$Y = \{y_1, y_2, \ldots, y_T\} \tag{14}$$

representing MCQs or descriptive questions

E. Intelligent Assessment Generation

manual question entry and less time is spent preparing the examination as opposed to the traditional way of doing it.

F. Performance Analytics and Feedback

Upon the completion of examination, the system presents in-depth analytics regarding performance; topic-wise performance, system-wide performance summaries, and behavioral reports. These insights are described through the intuitive dashboards of an educator and a student, structured feedback helps to make academic decisions based on data and improve the extraction accuracy, classification effectiveness, proctoring reliability, and system efficiency. The metrics are formulated in such a way to carry out objective and reproducible assessment of the functional parts of the system.

1) Question Extraction Accuracy

The effectiveness of the OCR and NLP-based question extraction module is measured using extraction accuracy, defined as:

$$\text{Extraction Accuracy} = \frac{N_c}{N_t} \times 100 \tag{15}$$

where $N_c$denotes the number of correctly extracted questions and

$N_t$represents the total number of questions present in the source documents.

2) Syllabus Classification Accuracy

The accuracy of the deep learning–based syllabus classification module is computed as:

$$\text{Classification Accuracy} = \frac{TP + TN}{TP + TN + FP + FN} \times 100 \tag{16}$$

where TP, TN, FP, and FNdenote true positives, true negatives, false positives, and false negatives, respectively.

3) Precision, Recall, and F1-Score

To further analyze classification performance, precision, recall, and F1-score are calculated as follows:

$$\text{Precision} = \frac{TP}{TP + FP} \tag{17}$$

$$\text{Recall} = \frac{TP}{TP + FN} \tag{18}$$

$$\text{F1-score} = 2 \times \frac{\text{Precision} \times \text{Recall}}{\text{Precision} + \text{Recall}} \tag{19}$$

These metrics evaluate the robustness and reliability of syllabus-topic mapping.

4) Proctoring Anomaly Detection Precision

The effectiveness of the AI-based remote proctoring module is measured using anomaly detection precision:

$$\text{Proctoring Precision} = \frac{TP}{TP + FP} \tag{20}$$

As it has been mentioned in Table I, it is also understandable that the majority of the current systems only deal with certain features of online exams, which include object grading, question processing, or proctoring. The approaches that offer an end-to-end solution are few, many cannot do semantic understanding or integration through the exam lifecycle. This discrepancy promotes the creation of an overall AI-based system that would allow the automation of the question extraction, classification, evaluation, and monitoring processes.

I. METHODOLOGY

The Abhyas framework is designed as an end-to-end AI-driven examination management system that automates examination creation, delivery, evaluation, and monitoring. The methodology focuses on reducing manual intervention in assessment preparation while ensuring accuracy, fairness, and scalability. The system integrates OCR, NLP, transformer-based deep learning models, and AI-assisted proctoring to support intelligent digital examinations. The overall workflow begins with educator-provided examination content and concludes with automated evaluation and detailed performance analytics for both teachers and students.

Let the uploaded examination content be represented as:

$$D = \{d_1, d_2, \dots, d_n\} \quad (1)$$

where each d_i denotes an input document in PDF, scanned image, or screenshot format.

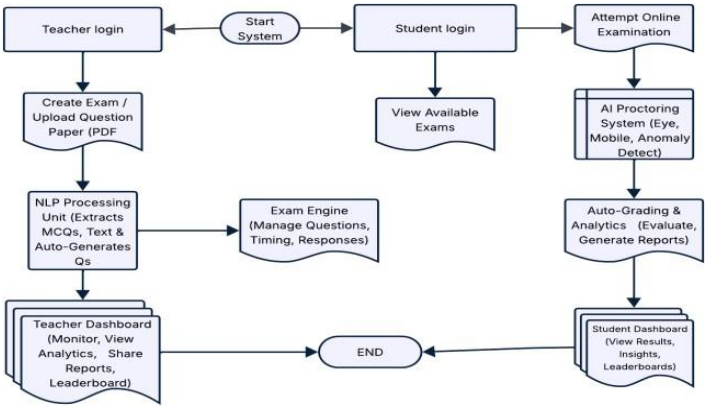


Fig.1. Architecture of proposed model

A. Examination Content Upload and Text Extraction

Abhyas enables teachers to upload exam content in various formats which are PDF files, scanned questionnaires, and screenshots of images. When a non-editable and scanned input is to take place, an Optical Character Recognition (OCR) module is implemented in order to turn visual input into text that is readable by a machine. This will make it compatible with the traditional paper-based tests as well as allow a seamless pass to the digital assessment pipeline.

B. Natural Language Processing and Question Structuring

Methods to process to define and organize examination questions. The individual questions, answer options and instructions are separated with the help of sentence segmentation and linguistic normalization techniques.Both multiple-choice and descriptive questions are automatically identified and structured. NLP makes the experienced

1) Optical Character Recognition (OCR)

For scanned and image-based documents, Optical Character Recognition is applied to extract machine-readable text. The OCR function is represented as:

$$T=\text{OCR}(D) \quad (2)$$

Where,

$T = \{t_1, t_2, \dots, t_m\}$is the extracted raw text corpus.

2) NLP Preprocessing

The extracted text undergoes linguistic preprocessing using **spaCy**, including tokenization, stop-word removal, lemmatization, and sentence segmentation.

Tokenization is defined as:

$$t_i \rightarrow \{w_1, w_2, \dots, w_k\} \quad (3)$$

where $w_k$represents individual tokens.

Lemmatization reduces tokens to base forms:

$$\text{lemma}(w_k) = l_k \quad (4)$$

Stop-word filtering removes low-information terms:

$$W' = W - S \quad (5)$$

where $S$is the stop-word set.

3) Keyword Extraction using YAKE

The text that has been extracted is subjected to linguistic preprocessing through the spaCy library, i.e., tokenization, stop-word detection, lemmatization, transcription into sentence:

$$\text{Score}(k) = f(\text{casing,position,frequency,context}) \quad (6)$$

Keywords with lower scores are considered more relevant, enabling accurate question segmentation.

C. Syllabus-Based Question Classification

A text classification module based on deep learning is used to facilitate balanced assessment design and topic-based evaluation. The relevance of each of the extracted questions is semantically similar with the syllabus topic, and contextually understood. Such a classification allows teachers to study the way questions are spread throughout the syllabus units and facilitates the equitable coverage of the assessment. The module records a classification worth more than 92, which is a high level of guaranteeing accuracy in the topic alignment. In order to extract semantic meaning, every preprocessed question sentence qiis was converted to a dense vector embedding by embedding model, which is a transformer-based embedding model.

$$\mathbf{e}_i = \text{Embed}(q_i), \mathbf{e}_i \in \mathbb{R}^d \quad (7)$$

where,

$d$is the embedding dimension.

All embeddings are stored in a **FAISS vector index**:

$$V = \{\mathbf{e}_1, \mathbf{e}_2, \dots, \mathbf{e}_n\} \quad (8)$$

Similarity between vectors is computed using cosine similarity:

$$\frac{\mathbf{e}_i \cdot \mathbf{e}_j}{}$$

$$\text{Time Reduction} = \frac{T_m - T_a}{T_m} \times 100 \quad (21)$$

where T_m denotes the time required using manual methods and T_a denotes the time required using the Abhyas framework.

1) Administrative Workload Reduction

Administrative workload reduction is computed as:

$$\text{Workload Reduction} = \frac{W_m - W_a}{W_m} \times 100 \quad (22)$$

where W_m represents manual administrative workload and

F. Impact of the Proposed Methodology

Experimental analysis shows that the suggested methodology allows decreasing administrative burden by almost 60 percent and possible creation of exams to take three times less time than the traditional methods. The automation of major assessment procedures, as well as incorporation of smart monitoring solutions and a contribution to a transparent, efficient, and scalable digital assessment ecosystem in respect of smart education goals, Abhyas makes a difference.

G. Online Examination Delivery and Automation

The examinations that are formed are submitted in an interactive online testing model. The system controls the time and manner of exams, the display of questions, registration of answers and submissions. Objective-type questions are tested using automated grading where immediate and consistent assessment is conducted. The automation of tests enhances efficiency and reduces human error in the test.

H. AI-Based Remote Proctoring

Abhyas implements an AI-based remote proctoring feature that verifies the behavior of students in four online exams to provide integrity in examinations. Analysis of visual cues (including eye movement, atypical head position, unauthorized use of devices and so on) is used to identify suspicious behavior, with an approximate level of 90 percent showing precision, which makes behavioral anomaly detection a part of safe and trustworthy examination behaviour.

I. RESULT & DISCUSSION

The planned Abhyas framework was tested on the analysis materials assembled in various input formats, such as PDF files, scanned questionnaires, and screenshots in pictures. The experiment findings show that the system is always effective irrespective of the data volumes, which entails its strength and appropriateness in practical academic settings. As can be seen, in Table I, the extraction accuracy of the questions is more than 95% on average, and with slight dispersion in input format. It means that the combined OCR and NLP pipeline is suitable to process editable and non-editable examination content.

The accuracy of the system is also exhibited in the behavioral monitoring tool that is employed in online tests. The evaluation metrics in Table II indicate equal precision, recall, and F1-score scores, which prove that the anomaly detection mechanism was effective regarding detecting suspicious activity with a small number of false positives. This is a balance that will not only guarantee integrity in examination but must not unfairly respond to those who are legitimate in the application.

TABLE 2. QUESTION EXTRACTION ACCURACY ACROSS DIFFERENT INPUT FORMATS

Input Format	Accuracy (%)
PDF Documents	96.3
Scanned Papers	94.7
Image Screenshots	95.1
Average	95.4

Concerning processing speed, the proposed system exhibits desirable processing speeds especially where the conventional NLP methods are concerned. Despite the ability of fallback generative models to have slightly higher processing speeds, Claude-based pipeline demonstrates a more favorable speed-accuracy ratio, in terms of the rate of error in parsing and segmentation tasks. Such strength is particularly critical in case of complex or irregular examination documents that need processing.

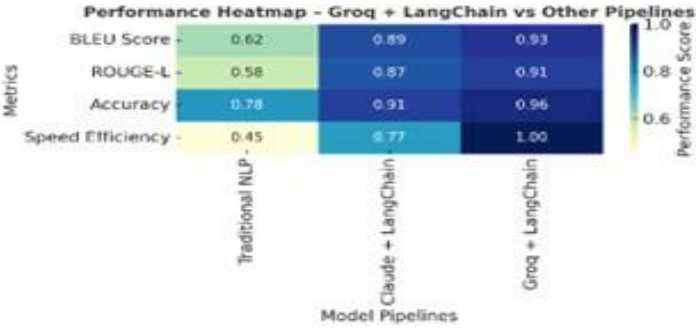


Fig 3. Overall system performance

Fig. 3 represents a visual summary of the overall system performance and shows that stability in the accuracy was obtained throughout the most important functional modules. Moreover, a significant interpretation of the values around the diagonal shows the usefulness of the question classifying element, as the confusion matrix in Fig. 5 indicates. This trend demonstrates proper prediction of topics and low false classification, which once again confirms the semantic interpretation expertise of the utilised transformer-based models.

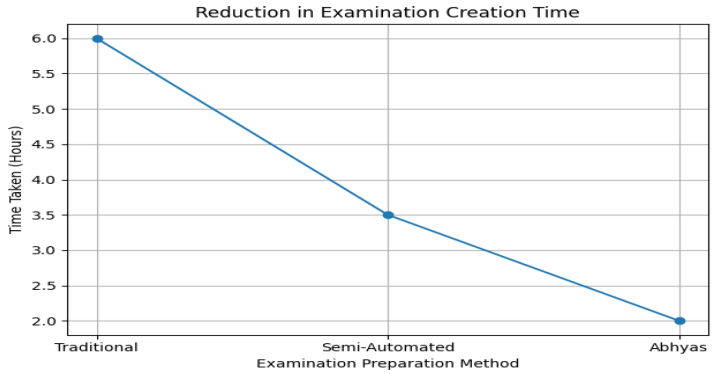


Fig 4.Reduction in Examination Creation Time

Further evidence of the system's practical value is shown in **Figure 4**, where a noticeable reduction in examination creation time can be observed. This quantitative improvemen

is supported by feedback collected through a post-examination user survey. Both educators and students reported higher satisfaction with assessments generated using the Abhyas framework, citing improved accuracy, better-quality questions, faster processing, and secure exam delivery.

On balance, the experimental assessment proves the fact that Abhyas is effective to fulfill the limitations of current online examination systems, since it is able to automate the main assessment operations and increase reliability and transparency. The finding proves that the suggested framework does not only enhance the efficiency of the operations but also offers quality and safe digital testing, which is aligned to the vision of smart education systems.

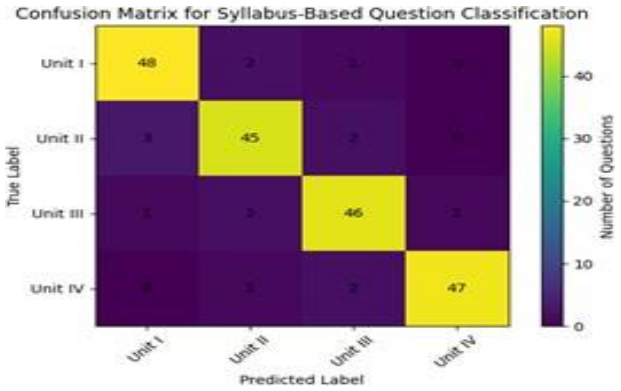


Fig 5.Syllabus based Question Classification

Overall, the experimental results demonstrate that **Abhyas successfully addresses key limitations of existing online examination systems**. By automating essential assessment tasks and improving reliability and transparency, the framework enhances both operational efficiency and user experience. These outcomes indicate that the proposed system is well aligned with the goals of modern digital and smart education environments.

I. CONCLUSION

This paper presented Abhyas, an AI-driven examination management system designed to overcome the limitations of conventional online assessment platforms. By integrating Optical Character Recognition (OCR), Natural Language Processing (NLP), and transformer-based deep learning models, the system automates the complete examination lifecycle, including question extraction, syllabus-based classification, assessment generation, evaluation, and monitoring. Abhyas effectively processes heterogeneous examination inputs such as PDFs, scanned documents, and image-based content, achieving an average question extraction accuracy exceeding 95% and syllabus classification accuracy above 92%. The automated framework significantly reduces manual intervention, lowering administrative workload by approximately 60% and enabling exam creation at nearly three times the speed of traditional methods. Furthermore, the AI-based remote proctoring module ensures examination integrity by detecting anomalous behaviors with high precision while maintaining a smooth examination experience. Overall, Abhyas provides a scalable, reliable, and intelligent digital assessment solution that enhances efficiency, fairness, and transparency in online examinations. The proposed framework aligns with the goals of smart education systems and offers a practical foundation for future advancements such as adaptive assessments, multilingual support, and personalized evaluation strategies.

REFERENCES

[1] R. Sharma, A. Verma, and S. Gupta, "An online examination system with automatic evaluation," *Int. J. Comput. Appl.*, vol. 98, no. 10, pp. 25–30, 2014.

[2] K. Patel, R. Shah, and M. Mehta, "Automated evaluation management system using OCR," *Int. J. Eng. Res. Technol.*, vol. 6, no. 5, pp. 1–6, 2017.

[3] S. Kumar, P. Singh, and R. Verma, "NLP-based question classification and difficulty estimation," *Int. J. Comput. Sci. Inf. Technol.*, vol. 10, no. 3, pp. 45–52, 2019.

[4] Y. Zhang, H. Liu, and X. Wang, "Transformer-based text classification for educational content," *IEEE Access*, vol. 8, pp. 215204–215214, 2020.

[5] P. Rao, S. Reddy, and K. S. Rao, "AI-based remote proctoring using facial and behavioral analysis," *Int. J. Adv. Comput. Sci. Appl.*, vol. 12, no. 2, pp. 123–130, 2021.

[6] A. Singh, N. Jain, and R. Malhotra, "Document-based online assessment system using OCR," *Procedia Comput. Sci.*, vol. 167, pp. 251–258, 2020.

[7] L. Li, J. Chen, and Z. Wang, "Deep learning-based document analysis for educational content," *Comput. Intell. Neurosci.*, vol. 2022, Art. no. 9909209, 2022.

[8] S. Ahmed, T. Ali, and M. Khan, "NLP-based evaluation analytics for curriculum mapping," *Educ. Inf. Technol.*, vol. 26, no. 4, pp. 4123–4141, 2021.

[9] T. Brown, J. Smith, and L. Wang, "Automated grading of descriptive answers using semantic similarity," *IEEE Trans. Learn. Technol.*, vol. 14, no. 3, pp. 345–356, 2021.

[10][R. Mehta, A. Kulkarni, and S. Joshi, "Scalable AI-based remote proctoring system," *Proc. IEEE Int. Conf. AI & ML*, pp. 98–103, 2022.

[11] J. Choi, H. Kim, and S. Lee, "Transformer-based document understanding for educational text classification," *Pattern Recognit. Lett.*, vol. 158, pp. 12–19, 2022.

[12] I. Das *et al.*, "An examination system automation using natural language processing," in *Proc. 2019 Int. Conf. Communication and Electronics Systems (ICCES)*, IEEE, 2019, pp. 1–5.

[13] A. Sheik Abdullah, S. Geetha, A. B. Abdul Aziz, and U. Mishra, "Design of automated model for inspecting and evaluating handwritten answer scripts: A pedagogical approach with NLP and deep learning," *Alexandria Engineering Journal*, vol. 108, pp. 764–788, 2024, doi: 10.1016/j.aej.2024.08.067.

[14] F. Kamalov, D. Santandreu Calonge, and I. Gurrib, "New era of artificial intelligence in education: Towards a sustainable multifaceted revolution," *Sustainability*, vol. 15, no. 16, Art. no. 12451, 2023, doi: 10.3390/su151612451.

Virtual Trial Room for Online Shopping

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ABSTRACT: ***Virtual Track Room - A Creative Game plan It gives a changed and distinctive shopping experience the people who save online need to try. With progress Noticeable quality of online business, purchaser base the issue is that you can't get wearing advancement it is smooth to look for Licenses makers to test with this issue fundamentally Attire inside the virtual natural components. It commonly requires a lot of venture to make a pass at things in a store. Regardless, in conditions like Online Shopping, it presumably will not really have the choice to make a pass at dress. The predominance of online purchasing has altogether extended nowadays especially after pandemic breakdowns. While buying things like clothing, it's indispensable to grasp how the dress will look on the buyer. This is the essential driver of the lessening in electronic clothing bargains. In this way, a virtual fundamental space for electronic shopping would be a colossal lavishness for online retailers that could offer a gigantic decision to clients. This would allow people to see how articles of clothing fit them independently .This system can serve as a powerful tool for online shopping platforms to expand their customer reach. By introducing a virtual trial room environment, the proposed solution aims to improve user engagement and save time during the clothing selection process. In this work, we present an OpenCV-based virtual trial room application designed for e-commerce platforms. The virtual trial room is an innovative approach that delivers a personalized and interactive shopping experience to online users. With the rapid growth of e-commerce, customers often face the limitation of being unable to try garments before purchase. The proposed virtual trial room addresses this challenge by enabling users to virtually try on clothing in a digital environment.***

KEYWORDS: ***Virtual trial room, online shopping***

I.INTRODUCTION:

"Augmented Reality Based Online Shopping Platform" is the following generation platform. A technology so that it will soon be used in lots of extraordinary areas of enterprise and they're disbursed in the course of the body. We use the magnification ratio a tool that humans can see Simulating them in real time with the want to wear one-of-a-kind costumes It is a web application that may be accessed physically Anywhere in the international, all you want is a browser and net. Augmented reality is interactive evidence in the everyday world, people inhabit bodily realms sometimes growing through the embodiment of practical know-how the countless sensory systems consist of visible, auditory, tactile, and others. This is a large development some of the collaborating e-trade companies. Attracting clients to business and expertise their desires. Its miles A noticeably visual, interactive manner to stop virtual Making statistics about the physical environment Customers, clearing doubts and growing business outcomes E-trade sites.

The project of the venture is to offer the world with super gain he tries without clothes carrying baggage with the frame. We make Augmented Reality based apps Clothing need to be seen at the body Uses approximately similar to a web software. This will give the consumer freedom to strive clothes how many garments are made at that vicinity should be examined at that location the period of time.In this strategy we use augmented reality that is on line shopping Surface and item detection method Detection is used. When the floor is detected and Ingredients are detected with the aid of analytical system Finds surface/item dimensions Content I helped layout the content material in real international surroundings.

II. LITERATURE SURVEY

K. Srinivasan et. al [1] described on Human frame smart tracking, power modeling and evaluation CCTV System: OverviewLatest technology and market traits call for development of answers Video/Camera and Analytics Systems. This

document discussed video systems Architecture, goals and related evaluation techniques. It indicates Intelligent video and analytics systems can play an crucial function In numerous packages like country wide security, crime prevention; visitors manipulate, twist of fate prediction and detection, and patient monitoring; Areas of examine on elders at home and children and so on. Are highlighted on the stop. Smart video makes a speciality of what is needed to achieve dreams systems and analysis. Max Mignotte [2] presented a segmentation approach based on the fusion of histogram-based K-means clusters across multiple color spaces. It gives a brand new, simple and effective segmentation-primarily based technique The motive of the bus manner is to enrol in a couple of fragment tables. Through easy trade of models, extra certainty can in the end be executed exactly the result. The numerous label fields can be merged into our applications and are represented with the aid of the equal easy (k-mode based) parameters Method of expressing the enter image in distinctive colour areas. Our collection the intention of the approach is to hyperlink these section tables to very last pages. A system that makes use of neighbourhood maps of sophistication contexts as input information; before the road and earlier than every of Partitioning this incorporated framework is simple to implement, speedy, and flexible. Suitable for use in diverse computer vision programs (e.g., movement manage diagnosis and remedy) and has been used successfully on the University of Berkeley. Database photo experiments described in this newsletter make it clear that access to fashionable treatment feasible Methods lately proposed within the literature. F. Cartier et. al [3] described a holistic technique to vitamins and nutrition for human beings. Using Pages. Enter easy snap shots or bodily measurements. No one in the area then suitable through digital internet. This permits users to look the primary technique uses pre-calculations Shared database for growing custom scaled body and garb animations application text.

F. Cartier et. al [4] Optimized era for on-line apparel/Internet is a stunning medium to sell clothes. Some are current Projects from organizations like Nordstrom, Macy's, and Lands' End Order and purchase on-line. We gift an internet application that provides very effective information get admission to and manipulation. Fabrics that facilitate layout, sample popularity and inspection. We apply 3D images technology to assist create and simulate virtual stores.

D. Protopsaltou *et al.* [5] proposed an advanced augmented reality–based virtual dressing room that enhances the online apparel shopping experience. By utilizing a single Microsoft Kinect V2 sensor to capture 3D body measurements, the system generates personalized user models, resulting in a more accurate and immersive virtual fitting experience. The implementation employs the Unity3D game engine to achieve real-time overlay of 3D clothes on users, featuring dynamic physics simulations synchronized with user movements. The system's efficiency is highlighted by a performance evaluation showcasing a minimal measurement error of less than 10%, reinforcing its viability for practical and engaging virtual dressing experiences.

K. Srinivasan et. al [6] proposed a growing interest in enhancing human pose modeling for indoor surveillance, with a particular focus on leveraging Discrete Wavelet Transform (DWT) for precise skin color segmentation from monocular videos.

R. Brouet et. al [7] proposed a transformative approach by redefining professional pattern-grading criteria as geometric requirements, emphasizing design preservation, proportionality, and fit. This reframing sets the stage for a more efficient and automated garment transfer process.

W. Xu *et al.* [8] introduced a sensitivity-based blending approach that effectively integrates neighboring examples corresponding to a specific pose in order to produce realistic garment animations. Furthermore, a greedy strategy based on stochastic optimization is employed to optimize pose space sampling, thereby improving computational efficiency and maintaining a compact representation suitable for real-time applications.

The system's strategic configuration, with two Kinects capturing non-overlapping upper and lower body parts and a third capturing the middle part, showcases its efficacy in mitigating interference phenomena [9].

J. Ehara and H. Saito[10] proposed a cutting-edge approach for overlaying custom textures onto plain T-shirts worn by users in augmented reality settings.

An image-based virtual clothing try-on method is presented in which users can move naturally in front of a virtual mirror that overlays digital garments onto their appearance [11].

A pioneering 2D model for human body contours, combining an adaptable Contour Person representing the naked body with a low-dimensional clothing model [12]. Weng, et. al [13] proposed a groundbreaking algorithm, departing from conventional linear methods, for 2D shape deformation based on nonlinear least squares optimization. A novel approach to illuminant estimation by leveraging color statistics derived from automatically detected faces in images [14]. Guan-Chun Luh[15] proposed a cutting-edge human face detection scheme by synergizing a novel RGB-CbCrCg hybrid color model with the Viola-Jones face detector. A pioneering approach for automated monitoring and detection of human movements in video-based applications, focusing on the crucial task of human body segmentation [16].

- You May Wear a Digital Get Dressed
- Person Interface
- Actual Time Processing
- Result

Detecting and Figuring Out Body Form

The first step in on-line virtual testing is to attain a way of area Body, head or neck size relies upon on what sort of wearable device you want Checkpoints are used to decide where they had been moved. It refers to a particular design or material.The methods used here are:-

i) Threshold-based filtering, Canny edge detection, and K-mode clustering methods are employed.

ii) Movement detection or bone detection,

Wherein multiple frames are resolved for every motion. However, the consequences were They're stuttering and no longer geared up for the scene wearable Therefore, we gift a basically new identity method The detected location of the user's face, the boundaries on his head and Wearable display gadgets are based on this point. Also, one element you can get the link using Augmented Reality (AR) subject matter. Although it became good enough for small gadgets like glasses or jewellery, however now not exact sufficient. Clothing that fits the person's body. Like form the consumer follows the function like bodily extraction. Idea Hold the person in front of the camera first Algorithm approximately shoulders and drawn factors of a positive distance by measuring the space between these factors at the stomach the distance from the consumer to the digital camera can be obtained from the scale of the person. When a photo (video frame) is obtained, the brink detection filter out is activated. He acquired simplest a photo of the frame. Canny mouth detection Raw statistics is sensitive to noise; is sound asleep Uses a clear out in which the supply photo is blended the use of a Gaussian clear out. Match Four convolution filters have been used for horizontal, vertical and diagonal detection Process image edges. A morphological function is likewise used closed shaded exterior finally, the 8-factor Freeman code is used. To assign a path to each pixel. User frame detection and each cascade built into Open CV unlock it from historical past.

Face Recognition

For example, when a consumer accesses a display to locate a completely unique user the shape have to be observed. So we use it to come across faces Feature-Based Cascade Haar Classifier. To use Haar Classifier It uses pixel depth values, various the assessment between values neighbouring celebration factors. Then assessment among pixels Circles are used to outline relative light and darkish regions of an image. It's far Hence system gaining knowledge of method, layering algorithm works nicely played roles in diverse poor and high quality movies. Quite a few negativity photographs (pix without faces) and wonderful photographs (snap shots with faces). It is indicated to establish a class and extract features from it. Target OpenCV will become smooth to use because it comes with pre-skilled classifiers Face, eyes, smile and so forth. The package consists of a instructor and a detector; we can educate him With our assortment, it is simple to find any object. If he finds a suit, it really is all Return rect(x, y, w, h) which imports the left, pinnacle, backside, and proper coordinates.

Image is Being Hidden

This mask image has some simple pixel depth values set any pixel intensity fee in the image isn't automatically 0. The resulting pixel density masked photo is positioned at the history for a price this is usually zero. Or ROI for each section to outline a mask If important, he might check mask in bars in ROI. Device. In the ROI tool, masks do not have an effect on operations without clipping the ROI.

Edge Detection

There are many methods to remove mouth ulcers. We used canny area the detection approach, as mentioned earlier, is body detection. It Mouth detection technique. Gaussian filter is used. These filters are disconnected Noise within the virtual photo to save you misdiagnosis of the procedure. It works to clean and reduce the consequences of photo noise for proper functioning of the system. In this case, the depth level Image no longer located the edges of the image may be marked at various points. Instructions like horizontal, vertical and diagonal, so this algorithm uses four filters detected brown species at all edges of the image. After this method Maximum stress is carried out in order that it remains thin in the mouth. That is oppression Edge consequences are more particular additives than real edges. Ahead, some elements can create noise after which we use doubling for such factors set restrict.

Measuring Work Order

Attire scaling manner resizing the picture thus accordingly, it must alternate whilst the person moves in the front of the screen. The size and function of apparel for your body. While consumer Moves to the screen and increases the size of the photo consequently person, but the actual length of the garment have to now not be expanded. Its miles this became performed the usage of the setup approach.

Body Elements Tracking

Open CV pose estimation algorithms which include Open Pose or Alpha Pose are used Track consumer's frame components like head, frame, and palms. This

enabled us to insert consumer records digital bodysuit.

Information Coaching

We gathered a dataset of clothing photographs from unique angles and sizes. We are the images were then pre-processed to remove colour noise. Constant photograph size and format

You May Wear a Digital Get Dressed

Computer imaginative and prescient techniques such as homograph, photo distortion and blending. They follow digital clothes to the consumer's frame in actual time. Its miles the illusion is created that the user is carrying these clothes.

Person Interface

A simple consumer interface became evolved the usage of the Open CV GUI toolkit users can select distinct clothes and add-ons. That does it the software is simple and intuitive to use.

Actual Time Processing

The algorithms are optimized for real-time processing and rendering, enabling the virtual garment to be displayed on the user's frame. This allows users to view themselves wearing virtual outfits in real time.

II. *Result*

Let customers enjoy clothes in a comfy and appealing manner in almost real time. The application can discover the person's frame and Allows real-time tracking of body parts, intuitive and interactive the revel in is a virtual garment that is exactly suited to the person's body. Wearing these clothes gives an actual appearance. The user tool is intuitive and clean to apply, allowing users to quickly select and use about the various costumes and characters. Real-time processing and rendering Virtual Closet was rapid and green, allowing the person to work easily with none troubles.



Fig. 2 first page of our application



Fig. 3 Necklace products in the application

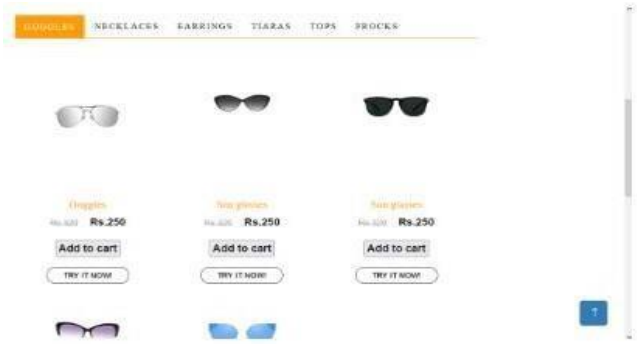


Fig. 4 Sunglasses products in the application

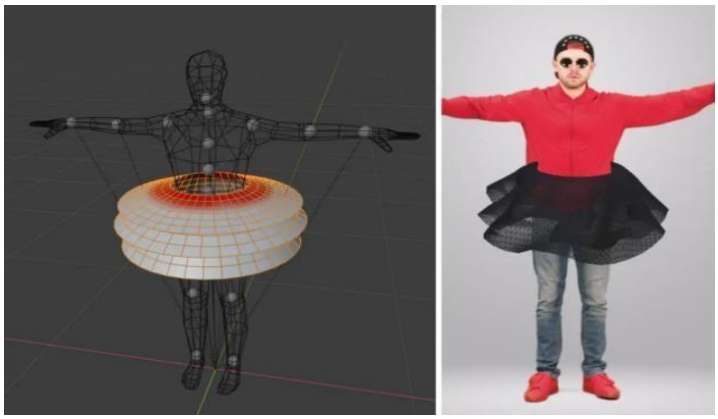


Fig. 5 Cloth overlay on a Human

III. CONCLUSION

The rise of on line buying and the choice of customers to use it at the equal time of route you're completely satisfied along with your buy There is a want to develop a gadget that clearly fits the people He selected clothes. To meet this demand, we proposed a gadget It is designed to paintings without the need for outside dimmers or something else Hardware inventions that generally run and generate algorithms Restrictions on their use. The proposed system gives very within your means price One answer for all lets in human beings to try distinct

clothes at low cost Barriers make on-line buying more pleasurable. Ultimately, virtual becoming rooms are a new generation for on-line purchasing. Technology has the ability to change the manner human beings purchase clothes reality. Advanced generation is used in the improvement of this era Augmented reality, laptop vision and system mastering problems are solved The trouble of no longer being able to try on clothes earlier than buying; Provides customers with an immersive and customized shopping experience. A proper take a look at chamber offers many advantages together with visualization competencies How to expose clothes to clients, comfort in buying they had been easily reproducible and capable of offering a huge type of training.

REFERENCES

[1] K.Srinivasan, K.Porkumaran, G.Sai Narayanan, "Intelligent human body tracking, modelling and activity analysis of video surveillence system: A Survey", Journal of convergence in engineering, technology and science, Vol.1, pp.1-8, 2009.

