A Smart Attendance Management System Using NRF51822 BLE Module and Mobile Application

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Abstract

The rapid advancement of mobile technology has revolutionized traditional attendance systems, offering efficient and user-friendly solutions. This research paper presents a Mobile Attendance System that uses Bluetooth Low Energy(BLE) technology via the NRF51822 module to enable students to mark attendance through a mobile app. The app allows students to log in, mark attendance by detecting BLE signals, view attendance records, and receive announcements, while ensuring data integrity by linking attendance to the unique device ID of their registered mobile device. In cases of device loss, students can request a mobile change, subject to admin approval. The integration of BLE technology ensures a seamless, contactless attendance process, making it ideal for modern educational environments. This system improves administrative efficiency, ensures data accuracy, and enhances communication between students and administrators. The project highlights the potential of mobile and BLE technologies to modernize attendance tracking, offering a scalable and innovative solution for educational institutions.

Keywords: Mobile Attendance System, Bluetooth Low Energy (BLE), NRF51822 Module, Contactless Attendance, Automated Attendance Tracking

1. Introduction

Attendance tracking is a fundamental process in educational institutions, essential for monitoring student participation and ensuring academic accountability. Traditional methods, such as manual roll calls or paper-based systems, are often time-consuming, error-prone, and inefficient, particularly in large classrooms or institutions. These limitations have created a demand for automated, secure, and scalable solutions that can streamline attendance management while minimizing administrative overhead. With the widespread adoption of mobile technologies and the emergence of wireless communication protocols like Bluetooth Low Energy (BLE), there is anopportunity to revolutionize attendance systems by integrating these advancements into a cohesive and user-friendly platform. This research proposes a Mobile Attendance System that utilizes BLE technology via the NRF51822 module to enable students to mark attendance seamlessly through a mobile app. The system ensures data integrity by linking each attendance record to the unique device ID of the student's registered mobile device, preventing unauthorized access and misuse. Additionally, it includes features such as mobile device change requests for students who lose or damage their devices, managed through an Admin Web App. By combining mobile and BLE technologies, this system offers a modern, contactless, and efficient solution for attendance management, addressing the limitations of traditional methods and enhancing the overall educational experience.

2. Literature Review

Traditional attendance management methods, including manual roll calls, paper-based registers, and RFID-based tracking systems, have been widely used in educational institutions. However, these methods suffer from inefficiencies, human errors, and security concerns. RFID-based systems, while improving efficiency, are prone to card loss and unauthorized

access, whereas biometric systems like fingerprint and facial recognition offer higher accuracy but require additional infrastructure and face privacy challenges (Adukkathayar et al., 2015; Baharin et al., 2020). With the advent of mobile and wireless technologies, there is a growing interest in contactless and automated attendance tracking methods to enhance accuracy and convenience. [1] Biometric-based solutions, including fingerprint, iris, and facial recognition, have been introduced to provide enhanced security and accuracy in attendance marking (Baharin et al., 2020). Fingerprint-based systems require dedicated scanners, which can be costly and require physical contact, making them less suitable for post-pandemic environments. Facial recognition systems, implemented via machine learning and AI-based algorithms, have shown improved accuracy but face challenges like low-light detection issues, high processing power requirements, and privacy concerns. In recent years, researchers have shifted towards mobile and wireless communication-based approaches to streamline attendance tracking. Bluetooth Low Energy (BLE)-based attendance systems have emerged as an effective solution, allowing students to mark attendance via their mobile devices without requiring physical interaction (Saparkhojayev et al., 2012). [2] BLE technology ensures low power consumption, real-time tracking, and secure authentication by linking attendance records to unique device IDs. Recent studies (John & Joseph, 2021) have demonstrated that BLE-based attendance systems significantly enhance efficiency, prevent proxy attendance, and minimize administrative overhead. The proposed Mobile Attendance System builds upon these advancements by integrating BLE technology with the NRF51822 module, ensuring contactless, secure, and automated attendance tracking through a mobile application. This approach effectively addresses the shortcomings of traditional and existing attendance systems, providing a scalable and reliable solution for modern educational institutions.[3] This study analyses the present attendance system, which has numerous drawbacks like being labor-intensive, time-consuming, and inefficient. This study then suggests an attendance management system (AMS) based on facial recognition & GPS monitoring and placement. In order to address the issue of students requesting leaves and showing up late for attendance, we can build up a variety of functionalities in this system in addition to adding a manual component. [4] The system can accommodate the fundamental requirements of attendance in the classroom simultaneously. When the teacher is ready to begin taking the attendance, students can sign in as directed by the teacher. The student's identification can be confirmed by facial recognition, and the teacher and student's locations are ascertained further through GPS tracking and positioning on mobile devices. The sign-in can be accomplished if the required range is satisfied. The advantages of this new approach to attendance are that it is accurate and more effective and makes up for all the other short comings which we can possibly face with traditional mode of attendance systems. [5]

