Unique Code Based Mobile Attendance System with An Emphasis on Fraud Prevention

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Abstract: The aim of this paper is to address the three major problems existing in today's online attendance systems namely attendance record maintenance, fraud prevention and time efficiency. As a solution we have implemented a mobile based attendance tracking system that has a separate module for the teacher, student and an administrator. An emphasis has been given for fraud detection where a five-factor authentication system was implemented to ensure attendance record authenticity. The problem of time consumption and lack of efficiency has been addressed by implementing a strictly time constrained process with an efficient and user-friendly interface. This system incorporates insights from multiple rounds of user interviews along with insights from literature surveys and provides a thorough solution to address the problems mentioned.

Key Words: —*Online attendance, Fraud Prevention, Face Recognition, Location Tracking.*

I. INTRODUCTION

The process of tracking attendance of attendants in lectures or seminars in education systems has been prevalent for a very long time; it has become a necessary practice to survey the number of attendants or, in some cases, ensure that the candidates attend the sessions. Conventional forms of attendance include roll call by the teacher or an attendance paper being circulated across the classroom where the students who are present would sign, the concerned faculty physically maintain these records as collections sorted by classes or subjects. More advanced forms of attendance collection have also arisen that include a web-based online attendance system that teachers can manually update, thereby dismissing the job of maintaining physical records. With the global rise in usage of the internet and mobile systems, internet attendance tracking systems of different kinds were introduced, and variations in such systems occur in terms of information architecture, database design and application development. Advanced technologies such as QR Scanning and Facial Recognition have also been applied to such systems.

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A survey of existing systems of tracking attendance brought us awareness about three significant problems present in such systems, namely Time Consumption, Record Maintenance and Fraud Prevention. The time consumed by following conventional methods of attendance tracking results in a waste of time for both the teachers and students; furthermore, processing conventionally collected records consume even more time. Attendance records must be maintained in secure conditions and protected from tampering; such records must be processed to generate attendance reports. Conventional attendance tracking hardens these processes. Finally, attendance has to be marked only for those students who are present in the classroom. Educational institutions establish a certain minimal level of attendance as a requirement for graduation, forcing students to resolve to false representations of attendance. Advancements in technologies have brought forth different alternative solutions that address these concerns, but the lack of a singular solution that addresses these problems concurrently is yet to be seen.

Numerous internet-based attendance tracking systems provide solutions that address a singular aspect in its entirety; if a system is addressing more than one concern effectively, users manage to figure out some form of loophole to exploit it. Preventing false attendance has been challenging among these concerns; maintaining the authenticity of attendance has become difficult for various reasons. Without the involvement of specialized infrastructure supported by advanced technologies, it has become nearly impossible to address all three concerns specified above.

Having described the current state of attendance tracking systems and the necessity for a complete system to address the three major problems. We propose a mobile-based attendance tracking system that employs simultaneous multi-factor attendance and allows students to mark attendance, supported by the corresponding teacher and administrator modules.

II. Literature Survey

While there is prevalent research and multiple approaches for the subject of discussion, a literature survey affirmed our belief in the necessity for an alternative attendance tracking system with an emphasis on fraud detection and prevention.

Masallah. F and Hirzalla. N propose a system where users mark their attendance by scanning a specialized QR code, which is further aided by a facial recognition algorithm and user authentication. This approach raises the question of the circulation of the QR code; in the absence of an overhead projector, QR codes have to be manually circulated, which would complicate the overall attendance process.[1] Chitresh S and Amit Kumar et.al, in their paper, propose a fingerprint-based attendance verification system, where they employ the minutiae technique to extract fingerprints.[2] This process requires an ultrasound sensor to capture the fingerprints, which results in additional costs for the institution's management.

Nirmalya Kar, Mrinal Kanti Debbarma et.al, in their paper take an alternative approach to face recognition. With a digital camera, images of students entering the classroom are captured and relayed to a backend system for comparison with the existing systems.[3] This approach requires a single candidate to be present in front of the camera, thereby increasing the time consumed to collect attendance. An approach by Partha Chakraborthy et al. also uses facial recognition to validate the presence of a student in a web-based solution that requires a computer and a camera to capture attendance.[4] In their paper, Murizah Kassim, Hasbullah Mazlan.et.al, propose an RFID-based attendance tracking, where students are required to scan their RFID tag-attached Identity card at an RFID reader.[5] Upon which the unique tag would help identify the student and grant attendance; this method allows a single student to scan the ID cards of multiple other students, thereby reducing the authenticity of the attendance records.