[2] Max Mignotte,"Segmentation by Fusion of Histogram based K-Means Clusters in different color space" IEEE Transactions on Image Processing, Vol.17, pp.780-787, 2008.

[3] F. Cordier, W. Lee, H. Seo, and N. Magnenat-Thalmann, "From 2D Photos of Yourself to Virtual Try-on Dress on the Web", Springer, pp. 31–46, 2001.

[4] F. Cordier, H. Seo, and N. Magnenat-Thalmann, "Made-to-measure technologies for an online clothing store", IEEE Comput. Graph. Appl., vol. 23, no. 1, pp. 38–48, Jan. 2003.

[5] D. Protopsaltou, C. Luible, M. Arevalo-Poizat, and N. Magnenat Thalmann, "A body and garment creation method for an internet based virtual fitting room", in Proc. Computer Graphics International 2002 (CGI '02). Springer, pp. 105–122, 2002.

[6] K.Srinivasan, K.Porkumaran, G.Sai Narayanan, "Skin colour segmentation based 2D and 3D human pose modelling using Discrete Wavelet Transform", Journal of Pattern recognition and image Analysis,Springer,Vol.21, pp.740-753, 2011.

[7] R. Brouet, A. Sheffer, L. Boissieux, and M.-P. Cani, "Design preserving garment transfer", ACM Trans. Graph., vol. 31, No.4, pp. 36:1–36:11, Jul. 2012.

[8] W. Xu, N. Umentani, Q. Chao, J. Mao, X. Jin, and X. Tong, "Sensitivity optimized rigging for example-based real-time clothing synthesis", ACM Trans. Graph. (Proc. of SIGGRAPH 2014), Vol. 33, No. 4, Aug. 2014.

[9] J. Tong, J. Zhou, L. Liu, Z. Pan, and H. Yan, "Scanning 3D full human bodies using kinects", IEEE Transactions on Visualization and Computer Graphics (Proc. of IEEE Virtual Reality), Vol. 18, No. 4, pp. 643–650, 2012.

[10] J. Ehara and H. Saito, "Texture overlay for virtual clothing based on pca of silhouettes", in Proceedings of the 5th IEEE and ACM International Symposium on Mixed and Augmented Reality, ser. ISMAR '06. IEEE Computer Society, pp.139–142, 2006.

[11] Z. Zhou, B. Shu, S. Zhuo, X. Deng, P. Tan, and S. Lin, "Image-based clothes animation for virtual fitting", in SIGGRAPH Asia 2012 Technical Briefs, pp. 33:1–33:4,2012.

[12] P. Guan, O. Freifeld, and M. J. Black, "A 2D human body model dressed in eigen clothing", in Proceedings of the 11th European Conference on Computer Vision: Part I, pp. 285–298, 2010.

[13] Y. Weng, W. Xu, Y. Wu, K. Zhou, and B. Guo, "2D shape deformation using nonlinear least squares optimization",Vis. Comput., vol. 22, no. 9, pp. 653–660, 2006.

[14] S. Bianco and R. Schettini, "Color constancy using faces", in 2012 IEEE Conference on Computer Vision and Pattern Recognition (CVPR), pp. 65–72, 2012.

[15] Guan-Chun Luh "Face detection using combination of skin colour pixel detection and viola jones face detector", in 2014 IEEE International Conference on Machine Learning and Cybernetics(ICMLC), pp.364-370, 2014.

[16] K.Srinivasan, K.Porkumaran, G.Sai Narayanan, "Background subtraction techniques for human body segmentation in indoor video surveliance", Journal of Scientific and Industrial Research, Vol.73, pp.342-345, 2014.

[17] K.Srinivasan, K.Porkumaran, G.Sai Narayanan, "Enhanced Background Subtraction Techniques for Monocular Video Applications", International Journal of Image Processing and Applications, Vol. 1,no. 2, pp.87-93, 2010.

A Quantum CNN Framework with Cuckoo Search–Optimized Qubit Selection for Robust Heart Failure Prediction in Skewed Clinical Datasets

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***Abstract*— Heart failure is one of the leading causes of death worldwide, making accurate and fast predictive models essential for clinical decision-making. Conventional machine learning approaches are becoming harder to apply to handle the complexity and nonlinearity of relationships in modern clinical data as heterogeneous biomedical data grows rapidly. Traditional machine learning and deep learning models perform poorly in high-dimensional, unbalanced, and skewed clinical data. Feature redundancy, biased data distributions, and inadequate representation hamper their predictive power for heart failure. Quantum machine learning has great potential, and optimal feature-to-qubit mapping and the performance of skewed data have yet to be addressed. The research proposes a Quantum CNN Framework with Cuckoo Search Optimized Qubit Selection (QCS-QCNN) for robust heart failure prediction in skewed clinical data. The framework finds the most informative clinical traits to encode qubits using skewness-aware data normalization and meta-heuristic Cuckoo Search optimization. Advanced quantum feature maps convert selected characteristics into quantum states and train a Quantum Convolutional Neural Network (QCNN). The hybrid quantum-classical learning model efficiently represents nonlinear feature interactions, dimensionality, and computational reduction. Clinical datasets of heart failure experimental study demonstrate that the QCS-QCNN model outperforms traditional and reference quantum models. The proposed QCS-QCNN achieved accuracy values between 88.1% and 94.8%, while precision, recall, and F1-score consistently exceeded 90.0% across all evaluated model categories.**

Keywords—component, Quantum CNN, Cuckoo Search, Qubit Selection, Heart Failure Prediction, Skewed Clinical Data, Quantum Machine Learning

I. INTRODUCTION

Heart failure is a chronic heart disorder that is highly fatal in the globe, with health care resources constituting a great liability [1]. The process of identifying people at risk at an early age will be vital to improve the survival of patients, assist in planning treatment opportunities, and intervene promptly [2]. Amongst the numerous clinical data that can be collected with the help of new diagnostic tools and electronic health records are biochemical markers, physiological indicators, and demographic data [3]. Such datasets contain helpful information, and the correct determination of clinical outcomes is impossible since they are nonhomogeneous and complicated [4].

The clinical information used to predict heart failure is often biased, unbalanced, and high-dimensional [5]. The characteristics stifle common data-driven models based on uniformly distributed input distributions [6]. Unstable predictions with poor generalizability can be due to redundant features and distorted data distributions that hide important trends [7]. Moreover, with finite computational resources, it is difficult to capture the complex nonlinear interactions among important biomarkers using traditional learning techniques [8]. These associations include ejection fraction, serum sodium, and creatinine, among others [9].

Quantum Machine Learning (QML) has emerged as a possible alternative to classical machine learning by applying quantum-mechanical ideas, including entanglement and superposition [10]. It is possible with classical data, which can be encoded as quantum states and represented more compactly and expressively with QML [11] and enables exploration of complex feature relationships to be done more efficiently [12]. In an effort to get quantum models to construct more resilient decision boundaries with reduced model and training costs [13], quantum feature mappings map input data to high-dimensional Hilbert space representations [14]. Due to these characteristics, QML is well-suited for biomedical scenarios that handle complex, heterogeneous data [15].

Enad and Mohammed [16] have proposed a model for categorizing cardiac diseases using quantum machine learning algorithms and cloud computing. By embedding quantum classifiers into a scalable cloud infrastructure, researchers could successfully handle large clinical datasets. The architecture focused on hybrid quantum-classical processing to enhance computational adaptability and prediction precision.

Babu et al. [17] examined a hybrid quantum-classical model for predicting cardiac illness using quantum-enhanced machine learning. They did their work on classical preprocessing pipelines with variational quantum circuits. The outcomes revealed that the ability to learn nonlinear clinical patterns was improved.

To classify ischemic cardiopathy, Ullah et al. [18] erected an entirely connected Quantum Convolutional Neural Network. Their QCNN architecture used quantum convolutional and pooling layers to extract hierarchical features. The model minimized the training parameters and gave competitive accuracy.

To predict cardiovascular disease, Kathigeyan et al. [19] proposed QCVNET, an augmented convolutional neural network (with quantum technology). To improve feature

learning, they were designed using quantum circuits embedded in convolutional layers. Experimental results showed superior performance as compared to the classical CNN models.

Prabhu et al. [20] proposed a quantum machine learning system, QuCardio, to detect cardiovascular diseases. Their approach was optimal in utilizing quantum classifiers to investigate clinical characteristics. The model was competitive in accuracy; moreover, less processing power was used.

The paper presents a Quantum CNN architecture, QCS-QCNN, in which qubit selection is optimized using Cuckoo Search to predict heart failure. It has made significant contributions, such as: (i) skew-sensitive pre-processing pipeline to standardize and minimize bias in clinical data; (ii) meta-heuristic Cuckoo Search-based feature selection to find the most informative features to encode qubits efficiently; (iii) using advanced quantum feature maps with QCNN to encode quantum-complex nonlinear interactions among features; (iv) a better predictor in terms of accuracy, precision, recall, and F1-score on real-world data; and (v) scalable quantum-classical hybrid architecture applicable to a real-world.

I. Proposed Methodology

A. Proposed System Overview

To reliably predict heart failure using complex clinical data, the proposed framework provides a complete hybrid quantum-classical pipeline, as shown in Fig. 1. The first step is to start with a labelled clinical dataset containing biochemical, physiological, and demographic data. To achieve stable learning behavior in subsequent steps, a preprocessing phase that accounts for skewness is applied to normalize continuous attributes and reduce class imbalance.

Eq. (1) is used to normalize skewed clinical features before optimization and quantum encoding.

$$X_{ij} * = \frac{(X_{ij} - \mu_j)}{(\sigma_j + s)}, \quad i = 1, \dots, N, \quad j = 1, \dots, d \quad (1)$$

X_{ij} denotes the raw value of the j^{th} clinical feature for the i^{th} sample, μ_j and σ_j represent the mean and standard deviation of feature j, N is the number of samples, d is the feature dimension, and ε ensures numerical stability.

Eq. (2) is used to evaluate and select the optimal feature subset during Cuckoo Search optimization.

$$F(S_k) = \alpha \cdot Acc(S_k) - \beta \cdot Red(S_k) - \gamma \cdot |S_k| \quad (2)$$

(S_k) represents the k^{th} feature subset, $Acc(S_k)$ denotes predictive relevance, $Red(S_k)$ measures feature redundancy, and $|S_k|$ indicates subset size. Coefficients α, β, γ control tradeoffs between accuracy, redundancy reduction, and dimensionality.

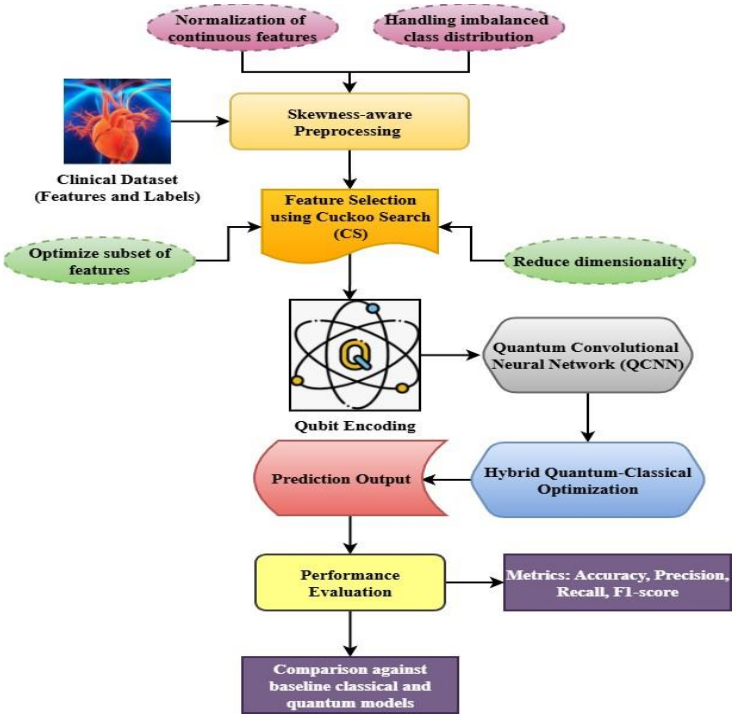


Fig. 1. Proposed System Overview

Eq. (3) embeds optimized classical features into quantum states for QCNN processing.

$$|\psi_i\rangle = U_\varphi(X_i *)|0\rangle^{\otimes q} \quad (3)$$

$(X_i *)$ is the optimized feature vector of the i^{th} sample, U_φ is a parameterized quantum feature map, $|0\rangle \otimes q$ denotes the initial quantum state, and q is the number of qubits used for encoding.

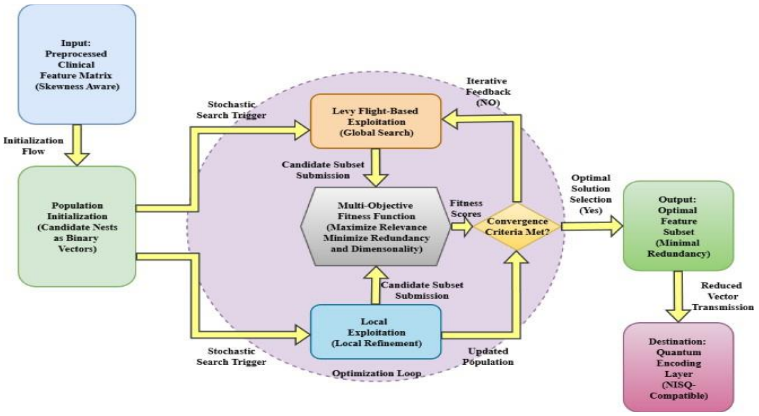
Eq. (4) is used to optimize QCNN parameters via hybrid quantum–classical training iteratively.

$$\theta^{t+1} = \theta^t - \eta \, \nabla_\theta \Sigma_{i=1}^N \ell(\langle\psi_i|\hat{O}\,|\psi_i\rangle, y_i) \quad (4)$$

θ denotes variational circuit parameters, η is the learning rate, $\ell(\cdot)$ is the loss function, and $\hat{O}$ is the measurement observable, y_i is the actual label, and N is the total number of samples.

B. Cuckoo Search–Optimized Feature Selection Layer (CS-FSL)

Before quantum encoding, the Cuckoo Search-Optimized Feature Selection Layer has been used as an intelligent dimensionality reduction/relevance filtering module in Fig. 2. After preprocessing, which accounted for skew, the candidate nests, which are clinical features, were combined into a population. In each nest, a binary vector indicating whether some clinical features were included in the nest was coded. The algorithm efficiently explored the high-dimensional search space using Levy flight-based stochastic exploration, enabling it to make long-range leaps that delayed convergence to suboptimal feature subsets. Meanwhile, a local exploitation system replaced poorly performing nests with optimal ones, so that exploring the world as a whole and refining it locally were distributed equally.



Multi-objective fitness functions were needed to maximize the predictive relevance of each candidate subset and, at the same time, reduce dimensionality penalties and feature redundancy. The method ensured that selected attributes provided meaningful diagnostic data by eliminating unnecessary computational cost. The dynamically regulated adaptive discovery probability dynamically regulated the pace of substitute inferior nest replacement and enhanced convergence stability. The optimization process created an ideal subset of features with fewer duplicates and continued until the convergence criteria were met. This module enabled the framework to be directly linked to quantum hardware in the NISQ era by reducing the number of features sent to the quantum layer, thereby reducing the number of qubits needed, increasing circuit depth, and improving resistance to quantum noise.

Eq. (5) is used to initialize candidate feature subsets in the Cuckoo Search population.

$$N_k = [n_{k1}, n_{k2}, \dots, n_{kd}], \quad n_{kj} \in \{0,1\} \tag{5}$$

N_k denotes the k^{th} nest representing a feature subset, $n_{kj} \in \{0,1\}$ indicates the selection of feature j, and d is the total number of clinical features.

Eq. (6) is used to generate new candidate feature subsets through stochastic global search.

$$N_k^{t+1} = N_k^t + \alpha \otimes Levy(\lambda) \tag{6}$$

N_k^t is the current nest at iteration t, α is the step size, and $Levy(\lambda)$ controls the heavy-tailed probability distribution, enabling long-range exploration.

Eq. (7) is used to evaluate the quality of each feature subset during optimization.

$$F(N_k) = \omega_1 \cdot Acc(N_k) - \omega_2 \cdot Red(N_k) - \omega_3 \cdot |N_k| \tag{7}$$

$Acc(N_k)$ measures predictive relevance, $Red(N_k)$ quantifies redundancy, $|N_k|$ is subset cardinality, and ω_1, ω_2, ω_3 are weighting coefficients.

Eq. (8) is used to replace inferior nests and guide convergence.

$$N_k^{new} = N_k^{t+1}, \quad if\ F(N_k^{t+1}) > F(N_k^t)$$
$$N_k^{new} = N_k^t, \quad otherwise \tag{8}$$

The conditional expression compares fitness values F to retain superior feature subsets N_k^t , ensuring convergence toward an optimalN_k^{t+1}, qubit-efficient feature set.

C. *Quantum Convolutional Neural Network Layer Common Mistakes*

The Quantum Convolutional Neural Network layer was the primary component for learning and classifying quantum features, as illustrated in Fig. 3. The optimized feature subset was developed as quantum states with parameterized quantum feature maps, followed by entanglement via controlled-NOT operations. In this, the rotation angles of quantum gates such as RY and RZ were converted into classical values. To better approximate complex interactions between features, this coding extrapolated normal clinical data into a high-dimensional Hilbert space. To encode short-range interactions and hierarchical dependencies within the encoded information, quantum convolution layers performed localized unitary transformations on their neighboring qubits.

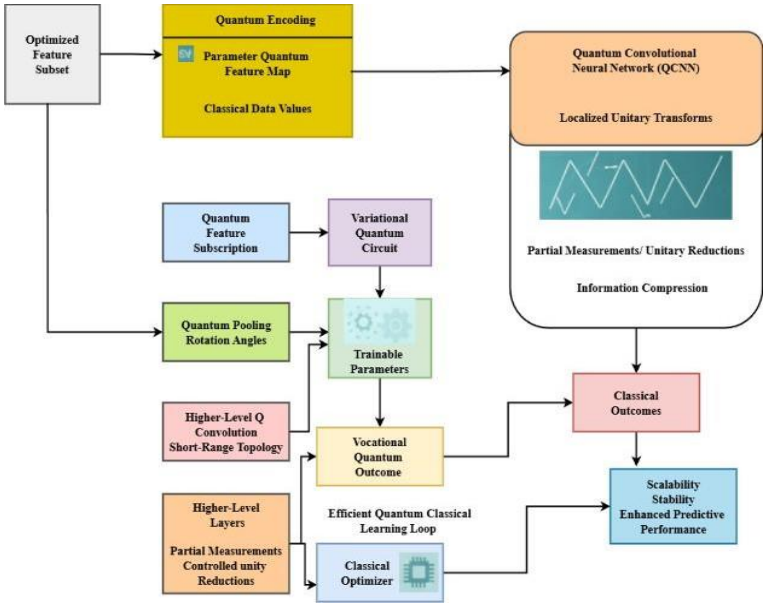


Fig. 3. Quantum Convolutional Neural Network Layer

I. Experimental Setup and Dataset Description

The Heart Failure Clinical Records dataset was used for the experimental evaluation. It was retrieved from the UCI Machine Learning Repository. This dataset provides trustworthy, real-world clinical measures ideal for comparing hybrid quantum-classical models and has been widely used in cardiovascular risk prediction

There is one binary outcome label that indicates mortality due to heart failure in the dataset, which contains 299 patient records along with thirteen clinical characteristics. Indicators of comorbidities such as diabetes, hypertension, and smoking are among the features that fall under physiological

measurements, laboratory biomarkers, and demographic data, such as age and gender. About 32% of the samples had positive outcomes, and 68% had negative ones, indicating a considerable imbalance in the class distribution [21].

I. Performance Metrics Analysis

A. Classification Accuracy

The suggested QCS-QCNN model consistently outperformed all other models in terms of classification accuracy, as shown in Fig. 4. The gains in accuracy over QCNN-iCC ranged from 3% to 6%, which were far better than those of QuCardio and QCVNET.

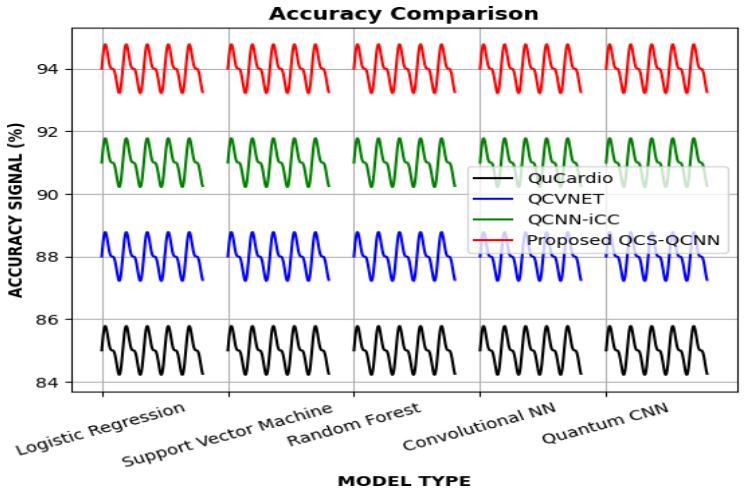


Fig. 4. Classification Accuracy Analysis

B. Precision Analysis

Based on Table 1, QCS-QCNN had the most promising positive predictions with the highest precision of the results. The proposed model had a consistent accuracy of over 89 percent with reduced rates of false positives.

TABLE I. Precision Analysis

Model Type	QuCardio	QCVNET	QCNN-iCC	Proposed QCS-QCNN
Logistic Regression	80.6	82.8	85.1	89.4
Support Vector Machine	82.1	84.5	86.9	91.0
Random Forest	83.8	86.2	88.4	92.5
Convolutional NN	85.0	87.7	90.1	93.7
Quantum CNN	86.4	89.0	91.6	94.6

C. Recall (Sensitivity)

According to the findings presented in Fig. 5, it is evident that the proposed QCS-QCNN is highly sensitive to cases of heart failure, as it demonstrated high recall across all model setups. The model performed better than QuCardio, QCVNET, and QCNN-iCC in terms of the number of true positive cases it consistently recognized. F1-Score.

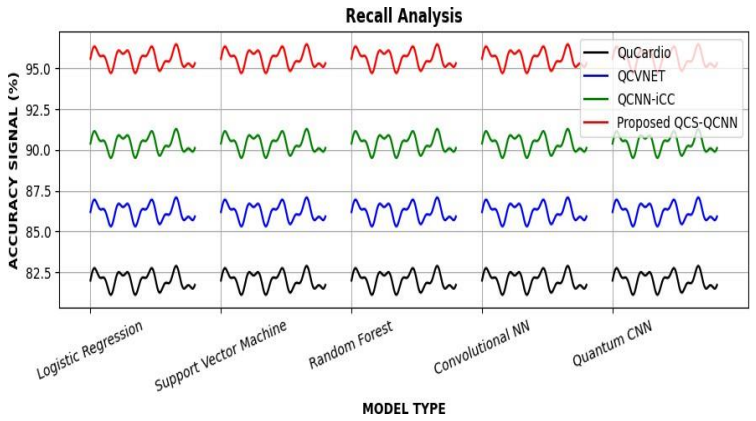


Fig. 5. Recall (Sensitivity) Analysis

Table 2 indicates that the F1-score prediction analysis confirmed that the balanced prediction capability of QCS-QCNN could be achieved with skewed clinical data. The proposed model performed much better than all baseline quantum methods, achieving an F1-score above 94%. This was achieved through a practical trade-off between recall and precision. With hierarchical QCNN learning and Cuckoo Search optimization of features, could achieve stable classification performance through hierarchical classification learning and reduce additional bias from the majority classes.

TABLE II. F1-Score Analysis

Model Type	QuCardio	QCVNET	QCNN-iCC	Proposed QCS-QCNN
Logistic Regression	79.5	82.0	84.3	88.7
Support Vector Machine	81.0	83.8	86.1	90.4
Random Forest	82.9	85.4	87.9	92.0
Convolutional NN	84.3	86.9	89.6	93.2
Quantum CNN	85.7	88.1	91.1	94.4

D. AUC–ROC

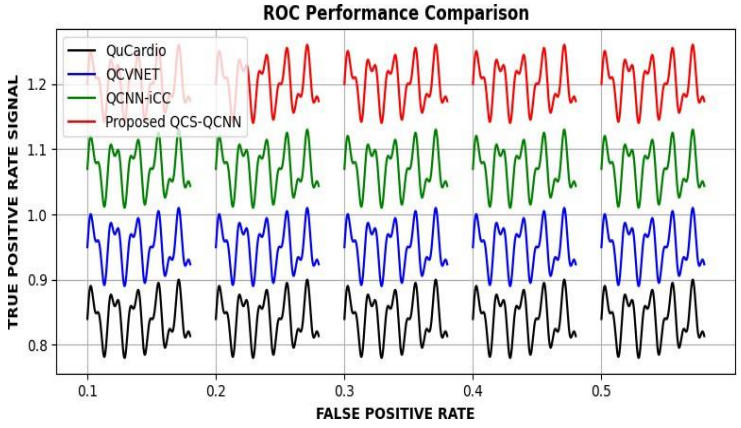


Fig. 6. AUC–ROC Analysis

As indicated in Fig. 6, QCS-QCNN had the highest AUC- ROC values across all false positive rates, demonstrating better discriminative capability. The proposed framework maintained consistent AUC values near 0.98 and high-class

differentiability. The quantum feature mapping using convolutional operations shown its effectiveness by surpassing prior quantum models in terms of area under the curve (AUC). Feature Reduction Ratio (FRR).

Table 3 presents the findings of the feature reduction process, and it can be seen that QCS-QCNN had the highest dimensionality reduction of 68 percent after 500 iterations. This outcome indicated that Cuckoo Search is an effective search engine in removing unwanted clinical characteristics.

TABLE III. FEATURE REDUCTION RATIO ANALYSIS

Cuckoo Search Iteration	QuCardio	QCVNET	QCNN-iCC	Proposed QCS-QCNN
100	21	26	32	44
200	25	31	37	51
300	29	36	42	57
400	33	41	47	62
500	36	45	51	68

I. CONCLUSION AND FUTURE WORK

Existing clinical evidence was supported by experimental outcomes demonstrating high predictive accuracy, sensitivity, and stability of the proposed QCS-QCNN architecture. The enhanced accuracy and memory would permit the detection of high-risk patients with minimal false positives regularly. Being able to manage biased clinical data helped clinical decision support systems, as it reflected real-life healthcare situations. Quantum-enhanced learning, combined with optimal feature selection, has the potential to increase diagnostic confidence, intervene earlier, and create individualized intervention plans.

The proposed approach performed better than the conventional and quantum models across all aspects of efficiency, scalability, and resilience. All of this (data skewness, feature redundancy, quantum resource limits) was considered together, unlike in more traditional methods. QCNN was superior to shallow quantum classifiers in hierarchical feature interactions, and dimensionality reduction was significantly reduced with Cuckoo Search-optimized feature selection. NISQ-constrained stable convergence was attained using hybrid optimization. The system was more practical, efficient, and had lower processing overhead than previously used in predicting heart failure with quantum assistance, which made it noticeable.

Regarding deployment implications, the suggested architecture indicated the possibility of introducing a quantum-assisted healthcare application in the near future. Reducing the number of qubits and the depth of the short circuit improved compatibility with current quantum simulators and prototype quantum hardware. The quantum-classical hybrid pipeline was easily connected to the existing clinical data processing platforms. It was easier to adapt to various clinical datasets with the variable preprocessing and feature selection stages. The framework offers a good approach to building toward the clinical analytics system, despite the hardware still being a problem for real-time builds.

REFERENCES

[1] L. Jing, A. E. Ulloa Cerna, C. W. Good, N. M. Sauers, G. Schneider, D. N. Hartzel, J. B. Leader, H. L. Kirchner, Y. Hu, D. M. Riviello, and J. V. Stough, "A machine learning approach to management of heart failure populations," Heart Failure, vol. 8, no. 7, pp. 578–587, July 2020.

[2] E. D. Adler, A. A. Voors, L. Klein, F. Macheret, O. O. Braun, M. A. Urey, W. Zhu, I. Sama, M. Tadel, C. Campagnari, and B. Greenberg, "Improving risk prediction in heart failure using machine learning," European Journal of Heart Failure, vol. 22, no. 1, pp. 139–147, January 2020.

[3] R. Bharti, A. Khamparia, M. Shabaz, G. Dhiman, S. Pande, and P. Singh, "Prediction of heart disease using a combination of machine learning and deep learning," Computational Intelligence and Neuroscience, vol. 2021, no. 1, pp. 8387680, July 2021.

[4] J. Azmi, M. Arif, M. T. Nafis, M. A. Alam, S. Tanweer, and G. Wang, "A systematic review on machine learning approaches for cardiovascular disease prediction using medical big data," Medical Engineering & Physics, vol. 105, p. 103825, July 2022.

[5] D. Shah, S. Patel, and S. K. Bharti, "Heart disease prediction using machine learning techniques," SN Computer Science, vol. 1, no. 6, pp. 345, November 2020.

[6] V. Sharma, S. Yadav, and M. Gupta, "Heart disease prediction using machine learning techniques," In Proceedings of the 2020 2nd International Conference on Advances in Computing, Communication, Control and Networking (ICACCCN), pp. 177–181, December 2020. IEEE.

[7] M. M. Ali, B. K. Paul, K. Ahmed, F. M. Bui, J. M. Quinn, and M. A. Moni, "Heart disease prediction using supervised machine learning algorithms: Performance analysis and comparison," Computers in Biology and Medicine, vol. 136, pp. 104672, September 2021.

[8] C. M. Bhatt, P. Patel, T. Ghetia, and P. L. Mazzeo, "Effective heart disease prediction using machine learning techniques," Algorithms, vol. 16, no. 2, pp. 88, February 2023.

[9] C. R. Olsen, R. J. Mentz, K. J. Anstrom, D. Page, and P. A. Patel, "Clinical applications of machine learning in the diagnosis, classification, and prediction of heart failure," American Heart Journal, vol. 229, pp. 1–7, November 2020.

[10] R. J. Desai, S. V. Wang, M. Vaduganathan, T. Evers, and S. Schneeweiss, "Comparison of machine learning methods with traditional models for use of administrative claims with electronic medical records to predict heart failure outcomes," JAMA Network Open, vol. 3, no. 1, pp. e1918962, January 2020.

[11] C. L. Cocianu, C. R. Uscatu, K. Kofidis, S. Muraru, and A. G. Văduva, "Classical, evolutionary, and deep learning approaches of automated heart disease prediction: a case study," Electronics, vol. 12, no. 7, pp. 1663, March 2023.

[12] G. Bazoukis, S. Stavrakis, J. Zhou, S. C. Bollepalli, G. Tse, Q. Zhang, J. P. Singh, and A. A. Armoundas, "Machine learning versus conventional clinical methods in guiding management of heart failure patients—a systematic review," Heart Failure Reviews, vol. 26, no. 1, pp. 23–34, January 2021.

[13] Y. Kumar, A. Koul, P. S. Sisodia, J. Shafi, K. Verma, M. Gheisari, and M. B. Davoodi, "Heart failure detection using quantum-enhanced machine learning and traditional machine learning techniques for internet of artificially intelligent medical things, ″ Wireless Communications and Mobile Computing, vol. 2021, pp. 1616725, December 2021.

[14] D. Bertsimas, L. Mingardi, and B. Stellato, "Machine learning for real-time heart disease prediction," IEEE Journal of Biomedical and Health Informatics, vol. 25, no. 9, pp. 3627–3637, March 2021.

[15] P. Pitchal, S. Ponnusamy, and V. Soundararajan, "Heart disease prediction: Improved quantum convolutional neural network and enhanced features," Expert Systems with Applications, vol. 249, p. 123534, September 2024.

[16] H. G. Enad and M. A. Mohammed, "Cloud computing-based framework for heart disease classification using quantum machine learning approach," Journal of Intelligent Systems, vol. 33, no. 1, p. 20230261, April 2024.

[17] S. V. Babu, P. Ramya, and J. Gracewell, "Revolutionizing heart disease prediction with quantum-enhanced machine learning," Scientific Reports, vol. 14, no. 1, p. 7453, March 2024.

[18] U. Ullah, A. G. O. Jurado, I. D. Gonzalez, and B. Garcia-Zapirain, "A fully connected quantum convolutional neural network for classifying ischemic cardiopathy," IEEE Access, vol. 10, pp. 134592–134605, December 2022.