3. Proposed Methodology

The proposed methodology for the Mobile Attendance System outlines a structured approach to design, develop, and implement a secure and efficient attendance tracking solution. The system leverages [6-8] Bluetooth Low Energy (BLE) technology via the NRF51822 module to enable students to mark attendance using their mobile devices. The methodology ensures seamless integration between the mobile app, BLE hardware, and the admin web app, providing a centralized platform for managing attendance, students, and announcements. The system is designed to ensure data integrity and prevent unauthorized access by tying attendance records to the unique device ID of the student's registered mobile device. Additionally, it includes features like mobile change requests to handle device loss or damage, ensuring uninterrupted access for students. (Figure 1) [9-11]

3.1.System Design

The system design focuses on creating a seamless interaction between the mobile app, BLE hardware, and the admin web app. The mobile app allows students to mark attendance using BLE signals, view attendance records, and manage their profiles. The admin web app provides a centralized platform for managing students, attendance, announcements, and

mobile change requests. The system ensures data integrity by tying attendance records to the unique device ID of the student's registered mobile device, preventing unauthorized access. [13]
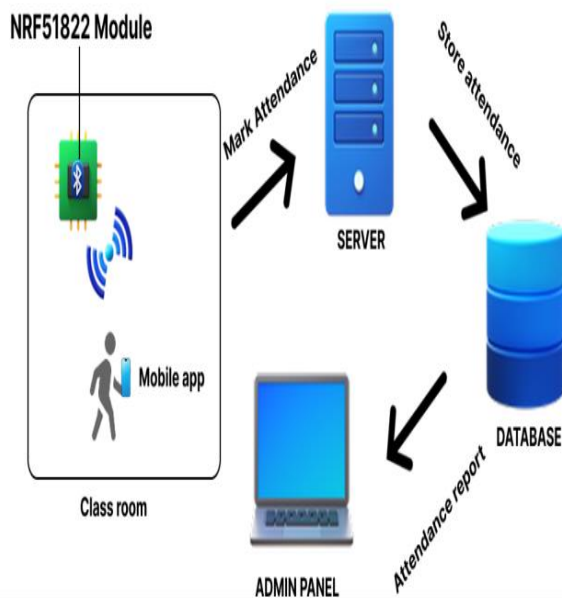

Figure 1 System Design

3.2.Software Architecture

The software architecture is designed to ensure scalability, security, and efficiency. It consists of the following layers:

Presentation Layer:

- Mobile App (Student Interface)

Admin Web App (Admin Interface) Application Layer:

- Attendance Marking Module
- Fraud Detection Module
- Mobile Change Request Module