A survey of these existing works showed us that while good work has been done on time reduction and management of attendance records, there is space for improvement in the fraud prevention of attendance systems. That is where we have focussed our efforts.

III. System Design

As a solution to the proposed problems, we propose a mobile-based attendance tracking system that promotes a simple and friendly user experience while addressing the significant problems in a clear yet intuitive way aimed at the college education system. While performing the system design and information architecture for the system, interviews were conducted with multiple faculty members and students on the current practices of attendance tracking, pain points in the existing systems were identified, and efforts were put into overcoming them in the proposed system. A competitive analysis of the existing work areas was also conducted, upon which we concluded the system's current architecture.

Regarding the technical architecture and database design, multiple similar works were studied to identify the developmental and testing approaches and observed for insights that influenced decisions.

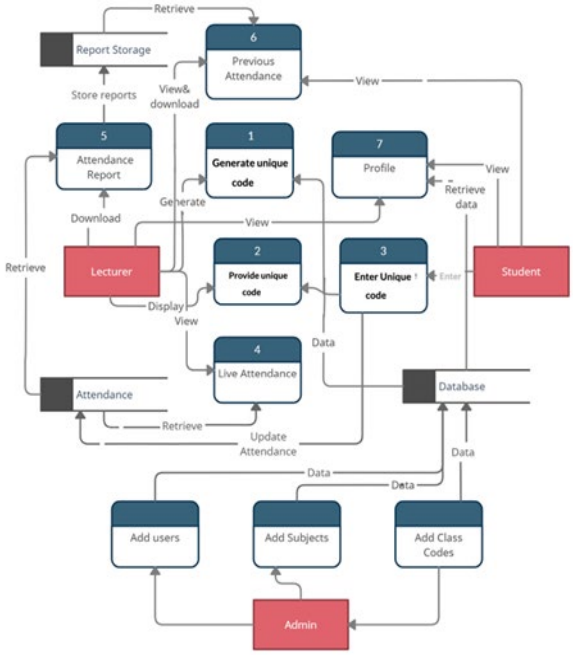

Fig.1. System Architecture of Online Attendance System

Our proposed system contains three individual modules that work harmoniously with each other: the student module, the Teacher module and the Administrator module. The student

and teacher modules are integrated into individual mobile applications, while the admin module is a web-based application. All three are connected to a central database that governs the authentications, attendance collection and record maintenance. Figure 1 offers the architecture of the system with all three modules included.

IV. Administrator Module

The admin module is the overall centre for controlling the attendance tracking system. The administrator would be the person who configures the system to collect attendance and store it. He is the super user of the system and the only one able to alter the records present in the system. The responsibilities of an admin are as follows.

- Establish the system
- Add student records into the system
- Add teacher records into the system
- Generate and distribute temporary credentials.
- Add subjects into the system and associate them with classes and semesters
- Monitor the collection of attendance and maintain the records.
- Prevent tampering with records.

In this system, the process of tracking attendance begins when an administrator adds students and teachers into the system; he adds the Name, Identification Number, and Associated mail address into the system and creates a user profile. Another crucial responsibility of his is to capture the individual face data of the student and upload it into the system; this is to prevent the student from uploading the face data of another student and indulging in fraudulent practices. The administrator also maintains the global repository of attendance collection for all students from all courses, and this user is the only one with permission to alter these records. This privilege is restricted only to him to prevent faculty or students from tampering with the attendance records. The administrator is the super user with overall control of the system. Typically, this role is taken by the head of a department or a dedicated individual in an institution.

V. Student Module

The student module is a mobile application that allows a student to log his attendance and track his previous attendance in his subjects. An emphasis on preventing fraudulent practices was given while designing the student's module, and a five-factor authentication system was developed to confront the practice of proxy attendance and ensure the attendance's authenticity. The Five methods of attendance are mentioned and described below.

- User login credentials with OTP.
- Location detection.
- Face Detection and Verification.
- Time Constraint.
- A Unique keyword.

A typical student flow in the module is described below.

- A student must change the default password when logging in for the first time. After logging in, the student would be logged out of the system every five days, and he would be required to log in using his credentials, and an OTP sent to the student's mail address or phone number.

