



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 12, Issue 5, May 2023

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.423

 9940 572 462

 6381 907 438

 ijrset@gmail.com

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Real Time Student's Attendance Monitoring System Using RFID and Fingerprint Sensor

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ABSTRACT: Attendance documentation is a crucial metric for determining a student's dedication, qualification, and status. Several types of systems have been developed for automated attendance. The majority of these implementations were built on a single factor template, representing a line of security error. In recent years, rapid development has taken place in several applications such as authorization, data access, and access control by implementing biometrics and radio frequency identification technologies. This research work focuses on designing a smart protocol for RFID authentication in combination with fingerprint biometric information, which guarantees confidentiality, identity verification, and data protection. Reaction time and event performance evaluation were the tests performed on the system. Ten students with unique fingerprints and RFID cards are assessed for the test. The test results show an average duration of 20.61 respective seconds for each student, and zero percent of false refusal rate was recorded in the implementation. Finally, the result shows the system is reliable and efficient. Each result revealed high speed performance due to software and hardware coordination. Biometric systems provided data integrity and security, RFID provided limited complexity, and the proposed method's technical programming pattern provided an average run time..

KEYWORDS: Biometric; RFID authentication; Radius Calculation; MATLAB; Authentication. Introduction

I. INTRODUCTION

Personal identification is considered an important aspect in recognizing the identity of a particular individual. A person's identity can be validated through the traditional or biometric methods. There are two types of traditional methods which are token-based and knowledge-based identifications [1]. Examples of the token-based method include possession of a passport, driving license, and different types of cards such as identity (ID) card and credit card. Although it is convenient to carry these identity documents, these documents can be reproduced, stolen, or lost. On the other hand, the knowledge-based method is related to a password or personal identification number (PIN) created by each individual for authentication. Nonetheless, it tends to be forgotten easily, especially if the person has several passwords or PINs for different applications. Another alternative method is through biometric adoption, which considers the physical or behavioural characteristics distinctive to an individual. Physical characteristics refer to inherent features of the human body part. These include the face, fingerprints, and iris. On the contrary, behavioural characteristics deal with features observed from human action. Examples of human action are gait, voice, and signature [2]. By using biometric methods, the problems faced in traditional methods as mentioned above can be solved.

Currently, biometrics are employed in a wide variety of domains. According to a 2018 report by German and Barber from the Center of Identity, University of Texas at Austin [3], the top three sectors which embrace biometric methods are financial services, technology, and government. This is followed by the workplace, recreation, and healthcare and with the least usage in the education domain. Figure 1 depicted the different domains as mentioned, along with the biometric application percentage.

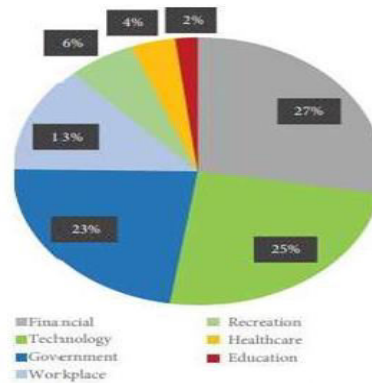


Fig.1 Applications of different biometrics in different domains

In financial services and technology domains, a person can use a mobile wallet to purchase goods. This is because most of the current mobile phones are integrated with a biometric scanner. By adding a credit card to a mobile wallet, payment for in store or web purchase can be done through Apple Pay or Samsung Pay. In Apple Pay [4], Face ID or Touch ID is used while Samsung Pay [5] utilized the fingerprint or iris for authentication. In addition, the banking industries are also adopting biometric measures to authenticate their customers at ATMs. For instance, almost 90% of the ATMs in Macau were installed with “Know-Your Customer” facial recognition technology [6]. Asserting that facial recognition is less secure, Bank of China (Hong Kong) equipped the company’s ATM with finger vein identification [7]. As of December 2017,160 ATMs had been installed in all the branches in the city state.

Governments all over the world are quick to adopt biometrics for different purposes. Malaysia is the 7 world’s first country to use an electronic passport with a thumbprint as the biometric security feature in 1998 [8]. Subsequently, the passport was further enhanced with an additional security feature using face recognition [9]. Other than that, the fingerprint is also incorporated inside the chip on the Malaysia’s identity card, MyKad [10]. Over in China, a vast network of surveillance cameras enabled with face recognition technology was installed to help in criminal detection and law enforcement [11]. Moreover, a number of international airports are seeking to enhance efficiency and improve passenger experience by deploying biometric technology. Besides, the biometric processing of a passenger also helps the respective government in controlling border checkpoint security. Face recognition technology is employed in Singapore’s Changi Airport [12] and Atlanta’s Hartsfield-Jackson International Airport in the US [13]. A new “smart tunnel” check-in system using iris recognition was implemented in Dubai International Airport [14].

