Smart Attendance Management System

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Abstract
Keeping track of attendance while engaging students in the classroom may be tough, especially when the class is big. The conventional method of calling pupils' names is tedious and time-consuming, and proxy attendance is always a possibility. To address this problem and maintain track of students' attendance, we presented a smart attendance management system (SAMS) using face recognition, fingerprints, and location. SAMS assists the instructor in two ways. First, it provides an automatic and error-free rollcall. Second, it records the attendance of pupils over time to share with the advising unit, and to generate a DN list of students with short attendance before the exam for the academic affairs unit. SAMS notifies students when the rollcall window on their smartphone is activated/opened, based on the precise date/time slot for a class (under instructor ID, subject ID, and classroom location). It allows students to register for classes using their smartphone's face recognition and/or fingerprint sensor. As a result, the student's rollcall is recorded in the system, along with the classroom location identifier. The system uses deep learning (DL) approaches for biometrics, such as the histogram of oriented gradient approach for facial and fingerprint recognition. The proposed system can also be used for rollcall in online classrooms.

Keywords:
SAMS, smart rollcall, Location based services, DN list, face recognition, fingerprints.

1. Introduction

The modern educational environments require building an integrated system for provisioning of educational resources in all forms, as well as pay attention to the way to access them this is where smart attendance comes in. The goal is not to force the student to attend, but rather to ensure the presence of students and their acquisition of the rich knowledge for his/her own good and to build the country.

The Saudi Vision 2030 recommend the development of educational systems by applying new technologies [1]. As artificial intelligence (AI) plays its role in enhancing this part to perform the basic daily tasks automatically like health factors etc. and improve the wellbeing. Similarly, it can be utilized for smart attendance by means of facial recognition, iris detection and fingerprints etc. [2]. The development is constant, as during the new situation in the pandemic some of the available techniques used in attendance process are prevented like fingerprint and signature in the paper (at campus), to save the spread the virus. This opens the opportunity to find an alternative technique such as the face detection which is smart enough to recognize the face with mask and other ambient hazards and inbuilt in many smartphones operating systems like Apple iOS 12 and above. The authentication based on multiple conditions provides high security for that reason used GPS technology (geo tags) with face detection, to track the movement and availability in the specific area. Furthermore, should manage the risk and prepare for it, be put into consideration in case of loss of services, by providing alternative choices instead such as the fingerprint.

This paper is organized as follows. The next section describes the related work. Section 3 discusses the problem statement. In section 4, we discuss proposed system architecture. Section 5 summarizes the implementation and section 6, concludes the paper.

2. Related Work

This section covers the well-the results of known technologies and systems currently in practice for smart attendance. Each technology mentioned here has its own pros and cons. Proposed system tries to overcome the possible research and development gap.

A) Fingerprint-Based Attendance Management system

Fingerprint has evolved into the most advanced and widely utilized biometrics technique for automated

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personal identification. The popularity of fingerprint verification can be attributed to fingerprints' uniqueness, stability, permanence, and ease of use [4]. This system proposes a new automatic attendance management system that incorporates fingerprint authentication into the attendance management process for both employees and students. Enrolment and authentication are the two procedures that make up this system. The user's biometrics are collected during enrolment, and the minutiae data is extracted and saved in a database as a template for the topic, along with the user's ID. After feature extraction, the enrollment module's goal is to accept a user into a database using his or her ID and fingerprints. These characteristics create a template for determining the user's identification and formulating the authentication procedure. An administrator of the attendance management system handles the enrollment process. During authentication, the user's biometrics are collected once more, and the extracted characteristics are compared to those previously stored in the database to see if they match. Following a successful match, attendance is recorded using the user's id that was used to match the templates. The project used a fingerprint reader as an input to capture pictures and built a program with a fingerprint recognition and identification system as well as a database to store user data. The fingerprint templates and other biodata of the users, as well as the attendance records kept by the users, are stored in the database. The attendance management system's design is depicted in Figure 1.