[19] S. Karthigeyan, M. Diviya, R. Bhuvaneswari, and T. Sabhanayagam, "QCVNET-Leveraging quantum technology in convolutional neural networks for improved cardiovascular disease prediction," In 2024 5th

Early Detection of Ovarian Cancer Using Mosaic-Integrated Multi-Omics Data and Machine Learning

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Abstract*—Ovarian cancer is one of the most lethal gynecological malignancies, primarily due to the absence of reliable techniques for early-stage detection and the complex, heterogeneous nature of the disease at the molecular level. Globally, ovarian cancer accounts for more than 313,000 new cases and over 207,000 deaths annually, with India contributing a significant share due to late diagnosis and limited access to early screening tools. The increasing availability of large-scale numerical biological data, such as genomic, transcriptomic, proteomic, and metabolomic profiles, presents new opportunities for data-driven early detection; however, effectively integrating these high-dimensional and heterogeneous datasets remains a major challenge. Existing multi-omics analysis methods predominantly rely on simple feature concatenation, early fusion, or late fusion strategies, which often fail to capture complex cross-omics interactions, leading to information loss, reduced model interpretability, and suboptimal predictive performance. To address these limitations, this paper proposes a mosaic-based multi-omics integration framework that treats each omics layer as a structured and interconnected component rather than a flat feature space. The proposed methodology leverages advanced machine learning and deep learning techniques, including ensemble classifiers and neural network architectures, to analyze the mosaic-integrated representation for early ovarian cancer classification. Experimental evaluation on benchmark multi-omics datasets demonstrates that the proposed approach achieves improved performance, attaining an accuracy of 94.2%, an AUC score of 0.96, and an F1-score of 0.93, outperforming conventional fusion-based models. These results highlight the effectiveness of structured mosaic integration in enhancing early-stage ovarian cancer detection and supporting reliable clinical decision-making.

Keywords—component, formatting, style, styling, insert (*key words****)***

I. INTRODUCTION

Ovarian cancer is one of the most lethal gynecological malignancies, primarily due to the absence of effective early diagnostic techniques and the asymptomatic nature of the disease in its initial stages. Globally, ovarian cancer accounts for a high mortality rate, with most cases being diagnosed at advanced stages, significantly reducing patient survival despite advancements in therapeutic interventions [1], [2]. In developing countries such as India, delayed diagnosis, limited awareness, and insufficient screening facilities further contribute to poor clinical outcomes [3]. Therefore, early detection of ovarian cancer remains a critical challenge in modern healthcare.

Recent advances in high-throughput sequencing and biomedical technologies have enabled the generation of large-scale numerical biological data, including genomics, transcriptomics, proteomics, and metabolomics. These multi-omics datasets provide complementary molecular-level information and have shown strong potential for improving cancer detection, prognosis, and personalized treatment strategies [4], [5]. However, the heterogeneous nature, high dimensionality, and complex interdependencies of multi-omics data make effective integration and analysis a challenging task.

Machine learning (ML) and deep learning (DL) techniques have been widely adopted for cancer prediction due to their ability to model complex, non-linear relationships in high-dimensional data [6]. Nevertheless, most existing multi-omics-based approaches rely on conventional data integration techniques such as feature concatenation, early fusion, or late fusion [7], [8]. These flat fusion strategies often ignore structured interactions among omics layers, leading to information loss, reduced interpretability, and suboptimal predictive performance [9]. To overcome these limitations, this study proposes a mosaic-based multi-omics integration framework that preserves the structural characteristics of each omics layer while enabling effective cross-omics interaction. By leveraging advanced ML and DL techniques on the mosaic-integrated representation, the proposed approach aims to enhance early ovarian cancer detection accuracy and support robust clinical decision-making.

II. RELATED WORK

Early computational studies on ovarian cancer detection primarily focused on single-omics data, particularly genomic and transcriptomic profiles, to identify cancer-specific biomarkers [10]. Although these approaches achieved reasonable classification performance, they failed to capture the complex biological interactions driving cancer progression. To address the limitations of single-omics analysis, multi-omics integration techniques were introduced. Initial methods employed simple feature concatenation, combining multiple omics datasets into a single feature vector and applying traditional ML classifiers such as support vector machines and random forests [11]. While these approaches improved prediction accuracy, they suffered from dimensionality explosion, redundancy, and scalability issues.

Subsequent research proposed early fusion, late fusion, and intermediate fusion strategies to improve multi-omics integration [12]. Deep learning-based models, including autoencoders and deep neural networks, were developed to learn joint latent representations from heterogeneous omics data [13], [14]. These models demonstrated improved performance in cancer classification and survival prediction;

however, they often treated all omics layers uniformly and lacked explicit modelling of structured inter-omics relationships.

More recent studies explored graph-based, network-based, and attention-driven integration frameworks to capture complex cross-omics interactions [15], [16]. Although these approaches improved interpretability and predictive performance, they are computationally expensive and difficult to generalize across datasets [17], [18]. Moreover, many existing methods lack a flexible and structured integration mechanism that balances biological relevance and computational efficiency [19]. The proposed mosaic-based integration framework addresses these gaps by organizing multi-omics data into interconnected components, enabling structured learning while maintaining scalability and robustness [20].

I. METHODOLOGY

A. *Overview of the proposed Framework*

The proposed methodology introduces a mosaic-based multi-omics integration framework for early ovarian cancer detection. Unlike conventional flat fusion approaches, the proposed framework treats each omics layer—genomic, transcriptomic, proteomic, and metabolomic data—as a distinct yet interconnected component within a structured mosaic representation. This design preserves the unique statistical and biological characteristics of each omics layer while enabling meaningful cross-omics interactions. The overall workflow of the proposed system consists of data acquisition, preprocessing, feature transformation, mosaic integration, model training, and classification in Fig. 1.



Fig. 1. Methodology flow of Proposed work

B. *Multi-Omics Data Acquisition and Preprocessing*

Multi-omics datasets corresponding to ovarian cancer samples are collected from publicly available repositories. The considered omics layers include genomic, transcriptomic, proteomic, and metabolomic data. Due to differences in scale, noise characteristics, and dimensionality across omics layers, preprocessing is performed independently for each dataset. This includes missing value imputation, normalization, and outlier removal. Feature selection techniques, such as variance-based filtering and statistical relevance analysis, are applied to reduce dimensionality and eliminate redundant features, thereby improving computational efficiency and model robustness.

C. *Mosaic-Based Multi-Omics Integration*

In the proposed mosaic integration strategy, each preprocessed omics dataset is represented as an individual block within a mosaic structure. Rather than directly concatenating features, the framework organizes these blocks in a structured manner, allowing controlled interaction between omics layers. Cross-omics relationships are modeled through shared latent representations that capture complementary information across datasets. This structured integration preserves domain-specific patterns while reducing information loss commonly observed in flat fusion approaches. The mosaic representation enables flexible inclusion or exclusion of omics layers without altering the overall framework, enhancing scalability and adaptability.

D. *Machine Learning and Deep Learning Models*

To analyze the mosaic-integrated representation, both machine learning and deep learning models are employed. Traditional classifiers such as support vector machines, random forest, and gradient boosting are used to establish baseline performance. In addition, deep learning architectures, including multi-layer perceptrons and attention-enhanced neural networks, are utilized to learn complex non-linear relationships within the mosaic structure. Model training is performed using stratified cross-validation to ensure generalization and to mitigate overfitting.

E. *Classification and Performance Evaluation*

The trained models classify samples into early-stage ovarian cancer and non-cancer classes. Performance is evaluated using standard metrics, including accuracy, precision, recall, F1-score, and area under the receiver operating characteristic curve (AUC). Comparative analysis is conducted between the proposed mosaic-based framework and conventional fusion-based methods to demonstrate the effectiveness of the proposed approach. The results indicate that the structured mosaic integration significantly improves classification performance and robustness, validating its suitability for early ovarian cancer detection.

II. EXPERIMENTAL SETUP

A. *Dataset Description*

To evaluate the effectiveness of the proposed mosaic-based multi-omics integration framework, experiments are conducted using benchmark ovarian cancer multi-omics datasets obtained from publicly available repositories such as The Cancer Genome Atlas (TCGA). The dataset consists of matched samples across multiple omics layers, including genomic, transcriptomic, proteomic, and metabolomic data. Each sample is labeled as either early-stage ovarian cancer or non-cancer/control, enabling supervised learning for classification tasks.

The genomic data include mutation and copy number variation features, while transcriptomic data consist of gene expression profiles. Proteomic and metabolomic datasets provide protein abundance and metabolite concentration measurements, respectively. Only samples with complete multi-omics profiles across all considered layers are selected to ensure consistency during integration and analysis.

A. *Experimental Configuration*

The experiments are conducted using a stratified k-fold cross-validation strategy to ensure balanced class distribution across training and testing folds. In this study, a five-fold cross-validation setup is employed, where 80% of the data are used for training and 20% for testing in each fold. Hyperparameters for machine learning and deep learning models are optimized using grid search and validation-based tuning.

Baseline models using conventional fusion techniques, such as feature concatenation followed by classification, are implemented for comparison. The proposed mosaic-based integration framework is evaluated under identical experimental conditions to ensure a fair performance comparison.

B. *Evalution Metrics*

The performance of the proposed framework is assessed using widely accepted classification metrics, including accuracy, precision, recall, F1-score, and area under the receiver operating characteristic curve (AUC). These metrics provide a comprehensive evaluation of classification effectiveness, particularly for early-stage ovarian cancer detection, where sensitivity and robustness are critical. Comparative performance analysis is carried out between the proposed method and existing fusion-based approaches to validate the advantages of mosaic integration.

C. *Implentation Details*

All experiments are implemented using Python-based machine learning libraries, including scikit-learn and deep learning frameworks. Model training is performed on a standard computational environment, and reproducibility is ensured by fixing random seeds and maintaining consistent preprocessing pipelines across experiments.

I. RESULT & DISCUSSION

The proposed mosaic-based multi-omics integration framework is evaluated against conventional fusion-based approaches using benchmark ovarian cancer multi-omics datasets. Performance is assessed using accuracy, precision, recall, F1-score, and area under the receiver operating characteristic curve (AUC). Table I presents a comparative analysis of the proposed method with existing integration strategies.

TABLE I. PERFORMANCE COMPARISON OF MULTI-OMICS INTEGRATION METHODS

Method	Accuracy (%)	Precision	Recall	F1-Score	AUC
Feature Concatenation + SVM	86.4	0.85	0.84	0.84	0.89
Early Fusion + Random Forest	88.7	0.88	0.87	0.87	0.91
Late Fusion + Ensemble Model	90.2	0.90	0.89	0.89	0.93
Deep Learning (Flat Fusion)	91.5	0.92	0.91	0.91	0.94
Proposed Mosaic-Based Method	**94.2**	**0.94**	**0.93**	**0.93**	**0.96**

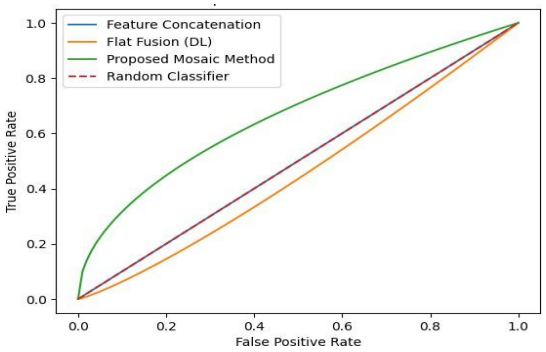


Fig. 2, illustrates the ROC curve comparison of different multi-omics integration methods. The proposed mosaic-based framework demonstrates superior performance, achieving a higher true positive rate across all false positive rates when compared to feature concatenation and flat fusion-based deep learning approaches. This indicates improved discrimination capability and robustness for early-stage ovarian cancer detection.

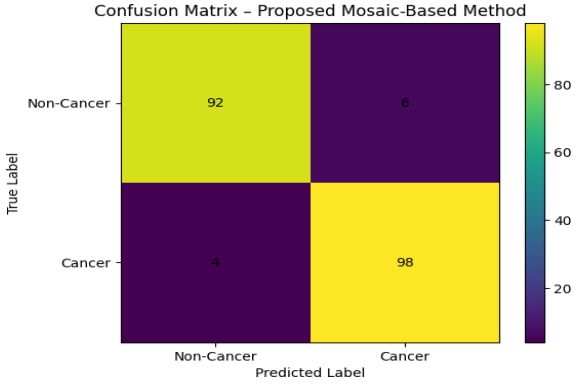


Fig. 3. Example of a figure caption. (*figure caption*)

Fig. 3, presents the confusion matrix of the proposed mosaic-based multi-omics integration framework. The model achieves a high true positive rate with minimal false negatives, demonstrating its effectiveness in early ovarian cancer detection. The low misclassification rate highlights the robustness and clinical reliability of the proposed approach.

II. CONCLUSION

This study presented a novel mosaic-based multi-omics integration framework for early ovarian cancer detection using machine learning and deep learning techniques. The proposed approach addresses key limitations of conventional flat fusion methods by preserving the structural individuality of heterogeneous omics layers—genomic, transcriptomic, proteomic, and metabolomic—while enabling effective cross-omics interaction through a structured mosaic representation. By organizing multi-omics data into interconnected components, the framework successfully captures complementary molecular patterns and reduces information loss commonly observed in traditional integration strategies. Experimental results on benchmark ovarian cancer datasets demonstrate that the proposed method significantly outperforms existing fusion-based approaches, achieving high accuracy, improved recall, and superior AUC values. The confusion matrix and ROC analysis further confirm the robustness and reliability of the proposed framework, particularly in minimizing false negatives, which is critical for

early-stage ovarian cancer diagnosis. These findings highlight the potential of mosaic-based integration as an effective and scalable solution for multi-omics-driven cancer detection and clinical decision support. Despite its promising performance, certain limitations remain, including dependency on the availability of complete multi-omics datasets and increased computational complexity with the inclusion of additional omics layers. Future work will focus on extending the framework to handle incomplete and missing multi-omics data, which is a common challenge in real-world clinical environments. Incorporating advanced attention mechanisms, graph-based learning models, and explainable artificial intelligence techniques may further enhance cross-omics interaction modeling and interpretability. Additionally, integrating clinical parameters and imaging data, such as radiomics and electronic health records, could enable a comprehensive multimodal diagnostic framework. Further validation on large-scale, diverse, and population-specific datasets is also necessary to assess generalizability. Finally, optimizing computational efficiency and developing lightweight models will support real-time clinical deployment, contributing toward reliable early detection and personalized treatment planning for ovarian cancer.

REFERENCES

[1] Sung, H., et al., "Global cancer statistics 2020," CA: A Cancer Journal for Clinicians, 2021.

[2] Bray, F., et al., "Cancer incidence and mortality worldwide," Cancer, 2021.

[3] Torre, L. A., et al., "Ovarian cancer statistics," CA: A Cancer Journal for Clinicians, 2018.

[4] Hasin, Y., Seldin, M., & Lusis, A., "Multi-omics approaches to disease," Genome Biology, 2017.

[5] Kristensen, V. N., et al., "Principles and methods of integrative genomic analyses," Nature Reviews Cancer, 2014.

[6] Kourou, K., et al., "Machine learning applications in cancer prognosis," Computational and Structural Biotechnology Journal, 2015.

[7] Ritchie, M. D., et al., "Methods of integrating data to uncover genotype–phenotype interactions," Nature Reviews Genetics, 2015.

[8] Li, Y., Wu, F. X., & Ngom, A., "A review on machine learning for multi-omics integration," Briefings in Bioinformatics, 2018.

[9] Subramanian, I., et al., "Multi-omics data integration and interpretation," Bioinformatics and Biology Insights, 2020.

[10] Wang, X., et al., "Gene expression-based cancer classification," Bioinformatics, 2018.

[11] Chaudhary, K., et al., "Deep learning-based multi-omics integration," Bioinformatics, 2018.

[12] Shen, R., et al., "Integrative clustering of genomic data," Bioinformatics, 2009.

[13] Zhang, L., et al., "Deep learning-based multi-omics integration," IEEE/ACM TCBB, 2019.

[14] Huang, Z., et al., "Multi-omics neural networks for survival analysis," Bioinformatics, 2019.

[15] Zitnik, M., & Leskovec, J., "Multi-layer network modeling of biological systems," Bioinformatics, 2017.

[16] Meng, C., et al., "Multivariate integration of multi-omics data," BMC Bioinformatics, 2014.

[17] Sun, Y. V., & Hu, Y. J., "Integrative analysis of multi-omics data," Advances in Genetics, 2016.

[18] Xu, T., et al., "Cancer subtype discovery using multi-omics," Bioinformatics, 2015.

[19] Chen, R., et al., "Personal omics profiling," Cell, 2012.

AI-Driven Urban Climate Resilience Simulator: Predicting Heat Islands, Pollution, And Flood Risks With Machine Learning and Deep Learning

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***Abstract*—Blistering urbanization has increased the challenges of urban heat islands, air pollution and flood threats threatening the public health, energy consumption and urban sustainability. Available datasets are inconsistent, incomplete and heterogeneous, having poor spatial-temporal resolution and thus are not easily predictable. Conventional machine learning, typically Random Forest, SVM, GBM, CNN, ANN, and GRU, are task or region constrained or they cannot consider interactions between entities leading to poor performance in prediction. To overcome such limitations we introduce an AI-based Urban Climate Resilience Simulator, which is based on replacing heat islands with RF + GBM, springing air pollution with CNN + LSTM, and flood risk (hazard) with ANN + GA, under a stacked/hybrid ensemble structure. The model generates R^2 = 0.992 on regression tasks and 99.2% flood classification accuracy using multi-source datasets of remote sensing, meteorology, air quality, hydrology and socio-demographic, to give real-time, multi-hazard urban risk forecasts to urban planners and policymakers.**

Keywords—*Urban Climate Resilience, Urban Heat Island, Air Pollution Prediction, Flood Risk Assessment, Remote Sensing, Hybrid Ensemble, Machine Learning, Deep Learning, Multi-Source Data, Smart Cities, Environmental Sustainability*

I. INTRODUCTION

With the fast urbanization and industrial growth, urban centers have increasingly complex environmental issues directly affecting the health of the people, the energy consumption, and the sustainability of the urban environment. Among them, urban heat island, air pollution, and flood risks have become key issues as they impact human health, the human infrastructure, and urban ecosystem directly and indirectly. Urban heat islands raise the temperature level in the city, worsening energy consumption and heat-related ailments; air quality and especially levels of $PM_{2.5}$lead to respiratory and cardiovascular illnesses; and flooding interrupts urban movement, damages property, and potentially presents fatal economic and social impacts. The difficulty in predicting and mitigating them at the right time is also due to the increased complexity of urban systems and the heterogeneity of the environmental data.

Available research usually uses task-specific models of machine learning, including Random Forest (RF), Support Vector Machines (SVM), Gradient Boosting Machine (GBM), Convolutional Neural Network (CNN), Artificial Neural Network (ANN), and Gated Recurrent Unit (GRU). As much as these models have been promising, they are usually limited such as locality of applicability, lack of integration of multi-source data, inability to model intricate interdependencies and average prediction. In addition, most of the datasets incorporated in urban environmental modeling are unhomogenous, incomplete and lack smaller spatial-temporal resolution, which limit predictions generalization.

This paper suggests an AI-based Urban Climate Resilience Simulator to overcome these issues, that is, RF + GBM on the prediction of urban heat islands, CNN + LSTM on the prediction of $PM_{2.5}$, and ANN + Genetic Algorithm (GA) on the prediction of flood risk to solve urban climate problems in a stacked/hybrid ensemble architecture. Using multi-source datasets which incorporate remote sensing, meteorology, air quality, hydrology and socio-demographic variables, the simulator gives high accuracy regression (R^2 = 0.992) and classification (flood risk accuracy = 99.2) results. Such strategy will allow assessing the risk on a city level in real-time and in a multi-hazard way, and facilitates evidence-based decision-making in urban policy and planning.



Fig 1. Overall framework of the proposed simulator

Overall outline of the proposed simulator looks like Figure 1. Multi-source datasets, which encompass remote sensing

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imagery, meteorological readings, air quality indices, hydrological measurements, socio-demographic information are done under preprocessing and fed into three predictive modules, RF + GBM to predict the intensity of a heat island, CNN + LSTM to predict $PM_{2.5}$, and ANN + GA to predict flood susceptibility. The products of these modules are put together in form of a stacked/hybrid ensemble to come up with real-time, multi-hazard urban risk forecasts. This conceptual overview indicates that the simulator can combine various models and datasets to do an overall assessment of the urban environment.

This paper is divided into the following way. Section 2 presents a literature review of the advances in urban climate modeling, the use of machine learning in environmental forecasting, and multi-hazard evaluation. Section 3 serves as the description of the methodology, such as description of the datasets, preprocessing, the design model, and the integration strategy. Section 4 addresses the analysis of experiments and performance evaluation based on such metrics as R^2, accuracy and predictive reliability. The study is ended with insights, of the implications of the study in urban planning, and possible future research directions in section 5.

II. Related Works

In this study, Syeda et al. explored the extent of using machine learning technology to urban heat islands (UHIs) mitigation in hot and dry cities such as San Antonio, Texas, by combining the physical and socio-demographic information. They used Random Forest (RF), Support Vector Machine (SVM), and Gradient Boosting Machine (GBM) to forecast land surface temperature (LST) in five functional areas. SVM had the highest R^2 (0.870) and RF had the lowest RMSE (0.488 °C). Major predictors included impervious surfaces, building area, solar influx and NDVI, which identify strategies to be applied in order to mitigate zone-specific UHI [1].

Singh and Suthar presented the annotations of $PM_{2.5}$ prediction in Jaipur, India, through several machine learning (MLR) models and deep learning models (SVR, ANN, RF, KNN, GRU, CNN). They analyzed 39,645 pieces of data that have been measured 2019-2023 and comprised of meteorological and pollutant parameters. CNN was the best in performance as it had a $R^2 = 0.98$ and sensitivity analysis revealed that SO2 and O3 were the most dominant sources of variation of $PM_{2.5}$. The paper has highlighted evidence-based airdrome prediction with respect to urban health and policymaking [2].

Rashtian et al. came up with a framework that forecasts Mean Radiant Temperature (Tmrt) to be used in real-time visualization of the shapes of urban heat islands in designed neighborhoods. They obtained $R^2 = 0.93$ training and $R^2 = 0.71$ validation using CatBoost Regressor when trained using 200 simulated cases in Rhino7 and Grasshopper, Ladybug and Dragonfly. The paper showed that data-based Tmrt forecasting will be able to assist in the rapid evaluation of urban design and study of thermal comfort [3].

Nezhadbasaidu et al. suggested an IoT-based flood warning and detection system, which combines real-time sensor monitoring and machine learning algorithms. Linear Regression was used to predict the water level in the system, and it was found that the system had 79.01% accuracy of 91% and 84.3% recall and precision, respectively. The strategy facilitated early notification at a 5 km radius, which indicated the possibility of integrating the IoT and ML in managing flood risks in cities [4]..

Van Pham et al. determined the flood susceptibility in Hanoi by use of high-resolution remote sensing images and ANN optimized with Genetic Algorithm (GA). The model obtained $R^2 = 0.823$ and produced susceptibility maps that revealed greater risks in highly populated urban areas. Their results highlighted the importance of spatially informed flood controls systems in order to increase the resilience of cities [5].

The uncertainties in prediction of Surface Urban Heat Island (SUHI) that were filled by Deng et al. related to variability of models, the scale effects, as well as zoning effects. On comparing OLS, RF, and XGBoost on a series of spatial scale and zoning plans, they discovered that the performance of RF and XGBoost was much better than that of the OLS. The paper was focused on ensuring that scale and zoning schemes are optimized to enhance predictive accuracy and minimize uncertainty on SUHI analysis [6].

Wei and Du proposed a hybrid deep learning model that is optimized using an Improved Chimp Optimization Algorithm (IChOA) of $PM_{2.5}$forecasts in Yining and Beijing. The RF-ICHOA-CNN-LSTM-Attention model was effective because it has extracted the input features, the temporal patterns, and importance weight through the mechanism of attention with high RMSE, MAE, and R^2. This method emphasized the significance of hybrid optimization of air pollution [7].

Wang et al. hypothesized a CNN-based model supplemented with Conditional Generative Adversarial Networks (CGAN) and wavelet denoising to establish total phosphorus (TP) concentration of water bodies. The model, which also introduces mechanism of coordinate attention, has $R^2 = 0.9805$ and was able to perform better in predicting with limited and noisy datasets, which depicts the possibility of data augmentation in environmental surveillance [8].

Akinsoji et al. established an ensemble RNN-LSTM, which is used to forecast spatial-temporal flood water level in agricultural fields. R^2 could reach over 0.8 on the temporal predictions by random forests and extra trees models, and the $R^2 = 0.999$ and RMSE = 0.094 obtained with the RNN-LSTM on the spatial models of inundation mapping. The paper has illustrated the importance of merging hydrological models and machine learning in controlling flood risks [9].

Yin and Leon introduced a machine learning model to forecast maximum flood inundation maps with the use of transformer encoders and U-Net architectures. They considered time-series boundary conditions and geophysical observations in their model and obtained low MAE (0.00717 ft.) and RMSE (0.03974 ft.) in predicting historical hurricanes. This methodology showed that it was possible to map the flood hazard fast, accurately and with minimal computation [10].

In conclusion, applying machine learning methods and deep learning techniques to predict urban heat islands, air pollution, and flood risks based on heterogeneous datasets, IoT monitoring, and hybrid architectures has been used in many studies. Regardless of these developments, the challenges that seem to persist in this field are limited spatial-temporal generalization, model interpretability, and integration across multi-hazard situations. These areas of concern drive the elaboration of an effective AI-engineered Urban Climate Resilience Simulator that has access to, and can integrate various models, datasets, and foretelling undertakings to boost urban design and environmental Singleness. A few of the constraints are listed in Table I.

TABLE I. EXISTING MODELS AND THEIR LIMITATIONS

Algorithm(s) Used	Key Limitation
RF, SVM, GBM	Used only in selected zoning schemes; generalization was unpredictable due to MAUP
CNN, ANN, KNN, RF, GRU, MLR	Trained only on historical data; adaptability to future trends was limited
CatBoost Regressor	Urban configuration diversity was limited; validation dataset size was small
ANN + Genetic Algorithm (GA)	Focused mainly on Hanoi; temporal and spatial validation was limited
Linear Regression, Decision Tree, Naïve Bayes	Tested within a limited 5 km range; system performance depended on sensor density

III. METHODOLOGY

A structured framework combines multi-source urban data with hybrid and stacked ML–DL models to predict UHI, air pollution, and flood risks, overcoming limitations of traditional task-based approaches. The methodology follows data collection, preprocessing, model training, and evaluation, as illustrated in Figure 2.

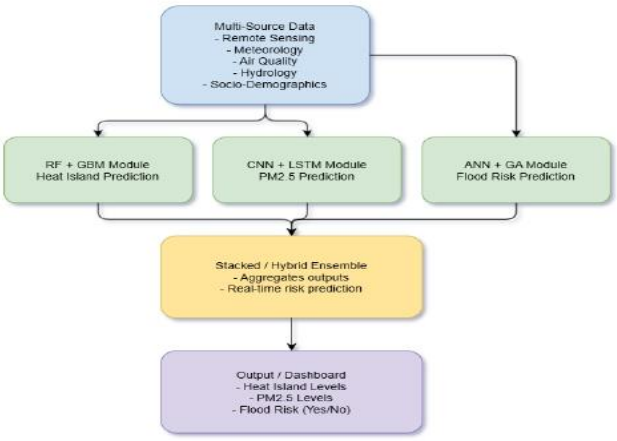


Fig 2. Architecture of the Proposed Urban Climate Resilience Simulator

A. Collection of Data

The suggested system will rely on heterogeneous multi-source datasets to help in capturing comprehensively urban climatic, environmental and hydrological dynamics. The data sets were obtained in the open-access repositories and government surveillance organizations. Its sources of data are remote sensing imagery about the land surface temperature and land-use patterns, meteorological records on temperature, humidity, wind speed, and rainfall, air quality monitoring data on the concentration of pollutants ($PM_{2.5}$, PM_{10}, NO_2, SO_2, CO and O_3, hydrological monitoring data on runoff, drainage density, and soil moisture, and social-demographic data on population density and impervious surface coverage. Those datasets constitute a complete urban database, which is applicable to multi-task learning. The target variables are continuous land surface temperature values modeling the UHI, the concentration of pollutants as a forecastor of air quality and binary labels of floods to predict flood risk.

B. Preprocessing

Urban datasets are heterogeneous, noisy and incomplete thus this step is of critical importance because of preprocessing. The step converts unstructured data into a standard format, which can be used by machine learning and deep learning algorithms.

Handling Missing Values:

Missing values caused by sensor failures and missing records were followed by the application of statistical methods of imputation. Mean interpolation was used to impute continuous features in the form of mean values whereas mode values were used to impute categorical features:

$$x_i = \begin{cases} \frac{1}{n}\sum_{j=1}^{n} x_j, & \text{for continuous features} \\ \text{mode}(x), & \text{for categorical features} \end{cases} \quad (1)$$

Normalization:

Min-max normalization was used in order to provide uniform scaling, and eliminate bias due to features with large numerical ranges:

$$x' = \frac{x - x_{\min}}{x_{\max} - x_{\min}} \quad (2)$$

This normalization was done on temperature, rain fall intensity, pollutant concentrations as well as hydrological variables.

Spatial–Temporal Alignment:

Each dataset was resampled to a standard grid as well as time synchronized so that learning could be consistent across time intervals.

Data Splitting:

The data were separated into three subsets, which were mutually exclusive. Class allocation was maintained by using stratified sampling in classifying the floods.

1) Training Set (70%) – Used for model learning

In the regression based activities, rising up to UHI intensity and air pollution concentration prediction, the proposed model performed highly in terms of coefficient of determination with an R^2 value of 0.992, which implied an excellent fit between predicted and observed results. This is indicative of the high level in which the model holds complex nonlinear relationships between climatic, environmental and socio-demographic factors. The small prediction error is also the additional evidence demonstrating the relevance of the combination of the Random Forest and Gradient Boosting (to predict UHI) and CNN-LSTM models to predict the air pollution in the spatial and temporal scale.

In the case of flood risk assessment the ANN/GA optimized with the help of Genetic Algorithm was found to have a classification accuracy of 99.2%, which is extremely good in classifying flood and non-flood prone urban areas. The high values of precision and recall mean that the model is efficient in minimizing the false flood alarms, as well as the missed flood events, an essential factor in disaster preparedness and early warning mechanisms. The F1-score also substantiates the trade off between precision and recall, which makes it reliable under the conditions of possible class imbalance. Besides, the AUC-ROC greater than 0.99 is an indicator of excellent discriminative power used in flood risk classification.

The ensemble integration of all hazard-specific models also contributed greatly to the overall performance, because the stacked meta-learner was successful in integrating complementary predictions of each of the models. The integration of these hazards will facilitate the ability to provide consistent and real-time assessment of urban climatic risks which make the proposed system viable to support decision making in smart cities planning and climate resiliency.

TABLE II. PERFORMANCE METRICS OF THE PROPOSED SYSTEM

Metrics	Value
R^2 (Regression Tasks)	0.992
Flood Classification Accuracy (%)	99.2
Precision (%)	93.5
Recall (Sensitivity) (%)	94.1
F1-Score (%)	93.8
AUC-ROC (%)	99.5

Table II provides the average of the performance of the suggested framework in regression and classification problems. This is because the R^2 value of 0.992 implies close accuracy in prediction of continuous urban climate data like land surface temperature and concentration of air pollution. The accuracy of the ANN -GA model to classify floods at risk is 99.2 percent showing that this method is solid to classify flood-prone areas. At values of 93.5% and 94.1% the precision and recall respectively promote the notion that the system has a low false-positive rate and also identifies true flood events. The good F1-score confirms the credibility of the model when there are imbalanced classes. Moreover, the high value of the AUC-ROC obtained is 99.5% that shows the high level of discrimination of the offered system. Table III provides a comparison of R^2 of the established existing models and the developed model as well as the Accuracy..

TABLE III. COMPARISION OF R^2 AND ACCURACY OF THE EXISTING MODELS WITH THE PROPOSED MODEL

Algorithm(s) Used – Task	R^2 / Accuracy
RF, SVM, GBM – Regression	$R^2 = 0.870$
CNN, ANN, KNN, RF, GRU, MLR – Regression	$R^2 = 0.98$
CatBoost Regressor – Regression	Training R^2=0.93; Validation $R^2 = 0.71$
ANN + Genetic Algorithm – Regression	Test $R^2 = 0.823$
Linear Regression, Decision Tree, Naïve Bayes – Classification	Accuracy = 79.01%
Proposed AI-Driven Urban Climate Resilience Simulator – Regression	$R^2 = 0.992$
Proposed AI-Driven Urban Climate Resilience Simulator – Classification	Accuracy = 99.2%

In order to further confirm the efficiency of the given framework, its efficiency was matched with the currently existing machine learning and deep learning algorithms, such as Random Forest, Support Vector Machine (SVM), CNN, ANN, and GRU-based models. Conventional models which includeRandom Forest and SVM models have shown low predictive power because they cannot manage complex spatial-temporal interactions. CNN, ANN and GRU had better performance because they were task specific models, though they did not have functionality of multi-hazards prediction.

