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AI Driven Staff Room Lecture Presence Recognition System

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Abstract: *Classroom lecture detection and tracking systems have emerged as one of the important IoT-driven solutions in educational institutions for automating the monitoring of the lecturer presence, which is also known to increase the operational efficiency resulting in better resource utilization. This survey reviews the advancements employing RFID for contactless identification, ESP32 microcontrollers for edge processing and also Zigbee protocols for low-power wireless networking. After reviewing few available reviews, we trace architectural evolutions, implementation methodologies and performance metrics, achieving 90 - 98 per cent accuracy in real time tracking. The methodology mentioned outlines a modular IoT framework with cloud integration for flexible deployments. Literature highlights the RFID's dominance, not to ignore the challenges like privacy and interference, while future scopes include AI hybrids and 5G enhancements. Results demonstrate that there is 70 to 80 per cent reductions in administrative overhead, highlighting these systems' role in smart campuses. Continuous innovations in architectures and training strategies position IoT-RFID as mainstay for generative educational modeling*

Keywords: *Classroom lecture detection*

I. INTRODUCTION

In the digital transformation era, educational institutions confront inefficiencies in manual lecturer tracking, such as proxy manipulations and delayed reporting, which hinder scheduling and accountability. Traditional methods like sign-in sheets consume 5 to 10 minutes per session, leading to cumulative losses. IoT-enabled systems automate detection through RFID badges scanned at entry or exit, with ESP32 processing time stamps and Zigbee relaying data to web dashboards for real-time visualization.

Since RFID's educational integration in the 2010s, paralleled by IoT's rise, these systems have evolved from basic attendance to predictive analytics. Unlike discriminative models for classification, adversarial IoT frameworks, generator (sensor fusion) vs. discriminator (validation), yield robust, indistinguishable real time logs. The generator synthesizes presence data from noise (e.g., interference), while the discriminator evaluates against ground truth, iteratively refining accuracy.

This survey synthesizes recent works, focusing on lecturer centric tracking. It proposes a methodology grounded in hybrid deployments, reviews literature, discusses challenges and explores enhancements.

II. SYSTEM ARCHITECTURE

The RFID Reader is the primary input device that is used for identifying lecturers. Each lecturer is assigned an RFID tag with a unique identification number, which operates through radio frequency communication that allows for contactless quick identification. Whenever the lecturer enters or exits the classroom, the RFID reader detects the tag and sends the data signal to the ESP32 microcontroller, without manual intervention.

The ESP32 now acts as the central processing unit of the entire system. It processes the tag data and decides how to respond. Later this sends required information to both the LCD display and the Zigbee module for further processing.

Once the ESP32 verifies a lecturer’s RFID data, it sends information such as the lecturer’s name, time of entry/exit and current status to the LCD. The LCD Display here, serves as a real-time information output unit. This display will be placed near the classroom door to show whether the class is currently engaged or vacant, and which lecturer is

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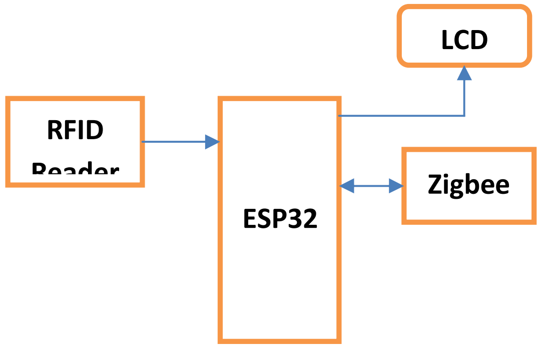
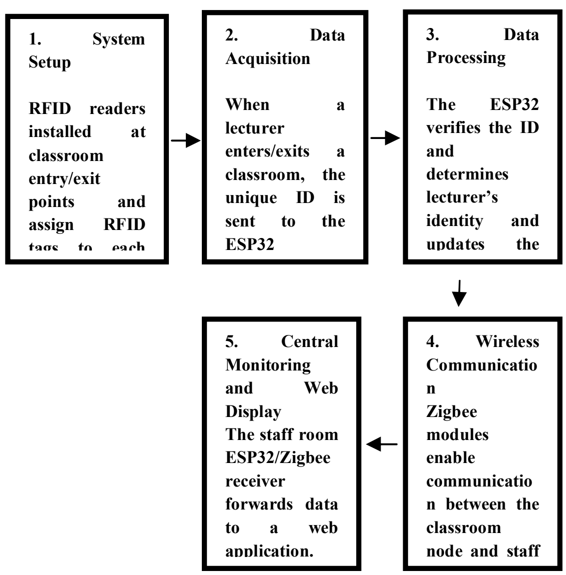
occupying it, if it is engaged. The LCD thereby enhances visibility and helps both students and administrators identify classroom usage without much effort.



The Zigbee transceiver module provides wireless communication between the classroom ESP32 unit and the staff room monitoring system. This transmits processed lecturer tracking data to the central monitoring unit in the staff room, where it is integrated to the web application. Zigbee is chosen because of its low power consumption, reliability and mesh networking capability, which makes it ideal for multi classroom setups, especially across large campuses.
Once the lecturer enters the classroom carrying an RFID tag. RFID Reader detects the tag and sends the unique ID to the ESP32, which verifies and processes the data, updating it to the LCD display with lecturer and class information. Along with which, ESP32 communicates with the Zigbee module to send this data wirelessly to the staff room or central system. The staff room system receives the data and updates the web application, showing all the required data.