Announcement Management Module Data Layer: Central Database (MongoDB) for storing student details, attendance records, and device information. The architecture ensures smooth communication between the mobile app, BLE hardware, and the admin web app, with the database acting as the central repository for all data. access by tying attendance records to the unique device ID of the student's registered mobile device. Additionally, it includes features like mobile change requests to handle device (Figure 3) [14]
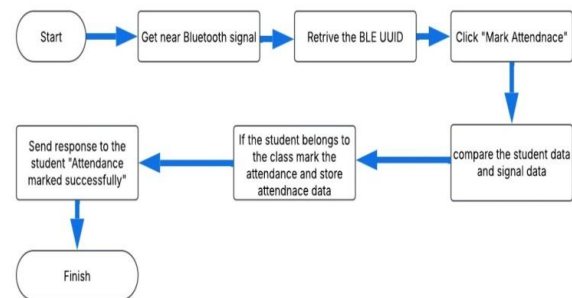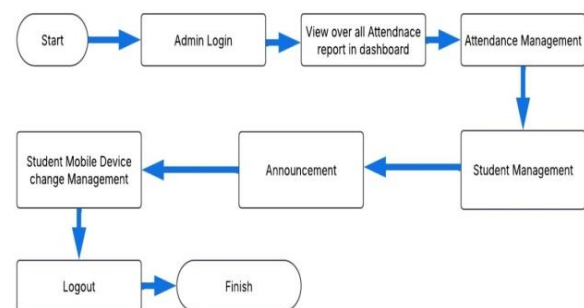

Figure 3 Flow of Student Mobile Application

Figure 4 Flow of Admin Panel
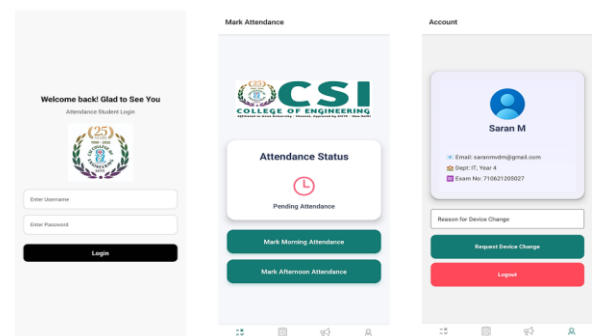
4. Results and Discussion
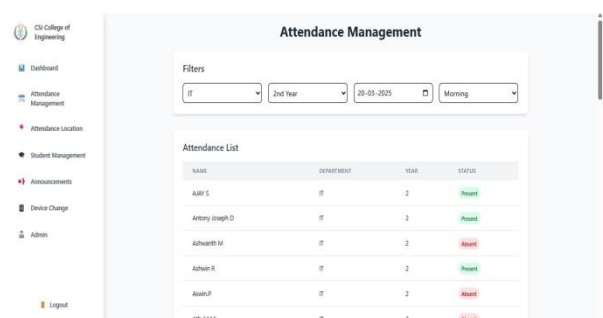

Figure 5 Student Mobile App

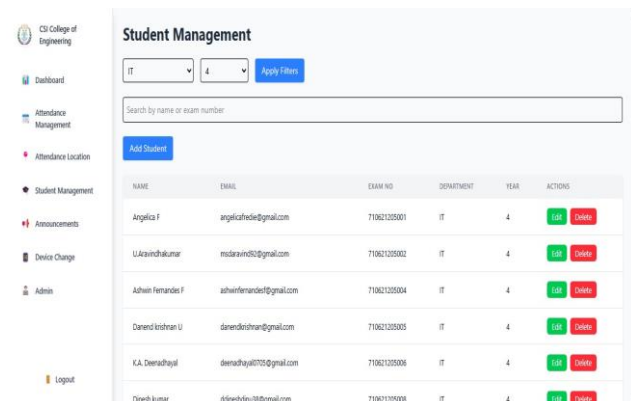**Figure 6** Admin Attendance Management

Figure 7 Admin Student Management

Conclusion

The proposed Mobile Attendance System leverages BLE technology and the NRF51822 module for contactless attendance marking via a mobile app. Admins manage records and announcements through a centralized web app, ensuring efficient oversight. Attendance is tied to the unique device ID of each student's registered mobile device, preventing unauthorized access. Mobile change requests handle device loss or damage, maintaining system accessibility. The system modernizes attendance tracking, improving accuracy and administrative efficiency. This project offers a scalable, user-friendly solution for educational institutions, addressing the limitations of traditional methods. [15]

References

[1]. Mobile Based Student Attendance System Using Geo-Fencing with Timing and Face Recognition Akinbowale Babatunde, Afeez oke, Ronke Seyi Babatunde, Opeyemi Ibitoye, E R Jimoh, March 2022, International Journal of Advances in Pharmaceutical Sciences 10(1):75 – 90,DOI:10.22624/AIMS/MATHS/V9N1P8.