The workplace and education domains applied biometric technology for attendance recording or tracking [15–17], accessing permission, and behavioral analysis [16]. Attendance records are used for an employee’s payroll and to determine whether a student is eligible to sit for an exam. Access permission ensured that only authorized personnel can enter a premise. Furthermore, behavioral biometrics is used to track the concentration level of each individual either in an office or in a classroom. The recreation domain also embraced biometric technology, as can be seen in Universal Studio Hollywood, which required guests to fingerprint in order to enter the theme park. Another example is in Wuzhen, a historic tourist park in China. Visitors need to register using facial biometrics to gain entry into various attractions. In the healthcare domain, biometrics has been introduced for patient identification and electronic medical record management. For the e-health system, patients at home use biometric features to identify themselves for receiving medical service remotely. A wearable device with built-in sensors is used to transfer real-time data of the patient to the doctors in the hospital. As a result, doctors can make accurate and timely treatment based on the data and electronic medical record.

Due to the low percentage of biometric applications in the education sector, this paper provides details in the biometric-based attendance recording or tracking system. In academic institutes, both teaching and training are delivered to transfer knowledge and skills from educators to the students. For a conducive learning environment, there is a need for students to attend classes so that they can seek knowledge and learn skills from their educators. Although there are many online courses available, these courses do not offer the opportunity of a direct face-to-face interaction with the educator. Through continuous interaction, students can get immediate feedback regarding any



doubt in a particular topic. Besides, it also helps to strengthen the relationship between educators and students; thus, students tend to be more motivated to study.

II. RELATED WORK

Attendance marking is considered as one of the crucial parts of a class. This is to ensure students participate in the class activities and learn from their educators. Besides, in some institutes, the percentage of attendance must be 80% and above for the whole semester for them to be eligible to sit for the final examination. Currently, most of the attendances are marked by using the conventional methods such as calling out names or signing off attendance in paper. Unfortunately, these methods are not suitable for a large class. It is a waste of time for the educator to call out all the students' name to mark their attendance whereby the time can be utilized more efficiently for the teaching and learning processes. Another method is by signing off attendance. Distraction happens because the student needs to sign the attendance list and pass on to the other student during class. Moreover, it can be compromised by a student who signs on behalf of their friend who does not attend the class. In addition, it also helps in improving efficiency and reduces the educator's burden as the attendance is marked automatically. Besides marking attendance, some systems can determine the students' seating positions [15] while the other classifies gender of students using facial features. There are several aspects and specification to be considered in developing this type of system. First, it is the number of students. The biometric-based attendance system can be designed and implemented for a small or large class. From the literature survey, the ranges are from five to two hundred students. Raghuwanshi and Swami have developed their system with the least number of students, which is only five students. On the other hand, there were also systems implemented for a large classroom with 200 students. The second factor to be considered is the time taken for attendance marking. Generally, the numbers of students in a class are directly proportional to the time taken for attendance marking. According to Adeniji et al., the conventional method of taking attendance using paper is more time consuming, which is around 22.6 seconds per student. On the contrary, the time taken for the biometric-based attendance systems ranges from less than one second to 26 seconds [17]. The voice-based attendance system developed by Dey et al. [17] took more time as compared to the conventional method because students were asked with several questions to ensure that sufficient numbers of speech frames were obtained for verification. Other biometric-based methods [15] took less than 10 seconds to take the attendance of one student. Another point to look at is on when the attendance is being recorded. Most of the systems took the attendance for one time during the beginning of a class with the date and entrance time [16]. However, cheating can still occur if students skip the class once they take the attendance before the class starts. In order to solve this problem, attendance taking for more than one time was suggested. Normally, students' attendances were taken twice, which are at the beginning and at the end of a class with the entrance and exit time, respectively. Besides that, continuous or periodic observation can be implemented by tracking facial images from video frames to mark students' attendance.