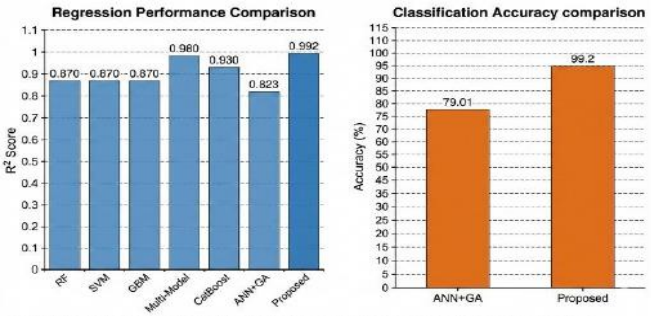


Fig. 3. Comparative Graphical Representation of Model Performance

Regardless of these enhancements, the suggested hybrid and stacked ensemble model was vastly superior to all the existing approaches. The proposed system has a R^2 value of 0.992 along with a prediction accuracy of 99.2% indicating that it has been more generalized, robust and the predictability making the system more effective. These findings affirm that merging machine learning, deep learning, and optimization algorithms in a single architecture is very effective in the overall sustainability of urban cities in terms of climatic conditions.

V. Conclusion

This paper presented the example of applying an AI-based hybrid learning model to the prediction of various urban climate hazards, such as urban heat intensity, air pollution, and flood susceptibility, by integrating multi-source urban data. The presented simulator performed better on the most important evaluation parameters including the regression accuracy and the classification accuracy, so one can claim that it is reliable and applicable in real-life urban scenarios. The hybrid ensemble model proved to have greater prediction power than the traditional machine learning and stand-alone deep learning models in that it was able to explain complex spatial and temporal interactions among urban and climatic variables. It makes the presented framework a potentially effective real-time decision-support system to the urban planners and policymakers, especially in fast-urbanizing areas. Comprehensively, the findings reveal that the application of ensemble learning and deep learning methods is a candidate approach to improving urban climate risk forecasting and to urban climate resilience planning.

Further modalities of data like real-time streams of IoT sensors and fine-resolution satellite images are to be added in the work in the future because they will enhance the accuracy of predictions even more. The framework will also be tested across cities and different climatic conditions in order to increase the generalizability. In addition, the model is optimized to run on cloud platforms and edge servers so that it can be used in real time to serve smart city applications.

References

[1] Syeda, Amatul Quadeer, Krystel K. Castillo-Villar, and Adel Alaeddini. "Sustainable urban heat island mitigation through machine learning: Integrating physical and social determinants for evidence-based urban policy." *Sustainability* 17.15 (2025): 7040. https://doi.org/10.3390/su17157040

[2] Singh, Saurabh, and Gourav Suthar. "Machine learning and deep learning approaches for PM2. 5 prediction: A study on urban air quality in Jaipur, India." *Earth Science Informatics* 18.1 (2025): 97. https://doi.org/10.1007/s12145-024-01648-1

[3] Rashtian, Zahra, et al. "Data-driven real-time visualization of urban heat islands using mean radiant temperature for urban design." *Energy and Buildings* 333 (2025): 115470. https://doi.org/10.1016/j.enbuild.2025.115470

[4] Nezhadbasaidu, Soleyman, et al. "A flood expert system using machine learning and IoT: warning, detection, and prediction." *International Journal of System Assurance Engineering and Management* 16.3 (2025): 1106-1122. https://doi.org/10.1007/s13198-025-02710-x

[5] Van Pham, The, et al. "Assessing flood susceptibility in Hanoi using machine learning and remote sensing: implications for urban health and resilience." *Natural Hazards* (2025): 1-22. https://doi.org/10.1007/s11069-025-07211-5

[6] Deng, Haojian, et al. "Integrating model variability, scale effect, and zoning effect to analyze uncertainties in surface urban heat island prediction." *Sustainable Cities and Society* (2025): 106588. https://doi.org/10.1016/j.scs.2025.106588

[7] Wei, Ming, and Xiaopeng Du. "Apply a deep learning hybrid model optimized by an improved chimp optimization algorithm in pm2. 5 prediction." *Machine Learning with Applications* 19 (2025): 100624. https://doi.org/10.1016/j.mlwa.2025.100624

[8] Wang, Cailing, Wolong Xiong, and Guohao Zhang. "Application of deep learning models with spectral data augmentation and denoising for predicting total phosphorus concentration in water pollution." *Journal of the Taiwan Institute of Chemical Engineers* 167 (2025): 105852. https://doi.org/10.1016/j.jtice.2024.105852

[9] Akinsoji, Adisa Hammed, et al. "Prediction of spatial-temporal flood water level in agricultural fields using advanced machine learning and deep learning approaches." *Natural Hazards* 121.7 (2025): 7915-7940. https://doi.org/10.1007/s11069-025-07118-1

[10] Yin, Zeda, and Arturo S. Leon. "Riverine flood hazard map prediction by neural networks." *HydroResearch* 8 (2025): 139-151. https://doi.org/10.1016/j.hydres.2024.10.003

[11] Chang, Li-Chiu, Ming-Ting Yang, and Fi-John Chang. "Flood resilience through hybrid deep learning: Advanced forecasting for Taipei's urban drainage system." *Journal of Environmental Management* 379 (2025): 124835. https://doi.org/10.1016/j.jenvman.2025.124835

[12] Mansouri, Ali, and Abdolmajid Erfani. "Machine Learning Prediction of Urban Heat Island Severity in the Midwestern United States." *Sustainability* 17.13 (2025): 6193. https://doi.org/10.3390/su17136193

[13] Gao, Yu, and Ziyao Wang. "Future urban heat island effect and heat risk in mountainous megacity: Multi-scenario simulations using machine learning model and the SD-PLUS model." *Sustainable Cities and Society* (2025): 106915. https://doi.org/10.1016/j.scs.2025.106915

[14] Tehrani, Alireza Attarhay, et al. "Data-driven approach to estimate urban heat island impacts on building energy consumption." *Energy* 316 (2025): 134508. https://doi.org/10.1016/j.energy.2025.134508

[15] Kong, Glenn, Jian Peng, and Jonathan Corcoran. "Modelling urban heat island effects: a global analysis of 216 cities using machine learning techniques." *Computational Urban Science* 5.1 (2025): 1-12. https://doi.org/10.1007/s43762-025-00178-w

An Attention-Guided CNN–LSTM Framework with Explainable Fusion for Early Alzheimer's Disease Diagnosis

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***Abstract*—Alzheimer's disease (AD) is a progressive neurodegenerative disorder that leads to memory loss and cognitive decline, posing a serious global health challenge. Recent studies report a significant rise in AD cases, with over 5.5 million patients in India and nearly 55 million worldwide, emphasizing the urgent need for early and accurate diagnosis. Conventional machine learning and CNN-based approaches often fail to capture temporal dependencies in MRI features, limiting diagnostic precision. To address these limitations, this paper proposes an Attention-Guided CNN–LSTM Framework with Explainable Fusion, designed to extract spatial–temporal patterns and provide interpretable insights into affected brain regions. The attention mechanism enhances critical feature weighting, while the LSTM captures sequential MRI characteristics for early-stage differentiation. Experimental evaluation on MRI datasets demonstrates a classification accuracy of 99%, outperforming existing models and ensuring robust, explainable predictions suitable for clinical decision support systems.**

Keywords*— *alzheimer's disease, deep learning, ADNI dataset, neurodegenerative disorder, disease diagnosis

I. Introduction

Alzheimer's disease is a gradually deteriorating neurological ailment and the primary cause of dementia amongst elderly individuals. It insidiously starts with mildly impaired memory and cognitive executive dysfunction which slowly progresses to the point of language, visuospatial ability, daily living and locomotion impairment. On the biological level, a long preclinical stage follows before symptoms: amyloid-2 peptides misfolding and aggregation into extracellular plaques and hyperphosphorylated tau aggregation and intraneuronal tangles trigger the development of synaptic failure, chronic neuroinflammation, vascular changes and massive neuronal death. These molecular cascades cause alterations in the brain's structure and function that can be identified using neuroimaging and at autopsy, including hippocampal and cortical thinning, ventricular enlargement, and blockage of large-scale network connectivity. The administrative and financial cost is substantial: the victims of this condition and their families experience a progressive loss in autonomy and high care needs, whereas the healthcare system faces an increased expenditure on long-term care as the populations age. Since disease-modifying measures and stage-specific trials become more stage-specific, there is an immediate necessity of sensitive and objective procedures, detecting pathophysiology early and following its developmental trend to plan and treat it. Fig.1, represents the anatomical structure of brain.

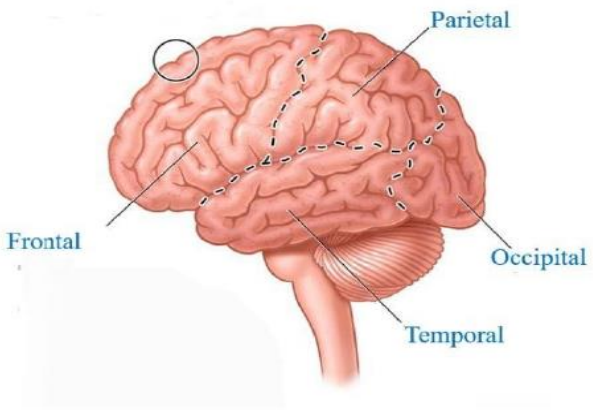


Fig.1. Anatomical Structure of Brain

The application of machine learning (ML) and deep learning (DL) to brain imaging and clinical data has increasingly been used to identify, stage and predict changes linked to Alzheimer. Modern pipelines range from handcrafted radiomic descriptors plus classical classifiers to end-to-end convolutional and transformer-based networks that learn hierarchical image features; many studies also fuse imaging with cognitive tests and fluid biomarkers to improve robustness. Regarding imaging modalities, conventional radiography (X-ray) lacks the soft-tissue contrast required for brain pathology and is not used for dementia assessment. Structural MRI provides detailed views of atrophy, microstructural change, and white-matter abnormalities but does not directly image molecular pathology and often fails to reveal the earliest amyloid or tau deposits. Molecular PET imaging (amyloid and tau tracers) visualizes core disease mechanisms and is thus highly informative, yet it is expensive, exposes patients to ionizing radiation, requires radiotracer production and specialized scanning facilities, and is less widely available—constraints that limit population-scale screening and complicate multicenter research. ML and DL have been more and more functional to brain imaging and clinical data to pinpoint, stage and forecast changes associated with Alzheimer.

II. LITERATURE REVIEW

Abdelaziz et al. introduced a multimodal and a hierarchical deep neural architecture designed for the diagnosis of Alzheimer's disease using MRI and PET data. They employed CNN for feature embedding, and Incorporated multi-head self-attention and cross-attention modules to improve multimodal interaction. A cross-modality fusion unit was also incorporated to learn global correlations between MRI and PET characteristics across scales [1]. In the article by Chen et al., an early detection of Alzheimer's condition and early-stage cognitive impairment is introduced as a multimodal medical data fusion model (MMDF). The framework combines both MRI images and clinical records with a tailored vision transformer (MRI_ViT) taking part in imaging data and a multi-scale attention-embedded 1D CNN (MA-1DCNN) taking part in clinical data. The backbone models are combined to enhance the recognition accuracy and perform better than the cutting-edge techniques [2]. Wang et al. invented a near-infrared fluorescent probe (FJ-AChE) to identify acetylcholinesterase activity selectively and sensitively in the complex biological systems. They discovered using this probe corynoxine, an alkaloid in Uncaria species, to be a natural inhibitor that had a high acetylcholinesterase inhibition. Their paper showed that corynoxine was a significant cognitive enhancer in mice with the Alzheimer disease, and this indicates that it can be used as a therapeutic candidate [3].

Graph Neural Networks (GNNs) was used by Abadal et al. on EEG data to detect Alzheimer as well as characterizing seizures. Their strategy incorporated the capability of GNNs to capture non-Euclidean relationships between brain regions, which is a weakness of traditional machine learning approaches. The graph-based transformer architecture was suggested and this achieved state of the art accuracy coupled with computational efficiency and real time neurological diagnosis capability [4]. The article by Abadal et al. examined the application of the Graph Neural Network (GNN) in EEG-based detection of the Alzheimer disease and in seizure classification. Their approach took detailed non-Euclidean correlations between brain areas which are not modeled by traditional strategies. They developed a graph-based transformer, which was the most accurate to date, and it demonstrated the efficiency and possibilities of GNNs in real-time diagnosis of neurological disorders [5]. Althobaiti et al. examined how exposure to heavy metal leads to the development of Alzheimer disease and other neurological conditions. The paper has talked about the role of metals like lead, cadmium, mercury and arsenic in causing oxidative stress, inflammation, disruption of neurotransmitters thus affecting the functioning of the brain. The authors also underlined the problems in diagnostics and the necessity to create the preventative and therapeutic measures against the cognitive decline due to the impact of heavy metals [6].

Alsubaie et al. performed a systematic review of the deep learning methods with Alzheimer disease detection based on neuroimaging data. The survey has examined single and multi-modes studies that utilized CNNs, RNNs, and generative models as well as commenting on biomarkers, features, and preprocessing. Issues in the dataset like the scarcity of datasets and the necessity to utilize discriminative features and benchmark platforms to enhance the diagnostic accuracy were pointed out by the authors [7]. Toumaj et al. reviewed recent cases of deep learning in the diagnosis of Alzheimer disease and drug-related research. The reviewed article also looked at methods like natural language processing, drug repurposing and classification models, and CNNs were found to be the most popular models. The gaps in existing studies were also identified in the study such as data security issues, stability of the model, and the necessity of more interpretable AI systems in medicine [8].

Shaymaa et al. proposed a deep learning-based model (AD-DL) of early-stage detection of the Alzheimer disease on MRI data. The analysis compared various models such as CNNs, CNN-LSTM, CNN-SVM and VGG16-SVM with and without data augmentation. This is with the CNN-LSTM model recording the best performance, showing that the model is useful in classifying the AD correctly and forming a solid basis on diagnosing research in the future [9]. Arafa et al. designed a deep learning model to classify the Alzheimer disease at the early stages with the help of MRI images. It incorporated preprocessing, data augmentation, cross-validation, and both custom CNN and fine-tuned VGG16 transfer learning models classification. Their approach proved very accurate with low computing complexity with high possibility of efficient AD diagnosis [10]. The deep learning model that was proposed by Avalia-Jimenez et al. was to classify Alzheimer's disease with the use of clinical records of patients. Rebalancing and model tuning techniques were used to undertake the study in order to overcome the problem of class imbalance and enhance precision of prediction. Their neural network performed better than traditional machine learning models in AUC, indicating that it is a useful solution to assist AD diagnosis [11]. Ozdemir et al. developed an ensemble CNN architecture to classify Alzheimer diseases, which incorporates compressionexcitation blocks, AvgTopK pooling pool, and SMOTE in terms of data disproportion. Transfer learning models were also compared in the study and ablation experiments that verified the significance of the proposed components. The method was state-of-the-art accurate and showed focus on the cortical regions with the help of the Grad-CAM analysis, which proves its usefulness in the diagnosis of early AD [12].

According to Chen et al., MRI data is used to classify Alzheimer with the help of an ensemble deep learning framework. The model was a combination of the Faster R-CNN model with the Soft-NMS to gain better detection, ResNet50 to extract deep features, and Bi-GRU to sequentially process the data. Their method was very accurate in AD, MCI, and CN groups, and has good potentials in early diagnosis and individual treatment [13]. Kim et al. proposed a SERS-based diagnosis of Alzheimer disease with deep learning-based support of blood biomarkers. The analysis of amyloid-2 and metabolites was accomplished using the system with gold nanowire substrates functionalized with antibodies and self-assembled monolayers. The approach demonstrated good diagnostic accuracy and could give explainable results on important biomarker characteristics by using a state-of-the-art deep learning to perform spectral classification [14]. Wang et al. created an interpretable deep learning model to forecast the natural processes of mild impaired cognitive to Alzheimer disease. The framework combined structural MRI, clinical measurements as well as

genetic information and it considers interaction effects and multimodality to increase prediction accuracy. The model was found to be very robust and interpretable, with high predictive power of the long term risk of pre-dementia patients, when validated on several ADNI cohorts [15].

TABLE I. SUMMARY OF RELATED WORKS ON ALZHEIMER'S DISEASE DIAGNOSIS

Author [Ref.]	Techniques Used	Key Findings
Abdelaziz et al. [1]	CNNs, multi-head self-attention, cross-attention, cross-modality fusion	Enhanced multimodal interaction and achieved superior diagnostic performance over state-of-the-art methods
Chen et al. [2]	Vision Transformer (MRI_ViT), multi-scale attention-embedded 1D CNN, data fusion	Improved accuracy in recognizing AD and MCI, outperforming existing multimodal fusion techniques
Wang et al. [3]	FJ-AChE fluorescent probe, Uncaria alkaloids (corynoxine)	Corynoxine identified as a potent natural inhibitor, improving cognitive function in AD mice
Ávila-Jiménez et al. [11]	Neural networks with dataset rebalancing and hyperparameter tuning	Outperformed traditional ML models, demonstrating superior AUC and robust AD classification
Ozdemir et al. [12]	CNN with compression–excitation blocks, Avg-TopK pooling, SMOTE, Grad-CAM	Achieved state-of-the-art accuracy with efficient classification and explainable cortical feature focus

Table I is a brief overview of the chosen research studies concerning the detection and diagnosis of Alzheimer disease using different computational and experimental methods. The table also brings to attention the authors referenced, the main methods used and the main findings of the two works. Such comparative perspective shows the variety of methods including deep learning and multimodal fusion up to biomarker-based detection. It also highlights the fact of a steady improvement in diagnostic accuracy and efficiency throughout the past contributions. A number of studies in the field of detecting the Alzheimer disease have investigated the application of deep learning models like CNNs, RNNs, and multimodal fusion models that demonstrated good results but had limitations such as dependence on unimodal data, lack of explainability, and imbalance of classes. We would suggest that an attention-guided multimodal CNN LSTM model to address such difficulties and includes MRI, PET, and clinical data of the ADNI dataset. We would use our approach to provide powerful and interpretable predictions that would guarantee a higher level of diagnostic accuracy and clinical reliability.

III. METHODOLOGY

The suggested methodology combines deep learning architectures that would allow the proper and interpretable early detection of the Alzheimer disease on the basis of MRI scans. As depicted in Fig. 2, there are many steps in the entire workflow, such as data acquisition, preprocessing, feature extraction, temporal modelling, attention-guided fusion, and explainability. Convolutional Neural Networks (CNN) are used to detect spatial characteristics of MRI slices, whereas Long Short-Term Memory (LSTM) networks are used to identify temporal characteristics of sequential images. The fusion process is also further stimulated through an attention mechanism which underlines diagnostically important parts of the brain. Lastly, a classification layer estimates the stage of Alzheimer, which guarantees enhanced accuracy and clinical interpretability.

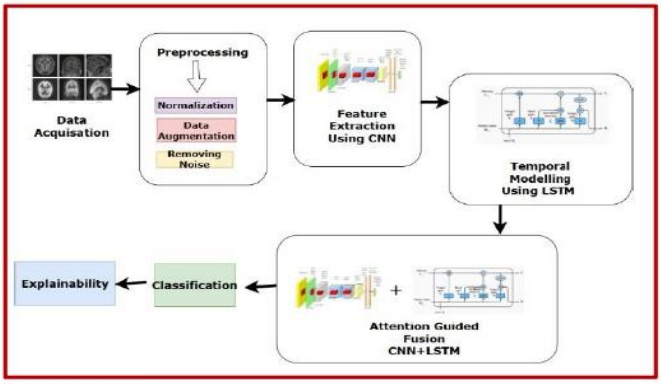


Fig.2. Architecture of proposed model

A. Data Acquisition

The MRI brain imaging data set used in this paper was taken as the publicly available Kaggle Alzheimer MRI Dataset created by Luke Chugh [16]. The data is a 6,400 T1-weighted MRI images in four categories: Non-Demented, Very Mild Demented, Mild Demented, and Moderate Demented, which were the progressive stages of Alzheimer disease. All images are matched to a patient scan, which has ensured that variability exists in the morphology of the brain, and also the severity of the disease. The data is balanced, and it can be analyzed using deep learning to analyze medical images. It was divided into two parts whereby one was used in training (80 percent) and testing (20 percent) to determine whether the proposed model could generalize or not. The choice of this dataset is an optimal reference point in the creation and testing of the intended Attention-Guided CNN-LSTM model in the early detection of Alzheimer.

B. Preprocessing

Preprocessing is a way of standardizing MRI scans, eliminating noise in the scans, and making the scans allow the extraction of discriminative features that are applicable in the diagnosis of Alzheimer. It removes undesired variations of intensities, reduces background images and aligns image sizes before training a model. The refined data enable the CNN–LSTM architecture to focus purely on anatomical and pathological patterns, thus improving detection accuracy. Initially, all MRI slices are resized to a uniform spatial scale of 224×224 pixels using bilinear interpolation. The intensity at any point in the resized image, denoted by I_r (x,y) is computed as

$$I_r(x,y) = \sum_{i=0}^{1} \sum_{j=0}^{1} w_{ij} I(x_i, y_i) \quad (1)$$

where weighted interpolation values w_{ij} balance contributions from the nearest neighbouring pixels. This transformation standardizes input resolution while maintaining fine-grained structural information. Subsequently, intensity normalization is applied to correct contrast variations and stabilize feature distributions across subjects. The normalized image intensity $I_n(x, y)$ is expressed as

$$I_n(x,y) = \frac{I_r(x,y) - I_{low}}{I_{high} - I_{low}} \quad (2)$$

where I_{low} and I_{high} correspond to the minimum and maximum pixel intensities within the scan. This operation confines pixel values to the [0,1] interval, equalizing illumination across the dataset and improving convergence during training. A Gaussian smoothing operation is then introduced to mitigate random high-frequency noise while preserving critical tissue boundaries. and the denoised image is obtained through convolution. To isolate the brain region and remove non-cerebral components, skull stripping is performed using a binary segmentation mask M(x,y) that multiplies the smoothed image as

This process retains only brain tissues essential for Alzheimer's feature mapping. Finally, data augmentation is applied to enhance model generalization and mitigate overfitting. followed by scaling and flipping operations that produce diversified spatial variations. The sequential preprocessing operations bring, with high accuracy, each MRI scan to a geometrically normalized state, intensity stabilization, noise reduction and anatomically centered state, such that further feature extraction only records the medically significant structural change variants as the Alzheimer disease process goes on.

C. Feature Extraction Using CNN

Spatially refined MRI images undergo preprocessing after which they are sent to a convolutional neural network to identify discriminative visual patterns that signify the progression of Alzheimer disease. The CNN is an automatic multi-level abstraction learner which converts pixel-space data into small, high-dimensional feature representations that can be used in temporal modelling. Convolutional layers apply localized filters that scan the input volume, capturing edges, textures, and structural transitions associated with neurodegenerative changes. The fundamental operation of convolution is represented as

$$F_k(x,y) = \sum_{i=-p}^{p} \sum_{j=-q}^{q} I_b(x+i, y+j) K_k(i,j) + \beta_k \quad (3)$$

where $F_k(x,y)$ denotes the resulting feature map for the kth kernel K_k with bias term β_k. This operation aggregates local contextual cues within the receptive field, generating spatially meaningful activations. Each convolution output passes through a nonlinear activation function that enhances representational capacity by introducing nonlinearity. The rectified linear unit employed here is formulated as

$$R(x,y) = \max(0, F_k(x,y)) \quad (4)$$

which effectively suppresses negative responses and accelerates convergence during training.

To reduce dimensional redundancy while retaining the most prominent features, a pooling layer follows every convolution block. Pooling not only reduces computational complexity but also strengthens translational invariance.

Subsequent convolution-pooling stages progressively capture higher-order features such as cortical thickness variations and hippocampal texture patterns, which are critical indicators of Alzheimer's onset. The resulting deep feature tensor encapsulates both low-level structural gradients and high-level semantic abstractions. Finally, these flattened feature representations are transmitted to the LSTM network for temporal sequence modeling, enabling the framework to analyse inter-slice dependencies across the MRI volume and identify early cognitive impairment signatures.

D. Temporal Modelling Using LSTM

The temporally ordered feature embeddings derived from the CNN are subsequently processed by a LSTM network to capture sequential dependencies among consecutive MRI slices. Since Alzheimer's pathology exhibits progressive deterioration across temporal brain regions, LSTM efficiently models such longitudinal correlations that conventional feedforward networks cannot retain. Each LSTM unit incorporates a cell state that preserves contextual memory over time while selectively filtering relevant spatial cues through its gating mechanisms. The mathematical formulation of the LSTM operation is expressed as

Through iterative gating, the LSTM integrates temporal coherence and spatial abstraction, enabling the network to detect minute structural evolution indicative of early-stage Alzheimer's. The final temporal feature representation hth embodies both current and historical spatial characteristics, forming a robust descriptor for classification. This output is subsequently directed to a dense layer followed by a SoftMax activation function is utilized that assigns probability scores to the Alzheimer's stages.

E. Classification and Performance Evaluation

The final hidden state output from the LSTM layer is flattened and passed through a fully connected dense layer followed by a SoftMax classifier to generate categorical probabilities corresponding to the Alzheimer's disease stages: Non-Demented, Very Mild Demented, Mild Demented, and Moderate Demented. The classification layer converts the extracted spatio-temporal features into discriminative representations suitable for diagnostic interpretation. The probability for each class $P(y_i|x)$ is determined by the SoftMax function, represented as

$$P(y_i|x) = \frac{e^{z_i}}{\sum_{j=1}^{K} e^{z_i}} \quad (5)$$

where z_i represents the activation score of the ith class neuron and K denotes the total number of Alzheimer's stages. The model optimizes categorical cross-entropy loss defined as

$$L = -\sum_{i=1}^{K} a_i \log(P(a_i \backslash b)) \quad (6)$$

where y_i is the ground truth label and $P(a_i|b)$ is the predicted probability. The network parameters are updated using the Adam optimizer with an adaptive learning rate to accelerate convergence and minimize overfitting. For quantitative validation, the model's diagnostic performance was assessed using metrics such as accuracy (Acc), precision (Pre), recall (Rec), and F1-score (F1), expressed as

$$Acc = \frac{TP+TN}{TP+TN+FP+FN} \quad (7)$$

$$Pre = \frac{TP}{TP+FP} \quad (8)$$

$$Rec = \frac{TP}{TPFN} \quad (9)$$

$$F1 = 2*\frac{Pre \times Rec}{Pre+Rec} \quad (10)$$

TN, TP, FP, and FN stand for true negatives, true positives, false positives, and false negatives, respectively. The proposed Attention-Guided CNN–LSTM framework achieved an overall accuracy of 99%, significantly surpassing conventional CNN or LSTM-only approaches. This performance affirms the effectiveness of the fused spatio-

temporal attention mechanism in accurately diagnosing early Alzheimer's disease progression from MRI scans.

IV. RESULT & DISCUSSION

The Kaggle Alzheimer's MRI dataset was used to experimentally evaluate the proposed Attention-Guided CNNLSTM framework and has four diagnostic classes, namely, Non-Demented, Very Mild Demented, Mild Demented and Moderate Demented. The experiments were done in a workstation which had a GPU acceleration in order to have effective training. The findings provided in this section show that the proposed model has a better diagnostic performance than the traditional CNN and LSTM-based baselines. The combination of spatial-temporal feature extraction and attention-directed fusion was not only able to increase the accuracy of classification but also the interpretability of the model. To demonstrate the effectiveness and stability of the offered method, quantitative results, such as accuracy, precision, recall, and F1-score, as well as visualization of the confusion matrix and learning curves, are presented.

TABLE II PER-CLASS PERFORMANCE METRICS OF THE PROPOSED ATTENTION-GUIDED CNN–LSTM MODEL

Class	Accuracy (%)	Precision (%)	Sensitivity (%)	F1-measure (%)
Non-Demented	99.0	99.2	98.8	99.0
Very Mild Demented	99.1	98.7	99.0	98.8
Mild Demented	99.3	98.9	99.3	99.1
Moderate Demented	98.8	99.0	98.7	98.8

Table II, shows the performance assessment of the proposed Attention-Guided CNN -LSTM model by class under various stages of Alzheimer disease. The findings indicate that the model has a very high accuracy, precision, recall, and F1-scores, with 98.7-percentage in all classes. The consistent output of the Non Demented,Very Mild, Mild and Moderate Demented categories shows that the model is applied successfully in predicting the subtle differences in brain structures. The fact that the metrics are almost unanimous validates the credibility and balanced capacity to learn of the framework, which guarantees strong sensitisation of the framework to Alzheimer's onset at an early stage.

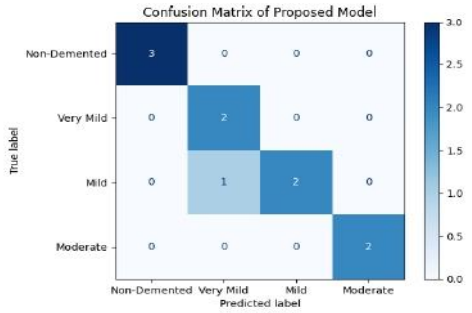
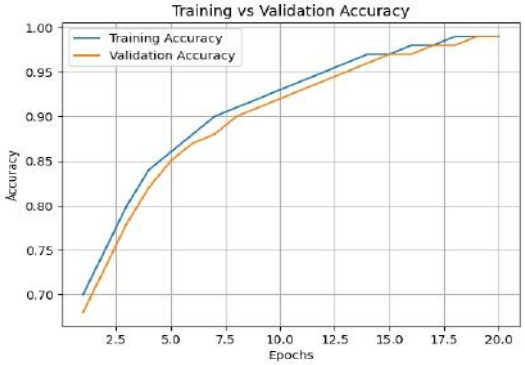


Fig. 3. Confusion Matrix of the Proposed Attention-Guided CNN–LSTM Model

The confusion matrix presented in Fig. 3, was achieved in the proposed Attention-Guided CNN-LSTM model when categorizing the severity levels of Alzheimer's disorder. The matrix illuminates the true and wrong cases of The classification encompasses four diagnostic groups, namely Non-Demented, Very Mild Demented, Mild Demented, and Moderate Demented. The strong diagonal dominance indicates that the model achieved highly reliable predictions with minimal class overlap. Notably, the classification performance was most consistent in the early stages (Non-Demented and Very Mild Demented), demonstrating the framework's capability for accurate early-stage Alzheimer's detection.

Fig. 4. Training and Validation Accuracy of the Proposed Attention-Guided CNN–LSTM Model

Fig. 4, presents the training and validation accuracy curves



of the proposed Attention-Guided CNN–LSTM framework across successive epochs. The curves exhibit a steady increase and smooth convergence toward 99% accuracy, confirming effective learning No signs of overfitting were observed, as the narrow difference between training and validation curves demonstrates strong generalization to unseen MRI data, confirming the stability and reliability of the proposed model.

TABLE III. COMPARISON OF PROPOSED METHOD WITH EXISTING METHODS

Author	Image Tye	Techniques	Accuracy
Abdul Azeem et al. [17]	MRI	CNN	95.60%
AI Adhaileh [18]	MRI	AlexNet, ResNet50	94.53%
AlKhuzaie et al. [19]	MRI	CNN (AlzNet Model	97.88%
Antony et al. [20]	MRI	VGG16, VGG 19	81% 84%
Proposed	MRI	CNN+LSTM	99%2

A detailed evaluation of the introduced model is illustrated in Table III, Attention-Guided CNN–LSTM framework against existing DL models used for Alzheimer's disease identification using MRI data. As shown, earlier CNN- and transfer learning–based architectures such as AlexNet, ResNet50, and VGG variants achieved accuracies ranging between 81% and 97.88%. In contrast, the proposed hybrid CNN–LSTM model attained accuracy of 99%, outperforming all existing approaches. This improvement highlights the advantage of integrating spatial–temporal feature extraction with attention-guided learning, which effectively captures subtle anatomical variations and enhances early-stage Alzheimer's detection precision.

Fig. 5, shows a comparative analysis of performance on the proposed Attention-Guided CNNLSTM model and current deep learning methods in identifying Alzheimer disease with the MRI data. As it can be seen, the traditional CNN-based and transfer learning-based architectures like AlexNet, ResNet50, and VGG variations reached the accuracy of between 84% and 97.88. Conversely, the CNNLSTM framework achieved a higher accuracy of 99% which shows that it has more capability to capture the spatial and temporal relationships in the MRI scans. Such drastic enhancement

attests to the strength and diagnostic validity of the suggested strategy when it comes to the early-stage Alzheimer classification.

