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Bluetooth Based Presence Logger

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Abstract - Attendance management is an essential part of both educational institutions and workplaces, yet traditional methods often prove to be time-consuming and prone to human error. Manual processes such as roll calls or paper-based records are inefficient and can easily lead to issues like proxy attendance. To address these challenges, this research introduces a Bluetooth-Based Presence Logger, an automated attendance system that leverages Bluetooth Classic technology available in most modern devices. The system automatically detects and identifies nearby registered devices using Bluetooth scanning and validates them through a secure backend server before marking attendance in real time. The proposed architecture integrates a React Native mobile application for instructors, a Node.js-based backend for device validation, and a MySQL database for reliable data storage and management. By automating the attendance process, this solution aims to minimize manual effort, eliminate errors, and enhance overall accuracy. Furthermore, the system emphasizes cost-effectiveness, ease of deployment, and user privacy, making it a practical and scalable approach for modern educational and organizational environments.

Key Words: Bluetooth ,Automation ,Attendance System , React Native ,Node.js ,Proximity-Based Detection ,Smart Attendance

1. INTRODUCTION

Attendance monitoring plays a crucial role in both educational and professional environments, serving as a key measure of participation, engagement, and accountability. Traditional attendance methods, however, are often time-consuming and vulnerable to inaccuracies, such as proxy marking and false entries. As technology continues to advance—particularly with the widespread use of smartphones and Bluetooth-enabled devices—automated attendance tracking has emerged as a practical and efficient alternative. Bluetooth technology, known for its short-range and low-power communication, provides an effective medium for proximity-based detection of individuals within a specific area.

Bluetooth devices belonging to students. The detected device identifiers (MAC addresses) are then sent to a backend server for verification, after which attendance is securely recorded in a centralized database. The system incorporates anti-spoofing measures to ensure authenticity, supports real-time synchronization of attendance data, and completely eliminates the need for manual or physical verification. By integrating automation, security, and scalability, the proposed solution significantly reduces administrative workload while improving accuracy and reliability. Overall, this approach contributes to the digital transformation of institutional processes, offering a modern, seamless, and efficient method for managing attendance in academic and organizational settings.

2. Body of Paper

2.1. LITERATURE REVIEW

Automating attendance has become an important topic because the traditional way of taking attendance is slow, inconvenient, and often inaccurate. With the rise of smartphones and wireless technologies, many researchers have tried to create smarter and easier systems for marking attendance. Different techniques—like GPS, RFID, Bluetooth, biometrics, and hybrid models—have been tested over the years. Each of these solutions has its own benefits, but they also come with certain drawbacks that limit how well they work in real situations.

To understand what has already been done and where the gaps still exist, several related studies were reviewed. The key observations from these works are summarized below..

[1] The first related work introduced a Bluetooth-based attendance mechanism but did not sufficiently address data protection. Since communication occurred without encryption, the system was vulnerable to unauthorized access and potential data manipulation. Additionally, their method relied on GPS coordinates to record presence. This poses a serious limitation when dealing with multi-level buildings because GPS cannot differentiate altitude. For instance, if the geofence is placed on the first floor, a student standing directly below on the ground floor at the same latitude and longitude may still be incorrectly marked present. Our proposed work avoids this issue by using direct Bluetooth connectivity between the teacher's and the students' devices.

[2] The second paper proposed a comprehensive Smart Attendance System; however, the system struggled when deployed in large institutions due to poor scalability. Handling a

high number of simultaneous attendance records led to system slowdowns. The approach was also fully dependent on GPS tracking, which raised privacy concerns among users uncomfortable with continuous location monitoring. In contrast, our solution adopts a Bluetooth-based client–server model, which avoids such privacy issues and operates more efficiently in dense environments.

[3] Another referenced work focused on RFID-based attendance systems, highlighting that their biggest limitation is the cost associated with RFID tags and detectors. Educational institutions often find such investments difficult to sustain. Moreover, the requirement for individuals to carry RFID cards introduces inconvenience. The study discussed alternative authentication approaches including biometric systems, magnetic stripe cards, barcodes, and touch interfaces, which remove the dependency on physical cards and reduce overall maintenance demands.