In terms of the operation stages of the biometric-based attendance system, it can be viewed from the user's context or developer's perspective as shown in Figure 2. From the user's context, there are two operation stages which are the enrollment stage and authentication stage. In the enrollment stage, all the students' biometric characteristics are captured and labelled with their name or roll number, respectively. These biometric characteristics can be in the form of the iris, voice, fingerprint, or face. Generally, the iris or face images are acquired using cameras, voice recorded with microphones, and fingerprint obtained through a scanner. At the beginning of a semester, the students are required to register their biometric traits during the enrollment stage. These biometric data are stored in the database and serve as templates for the authentication stage. The numbers of templates required for every student are different for each system. In the speech-based attendance system, three spoken text templates are required each for the voice password (VP) and text-dependent (TD) modules. For the fingerprint-based attendance system, the templates vary from one, two, four to ten. With regard to the attendance system based on face recognition, the minimum number of templates is five while the maximum value is 1000. Furthermore, the numbers of templates for other face recognition systems are below sixty templates with most of them having values in between six and twenty-one. Next is the authentication stage that involved matching captured biometric data with those templates in the database. During a class, the students' biometric characteristics are captured once again with either the awareness or the ignorance of students. For the iris, voice, and fingerprint, students are aware because they need to be in contact with the devices to capture their biometric traits. However, most of the face based systems are contactless, and hence, students do not know when will the attendance be taken by the camera [30, 31, 49, 50, 57, 63, 64, 68, 70, 71]. Nevertheless, there are some cases where the students are mindful that their facial images are being captured, because they are required to face the front of the camera. In order to authenticate these new data, it is followed by either identification or verification process.



Conversely, verification involves comparison only to the templates of the claimed identity (one-to-one) .

The action involving one being present, the pace at which a person is present, or the number of people in attendance are all examples of attendance [1]. There are a couple of attendance systems that have been implemented in this era. Attendance systems are being used to monitor employees' attendance and movement within their working hours in an establishment, students attending a lecture in an institution, people who participated in an event, and so on. Keeping track of attendance is an essential part of every institution's recordkeeping process. Researchers have developed different automated systems for the attendance-taking role [2]. Using fingerprint biometric technology combined with Radio Frequency Identification (RFID) would increase attendance records' reliability and credibility [3]. The fingerprint-RFID based attendance system speeds up taking attendance, reduces error, removes the traditional means of choosing the audience; this means all of it can be accomplished with minimum human contact and allows easier verification of involvement. This technology is being used in real-world applications such as attendance tracking in large companies, sectors, industries, universities, and secondary and primary schools, among others, where there are many participants. Within a fraction of a second, the system records people's involvement. This system would aid in the generation of reports and the evaluation of a participant's attendance eligibility. RFID technology makes it simpler and faster to see what the participants are doing at any given time and reduces asset losses. For facilities management, fingerprint recognition is often used to recognize people more accurately and safely. The RFID-Fingerprint Attendance Management system is being built to provide a more safe, comfortable, and faster user authentication method than passwords and tokens.

III. METHODOLOGY

Since the system consists of both software and hardware elements, it is classified as an embedded system. The hardware components include an RFID reader, a fingerprint sensor unit, an Arduino Mega, an LCD, a buzzer, and a 12V power supply. Therefore, the project aims to achieve a specific purpose and outcomes, not to remain isolated from the project's objectives.

Several steps were taken in developing this project and can be summarised thus:

- Collection of information.
- Information collection using the respective problem solving choice approaches.
- Selection of construction tools and availability of materials.
- Construction of hardware.
- The microcontroller programming selection based on the availability of its shielding
- Integration of technology and hardware for testing.

The RFID reader and the fingerprint scanner are connected to the microprocessor. The data (ID numbers and fingerprint images) are registered as a part of the program into the Arduino Mega to identify each user automatically. A 12 V power supply will power the fingerprint sensor module, RFID scanner, memory card module, RTC module and Arduino Mega of the system. Attendance is being taken only when both input data match the previously stored data.

The design includes shield making ,connecting the power source and supplying the proper voltage to the system ,programming of the RTC module, fingerprint, RFID module and SD card module and linking them to make an embedded system. The circuit was simulated with Fritzing.

