Intelligent Attendance System with Facial Recognition and Wireless Integration

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***Abstract*— In modern institutions and organisations, maintaining accurate attendance records is essential for ensuring compliance and equality. A secure and reliable attendance system is crucial for preventing fraud, reducing the potential for manipulation, and ensuring the integrity of data. This paper presents an innovative model of an automated attendance system to reduce the manual effort for attendance registration and eliminate the chances of fraudulence. The model focuses on the integration between face recognition and radio frequency identification (RFID) to detect only the authorised persons and mark attendance for them. Also, this system captures and logs attendance data securely, which can be accessed in real-time through a locally hosted website. This web interface provides administrators with a user-friendly platform to monitor attendance and download logs for record-keeping and analysis, hence reducing the tedious manual task. By recognising the face of the individual and verifying it by RFID simultaneously, the limitations in the existing manual attendance system are mostly eliminated. Another important feature of the project is that all the face recognition and website hosting is done on the same Raspberry Pi unit, which will reduce the overall cost of the project.**

***Keywords*— Automated attendance, ESP32, Face recognition, Image processing, OpenCV, Raspberry pi 3, RFID readers, RFID tags**

I. INTRODUCTION

Institutions and organizations these days are required to keep precise, tamper-proof, and transparent attendance records. Secure attendance tracking not only is essential to operational efficiency but also is also important for compliance and equality among co-workers or students. Traditional attendance solutions, like manual registers or independent automated solutions like RFID cards, all have various loopholes for fraudulence. Manual-based solutions are more secure than radio frequency identification (RFID) systems, but they are laborious and prone to manual errors, whereas RFID-based solutions, although they are efficient, can be hacked using proxy cards. Loopholes like these render attendance data compromised in terms of integrity, thus creating administrative inefficiencies and possible legal or ethical consequences.

To solve these problems, this paper proposes a simple but innovative approach for a dual-factor authentication system using facial recognition and Radio Frequency Identification (RFID) technologies. The hybrid approach guarantees attendance registration only when both RFID tag and biometric facial information authentication of the user take place, thus eliminating proxy fraud and unauthorized access entirely by marking attendance only for authorized persons. By merging RFID's rapid identification with the biometric precision of facial recognition, the system has a robust, two-layered security.

Many other similar systems use Arduino or ATmega32 development kits to reduce the overall cost, but they lack scalability and easy access. To solve those issues, this project aims to host a local web server to store, review, and download the attendance records that are taken, a function that not only saves administrative overheads but also offers transparency and access. Both the face recognition and local web server hosting are done on the same Raspberry Pi module, hence allowing to keep the cost of the project low without compromising scalability and ease of deployment. This project offers a scalable solution for schools, corporate organizations, and institutions seeking secure and automated attendance management.

II. PROPOSED MODEL

Here a detailed block diagram of the attendance system based on face recognition and verification with RFID is depicted in Figure 1. The face recognition part is done through several steps. As our code prepared with Python in OpenCV generates 2D greyscale images of the students that work as the input, and after being trained on those images, the system finally detects faces on the live camera feed.