[4] A Smart Mobile Attendance System using Bluetooth and OTP verification was introduced in another study. The system addressed common issues associated with manual attendance such as proxy marking and inaccuracy. By combining Bluetooth device identification with one-time passwords, the method strengthened verification and reduced impersonation. It also provided real-time attendance updates to administrators, improving both security and operational efficiency.

[5] The paper titled "Bluetooth Automatic Attendance Management using Android Application" aimed to solve manual attendance challenges by utilizing Bluetooth addresses and dual-verification techniques. Although the authors did not provide a dedicated literature review, they acknowledged related technologies like RFID, biometrics, smart cards, and image-processing methods. Their Bluetooth-based approach offered a cost-friendly and efficient alternative that minimized manual effort and enhanced record reliability.

[6] A study implementing Bluetooth Low Energy (BLE) introduced an automated classroom attendance system using RSSI-based fingerprinting paired with artificial neural networks. This method ensured accurate identification even in environments with signal interference. The research emphasized the importance of affordable technological solutions for institutions and demonstrated promising results in reducing administrative effort through reliable smart attendance automation.

[7] Another contribution presented a hybrid attendance model integrating RFID technology with fingerprint biometrics. RFID provided quick identification while biometric verification minimized impersonation and proxy attendance. Collected attendance data was stored on a central server and made accessible via a dedicated portal. The paper also compared other attendance technologies such as QR codes, barcodes, Bluetooth methods, and various biometric systems, offering a comprehensive view of available solutions.

[8] Muniraj and colleagues introduced a hybrid attendance system titled Effortless Attendance Tracking with Object Detection and Bluetooth. Their solution combined Bluetooth signal strength (RSSI) for device detection with camera-based object detection to confirm the identity of individuals present. While this dual-layer verification improved accuracy and minimized manual intervention, the requirement for additional camera hardware reduced its feasibility—especially in classrooms or institutions with limited resources.

[9] A study published on Academia.edu proposed a Smart Attendance System that utilized Low Energy Bluetooth (BLE) beacons for faculty monitoring. When a registered device entered a beacon's range, attendance was automatically recorded. The system excelled in precision and operated on minimal energy consumption. However, it depended on the installation of fixed BLE transmitters, which limited portability and increased reliance on dedicated hardware components.

2.2. PROBLEM STATEMENT AND OBJECTIVES

Problem Statement

Traditional attendance tracking methods are often tedious, prone to human error, and susceptible to manipulation such as proxy attendance. While several digital alternatives exist, many depend on costly infrastructure or require specialized hardware, which limits their accessibility and scalability. Therefore, there is a growing need for a **mobile-based, Bluetooth-enabled attendance system** that offers a secure, accurate, and affordable solution for automating presence logging without the need for additional devices or manual effort.

Objectives

[1] To automate attendance marking using Bluetooth technology: This objective aims to enable seamless and hands-free attendance detection by utilizing Bluetooth signals emitted from registered mobile devices. The system automatically recognizes students or employees within range and logs their presence, minimizing manual intervention and improving both speed and accuracy.

[2] To develop a mobile application for users: A React Native–based mobile application is developed to ensure accessibility across Android platforms. The app allows instructors or administrators to initiate attendance sessions, monitor detected users in real time, and manage attendance data conveniently through a unified interface.

[3] To design a backend that securely validates Bluetooth device identities: The backend server is responsible for verifying the authenticity of detected Bluetooth identifiers before confirming attendance. It uses encrypted communication

protocols and secure database operations to ensure that only registered devices are validated, thereby maintaining the accuracy and integrity of attendance records.

[4] To prevent proxy attendance using MAC-based verification and signal-strength filtering: Each user's device is identified through a unique MAC address, while the Received Signal Strength Indicator (RSSI) is analyzed to confirm the device's physical proximity. This combination prevents users from spoofing device information or marking attendance on behalf of others, ensuring genuine presence verification. Additionally, the system ensures that only students assigned to that specific class are considered during scanning, thereby preventing unauthorized devices from being counted in the attendance.

