

AI-POWERED BLOCKCHAIN-ENABLED GEO-FENCED SMART ATTENDANCE SYSTEM

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Abstract:

Attendance tracking is an essential task in educational institutions, but it is often handled using methods that are either manual or only partially automated. These approaches take time. They also allow issues such as proxy attendance and data manipulation. Many digital systems improve either identity verification or location tracking. However, they rarely provide a complete solution. In this work, a smart attendance system is presented that combines face recognition, geofencing, and blockchain technology. The system first checks the user's identity using facial recognition. It then confirms whether the user is present within a defined location. Once both conditions are satisfied, the attendance record is stored securely using blockchain, making it tamper-resistant. This approach improves accuracy, reduces manual effort, and ensures transparency. The system is simple to use and suitable for real-world environments such as classrooms and workplaces.

Keywords — Artificial Intelligence, Face Recognition, Blockchain, Geofencing, Smart Attendance System, Secure Data Storage.

I. INTRODUCTION

Managing attendance is a basic requirement in institutions, yet it is still not handled efficiently in many cases. Traditional methods such as manual registers are slow and prone to errors. Even digital systems like RFID or card-based methods do not fully solve the problem, as they allow proxy attendance and lack strong verification.

With the growth of modern technologies, smarter solutions have started to appear. Face recognition allows automatic identification without any physical contact. At the same time, geofencing ensures that attendance is marked only when a person is physically present in a specific location. Blockchain provides a secure way to store data. Once recorded, the data cannot be changed.

However, most existing systems focus on only one or two of these aspects. Very few systems combine identity verification, location validation, and data security.

To overcome this limitation, this project proposes a smart attendance system that integrates artificial intelligence, geofencing, and blockchain. The goal is to create a system that is accurate, secure, and reliable in real-world usage.

In many real scenarios, a balance between convenience and security is missing. This highlights the need for a more reliable system.

II. LITERATURE SURVEY

A. Yash Mittal et al. (2015) – *Fingerprint-Based Attendance System*

In one of the earlier approaches, Yash Mittal et al. [1] designed a fingerprint-based attendance system to improve the reliability

of student attendance tracking. The idea was straightforward—each student's fingerprint is captured and used as a unique identifier, which removes the need for manual entry. This helps reduce errors and ensures that attendance is marked only by the actual person.

However, when this system is used in real environments like classrooms, a few practical issues come up. Since every student has to physically touch the sensor, it becomes time-consuming, especially when the class size is large. Also, continuous physical contact raises hygiene concerns. Another limitation is that the approach is mostly fixed to a particular location and does not support remote or flexible usage.

B. Riya Lodha et al. (2015) – Bluetooth-Based Attendance System

Riya Lodha et al. [2] explored a different direction by using Bluetooth technology for attendance tracking. In this approach, students' devices are detected using Bluetooth Low Energy (BLE), and attendance is marked automatically when they are within range. This reduces the need for manual input and makes the process faster.

Even though the system sounds convenient, it has its own drawbacks. The approach depends heavily on Bluetooth connectivity, which is not always stable. More importantly, it does not strongly verify who is carrying the device. If someone else brings the device, attendance can still be marked, making the system vulnerable to proxy attendance. Because of this, security becomes a concern.

C. H. K. Nguyen and M. T. Chew (2017) – RFID-Based Attendance System

Nguyen and Chew [3] proposed an RFID-based attendance system where each user is assigned a card that can be scanned to record attendance. This method is faster compared to manual systems and is relatively easy to implement in institutions.

However, the system depends entirely on RFID cards, which can be shared or duplicated. This means that even if the system works efficiently, it cannot fully prevent fraudulent attendance. Another issue is that it does not include any biometric verification or advanced security mechanism, making it less reliable in sensitive environments.

D. Khaled Mohammed et al. (2018) – Multimodal Attendance System

To overcome the limitations of single-method systems, Khaled Mohammed et al. [4] introduced a multimodal attendance system that combines RFID with face recognition. The goal here was to improve accuracy by using more than one method for verification.

While this combination improves reliability to some extent, it also increases system complexity. The setup requires multiple hardware components and proper environmental conditions, especially for face recognition. For example, lighting and camera quality can affect performance. In addition, the system still lacks a secure data storage mechanism, which means records can potentially be altered.