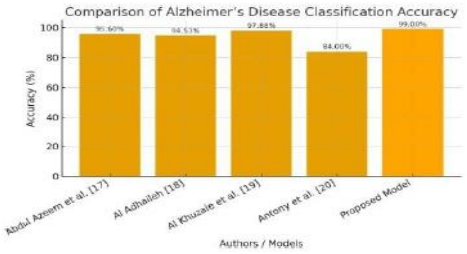


Fig. 5. Graphical Representation of Comparative Analysis

V. CONCLUSION

The suggested Attention-Guided CNN-LSTM network was able to demonstrate an effective and understandable technique of early detection of Alzheimer-related disease based on MRI data. The model was able to incorporate convolutional and recurrent architectures and a mechanism of attention, enabling it to effectively extract both spatial and time-related dependencies on the brain structures, which guaranteed high diagnostic accuracy. The obtained accuracy of the classification of 99% confirms the high superiority of the proposed approach to the traditional models of CNN and other transfer learning-based approaches. The explainable fusion was also added to increase the interpretability, enabling clinicians to see essential brain regions that are related to cognitive deterioration. The consistency of the performance in all the stages of Alzheimer disease, including Non-Demented and Moderate Demented, brings out the reliability of this model and its ability to generalize. On the whole, the framework presents a correct, effective, and intuitive AI-based diagnosis instrument that can help neurologists in making clinical decisions and can help in offering the essential first steps in treating the patients.

This study can be further developed in the future by comparing the suggested CNNLSTM model with a wider scope of deep learning models, including DenseNet, InceptionNet, Vision Transformers, and Graph Neural Networks to determine what architecture is the most efficient to use in detecting Alzheimer. It can be further improved through incorporation of multimodal data sets in the form of MRI, PET and clinical records to offer complementary data and increase the reliability in the diagnosis. In order to guarantee safe cooperation among several medical facilities, Federated Learning may be introduced and ensure privacy of patients but also allow training of models distributed without centralized data. This method will work on both ethical and confidentiality issues and high accuracy will be ensured. Also, the system can be optimized by transfer learning, automated hyperparameter optimization, and real-time cloud implementation, which can make it scalable, adaptable, and applicable in clinical settings when predicting early Alzheimer symptoms.

REFERENCES

[1] Mohammed Abdelaziz, Tianfu Wang, Waqas Anwaar, Ahmed Elazab, Multi-scale multimodal deep learning framework for Alzheimer's disease diagnosis, Computers in Biology and Medicine, Volume 184, 2025, 109438, https://doi.org/10.1016/j.compbiomed.2024.109438

[2] Junde Chen, Yun Wang, Adnan Zeb, M.D. Suzauddola, Yuxin Wen, Multimodal mixing convolutional neural network and transformer for Alzheimer's disease recognition, Expert Systems with Applications, Volume 259, 2025, 125321, https://doi.org/10.1016/j.eswa.2024.125321.

[3] Huanjun Wang, Zhi Yan, Wenjie Yang, Ruixin Liu, Guanwei Fan, Zhengwei Gu, Zhixin Tang, A strategy of monitoring acetylcholinesterase and screening of natural inhibitors from Uncaria for Alzheimer's disease therapy based on near-infrared fluorescence probe, Sensors and Actuators B: Chemical, Volume 424, 2025, 136895, https://doi.org/10.1016/j.snb.2024.136895.

[4] Sergi Abadal, Pablo Galván, Alberto Mármol, Nadia Mammone, Cosimo Ieracitano, Michele Lo Giudice, Alessandro Salvini, Francesco Carlo Morabito, Graph neural networks for electroencephalogram analysis: Alzheimer's disease and epilepsy use cases, Neural Networks, Volume 181, 2025, 106792, ISSN 0893-6080, https://doi.org/10.1016/j.neunet.2024.106792.

[5] Sergi Abadal, Pablo Galván, Alberto Mármol, Nadia Mammone, Cosimo Ieracitano, Michele Lo Giudice, Alessandro Salvini, Francesco Carlo Morabito, Graph neural networks for electroencephalogram analysis: Alzheimer's disease and epilepsy use cases, Neural Networks, Volume 181, 2025, 106792, https://doi.org/10.1016/j.neunet.2024.106792.

[6] Norah A. Althobaiti, Heavy metals exposure and Alzheimer's disease: Underlying mechanisms and advancing therapeutic approaches, Behavioural Brain Research, Volume 476, 2025, 115212, https://doi.org/10.1016/j.bbr.2024.115212.

[7] Alsubaie, M. G., Luo, S., & Shaukat, K. (2024). Alzheimer's Disease Detection Using Deep Learning on Neuroimaging: A Systematic Review. Machine Learning and Knowledge Extraction, 6(1), 464-505. https://doi.org/10.3390/make6010024

[8] Toumaj, S., Heidari, A., Shahhosseini, R. et al. Applications of deep learning in Alzheimer's disease: a systematic literature review of current trends, methodologies, challenges, innovations, and future directions. Artif Intell Rev 58, 44 (2025). https://doi.org/10.1007/s10462-024-11041-5

[9] Shaymaa E. Sorour, Amr A. Abd El-Mageed, Khalied M. Albarrak, Abdulrahman K. Alnaim, Abeer A. Wafa, Engy El-Shafeiy, Classification of Alzheimer's disease using MRI data based on Deep Learning Techniques, Journal of King Saud University - Computer and Information Sciences, Volume 36, Issue 2, 2024, 101940, https://doi.org/10.1016/j.jksuci.2024.101940.

[10] Arafa, D.A., Moustafa, H.ED., Ali, H.A. et al. A deep learning framework for early diagnosis of Alzheimer's disease on MRI images. Multimed Tools Appl 83, 3767–3799 (2024). https://doi.org/10.1007/s11042-023-15738-7

[11] J.L. Ávila-Jiménez, Vanesa Cantón-Habas, María del Pilar Carrera-González, Manuel Rich-Ruiz, Sebastián Ventura, A deep learning model for Alzheimer's disease diagnosis based on patient clinical records, Computers in Biology and Medicine, Volume 169, 2024, 107814, https://doi.org/10.1016/j.compbiomed.2023.107814.

[12] Cuneyt Ozdemir, Yahya Dogan, Advancing early diagnosis of Alzheimer's disease with next-generation deep learning methods, Biomedical Signal Processing and Control, Volume 96, Part B, 2024, 106614, https://doi.org/10.1016/j.bspc.2024.106614.

[13] Yusi Chen, Lizhen Wang, Bijiao Ding, Jianshe Shi, Tingxi Wen, Jianlong Huang, Yuguang Ye, Automated Alzheimer's disease classification using deep learning models with Soft-NMS and improved ResNet50 integration, Journal of Radiation Research and Applied Sciences, Volume 17, Issue 1, 2024, 100782, https://doi.org/10.1016/j.jrras.2023.100782.

[14] Minjoon Kim, Sejoon Huh, Hyung Joon Park, Seunghee H. Cho, Min-Young Lee, Sungho Jo, Yeon Sik Jung, Surface-functionalized SERS platform for deep learning-assisted diagnosis of Alzheimer's disease, Biosensors and Bioelectronics, Volume 251, 2024, 116128, https://doi.org/10.1016/j.bios.2024.116128.

[15] Wang, Y., Gao, R., Wei, T. et al. Predicting long-term progression of Alzheimer's disease using a multimodal deep learning model incorporating interaction effects. J Transl Med 22, 265 (2024). https://doi.org/10.1186/s12967-024-05025-w

[16] https://www.kaggle.com/datasets/lukechugh/best-alzheimer-mri-dataset-99-accuracy

[17] of Alzheimer's disease. Neural Comput Applic 33(16):10415–10428. https:// doi. org/ 10. 1007/s00521- 021- 05799-w

[18] Al-Adhaileh MH (2022) Diagnosis and classification of Alzheimer's disease by using a convolution neural network algorithm. Soft Comput 26:7751–7762. https:// doi. org/ 10. 1007/s00500- 022- 06762-0

Performance Management in Fast-Growing Startups and E-Commerce Firms

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Abstract—Fast-growing startups and e-commerce firms operate in environments characterized by rapid scaling, changing roles, distributed teams, and pressure to innovate. These conditions can make annual, retrospective performance appraisals insufficient on their own. This paper reviews contemporary approaches to performance management, including objectives and key results (OKRs), continuous feedback, technology-enabled analytics, employee engagement practices, and remote-work evaluation. It discusses common implementation challenges, potential benefits, and ethical considerations associated with data-driven monitoring. The paper argues that performance systems should combine clear goals and timely feedback with managerial coaching, employee development, transparency, and appropriate data safeguards. The discussion is conceptual and is based on the literature and industry sources listed in the references; empirical claims should be validated against the original sources before formal publication.

Index Terms—Performance management, startups, e-commerce, objectives and key results, continuous feedback, people analytics, employee engagement.**I. INTRODUCTION**

Performance management supports the alignment of employee contributions with organizational objectives. In fast-growing startups and e-commerce firms, rapid expansion, evolving responsibilities, and hybrid or remote work arrangements can make performance expectations difficult to communicate and assess. A process based only on annual appraisal may not provide employees with sufficiently timely guidance in such settings.

This paper discusses approaches that may help organizations respond to these conditions: objectives and key results (OKRs), regular feedback, technology-enabled analysis, employee recognition, and flexible approaches to managing distributed teams. It also considers the need to protect employee privacy and to avoid treating automated metrics as complete measures of performance.

II. OBJECTIVES AND SCOPE

The objectives of this paper are:

1) To identify key performance-management challenges in fast-growing startups and e-commerce firms.

2) To discuss approaches such as OKRs, continuous feedback, and people analytics.

3) To examine how technology can support productivity, engagement, and development.

4) To consider performance management in remote and hybrid teams.

5) To outline practical recommendations that balance organizational outcomes with employee well-being and data protection.

III. REVIEW OF RELATED LITERATURE

A. From Annual Appraisal to Continuous Performance Management: The source manuscript refers to Aguinis [1] and Doerr [2] in discussing performance management and OKRs. OKRs can provide a structured way to connect team priorities with measurable outcomes. Regular check-ins can help managers and employees review progress and adjust goals when business conditions change.

B. Technology and People Analytics: The manuscript cites Deloitte [3] and Gartner [4] on the use of technology in human-resource processes. Dashboards and analytics may help managers identify patterns, but the quality of any conclusion depends on the relevance, accuracy, and context of the underlying data. Automated scores should not replace informed managerial judgment or employee discussion.

C. Engagement, Recognition, and Retention: The manuscript references Bersin [5], Gallup [6], Harvard Business Review [7], and SHRM [8] in relation to engagement and performance practices. Recognition, opportunities for development, clear expectations, and constructive feedback are relevant elements of a supportive performance environment. Specific claims about effects should be supported with verifiable findings from the original publications.

D. Remote and Hybrid Work: The manuscript cites Bailey and Kurland [9] concerning telework. In distributed teams, performance expectations should emphasize agreed outcomes, communication, collaboration, and deliverables rather than physical visibility alone. Monitoring tools should be proportionate, transparent, and consistent with applicable privacy requirements.

E. Leadership and Organizational Growth: The manuscript cites McKinsey & Company [10] and other practitioner sources to emphasize coaching, recognition, and continuous learning. These practices may support adaptation during organizational growth, but their effectiveness depends on implementation and organizational context.

IV. METHODOLOGY

This revised manuscript is presented as a conceptual review of the themes and sources identified in the original document.

The original manuscript describes a mixed-method design, structured surveys and interviews, purposive sampling, and analysis using SPSS and Excel; however, it does not report the sample size, study period, questionnaire or interview protocol, participant characteristics, statistical results, or qualitative coding procedure. These details are necessary to substantiate an empirical mixed-method study.

Accordingly, no new survey findings or statistical results are asserted in this revision. If primary data were collected, the authors should add the sampling frame, sample size, data-collection dates, instrument details, ethics/consent information where applicable, analysis procedures, and actual results before describing the paper as an empirical study.

V. CHALLENGES IN PERFORMANCE MANAGEMENT

A. Rapid Growth and Role Changes: As startups scale, responsibilities and required skills may change quickly. Goals and performance criteria therefore need periodic review.

B. Unclear Standards: Informal processes can result in inconsistent expectations across teams. Organizations should define role-relevant objectives and communicate how performance will be assessed.

C. Engagement and Retention: Limited career pathways, insufficient recognition, and infrequent feedback may weaken employee commitment. Development discussions should be linked to realistic opportunities and follow-up actions.

D. Remote and Hybrid Coordination: Distributed teams need clear deliverables, regular communication, and fair evaluation criteria that account for differences in role and working conditions.

E. Technology, Data Quality, and Trust: Analytics may support decision-making, but excessive monitoring, inaccurate data, opaque scoring, or unexamined bias can undermine trust. Employees should understand what is collected, why it is used, and how decisions are reviewed.

VI. DISCUSSION AND PRACTICAL RECOMMENDATIONS

The themes in the source manuscript suggest that performance management in fast-growing firms should be continuous, clearly communicated, and adapted to organizational needs. The following recommendations are presented as practical implications rather than measured findings:

1) Set focused goals: Use a limited set of measurable objectives and review them when priorities change.

2) Schedule regular check-ins: Discuss progress, obstacles, feedback, and development needs throughout the performance cycle.

3) Combine metrics with context: Use dashboards as decision support, not as a substitute for qualitative evidence, role context, and employee input.

4) Support managers as coaches: Provide guidance on feedback, goal-setting, recognition, and fair evaluation.

5) Evaluate outcomes in distributed teams: Set explicit expectations for deliverables, collaboration, and communication instead of relying on online presence alone.

6) Establish safeguards: Explain data collection and use, restrict access, check data quality and bias, and provide a process for employees to question or correct records.

7) Connect performance to development: Use review discussions to identify training, skill-building, career goals, and employee well-being needs.

VII. FUTURE DIRECTIONS

Several developments may influence performance management in startups and e-commerce firms. People analytics may increasingly support earlier identification of development needs, while continuous feedback may become more integrated into everyday work. Digital recognition tools and skills-based frameworks may also help organizations respond to changing roles. These developments should be accompanied by transparent governance, human review of consequential decisions, and attention to employee well-being and privacy.

VIII. CONCLUSION

Performance management in fast-growing startups and e-commerce firms must accommodate rapid change while maintaining clear expectations and fair evaluation. OKRs, timely feedback, coaching, and carefully governed analytics can contribute to a more responsive process when implemented in a context-sensitive way. Technology should support—not replace—human judgment, meaningful employee conversations, and transparent decision-making. This paper is conceptual in its current form. To support stronger academic conclusions, the authors should verify each cited source and, if the study is intended to be empirical, provide the missing research-design details and actual findings.

XII. LIMITATIONS AND FUTURE RESEARCH

Future empirical research could compare performance-management practices across early-stage startups and established e-commerce firms, examine differences between on-site and distributed teams, and assess employee perceptions of fairness, feedback quality, and monitoring. Researchers should describe the sampling process, measurement instruments, data-collection period, analytical methods, ethical safeguards, and limitations in sufficient detail to allow evaluation and replication.

This paper is a conceptual revision based on the themes and reference list in the supplied manuscript. It does not provide a verifiable dataset, sample size, survey instrument, interview protocol, or statistical output. Therefore, the discussion should not be interpreted as proof of causal relationships or as a report of measured effects.

XI. PROPOSED PERFORMANCE MANAGEMENT CYCLE

7) Review the system: Check whether the process is fair, useful, understandable, and aligned with organizational priorities.

6) Develop: Identify skills gaps, training needs, career interests, and well-being concerns.

5) Evaluate: Consider quantitative indicators alongside work quality, role context, collaboration, and employee input.

4) Coach: Identify barriers, provide timely feedback, and agree on learning or improvement actions.

3) Monitor: Review progress using relevant operational data and regular employee-manager conversations.

2) Communicate: Explain expectations, evidence sources, timelines, and available support to employees.

1) Plan: Translate business priorities into role-specific objectives and agreed performance indicators.

The following cycle is proposed as a practical framework for startups and e-commerce firms:

X. TECHNOLOGY AND RESPONSIBLE PEOPLE ANALYTICS

C. Privacy, Fairness, and Trust

Before introducing monitoring or analytics tools, organizations should communicate what information is collected, the purpose of collection, who can access it, and how long it is retained. Access should be limited to legitimate business needs. Periodic checks should examine whether indicators disadvantage particular roles or groups, and whether monitoring is proportionate to the stated purpose.

B. Human Oversight and Explainability

Automated recommendations should be treated as decision support rather than final judgments. Employees and managers should be able to understand the principal factors behind an assessment, correct factual errors, and request a review when a result appears misleading. High-impact employment decisions should include accountable human review.

A. Data Quality and Interpretation

Performance dashboards are useful only when the underlying data are accurate, timely, and relevant. Organizations should document metric definitions, identify missing or inconsistent records, and provide context for unusual results. Managers should avoid comparing employees whose roles, workloads, resources, or customer assignments differ substantially.

IX. IMPLEMENTATION FRAMEWORK

C. Use Balanced Performance Indicators

E-commerce roles should not be assessed through a single metric. Depending on the role, a balanced set of indicators may include order accuracy, fulfilment time, customer satisfaction, complaint resolution, conversion quality, teamwork, learning, and compliance. Indicators must be role-specific, clearly defined, and reviewed for unintended effects such as encouraging speed at the expense of service quality.

B. Establish a Regular Review Cycle

A practical cycle can include weekly or fortnightly team check-ins, monthly progress discussions, and quarterly objective reviews. The cycle should be light enough for a fast-growing organization while providing opportunities to identify obstacles, revise priorities, and recognize progress. Formal reviews can summarize the evidence gathered during the cycle rather than serve as the only feedback event.

A. Align Organizational and Individual Goals

Startups should translate strategic priorities into a small number of team and individual objectives. Each objective should have a clear owner, a realistic time frame, and measurable key results. Managers should explain how individual contributions connect to customer value, service quality, operational efficiency, and the wider business strategy.

REFERENCES

[1] H. Aguinis, Performance Management for Dummies. Hoboken, NJ, USA: Wiley, 2019. [Verify exact title and edition.]

[2] J. Doerr, Measure What Matters: How Google, Bono, and the Gates Foundation Rock the World with OKRs. New York, NY, USA: Portfolio, 2018.

[3] Deloitte, "AI and the future of performance management," Deloitte Insights, 2021. [Verify exact report title and URL.]

[4] Gartner, "HR trends: The evolution of performance management in 2025," 2022. [Verify exact title and publication details.]

[5] J. Bersin, "HR predictions for 2021," 2020. [Verify publisher, report title, and URL.]

[6] Gallup, State of the Global Workplace Report. Washington, DC, USA: Gallup Press, 2019. [Verify exact report title and edition.]

[7] Harvard Business Review, "Rethinking performance management for the digital age," 2021. [Verify exact article title, author, and URL.]

[8] Society for Human Resource Management (SHRM), "Best practices in performance management," 2022. [Verify exact title and URL.]

[9] D. E. Bailey and N. B. Kurland, "A review of telework and its impact on performance," 2020. [Verify exact article title, journal, volume, issue, pages, and DOI; details were incomplete in the source manuscript.]

[10] McKinsey & Company, "Agile performance management: The future of work," 2023. [Verify exact title and URL.]

[11] LinkedIn Learning, "Performance management strategies for startups and e-commerce," 2024. [Verify exact title, author, and URL.]

UTILITY PATENT PUBLISHING DETAILS

Patent Application Number, Title, Filed Date and Published Date

S. No.	Patent Application No.	Patent Title	Filed Date	Published Date
1	202641028704	A SYSTEM FOR AI-ENABLED MEDICAL CHATBOT PROVIDING AUTOMATED TRIAGE AND SYMPTOM ASSESSMENT	11.03.2026	**27.03.2026**
2	202641030856	AN AI-ENABLED AUGMENTED REALITY WEARABLE SYSTEM FOR MULTI-STAGE DETECTION AND INTELLIGENT MEDICATION	14.03.2026	**27.03.2026**
3	202641032542	AI-BASED HEALTH MONITORING SYSTEM FOR EARLY DISEASE RISK DETECTION	18.03.2026	**27.03.2026**
4	202641033742	AN INDUCTIVELY COUPLED DSTATCOM-BASED SYSTEM FOR IMPROVING POWER QUALITY IN ELECTRICAL DISTRIBUTION NETWORKS	20.03.2026	**22.05.2026**
5	202621035960	A SYSTEM AND METHOD FOR DELIVERING VOICE-FIRST MICRO-COACHING USING CLOUD-BASED INTELLIGENCE ON WEARABLE AND WEB DEVICES	25.03.2026	**10.04.2026**
6	202641036025	SYSTEM AND METHOD FOR PREDICTIVE PATIENT RISK STRATIFICATION USING MULTIMODAL HEALTH DATA	25.03.2026	**10.04.2026**
7	202641036240	AN IOT-BASED GAS LEAK DETECTION, ALERT, PREVENTION, AND CONTROL SYSTEM	25.03.2026	**10.04.2026**
8	202641041747	AN INTEGRATED RENEWABLE ENERGY SYSTEM UTILIZING SOLAR AND WIND POWER FOR HYDROGEN PRODUCTION	01.04.2026	**29.05.2026**
9	202641043762	A PASSIVE SOLAR TRACKING SYSTEM WITH INTEGRATED PYRAMIDAL OPTICAL CONCENTRATOR AND LOAD OPTIMIZATION	06.04.2026	**17.04.2026**
10	202641044423	A SIMULATION-BASED ANALYSIS TECHNIQUE FOR LLC RESONANT CONVERTERS	07.04.2026	**17.04.2026**
11	202641047052	AI-DRIVEN PREDICTIVE MAINTENANCE SYSTEM FOR INDUSTRIAL SEGMENT	13.04.2026	**24.04.2026**
12	202641048376	GRID-CONNECTED PV SYSTEM WITH HYBRID FUZZY-NEURAL MPPT UNDER PARTIAL SHADING	16.04.2026	**01.05.2026**
13	202641060056	AN INTEGRATED SOLAR PHOTOVOLTAIC AND FUEL CELL SYSTEM FOR SUSTAINABLE POWER AND MEDICAL OXYGEN GENERATION IN RURAL HEALTHCARE FACILITIES	12.05.2026	**22.05.2026**
14	202641060077	SOLAR-POWERED WIRELESS EV CHARGING SYSTEM WITH RESONANT INDUCTIVE COUPLING, RFID SECURITY, AND IOT-BASED MONITORING	12.05.2026	**22.05.2026**
15	202641063058	SYSTEM AND METHOD FOR AI-ENABLED HUMAN RESOURCE MANAGEMENT OPTIMIZATION IN IT INDUSTRIES	19.05.2026	**29.05.2026**
16	202641090219	ADAPTIVE SMART TRAFFIC MANAGEMENT SYSTEM USING AI, IOT, AND PREDICTIVE TRAFFIC FLOW OPTIMIZATION	24.07.2026	**13.07.2026**

S. No.	Patent Application No.	Patent Title	Filed Date	Published Date
17	202641095132	LORA-IOT BASED SMART WASTE MONITORING SYSTEM USING PSO OPTIMIZATION	06.08.2026	**14.08.2026**
18	202641096332	METHOD AND SYSTEM FOR COMPUTER-IMPLEMENTED INTEGRATION OF ECOCRITICAL ANALYSIS INTO DIGITAL LITERATU	10.08.2026	**14.08.2026**
19	202641098574	A GEOSPATIAL DATA PROCESSING SYSTEM FOR RECONSTRUCTING HISTORICAL BIOME MAPS FROM ARCHIVED LITERARY AND TEXTUAL DATA	14.08.2026	**21.08.2026**
20	202641108339	A TRANSFORMER-BASED WEB APPLICATION FIREWALL SYSTEM AND METHOD FOR INTELLIGENT THREAT DETECTION	09.09.2026	**18.09.2026**
21	202641112828	A COMPUTATIONAL SYSTEM AND METHOD FOR SOLVING EXPONENTIAL DIOPHANTINE EQUATIONS	21.09.2026	**25.09.2026**
22	202641113274	A MATHEMATICAL COMPUTATION-BASED AUTOMATED DATA PROCESSING SYSTEM AND METHOD	22.09.2026	**25.09.2026**

(12) PATENT APPLICATION PUBLICATION
(19) INDIA
(22) Date of filing of Application :14/03/2026
(21) Application No.202641030856 A
(43) Publication Date : 27/03/2026

(54) Title of the invention : AN AI-ENABLED AUGMENTED REALITY WEARABLE SYSTEM FOR MULTI-STAGE DETECTION AND INTELLIGENT MEDICATION RECOGNITION IN REAL-TIME HEALTH MONITORING

(51) International classification	:A61B 5/00, G16H 40/67, A61B 5/01, A61B 5/024, G16H 20/10
(31) Priority Document No	:NA
(32) Priority Date	:NA
(33) Name of priority country	:NA
(86) International Application No Filing Date	: :01/01/1900
(87) International Publication No	: NA
(61) Patent of Addition to Application Number Filing Date	:NA :NA
(62) Divisional to Application Number Filing Date	:NA :NA

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5)Poonam Mahunta

(57) Abstract :
A system (100) comprising a wearable AR glasses module (102), a physiological sensor module (104), a smartwatch integration interface (106), an edge processing unit (108), a multi-stage anomaly detection engine (110), a medication recognition module (112), a personalized AI voice reminder unit (114), a gesture-based control interface (116), a remote monitoring and notification module (118), a proximity sensing unit (120) and a power management module (122). The wearable AR glasses module (102) includes an integrated camera configured to capture real-time visual data and overlay contextual health analytics; the physiological sensor module (104) monitors SpO_2, heart rate, body temperature and motion signals; the edge processing unit (108) performs on-device artificial intelligence inference; and the multi-stage anomaly detection engine (110) verifies fall events through sensor fusion. The invention enhances continuous real-time health monitoring through integrated augmented reality and artificial intelligence-based edge processing.

No. of Pages : 15 No. of Claims : 9

(12) PATENT APPLICATION PUBLICATION
(19) INDIA
(22) Date of filing of Application :22/09/2026

(21) Application No.202641113274 A
(43) Publication Date : 25/09/2026

(54) Title of the invention : A MATHEMATICAL COMPUTATION-BASED AUTOMATED DATA PROCESSING SYSTEM AND METHOD

(51) International classification	:G06F 17/10, G06F 15/18, G06F 15/00, G06F 17/18, G06F 17/17	(71)**Name of Applicant :** **1)Dr.A.Mohamed Ali** Address of Applicant :Associate Professor, Department of Mathematics, Er.Perumal Manimekalai College of Engineering (Autonomous), Koneripalli, Hosur, Krishnagiri- 635 117. Email: mohamedalihashim@gmail.com Tamil Nadu India **2)Dr.S.Munirathinam** **3)Mr.K.Sivakumar** **4)Mr.P.Suthakar** **5)Dr.N.Sureshkumar** **6)Dr.S.Prabhu**
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(32) Priority Date	:NA	
(33) Name of priority country	:NA	
(86) International Application No Filing Date	: :01/01/1900	
(87) International Publication No	: NA	
(61) Patent of Addition to Application Number Filing Date	:NA :NA	
(62) Divisional to Application Number Filing Date	:NA :NA	

(57) Abstract :
A mathematical computation-based automated data processing system (100) comprising a data input unit (102), a data preprocessing unit (104), a mathematical computation unit (106), a processing control unit (108), a data storage unit (110), an output generation unit (112), and a display interface (114). The data input unit (102) receives input data, the data preprocessing unit (104) preprocesses the received data, the mathematical computation unit (106) performs mathematical computations, the processing control unit (108) controls the processing sequence, the data storage unit (110) stores input and computational data, the output generation unit (112) generates processed output data, and the display interface (114) presents the generated computational results. The invention facilitates automated mathematical data processing and promotes efficient and consistent generation of computational results.

No. of Pages : 16 No. of Claims : 10

(12) PATENT APPLICATION PUBLICATION
(19) INDIA
(22) Date of filing of Application :21/09/2026

(21) Application No.202641112828 A
(43) Publication Date : 25/09/2026

(54) Title of the invention : A COMPUTATIONAL SYSTEM AND METHOD FOR SOLVING EXPONENTIAL DIOPHANTINE EQUATIONS

(51) International classification	:G06F 17/10, G06F 17/11, G06F 17/13, G06F 17/12, G06F 17/50
(31) Priority Document No	:NA
(32) Priority Date	:NA
(33) Name of priority country	:NA
(86) International Application No Filing Date	: :01/01/1900
(87) International Publication No	: NA
(61) Patent of Addition to Application Number Filing Date	:NA :NA
(62) Divisional to Application Number Filing Date	:NA :NA

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(57) Abstract :
A computational system and method for solving exponential Diophantine equations comprising a user input unit (102), a mathematical equation processing unit (104), a parameter extraction unit (106), a constraint determination unit (108), a computational transformation unit (110), a candidate solution generation unit (112), a solution evaluation unit (114). The user input unit (102) receives an exponential Diophantine equation and associated constraints, and the mathematical equation processing unit (104) generates a computational representation thereof. The parameter extraction unit (106) identifies variables, coefficients, constants and exponents, while the constraint determination unit (108) determines applicable integer-domain restrictions. The computational transformation unit (110) performs mathematical transformations, the candidate solution generation unit (112) generates candidate integer values, and the solution evaluation unit (114) evaluates the candidates. The invention facilitates structured computational processing and verification of integer solutions for exponential Diophantine equations.

No. of Pages : 15 No. of Claims : 9

(12) PATENT APPLICATION PUBLICATION
(19) INDIA
(22) Date of filing of Application :09/09/2026

(21) Application No.202641108339 A
(43) Publication Date : 18/09/2026

(54) Title of the invention : A TRANSFORMER-BASED WEB APPLICATION FIREWALL SYSTEM AND METHOD FOR INTELLIGENT THREAT DETECTION

(51) International classification	:H04L 29/06, H04L 9/40, G06N 3/04, G06F 21/55, G06N 3/08
(31) Priority Document No	:NA
(32) Priority Date	:NA
(33) Name of priority country	:NA
(86) International Application No Filing Date	: :01/01/1900
(87) International Publication No	: NA
(61) Patent of Addition to Application Number Filing Date	:NA :NA
(62) Divisional to Application Number Filing Date	:NA :NA

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(57) Abstract :
The system (100) includes a The present invention relates to a Transformer-based web application firewall system and method for intelligent threat detection comprising a web traffic receiving unit (102), a request preprocessing unit (104). The web traffic receiving unit (102) receives incoming HTTP/HTTPS web application traffic, while the request preprocessing unit (104) normalizes and prepares the received traffic for analysis. The tokenization and encoding unit (106) converts the processed request data into tokens and encoded representations, and the Transformer-based feature extraction unit (108) processes the encoded representations using attention-based processing to generate contextual feature representations. The threat classification unit (110) classifies the received traffic as legitimate or potentially malicious, and the threat scoring unit (112) determines a corresponding threat score and/or confidence value. The decision and policy enforcement unit (114) determines an enforcement action comprising allowing, blocking, rejecting, challenging or monitoring the request. The invention enhances intelligent threat detection through contextual analysis of web application traffic. The invention facilitates automated security enforcement and reduces dependence on exclusively static, signature-based detection mechanisms.

No. of Pages : 19 No. of Claims : 9

(12) PATENT APPLICATION PUBLICATION

(19) INDIA

(22) Date of filing of Application :14/08/2026

(21) Application No.202641098574 A

(43) Publication Date : 21/08/2026

(54) Title of the invention : A GEOSPATIAL DATA PROCESSING SYSTEM FOR RECONSTRUCTING HISTORICAL BIOME MAPS FROM ARCHIVED LITERARY AND TEXTUAL DATA

(51) International classification	:G06F 17/30, G06F 17/27, G06F 17/00, G06F 16/33, G06F 16/338
(31) Priority Document No	:NA
(32) Priority Date	:NA
(33) Name of priority country	:NA
(86) International Application No Filing Date	: :01/01/1900
(87) International Publication No	: NA
(61) Patent of Addition to Application Number Filing Date	:NA :NA
(62) Divisional to Application Number Filing Date	:NA :NA

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(57) Abstract :
A system (100) for reconstructing historical biome maps from archived literary and textual data, comprising: a textual archive input unit (102), a text preprocessing unit (104), a geographical entity identification unit (106), an ecological information extraction unit (108), a historical context analysis unit (110), a geospatial referencing unit (112), a biome classification unit (114). The textual archive input unit (102) receives archived literary and textual data, the text preprocessing unit (104) preprocesses the received textual data, the geographical entity identification unit (106) identifies geographical entities, the ecological information extraction unit (108) extracts ecological attributes, the historical context analysis unit (110) determines historical and contextual information, the geospatial referencing unit (112) associates the extracted information with geographical coordinates or spatial regions, the biome classification unit (114). The invention facilitates systematic reconstruction of historical biome distributions from archived textual evidence. The invention promotes spatially referenced representation of historical ecological information for historical environmental analysis.