BLOCK DIAGRAM OF THE MODEL

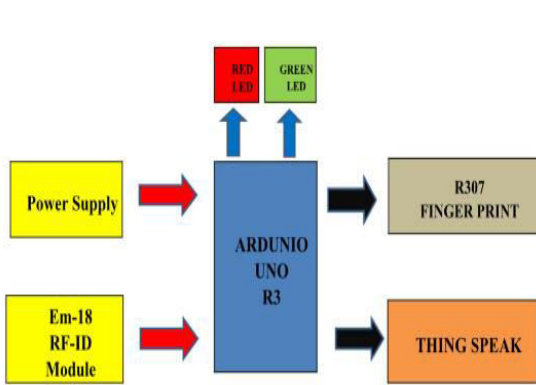


Fig 2 Block diagram of the model

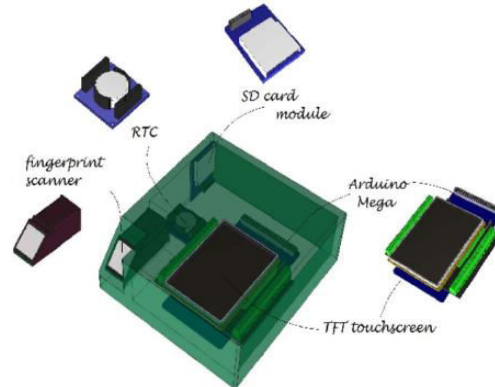


Fig 3 sketch of the design

IV. TESTING AND RESULTS

ENROLLMENT MODE TESTING

The testing steps are explained as follows:

- On entering the enrolment field, the admin will have to check, and this is because the administrator only has the right to enroll a student. The admin can be either a lecture or the administration. The admin can merely do the check by merely placing their registered finger on the fingerprint scanner.
- Next is informing the student to activate the enrolment mode on his or her RFID card. Since the micro-controller has the card's UID code, the corresponding no is verified. The system then displays the fingerprint ID no on the card and then knows the fingerprint slot number.
- The program prompts the student to insert a fingerprint. The system will then take the picture when the finger is put on the scanner.
- The system will then prompt the student to place the finger again to confirm whether it matches. If the fingerprint scans images match, the system will store the array.

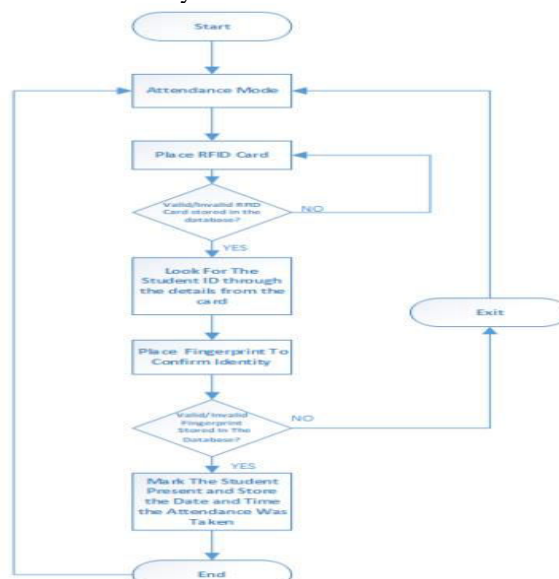


Fig.4 shows the steps in testing the enrolment mode



ATTENDANCE MODE TESTING:

Attendance mode is the first mode, and before using it, it does not need administration authorization. Testing steps:

- When a student inserts his or her card into the system, the RFID reader scans the code and looks up the student's number.
- The system then asks the student to place his/ her finger to confirm if it is indeed him/her.
- After confirmation, the system then marks the particular student present and then stores it on the array created for attendance.

COMPILEMENT MODE TESTING:

Complement mode helps put together all the present students. Immediately the complement mode has been activated; one can no longer adjust the attendance. Testing steps:

- The admin is required to verify before compiling the attendance. When the admin fingerprint is being placed and verification has been done, the system then autogenerates the attendance.
- The generated attendance is then stored on the SD card in the form of a TXT file. The generated attendance does show the ID no, date, and time together with status.

V. CONCLUSION

The manual method of taking attendance, which involves pen and paper records, has been used as the conventional way of taking attendance. Implementing an electronic attendance management system has been proven to help save time, secure attendance data and privacy, and help save time. The RFID-biometric attendance system gives administrators quick access to student attendance data and allows them to keep track of their students. The system is dependable, safe, and effective, and it can replace the outdated and inefficient manual attendance management process. Conclusively, developing a hybrid attendance system (Radio-frequency Identification and Biometric Security) that uses students to investigate was constructed. A system model was also developed, which included coordinated software and hardware design (embedded system). The design offered a convenient and safe attendance method compared to the conventional attendance system in reading time. The data was better-structured thanks to the external memory. The fingerprint data header configuration provides high security and high-speed performance and makes it easier to access student information with an RFID card. The conventional ways of attending and attending in a short time have always been needed to be removed; this RFID-Biometric attendance system can be happy to cater for it.

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