E. S. M. Bah and F. Ming (2020) – Face Recognition System

Bah and Ming [5] focused on improving face recognition accuracy using techniques like Local Binary Patterns and histogram equalization. Their approach works without physical contact, making it more convenient compared to biometric systems like fingerprint scanning.

Although the system performs well in identifying users, it does not check whether the person is actually present in a specific location. Also, it does not include any strong mechanism for securing stored data. As a result, while it solves one problem, it leaves other important issues unaddressed.

F. Mehraj Tamboli et al. (2024) – Geofencing-Based Attendance System

Tamboli et al. [6] designed a geofencing-based system where attendance is marked only when the user is inside a predefined geographical boundary. This ensures that users cannot mark attendance from outside the required location.

While this system is effective for location verification, it does not confirm the identity of the user. Anyone within the boundary can potentially mark attendance. Moreover, the system depends on GPS accuracy and internet connectivity, which may not always be reliable.

G. B. Ajith Kumar et al. (2024) – Blockchain-Based Attendance System

Ajith Kumar et al. [7] focused on blockchain-based system to address the issue of data security. In this system, attendance records are stored in a decentralized ledger, making them tamper-proof and transparent.

This method is strong in terms of security, but it does not fully solve the problem of authentication and location verification. Without integrating other technologies, the system cannot ensure whether the attendance is genuinely marked by the correct person at the correct place. Also, blockchain operations can increase computational overhead.

H. K. Suresh Varma et al. (2025) – Face Recognition with Geofencing

Suresh Varma et al. [8] combined face recognition with geofencing to improve attendance accuracy. The system checks both identity and location, making it more reliable than earlier methods.

Even though this system solves two major problems, it still lacks a secure storage mechanism like blockchain. This means

that while attendance is verified correctly, the stored data may still be vulnerable to modification.

From the above studies, it can be observed that most systems focus on only one aspect such as identity or location. A complete system combining all features is still needed.

Sl.No.	Paper	Technique Used	Objective	Key Contribution	Advantages	Limitations
1	Mittal et al. (2015) [1]	Fingerprint Biometric	Automate attendance using biometric identity	Introduced fingerprint-based authentication system	High accuracy, prevents impersonation	Requires physical contact, time-consuming
2	Lodha et al. (2015) [2]	Bluetooth (BLE)	Automate attendance using wireless detection	Developed Bluetooth-based mobile attendance system	Easy to use, reduces manual effort	Not secure, vulnerable to proxy
3	Nguyen & Chew (2017) [3]	RFID Technology	Speed up attendance process	Implemented card-based RFID attendance system	Fast and simple	Card sharing possible, no identity verification
4	Mohammed et al. (2018) [4]	Multimodal (RFID + Face Recognition)	Improve accuracy using multiple methods	Combined biometric and card-based authentication	More reliable than single method	Complex setup, depends on environment
5	Bah & Ming (2020) [5]	Face Recognition (AI/ML)	Enable contactless attendance	Improved facial recognition algorithm for attendance	Contactless, high accuracy	No location verification, security issues
6	Tamboli et al. (2024) [6]	Geofencing (GPS)	Ensure physical presence	Used location-based boundary validation	Ensures presence in area	No identity verification
7	Ajith Kumar et al. (2024) [7]	Blockchain + ML	Secure attendance records	Introduced tamper-proof storage using blockchain	Secure, transparent	No location validation, higher complexity
8	Suresh Varma et al. (2025) [8]	Face Recognition + Geofencing	Improve attendance accuracy	Integrated identity and location verification	More reliable system	No secure storage (blockchain missing)

Table 1: Comparison of Literature Survey Papers

III. RESEARCH GAP

Despite the availability of various attendance management systems, several important limitations still exist in current approaches. Traditional methods such as manual attendance and register-based systems are time-consuming and prone to human errors. Even with digital systems like RFID and Bluetooth-based attendance, some issues still

remain. Proxy attendance and lack of proper identity verification continue to exist [1], [2]. These systems mainly focus on simplifying the attendance process but fail to ensure authenticity and security.

Biometric systems such as fingerprint-based attendance improve identity verification to some extent, but they require physical interaction, making them less convenient and difficult to scale

in large environments. Face recognition-based systems provide a contactless solution and improve accuracy. However, they do not verify whether the individual is physically present at the required location, which still leaves room for misuse [5].