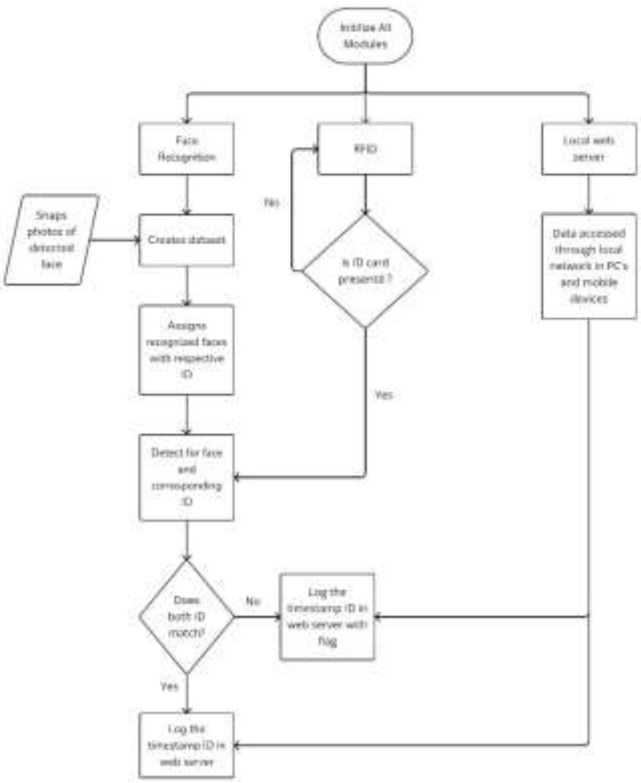

Fig. 1. Flowchart of the proposed circuit model.

Radio frequency identification (RFID) system is based on two components, which are a reader and a tag. Here the tag is attached to a person in the form of an ID card, and the reader identifies the proper person. The data here is transmitted by using radio waves.

The RFID tag has an embedded transmitter and receiver. An atypical RFID tag consists of two parts, an integrated circuit and an antenna. The integrated circuit is used for collecting and running information. And the function of the antenna is to receive and transmit a signal. RFID tags can be of three types, and they are active, passive, and battery assistive passive. Here we are using a passive RFID for cost-effectiveness. RFID tags are equipped with non-volatile memory storage.

The RFID reader transmits an encoded radio signal to the RFID tag by using a two-way transmitted receiver, which is also known as a transceiver and interrogate. All the RFID tags that are available fall into three categories. They are classified according to the type of tag and reader. Those are Passive Reader Active Tag (PRAT), Active Reader Passive Tag (ARPT), and Active Reader Active Tag (ARAT). We have used the second one for our proposed model.

The facial recognition is done using the OpenCV library and running the respective codes on Python. We have used OpenCV 2.4.0 and Python 2.7.13 specifically for this particular project, and the latter versions would need to have the codes changed. In our project, we use a Haar-like feature detection algorithm to detect faces. Even though a single strong classifier can detect most facial features correctly, it still has a considerably high false positive rate; hence, we apply the cascading method. Using cascade classifiers, our program scans every sub-window of the input feed image and classifies them as face or non-face. The majority of the non-face features are eliminated in the first few stages of the cascading process and then lets the program focus on the relevant face window. This method is very efficient since it is executed very fast and precisely.

The cascade classifier for multi-view face detection can scan the sub-windows in every position and scale of the input image and classify each sub-window into face or non-face. Both frontal and profile faces can be detected by this system. In the process of classification in the first few levels, the system can quickly eliminate a large number of non-face sub-windows and then let the rest level of the cascade classifier focus on the suspicious face sub-window. This detection method can achieve face detection rapidly and precisely. After the test on different kinds of datasets, we found that the cascade classifier can achieve high accuracy in face detection and reach the requirement of face detection in real time.

III. DESCRIPTION OF THE PROPOSED MODEL

The development of the attendance system based on face recognition and verification by RFID is distributed into two significant units: one is the hardware side, and another one is the software. Persons with proper authority can log in to the local network and look for information from there, which keeps a log of the ID, time, and date of every student that enters the classroom. It also can register a new student using a facial image and the tag ID of each tag.

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A. Hardware implementation of our project

In the following section, we are going to discuss how we implemented the hardware of our proposed project, intelligent attendance system with facial recognition and wireless integration. Figures 2 to 8 describe the hardware implementations.

Figure 2 is displaying the basic circuit design of our project. Here we can see that the RFID reader is connected to the breadboard. Also, an ESP32 and a camera are connected together. All of them combined connected to the Raspberry Pi 3B. And the Raspberry Pi 3B is connected to a power bank, which will be used to power all of the modules for this demo. The RFID tag and the camera module are the input here, and the output can be viewed on the locally hosted web server.

The Raspberry Pi 3B is equipped with a 32GB SD card (can be expandable based on user needs), which will be used for the boot and system partition for the operating system (Raspbian OS) and all of the necessary software and libraries that are used for our project. The web server's data is also stored on the SD card because the logs will use less storage, and the logs will automatically be deleted after a period of time. Automatic deletion of the log files is user-defined and can be easily modified.