[2]. Attendance System Based on Face Recognition and GPS Tracking and Positioning, Cui Zhao, Xiaodan Huang, 21664026, IEEE, DOI: 10.1109/ICAML51583.2020.00024, 23 November 2021.

[3]. Geo fencing Components and Existing Models, Anthony C Ijeh, David.S. Preston, Chris Imafidon, Titus .B. Watmon, Annette .O. Uwaechie , Nwadube Aaron, Kujabi Ebrina, Proceedings of the International Multi Conference of Engineers and Computer Scientists 2010 Vol II, IMECS 2010, March 17 - 19, 2010, Hong Kong.

[4]. Geo fencing on the Real-Time GPS Tracking System and Improving GPS Accuracy with Moving Average, Kalman Filter and Logistic Regression Analysis, Zeynep Özdemir, Bulent Tugrul, Ankara University, ISMSIT, October 2019, DOI:10.1109/ISMSIT.2019.8932766.

[5]. GPS based location monitoring system with geo-fencing capabilities, November 2019, AIP Conference Proceedings 2173(1):020014, Ali Hashim Abbas, Mohammed ihsanHabelalmateen, Syukran Jurdi, Lukman Audah, Nayef Alduais, DOI:10.1063/1.5133929.

[6]. Geo Fencing in Mobile Marketing, July 2019, James Seligman, University of Southampton.

[7]. Smart Geo fencing: An Inventive Mobile Marketing Strategy, Aagy Paulose, Aswathy K S, Nurjahan V A, Ilahia college of engineering and technology, Muvattupuzha, India, International Journal of Engineering Research & Technology (IJERT), IJERTV8IS060233, Vol. 8 Issue 06, June-2019.

[8]. Geo-fencing Infrastructure: Location Based Service, Sachin W. Rahate, Dr. M.Z. Shaikh, International Research Journal of Engineering and Technology (IRJET), Volume: 03 Issue: 11 | Nov -2016.

[9]. Face Recognition based Attendance Management System, Smitha, Pavithra S Hegde, Afshin, June 2020, International Journal of Engineering and Technical Research V9(05), DOI:10.17577/IJERTV9IS050861.

[10]. Android Application for. Presence

Recognition based on Face and Geofencing, Alvin Syarifudi Shahab, Riyanarto Sarno, IEEE, DOI: 10.1109/iSemantic50169.2020.9234253, 26 October 2020.

[11]. B. Badihi, F. Ghavimi, and R. Jantti, "On the system-level performance evaluation of bluetooth 5 in iot: Open office case study," in Proceedings of the International Symposium on Wireless Communication Systems, vol. 2019-August. VDE Verlag GmbH, Aug. 2019, pp. 485–489.

[12]. E. Park, M. S. Lee, H. S. Kim, and S. Bahk, "Adaptable: Adaptive control of data rate, transmission power, and connection interval in bluetooth low energy," Computer Networks, vol. 181, p. 107520, Nov. 2020.

[13]. B. Pang, T. Claeys, K. T'Jonck, H. Hallez, and J. Boydens, "Bluetooth low energy reliability and throughput under wi-fi interference," in 2022 31st International Scientific Conference Electronics, ET 2022 - Proceedings. IEEE, 2022.

[14]. G. A. Akpakwu, B. J. Silva, G. P. Hancke, and A. M. Abu-Mahfouz, "A survey on 5g networks for the internet of things: Communication technologies and challenges," IEEE Access, vol. 6, pp. 3619–3647, 12 2017.

[15]. M. Agiwal, N. Saxena, and A. Roy, "Towards connected living: 5g enabled internet of things (iot)," IETE Technical Review (Institution of Electronics and Telecommunication Engineers, India), vol. 36, pp. 190–202, 3 2019.