On the other hand, geofencing-based systems address the problem of location verification by ensuring that attendance is marked only within a predefined geographical boundary. This helps confirm physical presence, but it does not guarantee that the correct individual is marking attendance, as identity verification is not strictly enforced [6].

Recent approaches using blockchain technology have introduced secure and tamper-proof storage of attendance records, ensuring data integrity and transparency [7]. However, these systems mainly focus on data security and do not include identity verification or location validation. As a result, they cannot fully prevent fraudulent practices if used independently.

From the analysis of existing systems, it is evident that most solutions address these challenges separately rather than providing a complete solution. There is no unified system that simultaneously ensures accurate identity verification, physical presence validation, and secure data storage.

Therefore, there is a clear need to develop an integrated attendance system that combines artificial intelligence for identity verification, geofencing for location validation, and blockchain for secure and tamper-proof data storage. Such a system would provide a reliable, efficient, and transparent solution for modern attendance management.

IV. PROPOSED FRAMEWORK

To address the limitations identified in the existing systems, a smart attendance framework is proposed that integrates artificial intelligence-based face recognition, geofencing, and blockchain technology into a unified system. In this framework, each component plays a specific role in ensuring accuracy, security, and transparency in attendance management.

In the proposed system, users interact with the application through a mobile or web-based interface. When a user attempts to mark attendance, the system first verifies their identity using face recognition. The captured facial image is compared with the stored dataset. This ensures that only authorized individuals can proceed further. This step eliminates the possibility of proxy attendance by confirming the identity of the user. Once identity is verified, the system checks the user's location using geofencing. A predefined geographical boundary is set, and attendance is allowed only if the user is within this boundary. This makes sure that attendance is marked only when the individual is physically present in the required location. After successful identity and location verification, the attendance data is recorded and stored in a blockchain network. Once the data is stored in blockchain, it cannot be modified or tampered with. Each record is securely maintained, providing transparency and traceability for administrators.

Additionally, the system provides a dashboard interface for administrators and teachers to monitor attendance in real time. Reports can be generated easily, allowing better analysis and management.

This integrated framework combines identity verification, location validation, and secure data storage into a single system. By doing so, it overcomes the limitations of existing approaches and provides a reliable and efficient solution for modern attendance management.

The system is designed keeping real-world classroom conditions in mind, where both speed and accuracy are important.

Fig. 1 illustrates the workflow of the proposed attendance system, showing the process of user authentication, location verification, face recognition, and secure storage of attendance data.

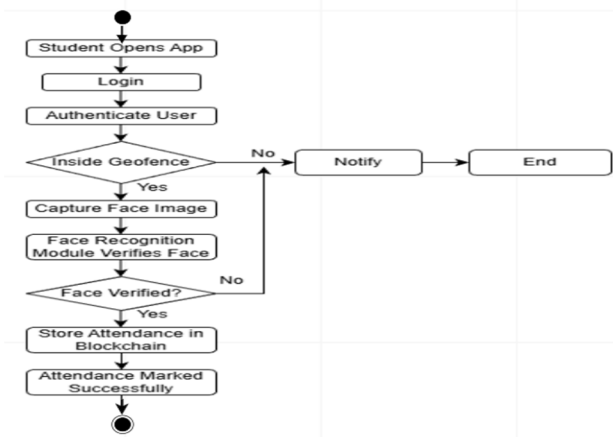


Fig. 1. Activity Diagram of Proposed System

V. APPLICATIONS

The proposed AI-powered attendance system can be applied across multiple real-world environments where accurate and secure attendance tracking is required. In educational institutions, it can automate student attendance by verifying identity through face recognition. It also checks physical presence using geofencing, thereby reducing manual effort and eliminating proxy attendance.

In corporate offices, it can be used to monitor employee attendance and working hours in a more reliable and transparent manner without the need for traditional punch-in systems.

In government organizations and public sector workplaces, the system can help maintain accurate attendance records and prevent data manipulation by storing information securely in blockchain. In training centers and coaching institutes, it can be used to track participation and improve accountability among students. Similarly, in industrial environments, the system can ensure that workers are present in designated areas before marking attendance, improving both security and operational efficiency.

These applications show how combining artificial intelligence, geofencing, and blockchain can create a secure and reliable attendance system.

The system can be easily adapted to different environments without requiring major changes.