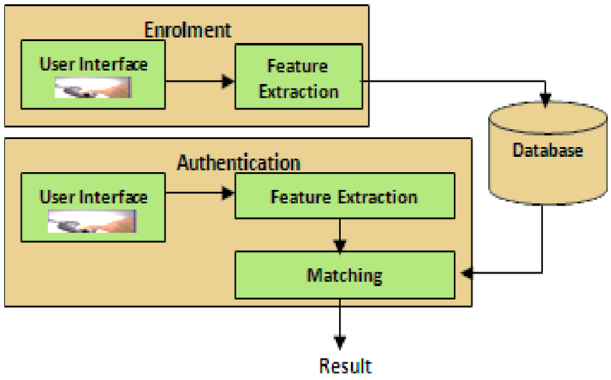

Fig. 1. Architecture of the fingerprint-based attendance management system [5].

In a realistic situation, one would like to evaluate the accuracy and speed of a fingerprint matcher. Biometric templates, unlike passwords and cryptographic keys, have a significant level of unpredictability. There is a lot of variances between biometric samples obtained at various times from the same individual. As a result, the match is always made on a probabilistic basis. This contrasts with password and token-based methods, which need a precise match. False Acceptance Rate (FAR) and False Rejection Rate (FRR) are two types of mistakes caused by inexact matching [6].

False Acceptance: An imposter may be mistaken for a real user if his template is close enough to the actual user's intra-user variation.

False Reject: Even a valid user may be denied during authentication if the biometric signal obtained is of poor quality. A 'false reject' is the term for this type of mistake. If you don't match against your own template, you've been rejected incorrectly.

B) Barcode-based Attendance Management System

Every employee must be given a badge/card with a barcode as part of the barcode attendance system. The badge/card is exchanged on the time clock to check into or out of the firm, and the data is recorded by the clock. Data is encoded in the magnetic stripe of the employee card in the magnetic stripe attendance system. The information on the card's magnetic stripe is captured by the time clock when the card is swiped through the employee time clock [7]. This method scans one card at a time and requires that the reader be in touch with it. RFID is a technology that uses radio waves to send data from an electronic tag, also known as an RFID tag or label, affixed to an object to a reader for the purpose of identifying and tracking the thing. Employee ID cards have an RFID tag inserted in them, which is read by a reader. This RFID technology uses a computer to connect to a database. When an employee enters or departs, an RFID card is used, and the data is recorded by the reader [8]. The RFID-based attendance management system architecture is depicted in Figure 2. Although the benefits of RFID for tracking and controlling daily things are obvious, wireless RFID sensors (both digital and analog) have yet to become widely used in the home and personal electronics sector. RFID sensing is now being held back by several major roadblocks. Collisions between sensor responses, An RFID sensing application consists of at least one reader and multiple RFID sensors, each of which has at least one sensor. When interrogating these tags, the tag collision problem

becomes the major emphasis. Because they share the same communication channel, their replies must be arbitrated to avoid collisions caused by simultaneous responses. This issue is one of the leading causes of energy waste, longer identification times, and lower read rates [10].

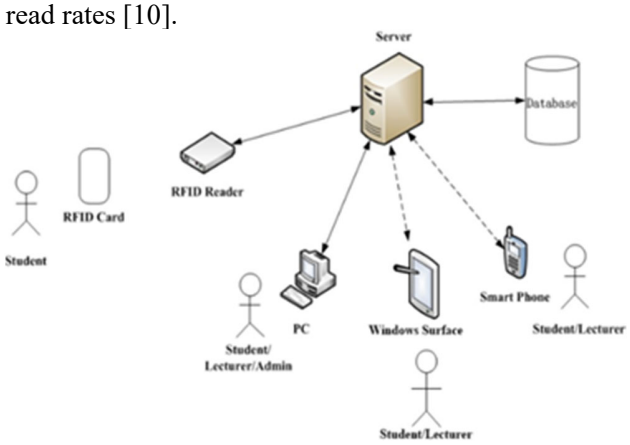

Fig. 2. Architecture of the RFID-based attendance management system [9].