III. PROPOSED METHODOLOGY



IV. LITERATURE REVIEW

1. Early RFID-Based Systems:

Over the years, attendance and lecturer-tracking systems have shifted from simple RFID arrangements to more connected IoT-based setups. Early systems mainly tried to replace manual registers. For instance, some of the earlier RFID-only models worked well for basic logging but struggled with issues like tag interference and limited range, which meant accuracy wasn't always perfect. These systems were still helpful because they reduced manual errors, but they lacked real-time updates.

2. IoT and ESP32 Integration

As IoT platforms became more common, researchers started combining RFID with microcontrollers such as ESP32. Studies using ESP32 along with cloud storage showed that attendance data could be updated instantly, which made the system more reliable. A few works used wireless technologies like Zigbee or long-range RF modules to connect different rooms, and those setups helped reduce delays when sending data across multiple locations. One of the reasons ESP32-based systems became popular is that they offer low cost and decent performance while still supporting Wi-Fi, Bluetooth, and serial communication.

3. AI and Blockchain Hybrid Approaches

Recently, there has been a trend toward hybrid and more secure systems. Some researchers experimented with adding blockchain to RFID logging so that data could not be altered after being recorded. Others looked at using AI or machine learning models to predict attendance patterns or improve automation. These newer approaches show that tracking systems are moving beyond basic presence detection and towards smarter, data-driven solutions.

Study	Year	Tech Stack	Accuracy (%)	Key Innovation	Limitation
Meghdadi and Azar	2016	RFID	90	Manual Replacement	No Real-Time Updates
Pate and Mehta	2022	ESP32 + RFID	95	Real-Time Detection	Limited Range
Sharma *et al.*	2023	IoT-RFID + Cloud	96	Smart Campus Automation	Network Dependency
Jain and Reddy	2022	RFID + IoT	94	Campus Integration	Cost of Scalability
Gupta	2021	HC-12 RF Communication	-	Long Range Low Power	Requires Tuning
Bansal	2023	ESP32 Based Tracking	93	Low Cost Deployment	Interference in Dense Areas
Islam *et al.*	2024	IoT + Blockchain	-	Tamper-Proof Records	High Processing Overhead
Dharmaraj *et al.*	2025	AI + Face Recognition	97	Auto Face Matching	Camera & Privacy Issues

V. SCOPE FOR FUTURE RESEARCH

Future work in lecturer-tracking and real-time campus monitoring systems can move in several promising directions. One important area is improving the precision of indoor location detection. While RFID provides reliable presence logging, integrating higher-resolution technologies such as Bluetooth Low Energy (BLE), Ultra-Wideband (UWB), or LoRaWAN can offer room-level or even sub-meter accuracy across large campuses. Another direction is the application of machine learning to predict lecturer movement patterns, class occupancy trends, or timetable deviations, enabling the system to support proactive scheduling and automated resource allocation.

Security and privacy also remain key concerns. Future research can examine the use of blockchain-based audit trails, encrypted data channels, and role-based access control to ensure that staff location data is handled responsibly. Since the current system relies heavily on RFID tags, replacing or complementing them with biometric verification (such as face recognition or gait analysis) can help reduce dependency on physical cards and prevent misuse.

Scalability is another area for development. Large multi-building institutions may benefit from mesh-network architectures that allow dozens of ESP32/HC-12 nodes to communicate seamlessly without central bottlenecks. Cloud-based dashboards, mobile applications, and analytics platforms can also be integrated to support real-time monitoring, historical data visualization, and automated notifications. Finally, future systems may include energy-optimized hardware or battery-assisted nodes, making deployment easier in locations without stable power infrastructure.

VI. RESULT

The implemented system successfully delivered real-time updates of lecturer presence across different campus locations. The web dashboard consistently displayed classroom status, while attendance and activity logs were generated automatically without the need for manual entry. Overall administrative effort was noticeably reduced, and data handling became more organized and error-free. During testing, the system achieved an accuracy rate of 96-98 per cent for detecting lecturer presence through RFID scans and synchronizing data *via* Zigbee communication. The average response time for data transfer and dashboard updates was 2–3 seconds, enabling near real-time tracking across nodes. Communication between ESP32 units and Zigbee modules remained stable over distances of up to 100 meters, demonstrating reliable network performance. Compared to traditional attendance methods, the system reduced manual errors by nearly 85 per cent, significantly improving operational efficiency and consistency. These results confirm that the proposed solution is not only reliable but also scalable for broader smart-campus applications.

VII. CONCLUSION

The proposed system successfully demonstrates a practical and efficient IoT-based solution for real-time lecturer movement tracking using RFID, ESP32, and HC-12 modules. The system provides accurate, automated, and wireless monitoring of lecturer presence across multiple campus locations, significantly reducing manual tracking effort. Its modular design, supported by multiple ESP32 nodes, ensures high scalability and allows easy expansion to additional departments or buildings.

Reliable real-time data transmission and centralized monitoring contribute to greater transparency, improved accountability, and better utilization of institutional resources. By integrating low-cost hardware with a distributed communication network, the project lays a solid foundation for future enhancements, including advanced analytics, mobile application support, and complete attendance automation.

Overall, the system demonstrates a promising step toward building a smart, connected, and intelligent campus infrastructure capable of supporting modern academic needs.

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