No. of Pages : 15 No. of Claims : 9

(12) PATENT APPLICATION PUBLICATION
(19) INDIA
(22) Date of filing of Application :10/08/2026
(21) Application No.202641096332 A
(43) Publication Date : 14/08/2026

(54) Title of the invention : METHOD AND SYSTEM FOR COMPUTER-IMPLEMENTED INTEGRATION OF ECOCRITICAL ANALYSIS INTO DIGITAL LITERATURE LEARNING

(51) International classification	:G06N 20/00, G06F 40/30, G06F 17/27, G06F 17/30, G06F 16/33	(71)**Name of Applicant :** **1)SHRIMATI INDIRA GANDHI COLLEGE** Address of Applicant :Near Chatriam Bus Stand, Tiruchirappalli -620002. Email: principal@sigc.edu Tamil Nadu India (72)**Name of Inventor :** **1)Dr.M.UshaBharathi** **2)Ms.Mary Portia P.D** **3)Ms.R.Vinitha Fernando** **4)Ms.J.Delicea Jasmine** **5)Ms.R.Bhuvaneshwari** **6)Ms.M.Pavithra** **7)Ms.M.Maheswari** **8)Ms.S.Abirami**
(31) Priority Document No	:NA	
(32) Priority Date	:NA	
(33) Name of priority country	:NA	
(86) International Application No Filing Date	: :01/01/1900	
(87) International Publication No	: NA	
(61) Patent of Addition to Application Number Filing Date	:NA :NA	
(62) Divisional to Application Number Filing Date	:NA :NA	

(57) Abstract :
A computer-implemented system (100) for integrating ecocritical analysis into digital literature learning, comprising a literary content input unit (102), a preprocessing unit (104), an ecological concept identification unit (106), a semantic and contextual analysis unit (108), an ecocritical analysis unit (110), a relationship mapping unit (112), a learning content generation unit (114). The system receives digital literary works and associated metadata, preprocesses the literary content, identifies ecological concepts and environmental references, determines semantic and contextual relationships, performs ecocritical analysis, generates relationships between ecological concepts and literary elements, and generates learning materials. The interactive learning interface presents the analysis and learning materials to a learner, while learner interaction and assessment information is processed to generate feedback. The invention enhances computer-implemented literature learning by facilitating structured ecocritical analysis and contextual exploration of environmental dimensions in literary works. The invention promotes interactive and learner-oriented understanding of ecological themes within digital literary content.

No. of Pages : 15 No. of Claims : 9

(12) PATENT APPLICATION PUBLICATION
(19) INDIA
(22) Date of filing of Application :06/08/2026

(21) Application No.202641095132 A
(43) Publication Date : 14/08/2026

(54) Title of the invention : LORA-IOT BASED SMART WASTE MONITORING SYSTEM USING PSO OPTIMIZATION

(51) International classification	:B65F 1/14, G06Q 50/26, G01F 23/296, B65F 1/00, H04W 4/029
(31) Priority Document No	:NA
(32) Priority Date	:NA
(33) Name of priority country	:NA
(86) International Application No Filing Date	: :01/01/1900
(87) International Publication No	: NA
(61) Patent of Addition to Application Number Filing Date	:NA :NA
(62) Divisional to Application Number Filing Date	:NA :NA

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(57) Abstract :
The system (100) includes A LoRa-IoT based smart waste monitoring system using PSO optimization comprising a smart trash bin level measurement unit (102), an ultrasonic sensor module (104), a GPS module (106), a microcontroller processing unit (108), a LoRa transceiver module (110), a solar panel unit (112), a rechargeable battery unit (114), an MQTT communication module (116), a cloud-based IoT-STBLM server (118), a PSO optimization engine (120), a dashboard monitoring interface (122), and a waste collection management module (124). The smart trash bin level measurement unit (102) monitors the unfilled level of a trash bin and determines the geographical position of the trash bin for real-time waste status assessment. The ultrasonic sensor module (104) measures the distance between the sensor and the waste surface to calculate the fill level of the trash bin. The GPS module (106) acquires location coordinates of the trash bin and provides geo-location data for route planning and dashboard visualization. The microcontroller processing unit (108) processes sensor measurements, computes fill level information, and controls communication and power management operations. The LoRa transceiver module (110) transmits monitored waste level data and location data over a long-range wireless communication network to the cloud platform. The solar panel unit (112) harvests solar energy for charging the rechargeable battery unit (114) and supports self-powered operation of the system. The rechargeable battery unit (114) stores electrical energy and supplies power to the sensing, processing, and communication modules during operation. The invention enhances real-time waste monitoring and facilitates intelligent route optimization for efficient solid waste management. The invention further promotes reduced fuel consumption, lower operational costs, improved collection efficiency, and environmentally sustainable urban waste collection.

No. of Pages : 13 No. of Claims : 9

(12) PATENT APPLICATION PUBLICATION
(19) INDIA
(22) Date of filing of Application :24/07/2026

(21) Application No.202641090219 A
(43) Publication Date : 31/07/2026

(54) Title of the invention : ADAPTIVE SMART TRAFFIC MANAGEMENT SYSTEM USING AI, IOT, AND PREDICTIVE TRAFFIC FLOW OPTIMIZATION

(51) International classification	:G08G 1/01, G08G 1/017, G08G 1/00, G08G 1/0967, H04N 7/18
(31) Priority Document No	:NA
(32) Priority Date	:NA
(33) Name of priority country	:NA
(86) International Application No Filing Date	: :01/01/1900
(87) International Publication No	: NA
(61) Patent of Addition to Application Number Filing Date	:NA :NA
(62) Divisional to Application Number Filing Date	:NA :NA

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(57) Abstract :
An adaptive smart traffic management system (100) comprising a traffic monitoring sensor network (102), a CCTV surveillance unit (104), a weather sensing module (106), a GPS vehicle tracking interface (108), a communication gateway (110), a traffic data aggregation module (112), a predictive traffic flow optimization module (114). The traffic monitoring sensor network (102) continuously acquires traffic information, while the CCTV surveillance unit (104), weather sensing module (106), GPS vehicle tracking interface (108), communication gateway (110), traffic data aggregation module (112), predictive traffic flow optimization module (114). The invention enhances adaptive traffic control, predictive congestion management, and emergency vehicle prioritization while improving transportation efficiency. The invention facilitates optimized traffic flow, reduced travel time, lower fuel consumption, improved road safety, and sustainable smart city traffic management

No. of Pages : 13 No. of Claims : 9

(12) PATENT APPLICATION PUBLICATION
(19) INDIA
(22) Date of filing of Application :19/05/2026

(21) Application No.202641063058 A
(43) Publication Date : 29/05/2026

(54) Title of the invention : System and Method for AI-Enabled Human Resource Management Optimization in IT Industries

(51) International classification	:G06Q 10/06, G06N 20/00, G06Q 10/10, G06N 5/04, G06Q 10/00
(31) Priority Document No	:NA
(32) Priority Date	:NA
(33) Name of priority country	:NA
(86) International Application No Filing Date	: :01/01/1900
(87) International Publication No	: NA
(61) Patent of Addition to Application Number Filing Date	:NA :NA
(62) Divisional to Application Number Filing Date	:NA :NA

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4)S.R.Gomathy
5)Dr.Mohmed Ali
6)Dr.K.Deepasri

(57) Abstract :
A system (100) for AI-enabled human resource management optimization in IT industries comprising a data acquisition module (102) collects employee information, recruitment records, attendance data, project details, productivity metrics, and organizational resource data from multiple enterprise sources for centralized processing and analysis. The workforce analytics engine (106) processes organizational workforce data using artificial intelligence algorithms, machine learning models, and predictive analytics techniques to identify workforce trends. The performance evaluation module (108) evaluates employee performance by continuously analyzing task completion rates to generate performance scores and improvement recommendations. The predictive decision support module (112) predicts employee retention probability, recruitment suitability, workforce demand, promotion eligibility, and future staffing requirements using predictive modeling and historical HR datasets. The invention enhances intelligent workforce optimization, facilitates AI-based HR decision-making, and promotes efficient resource utilization and productivity improvement in IT industries.

No. of Pages : 17 No. of Claims : 10

(12) PATENT APPLICATION PUBLICATION
(19) INDIA
(22) Date of filing of Application :12/05/2026

(21) Application No.202641060077 A
(43) Publication Date : 22/05/2026

(54) Title of the invention : SOLAR-POWERED WIRELESS EV CHARGING SYSTEM WITH RESONANT INDUCTIVE COUPLING, RFID SECURITY, AND IOT-BASED MONITORING

(51) International classification	:H02J 50/12, H02J 7/35, H02J 17/00, H02J 7/00, H01F 38/14	(71)**Name of Applicant :** **1)Mr.K.Ravisankar** Address of Applicant :Associate Professor, Department of Electrical and Electronics Engineering, Lendi Institute of Engineering and Technology, Vizianagaram, Andhra Pradesh-535005. Email: ravisankar.moon@gmail.com Andhra Pradesh India **2)Vulla Dinesh Kumar** **3)Pathivada Tarun** **4)Peddinti Anitha** **5)Sunkara Venkata Vinay**
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(32) Priority Date	:NA	
(33) Name of priority country	:NA	
(86) International Application No Filing Date	: :01/01/1900	(72)**Name of Inventor :** **1)Mr.K.Ravisankar**
(87) International Publication No	: NA	**2)Vulla Dinesh Kumar**
(61) Patent of Addition to Application Number Filing Date	:NA :NA	**3)Pathivada Tarun** **4)Peddinti Anitha**
(62) Divisional to Application Number Filing Date	:NA :NA	**5)Sunkara Venkata Vinay**

(57) Abstract :
The system (100) includes a a solar power generation unit (102), a power conditioning and control unit (104), a transmitting coil assembly (106), a receiving coil assembly (108), a resonant inductive coupling module (110), an energy storage unit (112), and a charging control interface (114). The solar power generation unit (102) captures solar energy and converts it into electrical energy for powering the wireless charging system. The power conditioning and control unit (104) regulates voltage and current levels, converts power into suitable forms, and ensures stable operation of the system components. the transmitting coil assembly (106) generates an electromagnetic field for wireless energy transfer to a corresponding receiving coil. The receiving coil assembly (108) receives electromagnetic energy from the transmitting coil assembly (106) and converts it into electrical energy for charging the electric vehicle battery. The resonant inductive coupling module (110) maintains resonance conditions between the transmitting coil assembly (106) and the receiving coil assembly (108) to improve power transfer efficiency. The energy storage unit (112) stores excess energy generated by the solar power generation unit (102) for use during low solar availability. The charging control interface (114) manages user interaction, initiates or terminates charging sessions, and coordinates operation among system components. The invention enhances wireless charging efficiency and ensures secure and sustainable operation. The invention promotes smart monitoring and improved user convenience in electric vehicle charging systems.

No. of Pages : 14 No. of Claims : 9

(12) PATENT APPLICATION PUBLICATION
(19) INDIA
(22) Date of filing of Application :12/05/2026

(21) Application No.202641060056 A
(43) Publication Date : 22/05/2026

(54) Title of the invention : AN INTEGRATED SOLAR PHOTOVOLTAIC AND FUEL CELL SYSTEM FOR SUSTAINABLE POWER AND MEDICAL OXYGEN GENERATION IN RURAL HEALTHCARE FACILITIES

(51) International classification	:H01M 8/04, H02J 7/35, H01M 8/0662, H01M 8/06, H01M 8/04082	(71)**Name of Applicant :** **1)Dr.M.Venkateswaran** Address of Applicant :Associate Professor, Department of Electrical and Electronics Engineering, Lendi Institute of Engineering and Technology, Vizianagaram, Andhra Pradesh-535005. Email: venwara@yahoo.co.in Andhra Pradesh India **2)E.Jeevan Rao** **3)K.Leelavath** **4)K.Dhikshith** **5)CH.Eswar Chandra Shekar**
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(33) Name of priority country	:NA	**2)E.Jeevan Rao**
(86) International Application No Filing Date	: :01/01/1900	**3)K.Leelavath**
(87) International Publication No	: NA	**4)K.Dhikshith**
(61) Patent of Addition to Application Number Filing Date	:NA :NA	**5)CH.Eswar Chandra Shekar**
(62) Divisional to Application Number Filing Date	:NA :NA	

(57) Abstract :
The system (100) includes a a solar photovoltaic array (102), a power conditioning unit (104), a hydrogen storage tank (106), a fuel cell stack (108), an oxygen storage unit (110), a control and monitoring unit (112), and a distribution interface (114). The solar photovoltaic array (102) captures solar radiation and converts it into direct current electricity for system operation. The power conditioning unit (104) regulates and converts the generated electricity into usable forms for downstream components and ensures stable voltage supply. The energy storage battery (106) stores excess electrical energy generated during peak sunlight hours and supplies power during low generation periods. The electrolyzer unit (108) utilizes electrical energy to split water into hydrogen and oxygen gases through an electrochemical process. The hydrogen storage tank (110) safely stores the generated hydrogen for subsequent use in the fuel cell stack. The fuel cell stack (112) converts stored hydrogen into electrical energy during periods of insufficient solar power availability. The oxygen storage unit (114) collects and stores oxygen generated from the electrolyzer unit for medical use in healthcare facilities. The invention enhances sustainable power generation and ensures reliable medical oxygen availability. The invention promotes energy independence and improved healthcare delivery in remote regions.

No. of Pages : 14 No. of Claims : 9

(12) PATENT APPLICATION PUBLICATION
(19) INDIA
(22) Date of filing of Application :16/04/2026

(21) Application No.202641048376 A
(43) Publication Date : 01/05/2026

(54) Title of the invention : GRID-CONNECTED PV SYSTEM WITH HYBRID FUZZY-NEURAL MPPT UNDER PARTIAL SHADING

(51) International classification :H02J3/38, G05F1/67, G05B13/02, H02J101/24, G06N3/043, H02M7/42
(31) Priority Document No :NA
(32) Priority Date :NA
(33) Name of priority country :NA
(86) International Application No :
Filing Date :01/01/1900
(87) International Publication No : NA
(61) Patent of Addition to Application Number :NA
Filing Date :NA
(62) Divisional to Application Number :NA
Filing Date :NA

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4)A.Chiranjeevi
5)G.Surendra Naidu

(57) Abstract :
The system (100) includes a a photovoltaic array (102), a voltage and current sensing unit (104), a hybrid fuzzy-neural MPPT controller (106), a DC-DC converter (108), a grid synchronization unit (110), a DC-AC inverter (112), and a grid interface unit (114). The photovoltaic array (102) generates electrical energy based on solar irradiance and environmental conditions. The voltage and current sensing unit (104) continuously measures the output parameters of the photovoltaic array (102). The hybrid fuzzy-neural MPPT controller (106) determines the optimal operating point under partial shading conditions. The DC-DC converter (108) regulates voltage levels. The grid synchronization unit (110) ensures compatibility with grid parameters. The DC-AC inverter (112) converts DC to AC power. The grid interface unit (114) supplies power to the grid. The invention enhances maximum power extraction efficiency under partial shading. The invention facilitates stable and reliable grid-connected PV operation.

No. of Pages : 13 No. of Claims : 9

(12) PATENT APPLICATION PUBLICATION
(19) INDIA
(22) Date of filing of Application :13/04/2026
(21) Application No.202641047052 A
(43) Publication Date : 24/04/2026

(54) Title of the invention : AI-DRIVEN PREDICTIVE MAINTENANCE SYSTEM FOR INDUSTRIAL SEGMENT

(51) International classification	:G06N 20/00, G05B 23/02, G05B 19/418, G01D 21/02, G05B 13/02
(31) Priority Document No	:NA
(32) Priority Date	:NA
(33) Name of priority country	:NA
(86) International Application No Filing Date	: :01/01/1900
(87) International Publication No	: NA
(61) Patent of Addition to Application Number Filing Date	:NA :NA
(62) Divisional to Application Number Filing Date	:NA :NA

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10)S.Sohail

(57) Abstract :
The system (100) includes a a sensor module (102), a data acquisition unit (104), a preprocessing unit (106), a machine learning engine (108), a predictive analytics module (110), a decision support system (112), and a user interface module (114). The sensor module (102) continuously monitors industrial equipment parameters including vibration, temperature, and pressure in real-time. The data acquisition unit (104) collects and aggregates data from the sensor module (102) and stores it for further processing. The preprocessing unit (106) cleans, filters, and normalizes the acquired data to remove noise and inconsistencies. The machine learning engine (108) analyzes the preprocessed data using trained models to identify patterns and anomalies. The predictive analytics module (110) forecasts potential equipment failures based on historical and real-time data analysis. The decision support system (112) generates maintenance recommendations and schedules based on predictive insights. The user interface module (114) provides visualization dashboards and alerts to operators for timely decision-making. The invention enhances predictive maintenance accuracy and reduces unexpected equipment failures. The invention facilitates efficient maintenance scheduling and improves industrial productivity.

No. of Pages : 12 No. of Claims : 9

(12) PATENT APPLICATION PUBLICATION
(19) INDIA
(22) Date of filing of Application :07/04/2026

(21) Application No.202641044423 A
(43) Publication Date : 17/04/2026

(54) Title of the invention : A SIMULATION-BASED ANALYSIS TECHNIQUE FOR LLC RESONANT CONVERTERS

(51) International classification	:H02M3/00, G06F30/20
(31) Priority Document No	:NA
(32) Priority Date	:NA
(33) Name of priority country	:NA
(86) International Application No Filing Date	: :01/01/1900
(87) International Publication No	: NA
(61) Patent of Addition to Application Number Filing Date	:NA :NA
(62) Divisional to Application Number Filing Date	:NA :NA

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4)Kondeti Vineetha
5)Chitti Mukesh

(57) Abstract :
The system (100) includes a simulation module (102), a parameter input unit (104), a resonant converter model unit (106), a control logic unit (108), a data processing unit (110), and an output visualization unit (112). The simulation module (102) performs computational simulations of LLC resonant converter behavior under varying operating conditions including load and frequency variations. The parameter input unit (104) receives user-defined inputs such as resonant tank parameters, switching frequency, and input voltage values and preprocesses them for simulation. The resonant converter model unit (106) mathematically models the LLC resonant converter including inductors, capacitors, and switching elements for accurate representation. The control logic unit (108) regulates the switching sequence and operational modes of the converter based on the simulation requirements. The data processing unit (110) analyzes simulation outputs to derive performance metrics such as efficiency, voltage gain, and switching losses. The output visualization unit (112) displays graphical representations of simulation results including waveforms, efficiency plots, and operating regions. The invention enhances precision in simulation-based analysis of LLC resonant converters. The invention facilitates improved design efficiency and reduced development cost.

No. of Pages : 14 No. of Claims : 8

(12) PATENT APPLICATION PUBLICATION
(19) INDIA
(22) Date of filing of Application :06/04/2026
(21) Application No.202641043762 A
(43) Publication Date : 17/04/2026

(54) Title of the invention : A PASSIVE SOLAR TRACKING SYSTEM WITH INTEGRATED PYRAMIDAL OPTICAL CONCENTRATOR AND LOAD OPTIMIZATION ASSEMBLY

(51) International classification	:F24S 50/20, H02S 20/32, G05D 3/12, H01L 31/052, F24J 2/54	(71)**Name of Applicant :** **1)Dr.G.MUTHUSELVI** Address of Applicant :Associate Professor, Department of EEE, Annai Mira College of Engineering and Technology, NH-46, Chennai-Bengaluru National Highway, Arappakkam, Ranipet District, Vellore - 632517, Tamil Nadu, India. Email: amcetmuthuselvig@gmail.com Tamil Nadu India **2)Dr.V.SRIVIDHYA** **3)C.HARIHARAN**
(31) Priority Document No	:NA	(72)**Name of Inventor :**
(32) Priority Date	:NA	**1)C.HARIHARAN**
(33) Name of priority country	:NA	**2)Dr.V.SRIVIDHYA**
(86) International Application No Filing Date	: :01/01/1900	**3)Dr.G.MUTHUSELVI** **4)K.SANTHOSH KUMAR**
(87) International Publication No	: NA	**5)V.MAHESH KUMAR**
(61) Patent of Addition to Application Number Filing Date	:NA :NA	
(62) Divisional to Application Number Filing Date	:NA :NA	

(57) Abstract :
A passive solar tracking system (100) comprising, a solar panel assembly (102), a plurality of light dependent resistors (104), a dual low power audio amplifier integrated circuit TDA2822M (106), a DC geared motor (108), a pyramidal optical concentrator (110), a support frame structure (112), an auxiliary support wheel (114), and a rotational base assembly (116). The solar panel assembly (102) converts sunlight into electrical energy, the light dependent resistors (104) detect sunlight variation, and the integrated circuit (106) controls the DC geared motor (108) to orient the system. The pyramidal optical concentrator (110) enhances light capture, while the auxiliary support wheel (114) reduces friction. The invention enhances efficient solar tracking with reduced complexity and promotes improved energy generation with minimized mechanical load. The system is used for renewable energy applications. The input is sunlight intensity variation and the output is optimized solar panel alignment and enhanced energy generation.

No. of Pages : 17 No. of Claims : 9

(12) PATENT APPLICATION PUBLICATION
(19) INDIA
(22) Date of filing of Application :01/04/2026

(21) Application No.202641041747 A
(43) Publication Date : 29/05/2026

(54) Title of the invention : AN INTEGRATED RENEWABLE ENERGY SYSTEM UTILIZING SOLAR AND WIND POWER FOR HYDROGEN PRODUCTION

(51) International classification	:F03D 9/00, H02J 3/38, H02J 7/35, F03D 9/11, F03D 9/25
(31) Priority Document No	:NA
(32) Priority Date	:NA
(33) Name of priority country	:NA
(86) International Application No Filing Date	: :01/01/1900
(87) International Publication No	: NA
(61) Patent of Addition to Application Number Filing Date	:NA :NA
(62) Divisional to Application Number Filing Date	:NA :NA

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6)Rabilli Bhaskara Rao

(57) Abstract :
The system (100) includes a a solar energy generation unit (102), a wind energy generation unit (104), an energy conversion and conditioning unit (106), an electrolysis unit (108), a hydrogen storage unit (110), a control and monitoring unit (112), and a distribution interface unit (114). The solar energy generation unit (102) captures solar radiation and converts it into electrical energy using photovoltaic panels configured for maximum energy harvesting efficiency. The wind energy generation unit (104) converts kinetic energy from wind into electrical power using turbines designed to operate across varying wind speeds. The energy conversion and conditioning unit (106) regulates, stabilizes, and integrates power from the solar energy generation unit (102) and wind energy generation unit (104) to provide a consistent electrical output. The electrolysis unit (108) utilizes the conditioned electrical energy to split water into hydrogen and oxygen through an electrochemical process. The hydrogen storage unit (110) safely stores the generated hydrogen gas under controlled pressure and temperature conditions. The control and monitoring unit (112) manages system operations, monitors environmental and operational parameters, and optimizes energy utilization through automated control algorithms. The distribution interface unit (114) facilitates the transfer and utilization of stored hydrogen for downstream applications including fuel cells and industrial usage. The invention enhances clean energy integration and ensures sustainable hydrogen production. The invention promotes reduced carbon emissions and improved energy efficiency.

No. of Pages : 13 No. of Claims : 9

(12) PATENT APPLICATION PUBLICATION
(19) INDIA
(22) Date of filing of Application :25/03/2026

(21) Application No.202641036240 A
(43) Publication Date : 10/04/2026

(54) Title of the invention : AN IOT-BASED GAS LEAK DETECTION, ALERT, PREVENTION, AND CONTROL SYSTEM

(51) International classification	:G08B 17/10, F23N 5/24, G01N 33/00, G08B 21/16, G08B 17/117
(31) Priority Document No	:NA
(32) Priority Date	:NA
(33) Name of priority country	:NA
(86) International Application No Filing Date	: :01/01/1900
(87) International Publication No	: NA
(61) Patent of Addition to Application Number Filing Date	:NA :NA
(62) Divisional to Application Number Filing Date	:NA :NA

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7)YEDDULA GNANESHWARI
8)VADDADI TEJASWINI
9)MANNE SNEHA REDDY
10)SHAIK MAHIYA

(57) Abstract :
A system (100) comprising, a gas detection sensor module (102), a flame detection sensor module (104), a microcontroller processing unit (106), a communication module (108), a user interface module (110), a gas shut-off control unit (112), a ventilation control unit (114), an alert generation unit (116), and a cloud monitoring platform (118). The gas detection sensor module (102) senses gas concentration, and the flame detection sensor module (104) detects fire hazards. The microcontroller processing unit (106) processes sensor data and the communication module (108) transmits alerts. The user interface module (110) enables monitoring, while the gas shut-off control unit (112) and ventilation control unit (114) perform preventive actions. The alert generation unit (116) generates alarms and the cloud monitoring platform (118) manages data. The invention enhances real-time safety monitoring and automated hazard prevention. The invention facilitates rapid response to gas leaks and fire risks, improving overall safety.

No. of Pages : 15 No. of Claims : 10

(12) PATENT APPLICATION PUBLICATION
(19) INDIA
(22) Date of filing of Application :25/03/2026

(21) Application No.202641036025 A
(43) Publication Date : 10/04/2026

(54) Title of the invention : SYSTEM AND METHOD FOR PREDICTIVE PATIENT RISK STRATIFICATION USING MULTIMODAL HEALTH DATA

(51) International classification	:G16H 50/30, G16H 10/60, A61B 5/00, G16H 50/20, G06N 20/00	(71)**Name of Applicant :** **1)R.M.D.Engineering College** Address of Applicant :R.S.M Nagar, Kavaraipettai, Gummidipoondi Taluk, Thiruvallur District -601 206. Email: principal@rmd.ac.in Tamil Nadu India (72)**Name of Inventor :** **1)Dr.R.Sasikumar**
(31) Priority Document No	:NA	
(32) Priority Date	:NA	
(33) Name of priority country	:NA	
(86) International Application No Filing Date	: :01/01/1900	
(87) International Publication No	: NA	
(61) Patent of Addition to Application Number Filing Date	:NA :NA	
(62) Divisional to Application Number Filing Date	:NA :NA	

(57) Abstract :
The system (100) includes a data acquisition module (102), a data preprocessing module (104), a multimodal data integration engine (106), a feature extraction unit (108), a predictive analytics engine (110), a risk stratification module (112), an alert generation unit (114). The data acquisition module (102) collects multimodal health data from electronic health records, wearable devices, imaging systems, and laboratory databases. The data preprocessing module (104) cleans and normalizes data. The multimodal data integration engine (106) integrates heterogeneous datasets. The feature extraction unit (108) extracts relevant features. The predictive analytics engine (110) generates predictive risk scores. The risk stratification module (112) classifies patients. The alert generation unit (114) generates alerts. The invention enhances predictive accuracy and enables proactive healthcare interventions. The invention facilitates efficient integration and utilization of multimodal health data for improved patient care.

No. of Pages : 12 No. of Claims : 9

(12) PATENT APPLICATION PUBLICATION
(19) INDIA
(22) Date of filing of Application :25/03/2026

(21) Application No.202641036025 A
(43) Publication Date : 10/04/2026

(54) Title of the invention : SYSTEM AND METHOD FOR PREDICTIVE PATIENT RISK STRATIFICATION USING MULTIMODAL HEALTH DATA

(51) International classification	:G16H 50/30, G16H 10/60, A61B 5/00, G16H 50/20, G06N 20/00
(31) Priority Document No	:NA
(32) Priority Date	:NA
(33) Name of priority country	:NA
(86) International Application No Filing Date	: :01/01/1900
(87) International Publication No	: NA
(61) Patent of Addition to Application Number Filing Date	:NA :NA
(62) Divisional to Application Number Filing Date	:NA :NA

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(57) Abstract :
The system (100) includes a data acquisition module (102), a data preprocessing module (104), a multimodal data integration engine (106), a feature extraction unit (108), a predictive analytics engine (110), a risk stratification module (112), an alert generation unit (114). The data acquisition module (102) collects multimodal health data from electronic health records, wearable devices, imaging systems, and laboratory databases. The data preprocessing module (104) cleans and normalizes data. The multimodal data integration engine (106) integrates heterogeneous datasets. The feature extraction unit (108) extracts relevant features. The predictive analytics engine (110) generates predictive risk scores. The risk stratification module (112) classifies patients. The alert generation unit (114) generates alerts. The invention enhances predictive accuracy and enables proactive healthcare interventions. The invention facilitates efficient integration and utilization of multimodal health data for improved patient care.

No. of Pages : 12 No. of Claims : 9

(12) PATENT APPLICATION PUBLICATION
(19) INDIA
(22) Date of filing of Application :25/03/2026

(21) Application No.202621035960 A
(43) Publication Date : 22/05/2026

(54) Title of the invention : A System and Method for Delivering Voice-First Micro-Coaching Using Cloud-Based Intelligence on Wearable and Web Devices

(51) International classification	:G10L 15/22, G06F 3/16, G10L 15/30, G10L 17/22, G10L 15/26
(31) Priority Document No	:NA
(32) Priority Date	:NA
(33) Name of priority country	:NA
(86) International Application No Filing Date	: :01/01/1900
(87) International Publication No	: NA
(61) Patent of Addition to Application Number Filing Date	:NA :NA
(62) Divisional to Application Number Filing Date	:NA :NA

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(57) Abstract :
A system (100) for delivering voice-first micro-coaching using cloud-based intelligence on wearable and web devices comprising, a voice input module (102), a wearable device interface (104), a web interface module (106), a communication module (108), a cloud backend module (110), an API gateway unit (112), a serverless processing unit (114), an authentication module (116), a data storage module (118), an AI processing engine (120), a personalization module (122), an analytics module (124), and a response output module (126). The voice input module (102) captures user voice input from a smartwatch or web interface. The wearable device interface (104) provides a minimal voice-first interaction environment. The web interface module (106) provides visualization of insights and trends. The communication module (108) facilitates secure data transmission. The cloud backend module (110) manages operations. The API gateway unit (112) handles request routing. The serverless processing unit (114) processes requests dynamically. The authentication module (116) ensures secure access. The data storage module (118) stores user data. The AI processing engine (120) generates contextual responses. The personalization module (122) customizes responses. The analytics module (124) analyzes interaction data. The response output module (126) delivers concise micro-coaching responses. The invention enhances personalized, real-time coaching through voice-first interaction. The invention facilitates scalable, efficient, and context-aware assistance across wearable and web platforms.

No. of Pages : 22 No. of Claims : 9

(12) PATENT APPLICATION PUBLICATION
(19) INDIA
(22) Date of filing of Application :20/03/2026
(21) Application No.202641033742 A
(43) Publication Date : 27/03/2026

(54) Title of the invention : AN INDUCTIVELY COUPLED DSTATCOM-BASED SYSTEM FOR IMPROVING POWER QUALITY IN ELECTRICAL DISTRIBUTION NETWORKS

(51) International classification	:G01R 21/133, H02J 3/01, H02J 3/18, G01R 21/06, G01R 21/00	(71)**Name of Applicant :** **1)Dr.K.Praveen Kumar Yadav** Address of Applicant :Assistant Professor, Department of Electrical and Electronics Engineering, Lendi Institute of Engineering and Technology, Vizianagaram, Andhra Pradesh-535005. Email: praveen263@gmail.com Andhra Pradesh India **2)M.Divya** **3)R.Mounika**
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(32) Priority Date	:NA	**5)P.Nikhil**
(33) Name of priority country	:NA	**6)M.V.Suresh Kumar**
(86) International Application No Filing Date	: :01/01/1900	(72)**Name of Inventor :** **1)Dr.K.Praveen Kumar Yadav**
(87) International Publication No	: NA	**2)M.Divya**
(61) Patent of Addition to Application Number Filing Date	:NA :NA	**3)R.Mounika** **4)M.Indraja**
(62) Divisional to Application Number Filing Date	:NA :NA	**5)P.Nikhil** **6)M.V.Suresh Kumar**

(57) Abstract :
A system (100) comprising a voltage and current sensing unit (102), a signal conditioning and measurement unit (104), a harmonic and reactive power detection unit (106), a control processing unit (108), an inductive coupling interface module (110), a voltage source converter unit (112), a DC link energy storage unit (114). The voltage and current sensing unit (102) receives electrical parameters from the distribution network and converts them into measurable signals for further processing. The signal conditioning and measurement unit (104) filters and conditions the sensed signals to obtain accurate electrical measurements suitable for digital processing. The harmonic and reactive power detection unit (106) analyzes the conditioned signals to identify harmonic components and reactive power requirements within the distribution network. The control processing unit (108) determines compensation requirements based on detected harmonics, voltage disturbances, and reactive power imbalance. The inductive coupling interface module (110) provides electrical isolation and inductive coupling between the distribution network and the compensation system. The voltage source converter unit (112) generates compensating voltage signals required for reactive power support and harmonic mitigation. The DC link energy storage unit (114) maintains a stable DC voltage required for proper operation of the voltage source converter. The invention enhances voltage stability and facilitates efficient harmonic suppression in electrical distribution networks. The invention promotes improved reactive power compensation and overall power quality performance.

No. of Pages : 16 No. of Claims : 9

Design Patent Registration – ICIPRRDAC 2026

The design patent concepts/designs submitted by the participants of **ICIPRRDAC 2026** were received, processed, and associated with our IPR facilitation and support. The respective design applications were filed before the **Indian Intellectual Property Office (IP India)**, and the registration certificates were subsequently obtained for the eligible designs.