VI. FUTURE WORK

Future improvements can focus on enhancing accuracy, scalability, and usability of the proposed

attendance system. One important direction is improving the performance of face recognition models under different environmental conditions such as low lighting, varying angles, and occlusions. Advanced techniques such as deep learning-based models and liveness detection can be used. These methods can strengthen identity verification and help prevent spoofing attacks.

Another area to improve is the efficiency of geofencing mechanisms. Improving location accuracy in indoor environments can make the system more reliable. Reducing dependency on continuous internet connectivity is also important. Additionally, optimizing the system to work effectively in large-scale environments with hundreds of users simultaneously is an important consideration.

Further research can focus on improving blockchain performance by reducing latency and computational overhead. Lightweight blockchain solutions or hybrid storage approaches can be explored to improve scalability while maintaining security.

Finally, integrating advanced analytics and reporting features can provide deeper insights into attendance patterns and user behavior. Real-world deployment and testing of the system will be essential to evaluate its effectiveness and identify areas that need improvement.

These improvements can make the system more practical for real-world use.

VII. RESULT

The suggested AI-based smart attendance system has been developed and verified using an online user interface. It consists of several modules, including admin login module, student registration, face recognition, and attendance monitoring modules.

The module for admin login allows the user to log into the system securely. The new students are registered through the module by providing all required details and loading several images of their faces. These images are used to train the model and generate embedding vectors.

After training the model, it will identify the face of students and verify their identities in real-time through a camera interface. Only after this process, the system marks attendance of any person in attendance data. The dashboard shows the total number of students, total attendance, and logs.

Experimental studies reveal that the system works effectively in identifying faces and maintaining attendance records. Face recognition makes sure of the identity of students, whereas the whole system saves efforts in the process of marking attendance.