C) Quick Response (QR) based Attendance Management System

A Quick Response code (QR-code) is a code that is arranged in black and white rows and columns and is designed to be read by a smart phone [11]. Using Quick Response (QR) codes as student tags guarantees a cost-effective advantage. QR codes are powerful in that they may contain almost any sort of data, including numeric, alphabetic, special, and binary information [12].

Scanning is a rapid process as the system is functioning. To produce an encrypted QR code with specified information, the system requires a simple login process by the class instructor using its Server Module. This may be done before class at any time. The lecturer shows an encrypted QR code to the students during or at the start of class. The students can then use their smartphones to scan the displayed QR code to record the attendance. The entire procedure should take no more than a minute for each kid and the entire class to complete their attendance confirmation. The QR-based attendance management system architecture is depicted in Figure 3. The QR code is simple to create and is completely free. QR code generators are accessible for free online, and there is also software that allows you to download the generators for free and use them even when you are not connected to the internet. The drawback is that the QR Codes generated are only for that single event. As a result, students in a university context will be required to preserve and maintain upwards of 10 codes every year for all their courses [14].

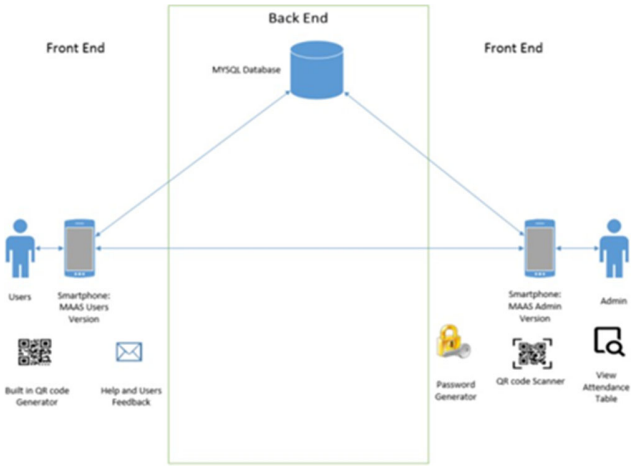

Fig. 3. Architecture of the QR-based attendance management system [13].

D) NFC-based Attendance Management System

Near Field Communication (NFC) is a technology that allows a device to detect information and/or commands from a tag by bringing them near together or even touching them. Each NFC tag contains a one-of-a-kind ID that can't be replicated. These NFC tags are subsequently distributed to students in every college faculty and department. While students tap these tags on the lecturer's NFC equipped mobile phone [15], the lecturer's NFC readers software reads individual tags, identifies, and verifies students from their respective NFC tags [16], and sends attendance data to the lecturer's smart phone [17]. By the end of the lecture, or by the end of the day, depending on the instructor desire, the smart phone uploads all the attendance data it has collected to the main server [18]. A model NFC-based attendance management system architecture is depicted in Figure 4. That is comprised of card NFC based smartphone, backend server and reporting equipment.

Because NFC technology often includes a suite of associated devices, equipment, and upgrade-dependent standards, it may be too costly for some campuses. This technique is not entirely risk-free.

Hackers have devised creative methods of getting illegal access to personal data held on phones, and the battle to protect that data is never-ending.

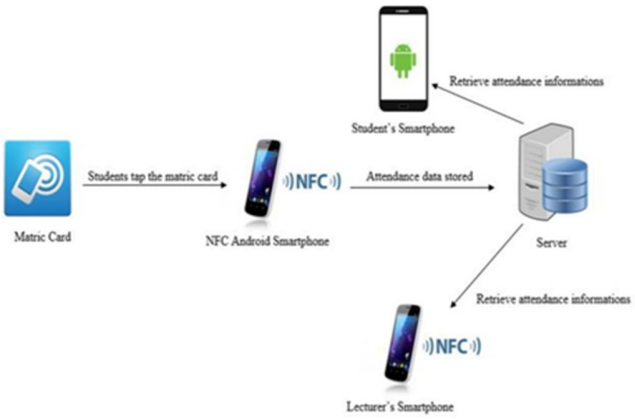

Fig. 4. Architecture of the NFC-based attendance management system [9].