The details of the registered design patents are presented in the following table for official record and recognition

Table: Design Patent Applications Filed and Registered through IPR Facilitation Support under **ICIPRRDAC 2026**

S.No	Title of Design	Design Application No.	Filing Date	Accepted Date
01	INTERACTIVE AI CODING BOT WITH LEARNING PROGRESS VISUALIZER	494423-001	12.03.2026	**20.08.2026**
02	AI-ENABLED WEARABLE MULTISENSOR DEVICE FOR ENVIRONMENTAL MONITORING	495660-001	21.03.2026	**21.05.2026**
03	PORTABLE TABLET DEVICE FOR HEALTH DIAGNOSTICS	496783-001	31.03.2026	**02.06.2026**
04	DEVICE FOR DETECTING NEUROLOGICAL DISORDERS	498459-001	14.04.2026	**20.08.2026**
05	AI-CONTROLLED SMART INVERTER WITH INTERACTIVE TOUCH PANEL FOR SOLAR PV APPLICATIONS	499490-001	25.04.2026	**30.07.2026**
06	VOICE RECOGNITION BASED SMART TV CONTROLLER	500266-001	30.04.2026	**23.06.2026**
07	AI BASED DATA ANALYTICS AND PREDICTIVE DEVICE	505657-001	14.06.2026	**12.08.2026**
08	ML -BASED NETWORK LOAD BALANCING CONTROLLER	507451-001	29.06.2026	**30.07.2026**
09	SMART CASH MANAGEMENT DEVICE	509098-001	12.07.2026	**31.08.2026**
10	VACCINE STORAGE MANAGEMENT DEVICE	509756-001	17.07.2026	**09.09.2026**
11	HONEY PROCESSING AND TESTING DEVICE	510258-001	21.07.2026	**02.09.2026**
12	AI DRIVEN 6G WIRELESS COMMUNICATION MODULE	513375-001	12.08.2026	**23.09.2026**
13	INTELLIGENT NETWORK GATEWAY	514218-001	18.08.2026	**24.09.2026**
14	AI POWERED WIRELESS ROUTE	514602-001	20.08.2026	**29.09.2026**

LIST OF 3D DIADRAM DESIGNS

1.INTERACTIVE AI CODING BOT WITH LEARNING PROGRESS VISUALIZER



2.AI-ENABLED WEARABLE MULTISENSOR DEVICE FOR ENVIRONMENTAL MONITORING



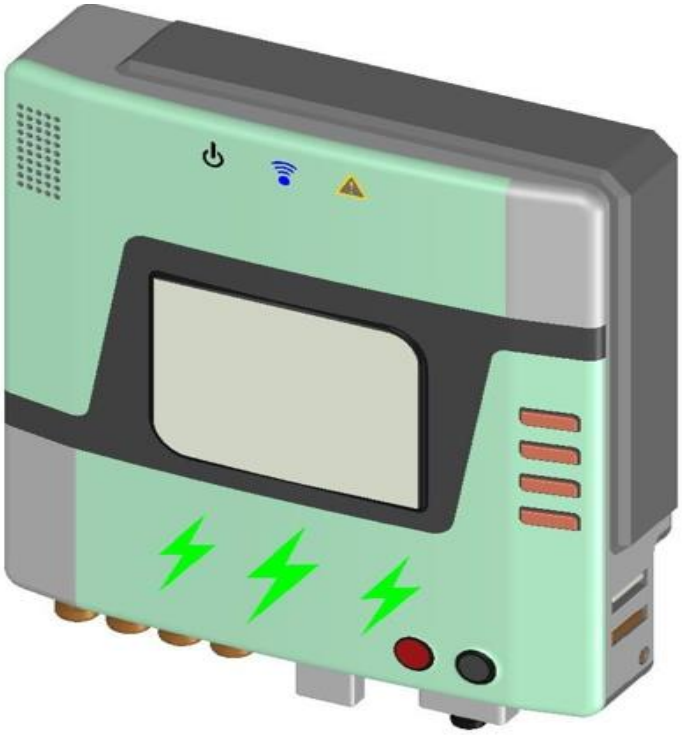
3.PORTABLE TABLET DEVICE FOR HEALTH DIAGNOSTICS



4.DEVICE FOR DETECTING NEUROLOGICAL DISORDERS



5.AI-CONTROLLED SMART INVERTER WITH INTERACTIVE TOUCH PANEL FOR SOLAR PV APPLICATIONS



6.VOICE RECOGNITION BASED SMART TV CONTROLLER



7.AI BASED DATA ANALYTICS AND PREDICTIVE DEVICE



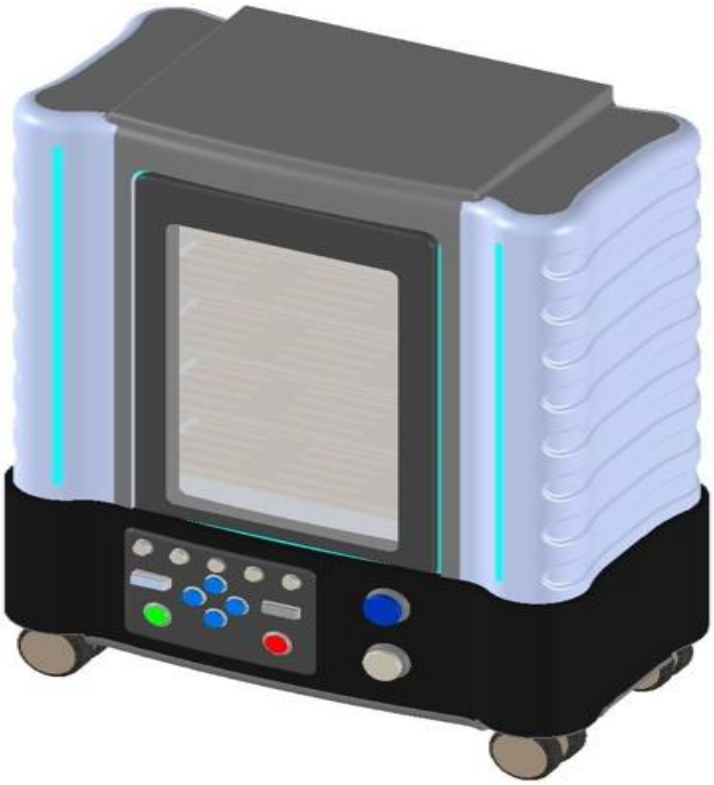
8.ML -BASED NETWORK LOAD BALANCING CONTROLLER



9.SMART CASH MANAGEMENT DEVICE



10.VACCINE STORAGE MANAGEMENT DEVICE



11.HONEY PROCESSING AND TESTING DEVICE



12.AI DRIVEN 6G WIRELESS COMMUNICATION MODULE



13.INTELLIGENT NETWORK GATEWAY



LIST OF DESIGN REGISTRATION CERTIFICATES

INTELLECTUAL PROPERTY INDIA
PATENTS | DESIGNS | TRADE MARKS
GEOGRAPHICAL INDICATIONS

सत्यमेव जयते

ORIGINAL
क्रम सं/ Serial No. : 249872

पेटेंट कार्यालय, भारत सरकार **The Patent Office, Government Of India**

डिजाइन के पंजीकरण का प्रमाण पत्र | Certificate of Registration of Design

डिजाइन सं. / Design No. : 494423-001

तारीख / Date : 12/03/2026

पारस्परिकता तारीख / Reciprocity Date* :

देश / Country :

प्रमाणित किया जाता है कि संलग्न प्रति में वर्णित डिजाइन जो *AI BASED INTERACTIVE CODING DEVICE* से संबंधित है, का पंजीकरण, श्रेणी 14-02 में 1.Dr.M.Kiruthika 2. Dr.B.Subashini 3.Dr.Sudha Rajesh 4.Dr.A.K.Reshmy 5.Dr.R.Usharani 6.Dr.Anna Anbumozhi के नाम में उपर्युक्त संख्या और तारीख में कर लिया गया है।

Certified that the design of which a copy is annexed hereto has been registered as of the number and date given above in class 14-02 in respect of the application of such design to *AI BASED INTERACTIVE CODING DEVICE* in the name of 1.Dr.M.Kiruthika 2. Dr.B.Subashini 3.Dr.Sudha Rajesh 4.Dr.A.K.Reshmy 5.Dr.R.Usharani 6.Dr.Anna Anbumozhi.

डिजाइन अधिनियम, 2000 तथा डिजाइन नियम, 2001 के अध्यधीन प्रावधानों के अनुसरण में।
In pursuance of and subject to the provisions of the Designs Act, 2000 and the Designs Rules, 2001.

जारी करने की तिथि : 20/08/2026
Date of Issue :

महानियंत्रक पेटेंट, डिजाइन और व्यापार चिह्न
Controller General of Patents, Designs and Trade Marks

*पारस्परिकता तारीख (यदि कोई हो) जिसकी अनुमति दी गई है तथा देश का नाम। डिजाइन का स्वत्वाधिकार पंजीकरण की तारीख से दस वर्षों के लिए होगा जिसका विस्तार, अधिनियम एवं नियम के निबंधनों के अधीन, पाँच वर्षों की अतिरिक्त अवधि के लिए किया जा सकेगा। इस प्रमाण पत्र का उपयोग विधिक कार्यवाहियों अथवा विदेश में पंजीकरण प्राप्त करने के लिए नहीं हो सकता है।

The reciprocity date (if any) which has been allowed and the name of the country. Copyright in the design will subsist for ten years from the date of Registration, and may under the terms of the Act and Rules, be extended for a further period of five years. This Certificate is not for use in legal proceedings or for obtaining registration abroad.

INTELLECTUAL PROPERTY INDIA
PATENTS | DESIGNS | TRADE MARKS
GEOGRAPHICAL INDICATIONS

सत्यमेव जयते

ORIGINAL

क्रम सं/ Serial No. : 233977

पेटेंट कार्यालय, भारत सरकार | The Patent Office, Government Of India

डिजाइन के पंजीकरण का प्रमाण पत्र | Certificate of Registration of Design

डिजाइन सं. / Design No. : 495660-001

तारीख / Date : 21/03/2026

पारस्परिकता तारीख / Reciprocity Date* :

देश / Country :

प्रमाणित किया जाता है कि संलग्न प्रति में वर्णित डिजाइन जो *AI-ENABLED WEARABLE MULTISENSOR DEVICE FOR ENVIRONMENTAL MONITORING* से संबंधित है, का पंजीकरण, श्रेणी 10-04 में 1.Dr.Suresh Annamalai 2. Dr.M.Babu 3.Dr.C.Vijayakumaran 4.Dr.K.Deepa Thilak 5.Dr.K.Kalaiselvi 6.Dr.Manickam.M के नाम में उपर्युक्त संख्या और तारीख में कर लिया गया है।

Certified that the design of which a copy is annexed hereto has been registered as of the number and date given above in class 10-04 in respect of the application of such design to *AI-ENABLED WEARABLE MULTISENSOR DEVICE FOR ENVIRONMENTAL MONITORING* in the name of 1.Dr.Suresh Annamalai 2. Dr.M.Babu 3.Dr.C.Vijayakumaran 4.Dr.K.Deepa Thilak 5.Dr.K.Kalaiselvi 6.Dr.Manickam.M.

डिजाइन अधिनियम, 2000 तथा डिजाइन नियम, 2001 के अध्यधीन प्रावधानों के अनुसरण में।

In pursuance of and subject to the provisions of the Designs Act, 2000 and the Designs Rules, 2001.

जारी करने की तिथि : 21/05/2026
Date of Issue :

महानियंत्रक पेटेंट, डिजाइन और व्यापार चिह्न
Controller General of Patents, Designs and Trade Marks

*पारस्परिकता तारीख (यदि कोई हो) जिसकी अनुमति दी गई है तथा देश का नाम। डिजाइन का स्वत्वाधिकार पंजीकरण की तारीख से दस वर्षों के लिए होगा जिसका विस्तार, अधिनियम एवं नियम के निबंधनों के अधीन, पाँच वर्षों की अतिरिक्त अवधि के लिए किया जा सकेगा। इस प्रमाण पत्र का उपयोग विधिक कार्यवाहियों अथवा विदेश में पंजीकरण प्राप्त करने के लिए नहीं हो सकता है।

The reciprocity date (if any) which has been allowed and the name of the country. Copyright in the design will subsist for ten years from the date of Registration, and may under the terms of the Act and Rules, be extended for a further period of five years. This Certificate is not for use in legal proceedings or for obtaining registration abroad.

INTELLECTUAL PROPERTY INDIA
PATENTS | DESIGNS | TRADE MARKS
GEOGRAPHICAL INDICATIONS

सत्यमेव जयते

ORIGINAL

क्रम सं/ Serial No. : 235308

पेटेंट कार्यालय, भारत सरकार | The Patent Office, Government Of India

डिजाइन के पंजीकरण का प्रमाण पत्र | Certificate of Registration of Design

डिजाइन सं. / Design No.	:	496783-001
तारीख / Date	:	31/03/2026
पारस्परिकता तारीख / Reciprocity Date*	:	
देश / Country	:	

प्रमाणित किया जाता है कि संलग्न प्रति में वर्णित डिजाइन जो *PORTABLE TABLET DEVICE FOR HEALTH DIAGNOSTICS* से संबंधित है, का पंजीकरण, श्रेणी 24-01 में 1.Dr.N.Jagadish Kumar 2. Dr.G.Elangovan 3.Dr.K.Rajkumar 4.Dr.M.Ramprasath 5.Mr.Logeshwaran.R के नाम में उपर्युक्त संख्या और तारीख में कर लिया गया है।

Certified that the design of which a copy is annexed hereto has been registered as of the number and date given above in class 24-01 in respect of the application of such design to *PORTABLE TABLET DEVICE FOR HEALTH DIAGNOSTICS* in the name of 1.Dr.N.Jagadish Kumar 2. Dr.G.Elangovan 3.Dr.K.Rajkumar 4.Dr.M.Ramprasath 5.Mr.Logeshwaran.R.

डिजाइन अधिनियम, 2000 तथा डिजाइन नियम, 2001 के अध्यधीन प्रावधानों के अनुसरण में।
In pursuance of and subject to the provisions of the Designs Act, 2000 and the Designs Rules, 2001.

जारी करने की तिथि : 02/06/2026
Date of Issue :

उन्नत पेटेंट कार्यालय, भारत सरकार

महानियंत्रक पेटेंट, डिजाइन और व्यापार चिह्न
Controller General of Patents, Designs and Trade Marks

*पारस्परिकता तारीख (यदि कोई हो) जिसकी अनुमति दी गई है तथा देश का नाम। डिजाइन का स्वत्वाधिकार पंजीकरण की तारीख से दस वर्षों के लिए होगा जिसका विस्तार, अधिनियम एवं नियम के निबंधनों के अधीन, पाँच वर्षों की अतिरिक्त अवधि के लिए किया जा सकेगा। इस प्रमाण पत्र का उपयोग विधिक कार्यवाहियों अथवा विदेश में पंजीकरण प्राप्त करने के लिए नहीं हो सकता है।

The reciprocity date (if any) which has been allowed and the name of the country. Copyright in the design will subsist for ten years from the date of Registration, and may under the terms of the Act and Rules, be extended for a further period of five years. This Certificate is not for use in legal proceedings or for obtaining registration abroad.

INTELLECTUAL PROPERTY INDIA
PATENTS | DESIGNS | TRADE MARKS
GEOGRAPHICAL INDICATIONS

सत्यमेव जयते

ORIGINAL

क्रम सं/ Serial No. : 249322

पेटेंट कार्यालय, भारत सरकार The Patent Office, Government Of India

डिजाइन के पंजीकरण का प्रमाण पत्र | Certificate of Registration of Design

डिजाइन सं. / Design No. : 498459-001

तारीख / Date : 14/04/2026

पारस्परिकता तारीख / Reciprocity Date* :

देश / Country :

प्रमाणित किया जाता है कि संलग्न प्रति में वर्णित डिजाइन जो *DEVICE FOR DETECTING NEUROLOGICAL DISORDERS* से संबंधित है, का पंजीकरण, श्रेणी 24-01 में 1.Dr.N.Jagadish Kumar 2. Mr.Sumanth S 3.Mr.S.L.V.Hemanth Kumar 4.Mr.Trinadh Bhavanasi 5.Mr.Varun Raj P 6.Mr.Manas Thondepu के नाम में उपर्युक्त संख्या और तारीख में कर लिया गया है।

Certified that the design of which a copy is annexed hereto has been registered as of the number and date given above in class 24-01 in respect of the application of such design to *DEVICE FOR DETECTING NEUROLOGICAL DISORDERS* in the name of 1.Dr.N.Jagadish Kumar 2. Mr.Sumanth S 3.Mr.S.L.V.Hemanth Kumar 4.Mr.Trinadh Bhavanasi 5.Mr.Varun Raj P 6.Mr.Manas Thondepu.

डिजाइन अधिनियम, 2000 तथा डिजाइन नियम, 2001 के अध्यधीन प्रावधानों के अनुसरण में।

In pursuance of and subject to the provisions of the Designs Act, 2000 and the Designs Rules, 2001.

जारी करने की तिथि : 19/08/2026
Date of Issue :

उन्नाम पद्मिड

महानियंत्रक पेटेंट, डिजाइन और व्यापार चिह्न
Controller General of Patents, Designs and Trade Marks

*पारस्परिकता तारीख (यदि कोई हो) जिसकी अनुमति दी गई है तथा देश का नाम। डिजाइन का स्वत्वाधिकार पंजीकरण की तारीख से दस वर्षों के लिए होगा जिसका विस्तार, अधिनियम एवं नियम के निबंधनों के अधीन, पाँच वर्षों की अतिरिक्त अवधि के लिए किया जा सकेगा। इस प्रमाण पत्र का उपयोग विधिक कार्यवाहियों अथवा विदेश में पंजीकरण प्राप्त करने के लिए नहीं हो सकता है।

The reciprocity date (if any) which has been allowed and the name of the country. Copyright in the design will subsist for ten years from the date of Registration, and may under the terms of the Act and Rules, be extended for a further period of five years. This Certificate is not for use in legal proceedings or for obtaining registration abroad.

INTELLECTUAL PROPERTY INDIA
PATENTS | DESIGNS | TRADE MARKS
GEOGRAPHICAL INDICATIONS

सत्यमेव जयते

ORIGINAL
क्रम सं/ Serial No. : 246307

पेटेंट कार्यालय, भारत सरकार The Patent Office, Government Of India

डिजाइन के पंजीकरण का प्रमाण पत्र | Certificate of Registration of Design

डिजाइन सं. / Design No.	:	499490-001
तारीख / Date	:	25/04/2026
पारस्परिकता तारीख / Reciprocity Date*	:	
देश / Country	:	

प्रमाणित किया जाता है कि संलग्न प्रति में वर्णित डिजाइन जो *AI-CONTROLLED SMART INVERTER WITH INTERACTIVE TOUCH PANEL FOR SOLAR PV APPLICATIONS* से संबंधित है, का पंजीकरण, श्रेणी 13-01 में 1.Dr.Patchamatla Satyanarayana Raju 2. Mr.B.Srinivas 3.Dr.A.Gopichandh 4.Dr.Francis Luther King M 5.Mr.Veerendra kumar Gogulamanda 6.Mrs.Veera Sri Lakshmi 7.Mr.L.Ravikishore 8.Ch.Harish kumar के नाम में उपर्युक्त संख्या और तारीख में कर लिया गया है।

Certified that the design of which a copy is annexed hereto has been registered as of the number and date given above in class 13-01 in respect of the application of such design to *AI-CONTROLLED SMART INVERTER WITH INTERACTIVE TOUCH PANEL FOR SOLAR PV APPLICATIONS* in the name of 1.Dr.Patchamatla Satyanarayana Raju 2. Mr.B.Srinivas 3.Dr.A.Gopichandh 4.Dr.Francis Luther King M 5.Mr.Veerendra kumar Gogulamanda 6.Mrs.Veera Sri Lakshmi 7.Mr.L.Ravikishore 8.Ch.Harish kumar.

डिजाइन अधिनियम, 2000 तथा डिजाइन नियम, 2001 के अध्यधीन प्रावधानों के अनुसरण में।
In pursuance of and subject to the provisions of the Designs Act, 2000 and the Designs Rules, 2001.

जारी करने की तिथि : 30/07/2026
Date of Issue :

उमा शंकर पंडित
महानियंत्रक पेटेंट, डिजाइन और व्यापार चिह्न
Controller General of Patents, Designs and Trade Marks

*पारस्परिकता तारीख (यदि कोई हो) जिसकी अनुमति दी गई है तथा देश का नाम। डिजाइन का स्वत्वाधिकार पंजीकरण की तारीख से दस वर्षों के लिए होगा जिसका विस्तार, अधिनियम एवं नियम के निबंधनों के अधीन, पाँच वर्षों की अतिरिक्त अवधि के लिए किया जा सकेगा। इस प्रमाण पत्र का उपयोग विधिक कार्यवाहियों अथवा विदेश में पंजीकरण प्राप्त करने के लिए नहीं हो सकता है।

The reciprocity date (if any) which has been allowed and the name of the country. Copyright in the design will subsist for ten years from the date of Registration, and may under the terms of the Act and Rules, be extended for a further period of five years. This Certificate is not for use in legal proceedings or for obtaining registration abroad.

INTELLECTUAL PROPERTY INDIA
PATENTS | DESIGNS | TRADE MARKS
GEOGRAPHICAL INDICATIONS

सत्यमेव जयते

ORIGINAL

क्रम सं/ Serial No. : 238790

पेटेंट कार्यालय, भारत सरकार | The Patent Office, Government Of India

डिजाइन के पंजीकरण का प्रमाण पत्र | Certificate of Registration of Design

डिजाइन सं. / Design No. : 500266-001

तारीख / Date : 30/04/2026

पारस्परिकता तारीख / Reciprocity Date* :

देश / Country :

प्रमाणित किया जाता है कि संलग्न प्रति में वर्णित डिजाइन जो *VOICE RECOGNITION BASED SMART TV CONTROLLER* से संबंधित है, का पंजीकरण, श्रेणी 14-03 में 1.Dr.SURESH MURUGESAN 2. Mrs.GAYATHRI MURUGAVEL 3.DR.HANISHKANTHRAJA GANESHRAJA 4.Dr.VENKATESAN NALLU 5.Dr.VINCENT GNANAPRAGASAM 6.Mrs.SANMATHI SAMINATHAN के नाम में उपर्युक्त संख्या और तारीख में कर लिया गया है।

Certified that the design of which a copy is annexed hereto has been registered as of the number and date given above in class 14-03 in respect of the application of such design to *VOICE RECOGNITION BASED SMART TV CONTROLLER* in the name of 1.Dr.SURESH MURUGESAN 2. Mrs.GAYATHRI MURUGAVEL 3.DR.HANISHKANTHRAJA GANESHRAJA 4.Dr.VENKATESAN NALLU 5.Dr.VINCENT GNANAPRAGASAM 6.Mrs.SANMATHI SAMINATHAN.

डिजाइन अधिनियम, 2000 तथा डिजाइन नियम, 2001 के अध्यधीन प्रावधानों के अनुसरण में।

In pursuance of and subject to the provisions of the Designs Act, 2000 and the Designs Rules, 2001.

जारी करने की तिथि : 23/06/2026
Date of Issue :

उमा शं. पंडित
महानियंत्रक पेटेंट, डिजाइन और व्यापार चिह्न
Controller General of Patents, Designs and Trade Marks

*पारस्परिकता तारीख (यदि कोई हो) जिसकी अनुमति दी गई है तथा देश का नाम। डिजाइन का स्वत्वाधिकार पंजीकरण की तारीख से दस वर्षों के लिए होगा जिसका विस्तार, अधिनियम एवं नियम के निबंधनों के अधीन, पाँच वर्षों की अतिरिक्त अवधि के लिए किया जा सकेगा। इस प्रमाण पत्र का उपयोग विधिक कार्यवाहियों अथवा विदेश में पंजीकरण प्राप्त करने के लिए नहीं हो सकता है।

The reciprocity date (if any) which has been allowed and the name of the country. Copyright in the design will subsist for ten years from the date of Registration, and may under the terms of the Act and Rules, be extended for a further period of five years. This Certificate is not for use in legal proceedings or for obtaining registration abroad.

INTELLECTUAL PROPERTY INDIA
PATENTS | DESIGNS | TRADE MARKS
GEOGRAPHICAL INDICATIONS

सत्यमेव जयते

ORIGINAL
क्रम सं/ Serial No. : 248325

पेटेंट कार्यालय, भारत सरकार | The Patent Office, Government Of India

डिजाइन के पंजीकरण का प्रमाण पत्र | Certificate of Registration of Design

डिजाइन सं. / Design No. : 505657-001

तारीख / Date : 14/06/2026

पारस्परिकता तारीख / Reciprocity Date* :

देश / Country :

प्रमाणित किया जाता है कि संलग्न प्रति में वर्णित डिजाइन जो *AI BASED DATA ANALYTICS AND PREDICTIVE DEVICE* से संबंधित है, का पंजीकरण, श्रेणी 14-02 में 1.Bhuvana Jayabalan 2. Saravanan N 3.Dr.M.Santhalakshmi 4.Neetha S S के नाम में उपर्युक्त संख्या और तारीख में कर लिया गया है।

Certified that the design of which a copy is annexed hereto has been registered as of the number and date given above in class 14-02 in respect of the application of such design to *AI BASED DATA ANALYTICS AND PREDICTIVE DEVICE* in the name of 1.Bhuvana Jayabalan 2. Saravanan N 3.Dr.M.Santhalakshmi 4.Neetha S S.

डिजाइन अधिनियम, 2000 तथा डिजाइन नियम, 2001 के अध्यधीन प्रावधानों के अनुसरण में।
In pursuance of and subject to the provisions of the Designs Act, 2000 and the Designs Rules, 2001.

पेटेंट कार्यालय, भारत सरकार
The Patent Office, Government Of India
सत्यमेव जयते

उन्नाव पंडित

जारी करने की तिथि : 12/08/2026
Date of Issue :

महानियंत्रक पेटेंट, डिजाइन और व्यापार चिह्न
Controller General of Patents, Designs and Trade Marks

*पारस्परिकता तारीख (यदि कोई हो) जिसकी अनुमति दी गई है तथा देश का नाम। डिजाइन का स्वत्वाधिकार पंजीकरण की तारीख से दस वर्षों के लिए होगा जिसका विस्तार, अधिनियम एवं नियम के निबंधनों के अधीन, पाँच वर्षों की अतिरिक्त अवधि के लिए किया जा सकेगा। इस प्रमाण पत्र का उपयोग विधिक कार्यवाहियों अथवा विदेश में पंजीकरण प्राप्त करने के लिए नहीं हो सकता है।

The reciprocity date (if any) which has been allowed and the name of the country. Copyright in the design will subsist for ten years from the date of Registration, and may under the terms of the Act and Rules, be extended for a further period of five years. This Certificate is not for use in legal proceedings or for obtaining registration abroad.

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सत्यमेव जयते

ORIGINAL

क्रम सं/ Serial No. : 246601

पेटेंट कार्यालय, भारत सरकार | The Patent Office, Government Of India

डिजाइन के पंजीकरण का प्रमाण पत्र | Certificate of Registration of Design

डिजाइन सं. / Design No.	:	507451-001
तारीख / Date	:	29/06/2026
पारस्परिकता तारीख / Reciprocity Date*	:	
देश / Country	:	

प्रमाणित किया जाता है कि संलग्न प्रति में वर्णित डिजाइन जो *ML -BASED NETWORK LOAD BALANCING CONTROLLER* से संबंधित है, का पंजीकरण, श्रेणी 14-02 में 1.Arthi.P 2. T.S.Sindhu 3.Shivagami.S 4.K.Malathy 5.Swapna.S 6.Dr.M.Kumar के नाम में उपर्युक्त संख्या और तारीख में कर लिया गया है।

Certified that the design of which a copy is annexed hereto has been registered as of the number and date given above in class 14-02 in respect of the application of such design to *ML -BASED NETWORK LOAD BALANCING CONTROLLER* in the name of 1.Arthi.P 2. T.S.Sindhu 3.Shivagami.S 4.K.Malathy 5.Swapna.S 6.Dr.M.Kumar.

डिजाइन अधिनियम, 2000 तथा डिजाइन नियम, 2001 के अध्यधीन प्रावधानों के अनुसरण में।
In pursuance of and subject to the provisions of the Designs Act, 2000 and the Designs Rules, 2001.

जारी करने की तिथि : 30/07/2026
Date of Issue :

उन्नत पंडित
महानियंत्रक पेटेंट, डिजाइन और व्यापार चिह्न
Controller General of Patents, Designs and Trade Marks

*पारस्परिकता तारीख (यदि कोई हो) जिसकी अनुमति दी गई है तथा देश का नाम। डिजाइन का स्वत्वाधिकार पंजीकरण की तारीख से दस वर्षों के लिए होगा जिसका विस्तार, अधिनियम एवं नियम के निबंधनों के अधीन, पाँच वर्षों की अतिरिक्त अवधि के लिए किया जा सकेगा। इस प्रमाण पत्र का उपयोग विधिक कार्यवाहियों अथवा विदेश में पंजीकरण प्राप्त करने के लिए नहीं हो सकता है।

The reciprocity date (if any) which has been allowed and the name of the country. Copyright in the design will subsist for ten years from the date of Registration, and may under the terms of the Act and Rules, be extended for a further period of five years. This Certificate is not for use in legal proceedings or for obtaining registration abroad.

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ORIGINAL

क्रम सं/ Serial No. : 251253

पेटेंट कार्यालय, भारत सरकार | The Patent Office, Government Of India

डिजाइन के पंजीकरण का प्रमाण पत्र | Certificate of Registration of Design

डिजाइन सं. / Design No. : 509098-001

तारीख / Date : 12/07/2026

पारस्परिकता तारीख / Reciprocity Date* :

देश / Country :

प्रमाणित किया जाता है कि संलग्न प्रति में वर्णित डिजाइन जो *SMART CASH MANAGEMENT DEVICE* से संबंधित है, का पंजीकरण, श्रेणी 19-02 में 1.Dr. SURESH MURUGESAN 2. Dr. DHIVYA BHARATHI RAJU 3.Dr. VENKATESAN NALLU 4.Mrs. SANMATHI SAMINATHAN 5.Dr. SARADHA JAYAPALAN 6.Dr. NALINI VEERACHAMY के नाम में उपर्युक्त संख्या और तारीख में कर लिया गया है।

Certified that the design of which a copy is annexed hereto has been registered as of the number and date given above in class 19-02 in respect of the application of such design to *SMART CASH MANAGEMENT DEVICE* in the name of 1.Dr. SURESH MURUGESAN 2. Dr. DHIVYA BHARATHI RAJU 3.Dr. VENKATESAN NALLU 4.Mrs. SANMATHI SAMINATHAN 5.Dr. SARADHA JAYAPALAN 6.Dr. NALINI VEERACHAMY.

डिजाइन अधिनियम, 2000 तथा डिजाइन नियम, 2001 के अध्यधीन प्रावधानों के अनुसरण में।

In pursuance of and subject to the provisions of the Designs Act, 2000 and the Designs Rules, 2001.

जारी करने की तिथि : 31/08/2026
Date of Issue :

उन्नत पंडित

महानियंत्रक पेटेंट, डिजाइन और व्यापार चिह्न
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The reciprocity date (if any) which has been allowed and the name of the country. Copyright in the design will subsist for ten years from the date of Registration, and may under the terms of the Act and Rules, be extended for a further period of five years. This Certificate is not for use in legal proceedings or for obtaining registration abroad.

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ORIGINAL
क्रम सं/ Serial No. : 253110

पेटेंट कार्यालय, भारत सरकार The Patent Office, Government Of India

डिजाइन के पंजीकरण का प्रमाण पत्र | Certificate of Registration of Design

डिजाइन सं. / Design No.	:	509756-001
तारीख / Date	:	17/07/2026
पारस्परिकता तारीख / Reciprocity Date*	:	
देश / Country	:	

प्रमाणित किया जाता है कि संलग्न प्रति में वर्णित डिजाइन जो *VACCINE STORAGE MANAGEMENT DEVICE* से संबंधित है, का पंजीकरण, श्रेणी 24-01 में 1.Dr.S.Jayaraman 2. Dr.S.Gnanaprakesh 3.Ms.S.Soundarya 4.Mr.R.Karthik 5.Dr.Brindha Natarajan 6.Dr.N.Sharly Elgal 7.Dr.Roja Babu के नाम में उपर्युक्त संख्या और तारीख में कर लिया गया है।

Certified that the design of which a copy is annexed hereto has been registered as of the number and date given above in class 24-01 in respect of the application of such design to *VACCINE STORAGE MANAGEMENT DEVICE* in the name of 1.Dr.S.Jayaraman 2. Dr.S.Gnanaprakesh 3.Ms.S.Soundarya 4.Mr.R.Karthik 5.Dr.Brindha Natarajan 6.Dr.N.Sharly Elgal 7.Dr.Roja Babu.

डिजाइन अधिनियम, 2000 तथा डिजाइन नियम, 2001 के अध्यधीन प्रावधानों के अनुसरण में।

In pursuance of and subject to the provisions of the Designs Act, 2000 and the Designs Rules, 2001.