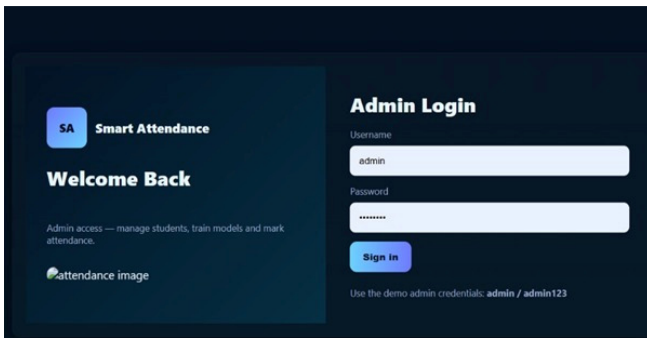


Fig. 2. Admin Login Interface

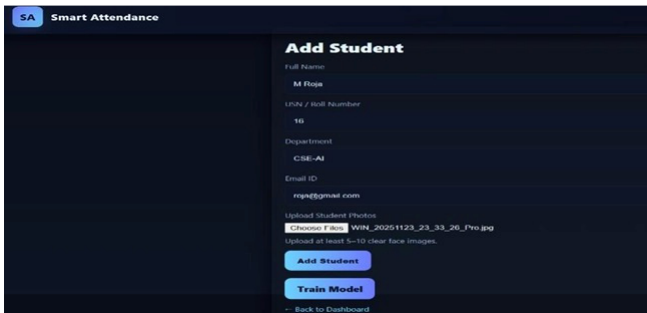


Fig. 3. Add Student Module

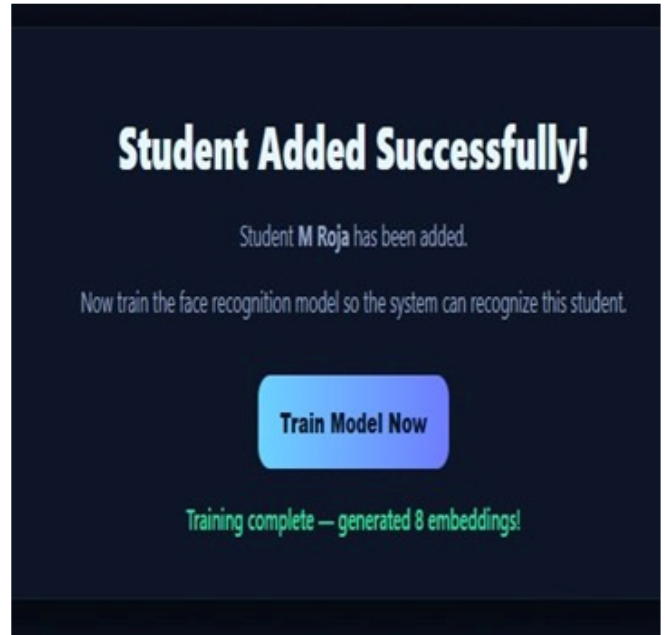


Fig. 4. Student Registration Confirmation

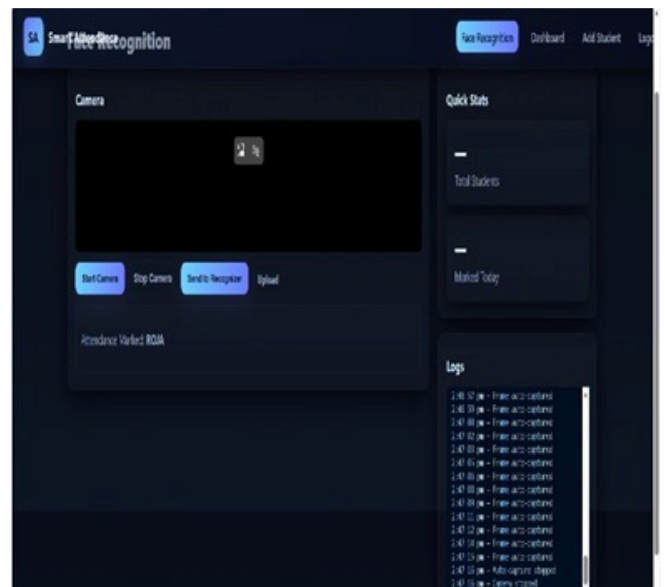


Fig. 5. Face Recognition and Attendance Module

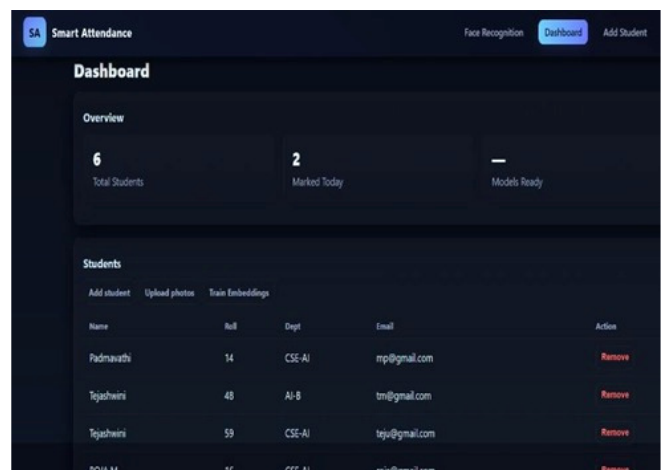


Fig. 6. Dashboard Overview

VIII. CONCLUSION

This paper presents a study of existing attendance management systems and highlights their key strengths and limitations. Traditional methods such as manual registers and basic digital systems are still widely used. However, they are time-consuming and prone to errors, including issues like proxy attendance and data manipulation. Even early automated approaches such as RFID and Bluetooth-based systems improved efficiency, but they lacked strong identity verification and security mechanisms [1], [2].

With advancements in biometric technologies, fingerprint and face recognition systems have improved identity verification and reduced manual effort. In particular, face recognition systems provide a contactless and convenient method for attendance marking. However, these systems still do not ensure that the individual is physically present at the required location. This leaves room for misuse [5]. Similarly, geofencing-based systems address the issue of location validation by restricting attendance marking within a predefined area, but they do not guarantee the authenticity of the user [6].

More recent approaches using blockchain technology have introduced secure and tamper-proof storage of attendance records, which improves transparency and data integrity [7]. While these systems improve security, they often lack integration with identity and location verification mechanisms, making them incomplete when used independently.

From the analysis of the literature, it is evident that existing systems focus on individual aspects such as identity verification, location validation, or data security, but do not provide a complete solution. There is a clear need for an integrated system that combines all these features into a single framework.

In conclusion, the proposed system addresses these limitations by integrating artificial intelligence for face recognition, geofencing for location validation, and blockchain for secure data storage. This combination ensures accurate, reliable, and tamper-proof attendance tracking. This system improves efficiency and transparency. It also provides a practical solution for modern institutions. In the future, this system can be further improved and applied in real-world environments on a larger scale.

Overall, the system is simple to use and suitable for practical implementation.

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