On entering the system, the student could perform two actions. He can check his attendance records

- from previous records or mark attendance for the current session.
- To mark attendance, he would click on the respective CTA and would then be asked to verify his face using the mobile phone's camera, this would be compared to the data uploaded by the administrator. The student would be allowed to proceed only if he satisfies this requirement.
- Then the student would be asked to submit the unique keyword provided by the teacher, he would have a 30 second limit to enter it and submit, failing which he would not be granted the attendance.
- Once the student submits the attendance the location of the student is captured in the background and is referenced to the location of the teacher, if the distance between them is within the limits set by the teacher, the student would be allowed to proceed forward, otherwise he would be shown an error asking him to be present in the classroom for marking attendance and this would reject the student from gaining attendance.
- Only by passing all of these constraints a student's attendance would be successfully marked.

The five layers of Authentication were implemented to prevent fraudulent practices in attendance generation. The student's credentials that reset every five days would allow the student to stay aware of the stringent security policies of the application. Face detection would only compare the attendance data with images uploaded by the administrator, and this module would only be active if the student is present within the required location. The location detection would act on the teacher's consent, who would typically set the acceptable limits, which would be the general classroom area with the teacher being the centre. This is to ensure that the student is indeed present within the classroom. The final layer is to confirm attendance, and the 30-second time limit adds an extra layer of protection to prevent further exploitation on the student's part. The entire process of attendance is also constrained by a time limit of 5 minutes. From the moment a teacher launches the keyword, students would be allowed to submit the attendance for 5 minutes, after which the system would stop accepting attendance. Stringent measures were taken to ensure the authenticity of the attendance record. The figure depicts the flow of a student in the student module.

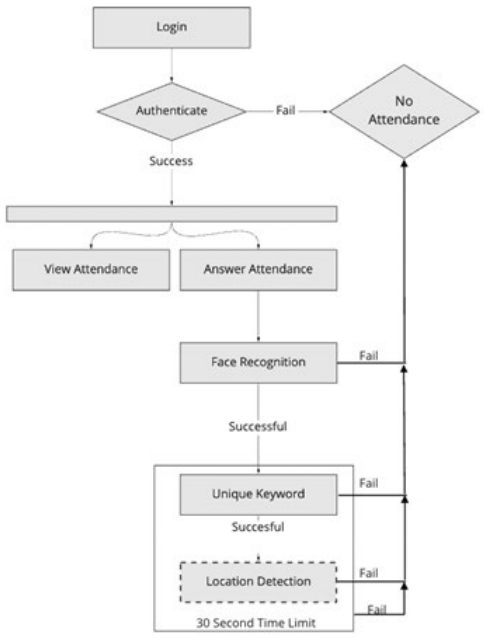

Fig.2. Student Module Flow

VI. Teachers Module

The teacher's module is the final module that makes up the attendance tracking system. Teachers are added to the system by the administrator, and he provides them with default passwords, which they are expected to change when they log in for the first time. The features present in a teacher's module are listed below.

- View previous class attendance records.
- Set the attributes and start an attendance poll.
- Disable an attendance poll.

After logging into the system, the teacher can perform two actions, view the records of previous classes or trigger an attendance poll. The flow to trigger an attendance poll is described below.

- The teacher chooses the appropriate CTA to start the attendance poll.
- Fills in the attributes that include location limit, course name, semester and subject.
- Launch the poll and collect the records.
- Disable polls.

Apart from launching the polls, disabling them and viewing the previous records, there is nothing much the teacher can do. This is also a security measure to prevent tampering or altering attendance records. The teacher can also export the existing records to excel sheets to process. This would make a copy of the permanent records and export it but would not affect the permanent records.

The entire process of attendance collection would take a maximum of 5 minutes, and extreme effort was put into designing the system for fraud prevention. The problem of record maintenance is also addressed here. We have designed a complete system that addresses all the significant problems of attendance tracking and comes up with a time-efficient, low-resource-consuming, simple and user-friendly method for securely collecting attendance.

VII. Implementation

7.1 Authentication

As Authentication is a crucial principle for all the modules and offers the first layer of security, we implemented Authentication using the Firebase Console. An E-mail ID and Password sign-in were configured from the authentication modules provided by Firebase. The automatic log-out after five days was implemented by disabling the session flags in the mobile application. OTP generation and validation were also leveraged from the Firebase Console itself.