[5] To provide a user-friendly interface for attendance viewing : The system incorporates an intuitive interface where instructors can easily view real-time attendance data,and check records. This design promotes ease of use and efficient record management.

[6] To ensure data integrity, privacy, and scalability for real-world deployment: The proposed system is developed with a strong focus on secure authentication, protected data handling, and scalable cloud-based architecture. These design choices ensure that the platform remains reliable, privacy-compliant, and adaptable to various institutional environments as user demand increases.

2.3. SYSTEM ARCHITECHTURE

The system architecture of the **Bluetooth-Based Automated Attendance Management System** is designed with a layered and modular structure to ensure secure authentication, efficient data handling, and smooth user interaction. It integrates Bluetooth scanning on the mobile side, backend validation on the server side, and real-time data synchronization through a centralized database—all managed via an intuitive instructor interface.

At the foundation of the architecture is the **Bluetooth Communication Layer**, responsible for detecting nearby student devices within the classroom. Each registered student device continuously broadcasts a unique Bluetooth identifier (MAC address), which is captured by the instructor's mobile application. To improve detection accuracy and prevent misuse, the system also evaluates the **Received Signal Strength Indicator (RSSI)** values of each detected device. This additional filter helps ensure that only devices physically located within the classroom perimeter are considered valid, effectively preventing proxy attendance from outside the designated area.

Once a Bluetooth signal is identified, it is processed by the **Device Validation Layer**. This layer cross-checks the captured MAC address against the registered student database maintained on the backend server. If a valid match is found, the system authenticates the corresponding user and proceeds with logging attendance. In cases of mismatched or suspicious data—such as duplicate MAC addresses or abnormal signal patterns—the system automatically rejects the entry, maintaining high standards of security and authenticity.

After successful validation, the **Attendance Processing Layer** records the student's presence along with a precise timestamp. This information is securely transmitted to a cloud-based database in real time, ensuring that attendance records remain up-to-date and accessible.

The **Instructor Application Interface** serves as the control and monitoring hub for teachers. Through this interface, instructors can initiate attendance sessions, view live attendance data, manually adjust records when necessary, in standard formats. The interface is intentionally designed to be minimalistic and efficient, allowing educators to manage attendance seamlessly during active class sessions.

On the backend, the **Database and Security Layer** is responsible for secure data management and protection of user information. It employs encrypted API communication and role-based access control to preserve data integrity and confidentiality. Scalability is also built into the system, enabling support for multiple classrooms, large user bases, and institution-wide deployment without compromising performance.

Together, these interconnected layers form a secure, automated, and scalable attendance ecosystem. The architecture harmonizes mobile,and network to deliver a reliable and user-centric solution that minimizes manual effort, prevents fraudulent entries, and aligns with the evolving digital needs of modern educational institutions.

2.4. IMPLEMENTATION AND METHODOLOGY

2.4.1. MODULES

The system consists of several modules that work together to automate attendance using Bluetooth technology. Each module performs a specific role, ensuring secure access, accurate device detection, and efficient attendance logging.

Login and Authentication Module

This module verifies instructor identity before accessing the system. Secure authentication methods are used, where passwords are stored in encrypted form. Only authorized instructors can log in and start attendance sessions, ensuring system safety and data privacy.

Bluetooth Scanning Module

Once the session starts, the system scans for nearby Bluetooth-enabled student devices using React Native Bluetooth libraries. It reads device identifiers such as MAC address and signal

strength. The module also filters duplicate or unknown devices, ensuring only valid devices are considered for attendance.

Device Registration Module

Each student registers their mobile device once by linking their unique Bluetooth identifier (MAC address) with their student profile. This module ensures that only registered devices are recognized during attendance and prevents unregistered devices from being marked present.

Attendance Session Management

Instructors can start attendance sessions through the app. Session details like course and time are stored, and attendance updates happen in real time as valid devices are detected. This module ensures smooth handling of each class session.