E) GPS-based Attendance Management System

Global Positioning System (GPS) is a satellite-based navigation system that provides continuous positioning and timing information [19]. Using GPS technology in the attendance system is considered trusty. The based goal is to make sure the students are in the class. By applying real-time tracking and continuous monitoring, instead of taking the attendance manually two times at the begging of the lecture and at the end, to ensure the student attends on the full hour. So, it has a big role in reducing the time-consuming and providing accurate time recording.

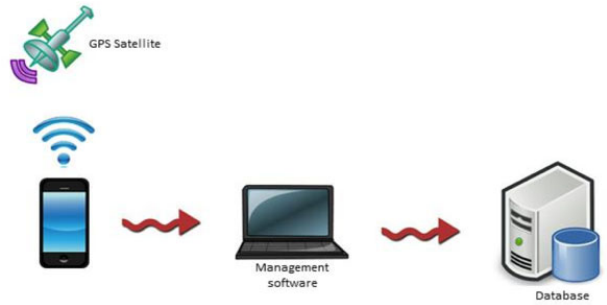

Fig. 5. Architecture of the GPS-based attendance management system [20].

The GPS-based attendance management system architecture is depicted in Figure 5. The system is an application that is installed on student devices. The application is connected to the server that holds the database for all students. The system will request student login with the id. At the time of taking attendance, the location of the student is determined, will be checked If the student is inside the class building, the system will record the student as present in the class, and if it is not there, the student is considered absent. Furthermore, the id and location will be encrypted and sent to the server. The system workflow is depicted in Figure 6. But it is not very effective because, like the current days, some lecture is performed online, and it is not possible to track location when outside the class building because the location of the student may be diverse as it is possible for the student to complete the lecture outside the home, such as the cafe or the library.

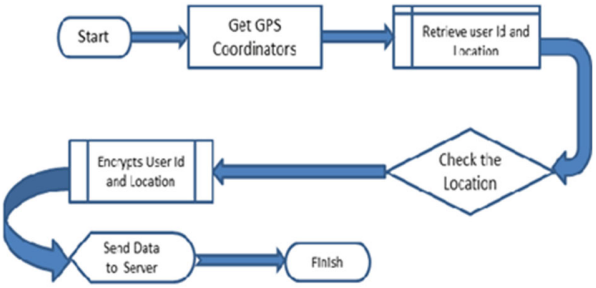

Fig. 6. The workflow of GPS-based attendance management system [20].

3. Problem Statement

It is commonly observed that students' rollcall in the universities is a time-consuming process, especially when the class size is large say twenty-five and above on average. In semester system, the faculty members are required to conduct roll call once or twice in each lecture. If the total time consumed during rollcall is accumulated, it becomes significant. The situation demands a smart, efficient, and reliable attendance system. As current practice, the instructors either rollcall or pass a sheet to be signed by the students. Both ways are time consuming as well as vulnerable to manipulation, where students proxy the attendance. This issue even elevated in the partition classrooms, where male faculty members are unable to see the female students beyond the glass [3].
Moreover, during the pandemic as the classes are taken online and some issues were observed as another person attended instead of a student. In the proposed system, students will login by their face ID and/or

fingerprint (using their smartphones) and together with the date/time stamp and location ID of the classroom. Consequently, the app running on the students' smartphone will upload the information to the server unit to confirm attendance. Smartphones may communicate with the server either through local intranet coverage provided by the universities or through the internet. System will only assist in terms of smart attendance, but also help in calculating the aggregate attendance during or at the end of semester. It will help the instructor in calculation the defaulters (DN) students list, who would not be able to appear in the exam due to short attendance policy of the university.

A) Goal

The main goal of SAMS is enabling university or college students to use smart attendance. Its ability to individually identify each student based on their fingerprint or face ID and class location makes providing security access easier, faster, and more secure than in the past.

B) Scope/Limitation

The suggested SAMS was created with universities in mind. There was a range for students as well as a range for instructors. The project's design and platform are an iOS-based system and android-based system that keeps track of students' attendance. In addition, the system assists the instructor in calculating the DN students list.