7.2 Database Design

Our intention to keep the system flexible while guaranteeing good security caused Database design to be a complex part of the implementation process. We utilized the Firebase cloud storage to implement the database for the applications. As the database is designed into collections and documents, it proved even more accessible to implement than a relational database. The design process is described further.

- Collections were created for each unique data set, such as attendance, class and semester.
- Further internal documents were created in each collection for a specific entity. For example, the semester collection had documents named one, two, three and four, signifying that they represented the first, second, third and fourth semester's data, respectively.
- Each document further had its fields that collected and stored data. This data was stored in JSON format.

The database was configured to hold the following data in multiple permutations as individual collections, each having its privileges and applications.

- Student name.
- Program.
- Semester.
- Teacher.
- Attendance
- Student ID.
- Course ID
- Subject Name.
- Class
- Branch
- Academic Year
- Role.

A combination of these data elements is present in each document as JSON data. The structure of the database schema is depicted in the following picture.

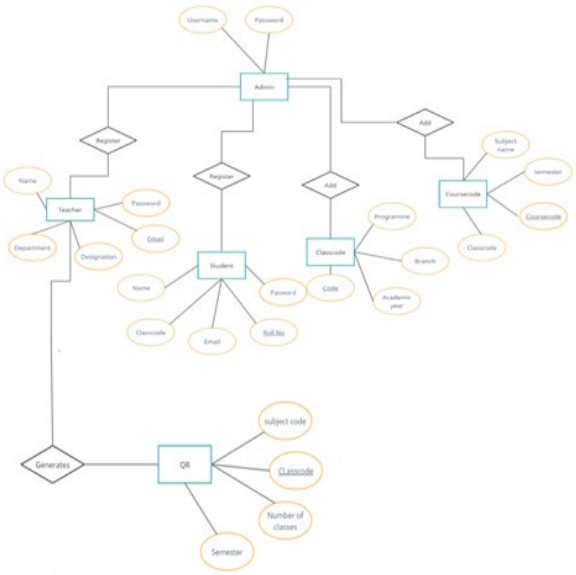

Fig.3. Database ER diagram

7.3 Record Maintenance

We have used Firebase cloud storage to store attendance records and facial recognition data. As data is stored in the form of documents and collections of CSV and JSON formats, respectively, each period's data is updated in a document associated with multiple collections such as the class, student, subject and semester and then at the end of marking the attendance it will be converted to CSV and stored in cloud storage. It ensures the authenticity of the data and ease of access for the front-end systems.

7.4 Face Detection and Location Verification

The feature of facial recognition is integrated by combining the working methodology of two computer vision models, the firebase ml vision model for detecting the face and preprocessing of the image and the mobile facet model for classification, processing, and transforming the data into a format that is saveable and reusable.

To use models in flutter apps, they have to be converted into TensorFlow lite models, which are compatible with execution in mobile applications. Thus, we have converted the mobile-facenet TensorFlow model into the TensorFlow lite model and integrated it into the app. The firebase ML vision is a face detection ML kit that provides an API to use its services. So, in our scenario, when a face is given, the image is passed

through the API to firebase ML vision for it to detect the face in the image and the cropped zone of the face and its counters will be returned, then we pass the returned data to mobile facenet model for processing and classification of the face.

7.5 User Interface Generation

Generating a unique keyword makes it easy for the lecturer to announce it to the students to mark attendance. It is an alphanumeric six-digit keyword, and each keyword generated is associated with the basic information regarding the respective class, i.e., class code, semester, subject, lecturer and students associated with the class code. To employ this feature, we used Flutter's built-in widget, which will generate a random alphanumeric code of a specified length each time we call the function.

7.6 User Interface Screens

The user interface screens of the mobile applications from the student application and teacher application are depicted below, these were built using the Flutter framework, the design system of both the applications is consistent, user friendly and based on research.

While there exist many more screens, we have only chosen to display a few of them based on their importance and uniqueness in the applications.