Fig. 2. Basic circuit design.

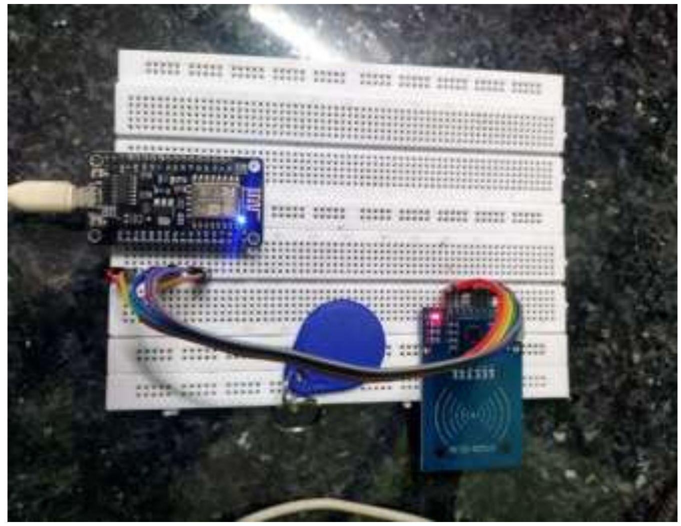

Fig. 3. Interfacing RC552 reader with ESP32 module.

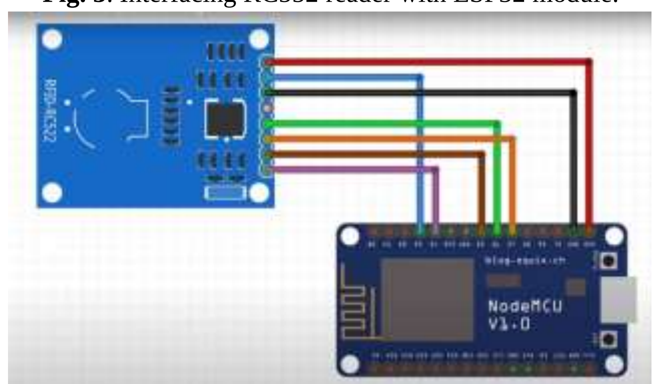

Fig. 4. Wire diagram of RC552 reader interfacing with ESP32 module.

In figure 3, we can see how the RFID reader (RC552) is interfaced with the ESP32 module. Figure 4 shows the wiring diagram of the RFID system and how it is interfaced with the ESP32 module, including all of the data connections, VCC, and ground connections. The antenna is embedded into the RC522 reader module.

B. Software implementation of our project

Fig. 5. Webcam detecting and taking inputs for dataset.

Figure 5 is showing us the face recognition process. After entering the name and ID, the program will ask for the photo of the person. He/she has to stand in front of the camera, and the camera will take 20 snaps simultaneously and store them in its database. One thing we have to remember is that for accuracy we have to move our face at different angles, and there has to be sufficient light.

Fig. 6. System recognizing face and showing appropriate ID.

In Figure 6, we can see that the system has successfully identified the person whose info and photo were entered into the database. Whenever a person is going to stand in front of the camera, if he/she is authorised, it will display his/her ID in the square block, and his/her attendance will be logged in the local web server automatically.

Fig. 7. Data is entered on to the web server.

Figure 7 shows us the web server interface, which will show the information like the name or ID of the person, date, and time when the attendance is registered. This locally hosted web server can be accessed via any device that has access to the web server.

Fig. 8. Downloading attendance on PDF format.

In figure 8, the recorded attendance is downloaded in PDF format. It can also be downloaded in Excel format to do administrative work easily.

V. CONCLUSION

The design and implementation of the intelligent attendance system with facial recognition and wireless integration, which was our aim and objective of the paper at the beginning, ends with success as both parts work as desired. There it goes without any saying that our proposed model has the potential to overcome the manual attendance system because it's efficient and convenient. Our model is more user-friendly, and it provides the most accurate and organised data. And with just a few modifications, we can use our system in any secure facilities.

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