The proposed attendance system SAMS should be able to enroll the student in the courses automatically. But that shall be excluded from the project due to restrictions, we postpone this feature because it requires to connect with "PeopleSoft" system to get access the information of students and will be the instructor enrolled her students through importing CSV file of enrolled students.

SAMS require the students must have a smartphone device during the class having inbuilt camera and/or fingerprint sensor. Failing to which, students won't be able to get the access.

4. Proposed System Architecture

Building a mobile application to manage the attendance based on the biometrics in order to prove the identity of the student by checking the fingerprint or Real-time face verification, as it is one of the recently used technologies based on deep learning by CNN model as it is used before in visual analyzing the image to find the pattern, by training the model to detect the face and then preprocessing the image to extract features and the output will be number stored in an array. Real-time face verification is achieved with *MobileFaceNets*. in addition to checking the location of the student to prove that the student is in the classroom. all the techniques used will provide high accuracy and security in attendance management rather than manually processing. The SAMS intends to be a mechanism for documenting student attendance using smartphones, which will save a lot of paperwork from the existing, manual attendance system. The SAMS is a standalone mobile application that will be beneficial for instructors and students at universities to keep track of attendance using location, face ID, and/or fingerprints. This is the system's most important feature. The system should generate a report on attendance. There should primarily be interfaces that are linked to a single database. Figure 7 Show the overall architecture of the system. In general, the instructor is responsible to manage the attendance. As for the student can check the attendance performance.

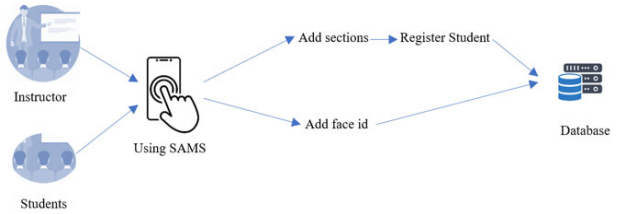

Fig. 7. Overall architecture of the system

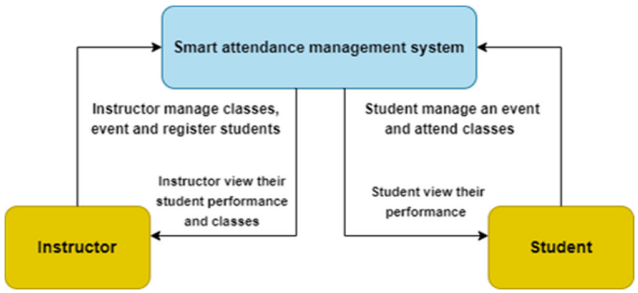

Fig. 8. General view of the system

The DFD context depicts the intended SAMS implementation's capabilities and limits. The context DFD depicts the system's limits as well as its interactions with its surroundings. The DFD context is

to show the user's connection and how they exchange information within the system. This section contains a flow diagram for additional functions in SAMS that are common to all users, instructors, and students, as well as how they interact with the system. Figure 8 depicts how data travels between the system and all users at DFD Level 0 for more typical functions. Following provides a graphical representation of how an instructor interacts with the system.
Figure 9 shows the Level-0 DFD of the instructor subsystem and describes how the data flow between the system.

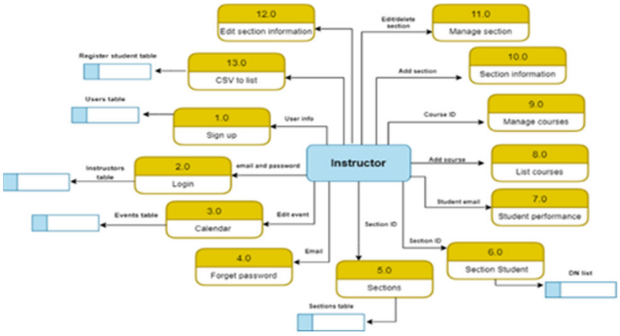

Fig. 9. Instructor subsystem

Following provides a graphical representation of how a student interacts with the system. Figure 10 shows the Level-0 DFD of the student subsystem and describes how the data flow between the system.