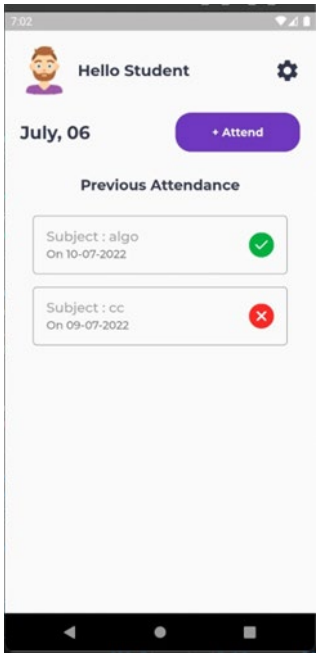

Fig.4. Student module home screen

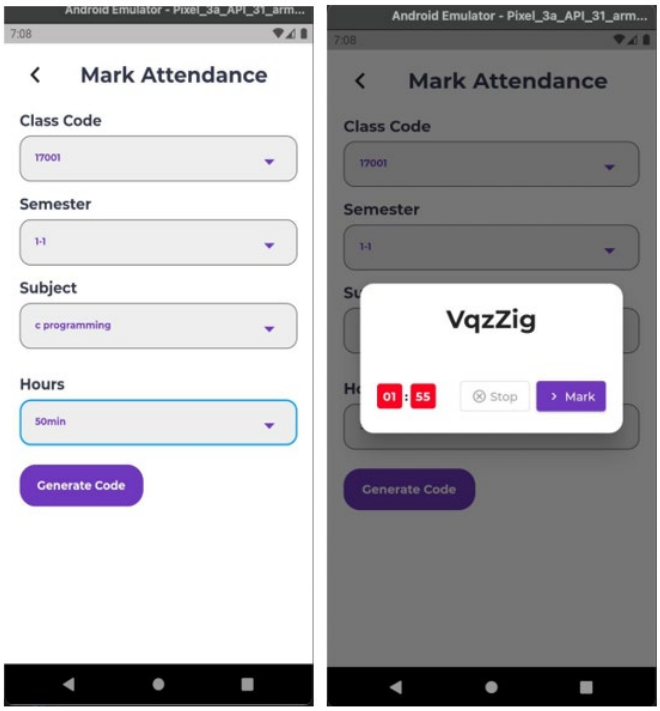

Fig.5. (a) Teacher Module for Code Generation

(b) Generated Code in the Teacher Module

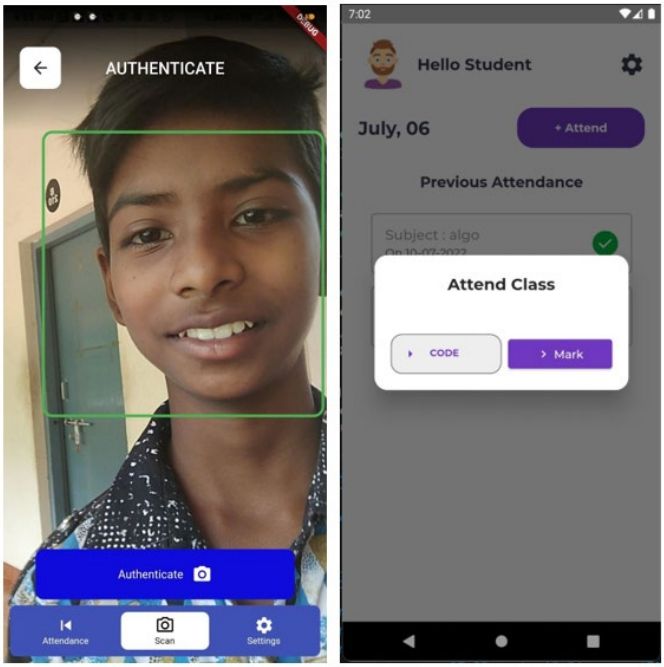

Fig.6. (a) Student Module to verify face

(b) Student Module to enter code and mark attendance

VIII. Conclusion And Future Work

A complete system for tracking attendance in educational institutions was proposed that addressed the problems of time consumption, record maintenance and Fraud Detection. With an emphasis on fraud detection, a Five Factor authentication system was implemented to prevent false attendance markings and improve the authenticity of the attendance. The system consists of three modules, teacher, student and administrator, where the administrator acts as a super user and accesses the system via a web application. The teachers and students have different but unique features and access the system via mobile applications.

The system is time efficient, structured, streamlined and result-oriented while promoting a friendly user experience. Great effort has been invested in addressing the concerned problems in an intuitive and novel manner.

Looking further, we intend to implement additional modules that would validate the presence of a student in the classroom to 100%. While the existing layers are sufficiently purged of potential loopholes, verifying a student's presence in class without their knowledge to supplement the system would be remarkable.

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