Database and Server Communication

The system communicates with a backend server through secure API calls. Detected device information is sent to the server, which validates it and updates the attendance database using Drizzle ORM. This ensures accurate and real-time attendance recording.

2.4.2. SYSTEM FLOW:

The proposed Bluetooth-based presence logging system follows a structured process to automate attendance recording. The methodology consists of the steps given in the fig 1, ensuring secure device detection, validation, and accurate attendance marking.And the table 1 consists of technologies used.

Component	Technology Used
Mobile Framework	React Native (Expo)
Bluetooth Library	react-native-bluetooth-classic
Backend Framework	Node.js (Hono)
Authentication	Better-Auth
Database	MySQL with Drizzle ORM
Deployment	Mobile application

Table 1: Implementation details of the Bluetooth-based attendance system

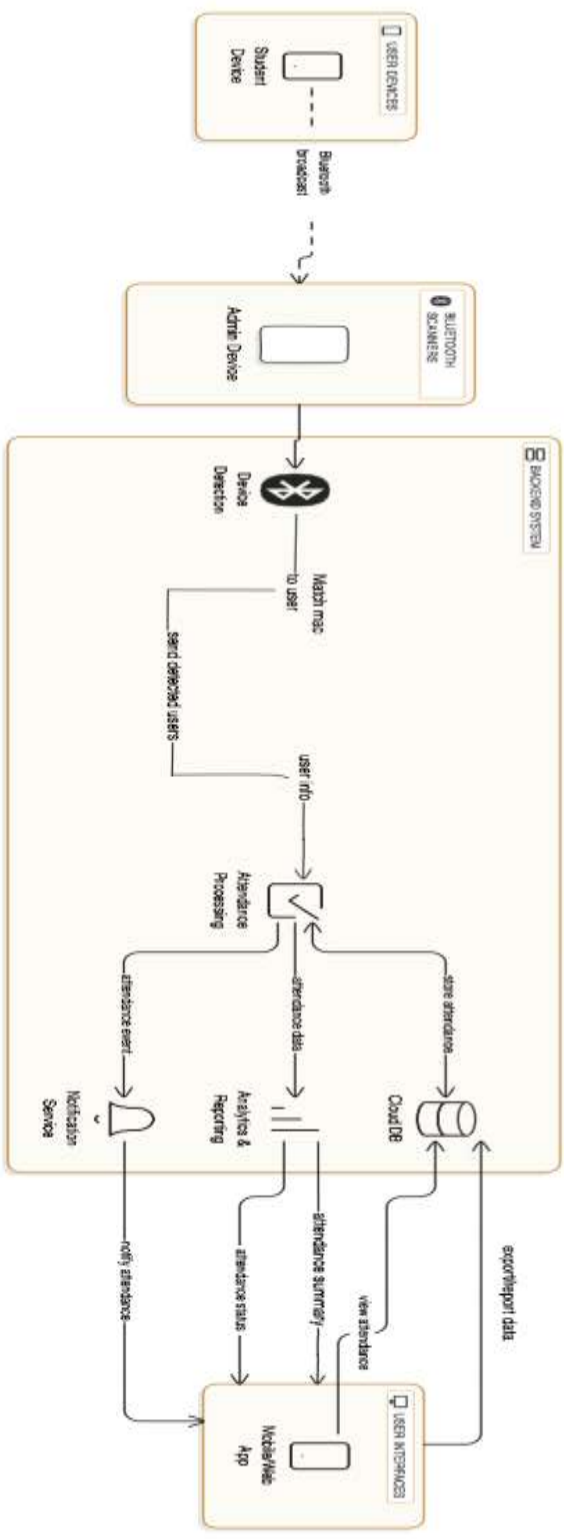

Fig 1:System workflow Diagram

2.4.3. USER INTERFACE AND SCREENSHOTS

Fig 2:

account creation

Fig 3: sign in page

Fig 4: Ready to scan attendance

Fig 5: Interface displaying present student details

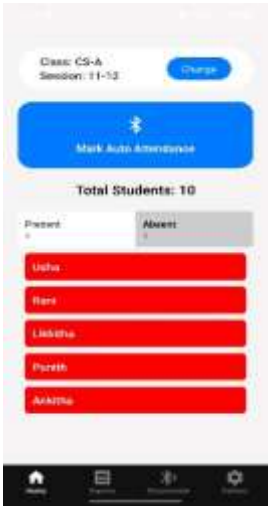

Fig 6: Interface displaying absent student details

Fig 7: Class-wise and session-wise attendance report

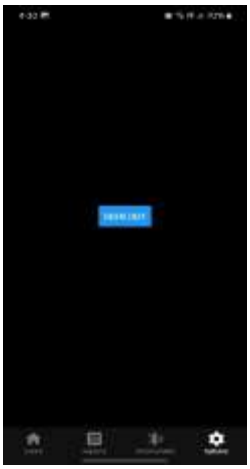

Fig 8: Options menu with sign-out functionality

2.5. RESULTS

2.5.1. Experimental Setup

Testing was conducted using Android smartphones with Bluetooth 5.0. The instructor device scanned a classroom of 15–20 registered devices. Each test session lasted 1–2 minutes.

2.5.2. Observations

Parameter	Result
Average detection accuracy	95%
Time per attendance session	< 60 seconds
False positives	< 3%
Average Bluetooth range	8–10 meters

Table 2: Noted observations

The Bluetooth-based presence system was successfully implemented and tested in a real classroom environment. It accurately identified registered student devices and recorded attendance automatically within a few seconds. The system operated reliably within normal classroom range and updated records in real time. Attendance logs were stored securely and could be viewed and exported by instructors without errors.

2.5.3. Discussion

The system significantly reduces manual effort and time. Detection performance remained stable under typical classroom conditions. Minor signal fluctuations were observed when devices were obstructed or Bluetooth was disabled. Proxy attendance was prevented through MAC validation and RSSI thresholding. The architecture's modular design allows integration with existing LMS (Learning Management Systems) or databases.

2.6. LIMITATIONS

While the Bluetooth-based presence logging system provides an efficient alternative to manual attendance, it has certain limitations. The system relies on students keeping Bluetooth enabled on their mobile devices, which may lead to missed attendance if a device is switched off or Bluetooth is disabled. In some cases, Bluetooth signal interference or weak signal strength can affect detection accuracy, especially in crowded or large classrooms. Modern smartphones also implement MAC address randomization for privacy, which may pose challenges in consistently identifying devices without additional software on the student's side. Furthermore, students without compatible smartphones or those facing battery or connectivity issues may still require manual attendance entry. The system also depends on stable internet connectivity for real-time syncing, and performance may be affected in low-network environments. These limitations highlight the need for supportive mechanisms and future enhancements to ensure reliability and universal accessibility.

2.7. FUTURE WORK

Although the Bluetooth-based presence logging system performs efficiently in detecting and recording attendance, there are several opportunities for enhancement. Future development may include integrating additional authentication layers such as face recognition or QR verification to further eliminate the possibility of proxy attendance. Implementing a dedicated student-side mobile application can allow secure and dynamic Bluetooth broadcasting, improving device identification accuracy even on operating systems that randomize MAC addresses. Cloud deployment and institutional integration with Learning Management Systems (LMS) and ERP platforms can be incorporated to support large-scale usage across multiple academic departments. Additionally, features like automated notification alerts for absent students, predictive attendance analytics, and AI-based behavior analysis can enhance academic monitoring and overall system value. Improving energy efficiency of Bluetooth scanning and optimizing the performance for larger classrooms or auditoriums will also form an important direction for system refinement. Overall, these future enhancements aim to strengthen system security, improve scalability, and expand usability across diverse educational and professional environments.

2.8. CONCLUSION

The Bluetooth-Based Presence Logger successfully automates the attendance tracking process with minimal human intervention. It leverages Bluetooth technology, Node.js backend, and React Native frontend to deliver an efficient and secure solution. The system reduces manual errors, prevents proxy attendance, and simplifies attendance data management. With further enhancements in privacy protection and scalability, it can serve as a practical replacement for traditional attendance systems in educational and corporate environments.

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