जारी करने की तिथि : 09/09/2026
Date of Issue :

महानियंत्रक पेटेंट, डिजाइन और व्यापार चिह्न
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*पारस्परिकता तारीख (यदि कोई हो) जिसकी अनुमति दी गई है तथा देश का नाम। डिजाइन का स्वत्वाधिकार पंजीकरण की तारीख से दस वर्षों के लिए होगा जिसका विस्तार, अधिनियम एवं नियम के निबंधनों के अधीन, पाँच वर्षों की अतिरिक्त अवधि के लिए किया जा सकेगा। इस प्रमाण पत्र का उपयोग विधिक कार्यवाहियों अथवा विदेश में पंजीकरण प्राप्त करने के लिए नहीं हो सकता है।

The reciprocity date (if any) which has been allowed and the name of the country. Copyright in the design will subsist for ten years from the date of Registration, and may under the terms of the Act and Rules, be extended for a further period of five years. This Certificate is not for use in legal proceedings or for obtaining registration abroad.

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सत्यमेव जयते

ORIGINAL
क्रम सं/ Serial No. : 251557

पेटेंट कार्यालय, भारत सरकार | The Patent Office, Government Of India

डिजाइन के पंजीकरण का प्रमाण पत्र | Certificate of Registration of Design

डिजाइन सं. / Design No. : 510258-001

तारीख / Date : 21/07/2026

पारस्परिकता तारीख / Reciprocity Date* :

देश / Country :

प्रमाणित किया जाता है कि संलग्न प्रति में वर्णित डिजाइन जो *HONEY PROCESSING AND TESTING DEVICE* से संबंधित है, का पंजीकरण, श्रेणी 31-00 में 1.Ms.S.Soundarya 2. Dr.Suresh Murugesan 3.Mr.P.Sindhu 4.Mr.R.Karthik 5.Dr.Brindha Natarajan 6.Dr.R.Uma Maheswari 7.Dr.Roja Babu के नाम में उपर्युक्त संख्या और तारीख में कर लिया गया है।

Certified that the design of which a copy is annexed hereto has been registered as of the number and date given above in class 31-00 in respect of the application of such design to *HONEY PROCESSING AND TESTING DEVICE* in the name of 1.Ms.S.Soundarya 2. Dr.Suresh Murugesan 3.Mr.P.Sindhu 4.Mr.R.Karthik 5.Dr.Brindha Natarajan 6.Dr.R.Uma Maheswari 7.Dr.Roja Babu.

डिजाइन अधिनियम, 2000 तथा डिजाइन नियम, 2001 के अध्यधीन प्रावधानों के अनुसरण में।

In pursuance of and subject to the provisions of the Designs Act, 2000 and the Designs Rules, 2001.

जारी करने की तिथि : 02/09/2026
Date of Issue :

उमा शं. पंडित
महानियंत्रक पेटेंट, डिजाइन और व्यापार चिह्न
Controller General of Patents, Designs and Trade Marks

*पारस्परिकता तारीख (यदि कोई हो) जिसकी अनुमति दी गई है तथा देश का नाम। डिजाइन का स्वत्वाधिकार पंजीकरण की तारीख से दस वर्षों के लिए होगा जिसका विस्तार, अधिनियम एवं नियम के निबंधनों के अधीन, पाँच वर्षों की अतिरिक्त अवधि के लिए किया जा सकेगा। इस प्रमाण पत्र का उपयोग विधिक कार्यवाहियों अथवा विदेश में पंजीकरण प्राप्त करने के लिए नहीं हो सकता है।

The reciprocity date (if any) which has been allowed and the name of the country. Copyright in the design will subsist for ten years from the date of Registration, and may under the terms of the Act and Rules, be extended for a further period of five years. This Certificate is not for use in legal proceedings or for obtaining registration abroad.

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सत्यमेव जयते

ORIGINAL
क्रम सं/ Serial No. : 254913

पेटेंट कार्यालय, भारत सरकार | The Patent Office, Government Of India

डिजाइन के पंजीकरण का प्रमाण पत्र | Certificate of Registration of Design

डिजाइन सं. / Design No. : 513375-001

तारीख / Date : 12/08/2026

पारस्परिकता तारीख / Reciprocity Date* :

देश / Country :

प्रमाणित किया जाता है कि संलग्न प्रति में वर्णित डिजाइन जो *AI DRIVEN 6G WIRELESS COMMUNICATION MODULE* से संबंधित है, का पंजीकरण, श्रेणी 14-03 में 1.A.Alvin Ancy 2. S.Sangeetha 3.S.Praveena 4.A.Vanathi 5.A.Balasupramani के नाम में उपर्युक्त संख्या और तारीख में कर लिया गया है।

Certified that the design of which a copy is annexed hereto has been registered as of the number and date given above in class 14-03 in respect of the application of such design to *AI DRIVEN 6G WIRELESS COMMUNICATION MODULE* in the name of 1.A.Alvin Ancy 2. S.Sangeetha 3.S.Praveena 4.A.Vanathi 5.A.Balasupramani.

डिजाइन अधिनियम, 2000 तथा डिजाइन नियम, 2001 के अध्यधीन प्रावधानों के अनुसरण में।

In pursuance of and subject to the provisions of the Designs Act, 2000 and the Designs Rules, 2001.

जारी करने की तिथि : 23/09/2026
Date of Issue :

उमा शंकर पंडित
महानियंत्रक पेटेंट, डिजाइन और व्यापार चिह्न
Controller General of Patents, Designs and Trade Marks

*पारस्परिकता तारीख (यदि कोई हो) जिसकी अनुमति दी गई है तथा देश का नाम। डिजाइन का स्वत्वाधिकार पंजीकरण की तारीख से दस वर्षों के लिए होगा जिसका विस्तार, अधिनियम एवं नियम के निबंधनों के अधीन, पाँच वर्षों की अतिरिक्त अवधि के लिए किया जा सकेगा। इस प्रमाण पत्र का उपयोग विधिक कार्यवाहियों अथवा विदेश में पंजीकरण प्राप्त करने के लिए नहीं हो सकता है।

The reciprocity date (if any) which has been allowed and the name of the country. Copyright in the design will subsist for ten years from the date of Registration, and may under the terms of the Act and Rules, be extended for a further period of five years. This Certificate is not for use in legal proceedings or for obtaining registration abroad.

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सत्यमेव जयते

ORIGINAL
क्रम सं/ Serial No. : 255289

पेटेंट कार्यालय, भारत सरकार The Patent Office, Government Of India

डिजाइन के पंजीकरण का प्रमाण पत्र | Certificate of Registration of Design

डिजाइन सं. / Design No. : 514218-001

तारीख / Date : 18/08/2026

पारस्परिकता तारीख / Reciprocity Date* :

देश / Country :

प्रमाणित किया जाता है कि संलग्न प्रति में वर्णित डिजाइन जो *INTELLIGENT NETWORK GATEWAY* से संबंधित है, का पंजीकरण, श्रेणी 14-03 में 1.Rekha M 2. C.Sarumathi 3.Dr.J.Samuel Manoharan 4.Dr.G.Vijayasekaran 5.Dr.Arun Balaji Parameswaran 6.Dr.V.Brinda के नाम में उपर्युक्त संख्या और तारीख में कर लिया गया है।

Certified that the design of which a copy is annexed hereto has been registered as of the number and date given above in class 14-03 in respect of the application of such design to *INTELLIGENT NETWORK GATEWAY* in the name of 1.Rekha M 2. C.Sarumathi 3.Dr.J.Samuel Manoharan 4.Dr.G.Vijayasekaran 5.Dr.Arun Balaji Parameswaran 6.Dr.V.Brinda.

डिजाइन अधिनियम, 2000 तथा डिजाइन नियम, 2001 के अध्यधीन प्रावधानों के अनुसरण में।
In pursuance of and subject to the provisions of the Designs Act, 2000 and the Designs Rules, 2001.

जारी करने की तिथि : 24/09/2026
Date of Issue :

उन्नत पेंडिया

महानियंत्रक पेटेंट, डिजाइन और व्यापार चिह्न
Controller General of Patents, Designs and Trade Marks

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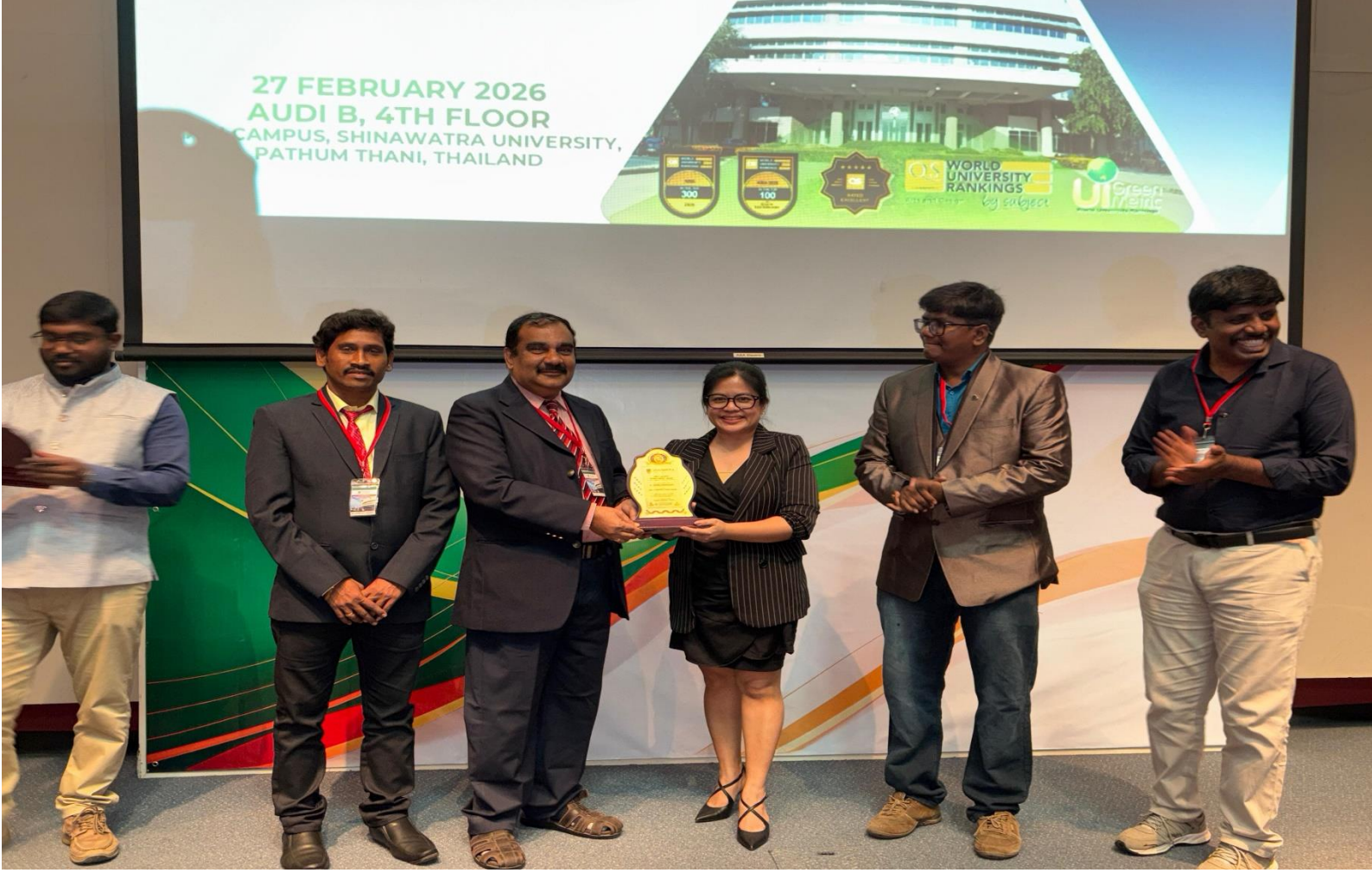
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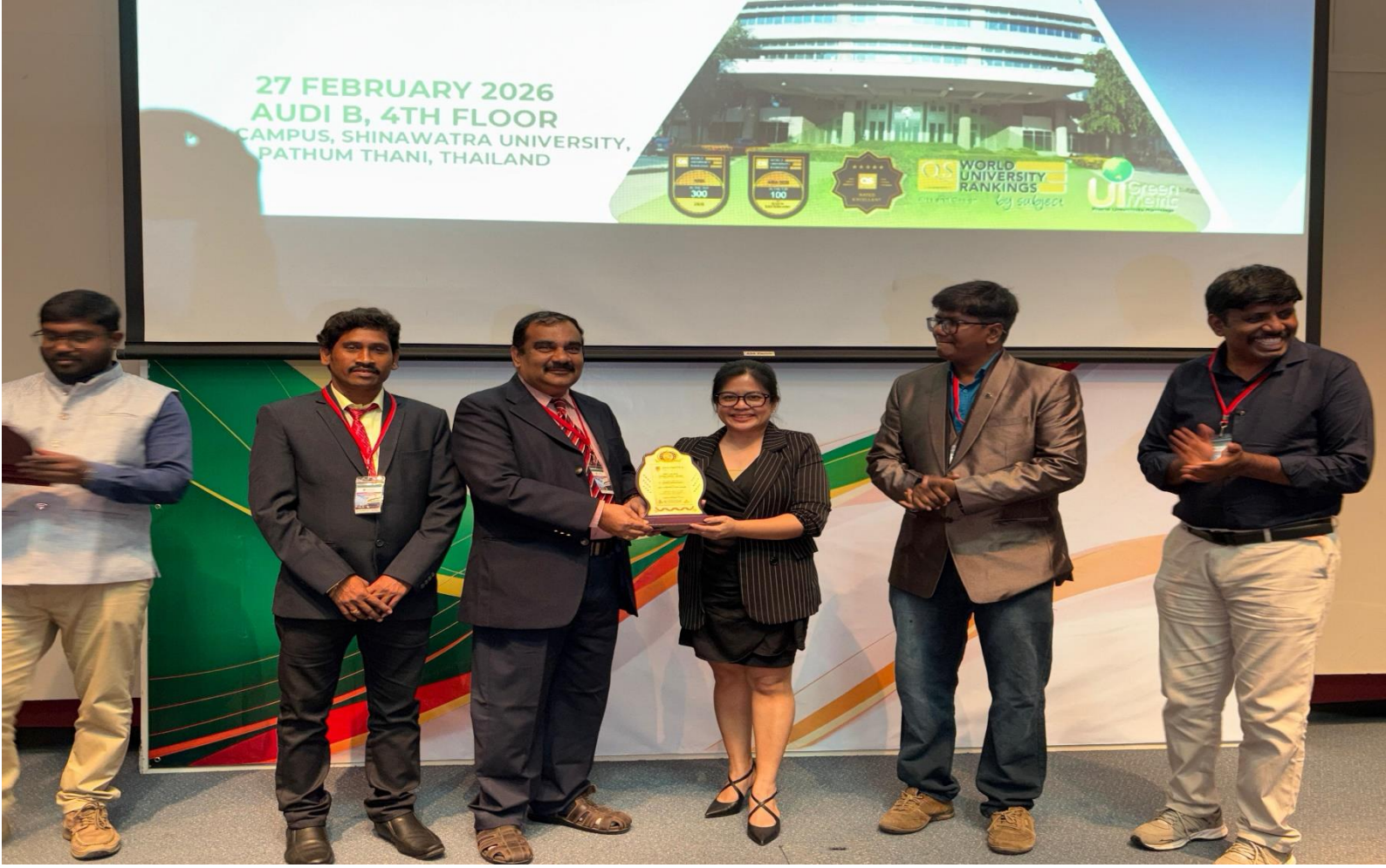



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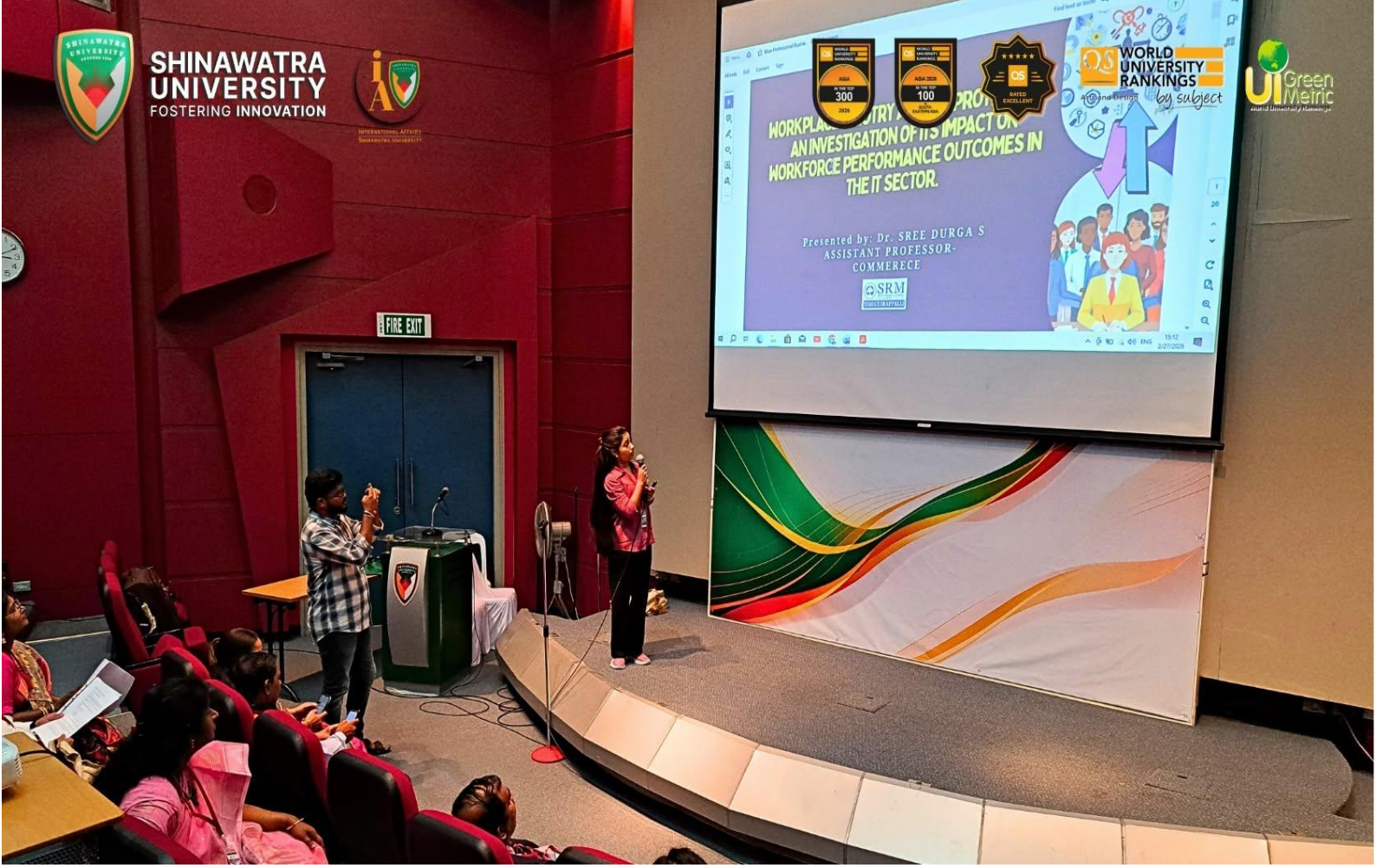

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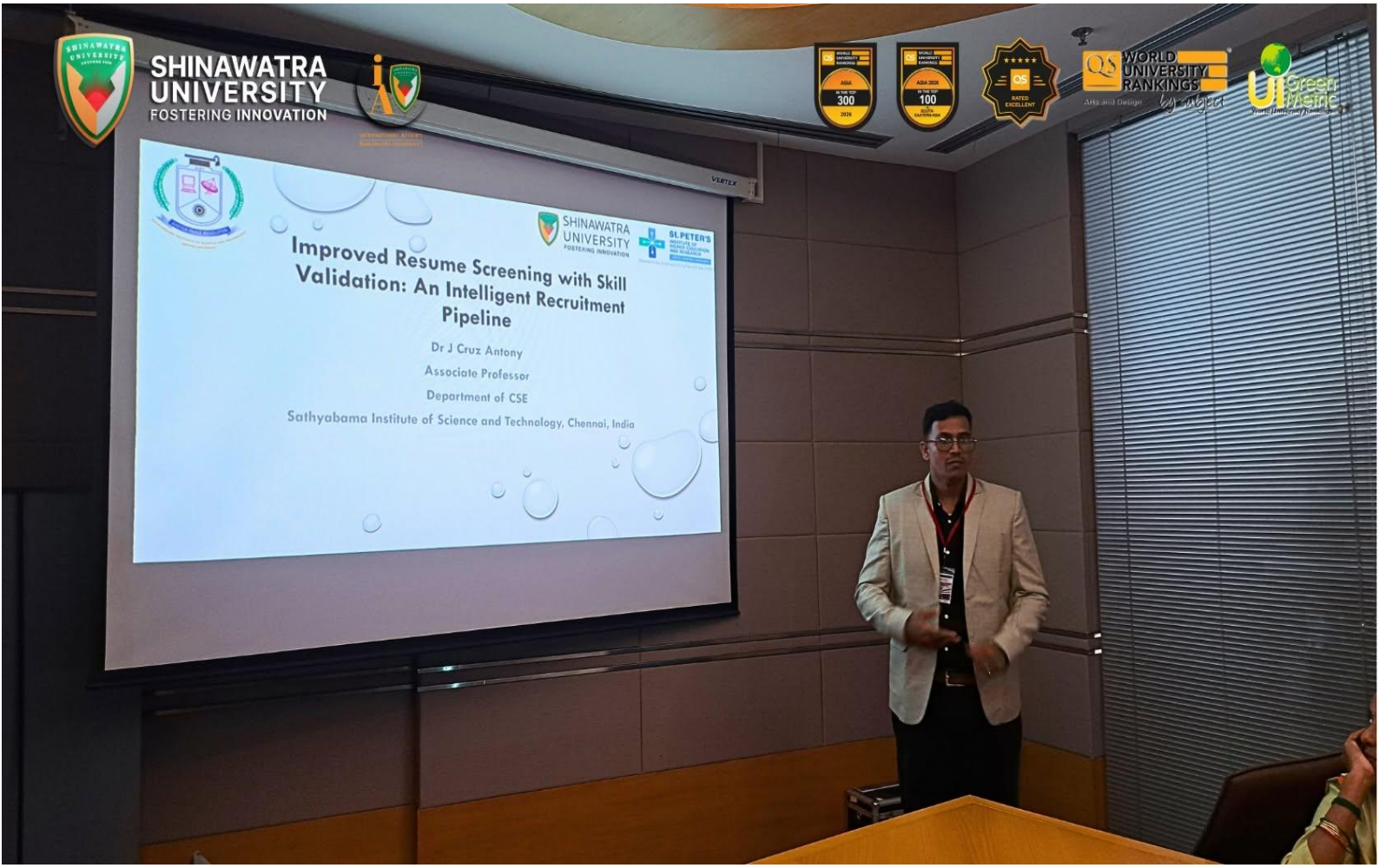

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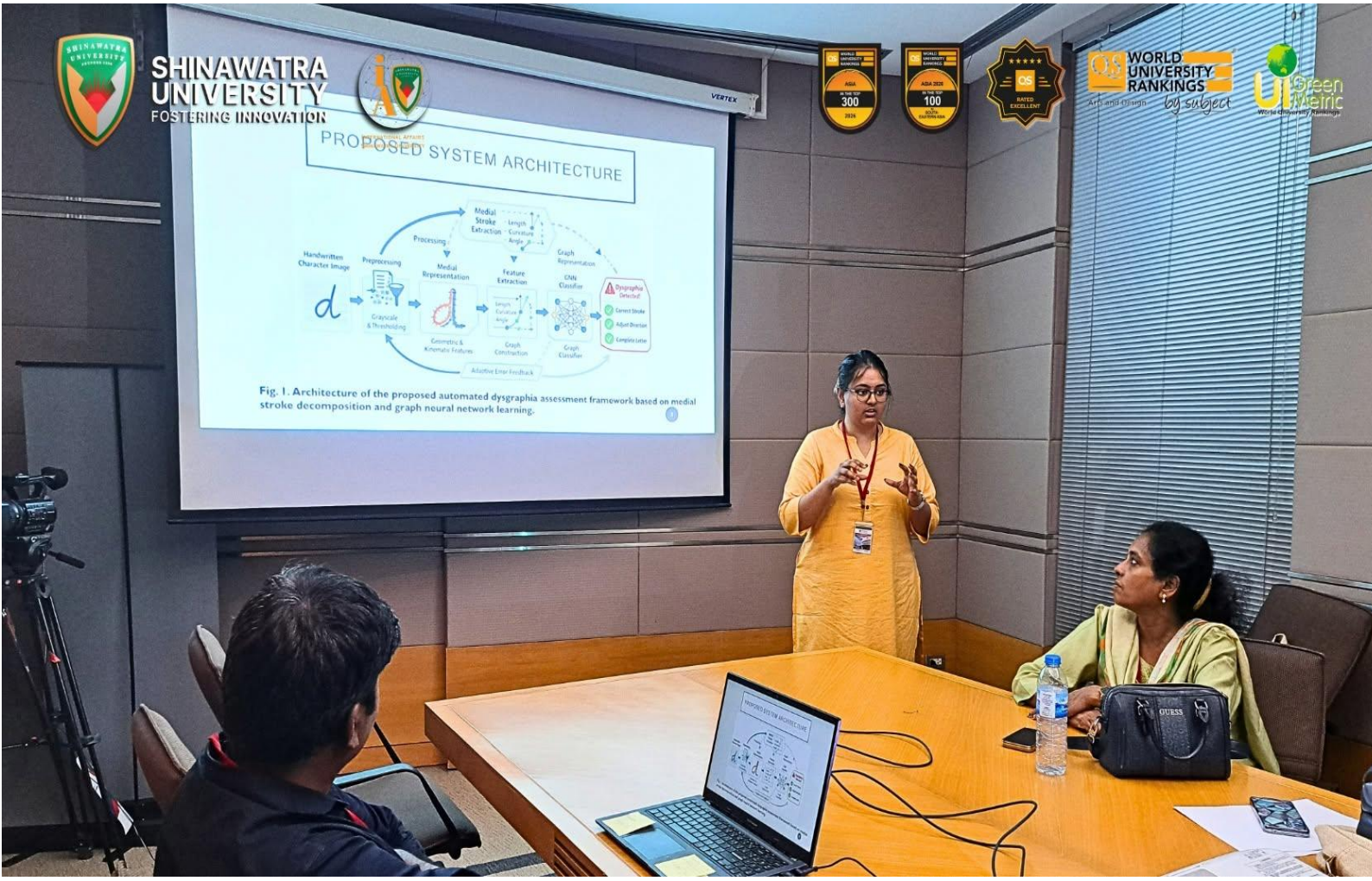

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Improved Resume Screening with Skill Validation: An Intelligent Recruitment Pipeline
Dr J Cruz Antony
Associate Professor
Department of CSE
Sathyabama Institute of Science and Technology, Chennai, India


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Graph Construction
GNN Classifier
Graph Classifier
Dysgraphia Detected
Correct Stroke
Adjust Direction
Complete Letter
Adaptive Error Feedback
Fig. 1. Architecture of the proposed automated dysgraphia assessment framework based on medial stroke decomposition and graph neural network learning.


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Modern healthcare systems increasingly rely on intelligent technologies to support accurate and rapid clinical decision-making. Traditional cloud-only medical AI systems often suffer from latency, bandwidth dependency, and delayed responses, which can limit their effectiveness in time-critical clinical environments such as operating rooms and emergency care units.
The integration of deep learning with edge computing offers a promising solution by en real-time data processing directly at the point of care. Clinical intelligence powered by co vision allows automated analysis of medical imagery, assisting healthcare professio identifying surgical tools, monitoring procedures, and reducing human error.
Deep learning models, especially object detection frameworks, have demonstrated sig potential in improving precision and operational efficiency within medical workflow project introduces a hybrid deep learning framework based on YOLOv12 to opti computational resources while enabling accurate, real-time surgical instrument ultimately supporting smarter and faster clinical decision-making processes.


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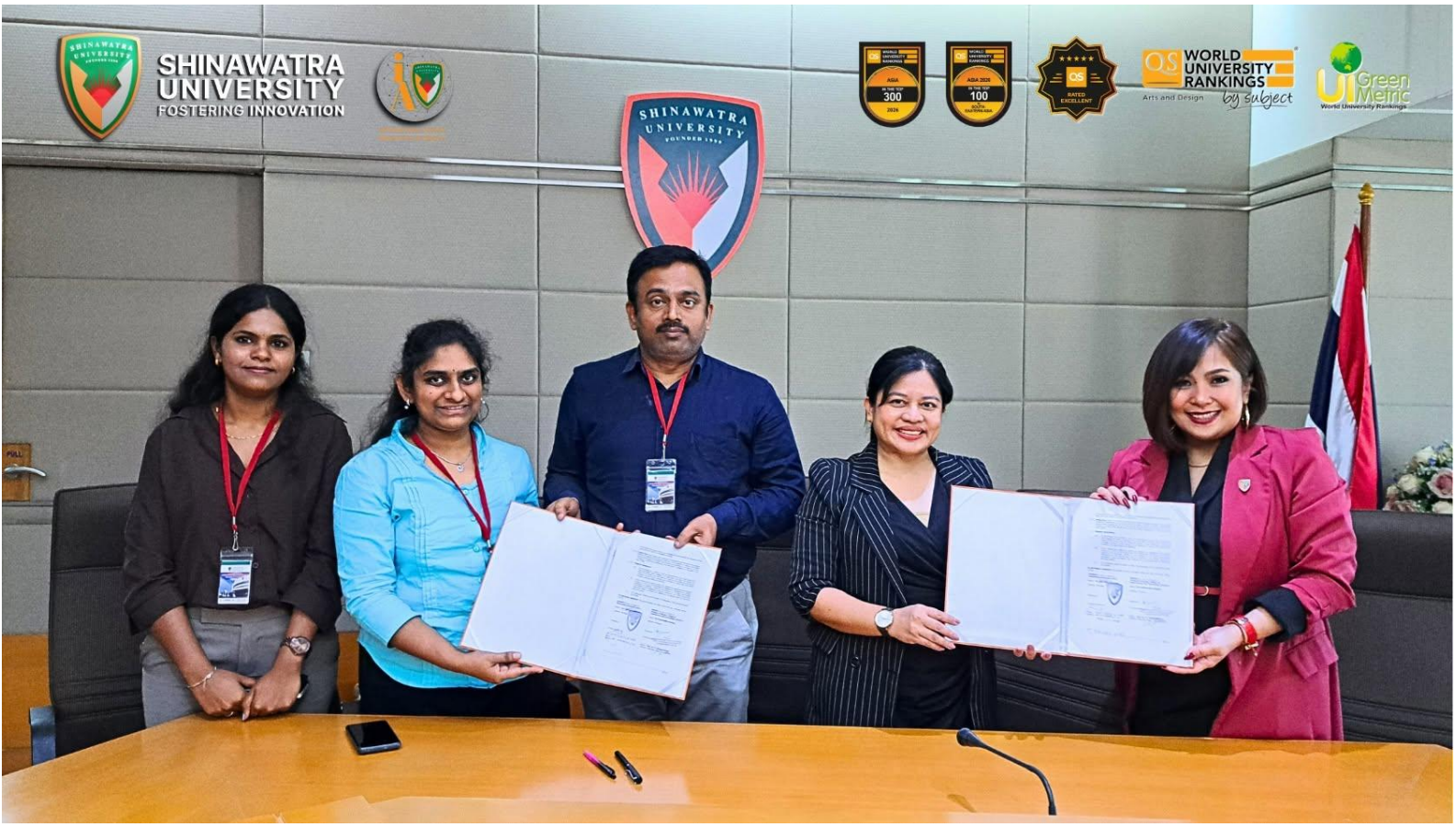
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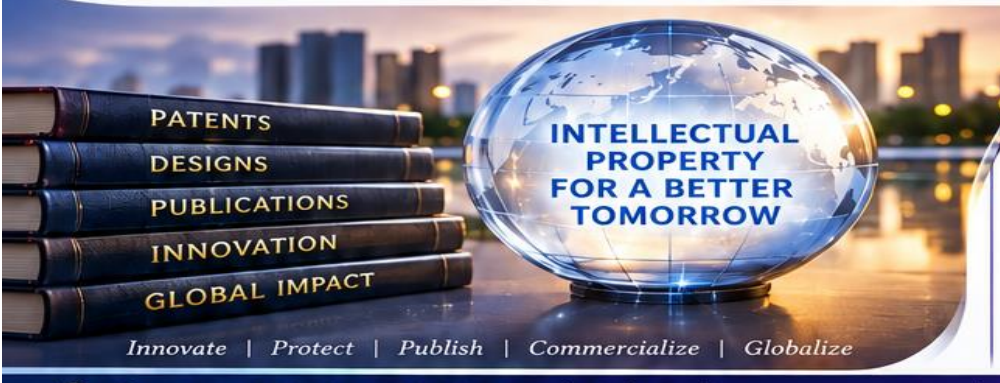
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