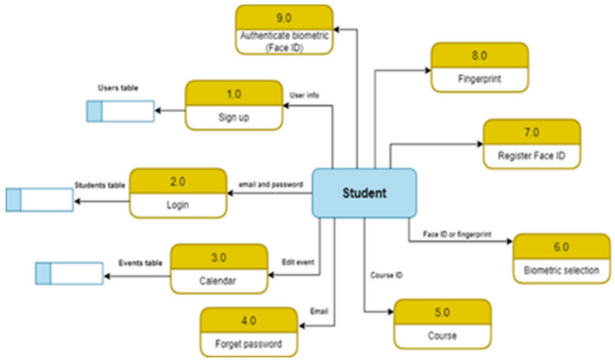

Fig. 10. Student subsystem

5. Implementation

The below figures are snapshots of some interfaces from the proposed SAMS prototype built for assessment.

Figure 11 shows the home screen for the student to select his/her class. Figure 12 shows the classes/subject students enrolled in and upcoming classes time. Figure 13 provides the option to select either biometric option that is facial recognition or fingerprint. Figure 14 and Figure 15 shows the interfaces for facial recognition system and fingerprint scanning system, respectively.

Fig. 11. Home screen

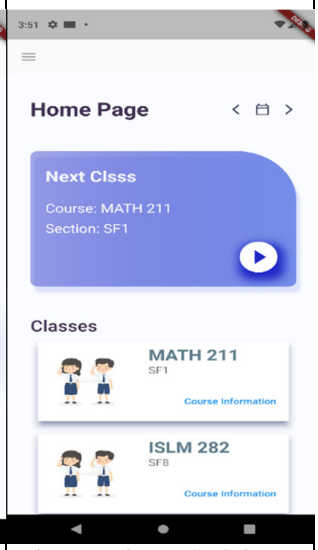

Fig. 12. Class schedule

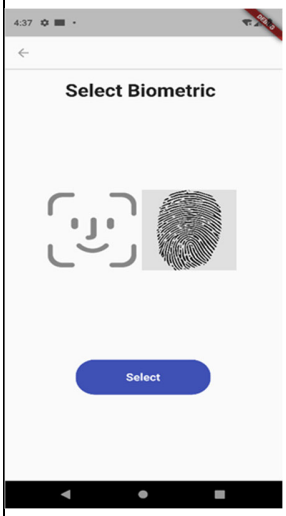

Fig. 13. Biomertric select

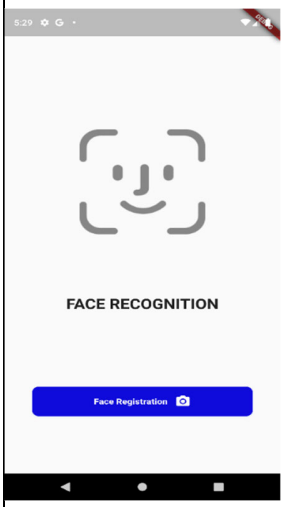

Fig. 14. Facial interface

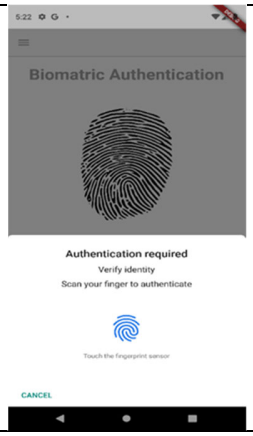

Fig. 15. Fingerprint interface

6. Conclusion

Smart attendance management system is designed to solve the issues of existing manual systems. We have used face recognition and fingerprint concept to mark the attendance of student and make the system better. The smart Attendance System helps in increasing the accuracy and speed ultimately to achieve the high-precision real-time attendance and its evaluation process. In future, we are intended to investigate more machine learning and deep learning-based system in contrast to the cloud computing for sake of smart attendance with added security solutions [21-55].

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