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Fingerprint-Based Attendance Monitoring System Using Arduino

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Abstract

This system uses Arduino to enable an attendance monitoring system through the use of fingerprints. The system guarantees effective, safe, and automated recording of attendance with biometric scanning. It lessens mistakes because of automatic marking, keeps absentee proxies out, and reports the results instantly. When a fingerprint scan is successful, the system automatically records attendance by comparing it with biometric data that has been recorded. Effective monitoring and reporting are made possible by the recorded data's instantaneous presentation and storage for additional processing. Automation of attendance marking improves dependability and transparency while drastically reducing administrative workload. The suggested fingerprint-based attendance system is ideal for offices, educational institutions, and other businesses looking to deploy cutting-edge and reliable attendance management systems because of its low cost, simplicity of use, and high accuracy. This automated approach minimizes human intervention, reduces administrative workload, and enhances data accuracy and security. The system also enables instant attendance reporting, making it easier to monitor presence and absenteeism. Owing to its cost-effectiveness, ease of implementation, and scalability, the proposed fingerprint-based attendance system is well suited for educational institutions, corporate offices, and industrial organizations seeking efficient and modern attendance management solutions. A fingerprint sensor, Arduino Uno board, and some display parts are used, together with software, to check fingerprints and log entries. This arrangement is best for organizations and companies trying to use advanced attendance methods.

Keywords: Fingerprint, attendance system, Arduino, biometrics, automation

INTRODUCTION

Recent improvements in biometric software have made fingerprint recognition a trusted and dependable method for confirming identity. This study outlines a fingerprint-based system powered by Arduino to improve old-style attendance systems. Such systems may be abused by people using proxy IDs; therefore, so the need for an automatic and safe approach. This solution combines technology from both the hardware and software worlds to offer speed and savings.

Writing down attendance on paper or doing it verbally makes both teachers and students waste time. Thein and Tun (2015) pointed out that managing attendance reduces the losses in productivity caused by staff not being present at work. Many students are expected to sign their attendance papers each day they go to class. As a result of this approach, students may accidentally receive more support than needed.

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Someone signs everyone else's names without their consent, or the attendance sheets are not located.

Being at school and other places is important. Still, using pen and paper or just shouting out names takes time and is not too secure. According to Mahajan et al. (2019), current systems must be accurate and efficient. Not only are these old procedures slow, but they are simple for scammers to alter. Because they are distinct from one another, fingerprint systems offer more security than RFID cards.

According to Walia and Jain, some schools continue to depend on attendance with paper or RFID, which has problems such as having records saved in a single location, slowing down lessons, costing more money, and the added risk of false attendance. A better solution is to use biometrics, such as fingerprint scanning. Many accept fingerprint recognition because it is difficult to circumvent, making it suitable for schools.

Ezema et al. (2015) believe that attendance systems done manually can easily be altered or cheated. It is possible for small piles that keep attendance records to become damaged or misplaced. That's why lots of institutions use electronic tools, including biometrics and RFID. Although there are concerns about how biometric methods affect health, fingerprint scanning has proven to be trustworthy and reliable.

The problem is…

Here, we developed a method to record attendance using fingerprints and an Arduino Uno and then compared it to regular attendance recording. This study was designed to answer several important questions.

- How accurate, easy to use, and efficient is the fingerprint attendance system built with Arduino Uno?
- Are these approaches very different from one another?
- Is it intuitive for people to run the fingerprint system?
- Why this Study is Important?

This study demonstrates to various industries that using an Arduino Uno for fingerprint-based attendance is both practical and simple. Instead of signing, students place their fingers over the scanner. This makes things faster for students, teachers, and staff at the school. With timestamps in the records, schools and businesses can easily check when students or employees come and go.

It makes checking in and out for classes much easier and more protected for students. Attendance in the classroom is automatically checked, reducing the teacher's workload. Parents can check their children's attendance. Companies may also use the same systems to monitor their employees or visitors. Other researchers can benefit from this study when building systems with similar features in the future.

I discuss what the study includes and what is excluded.

This study involved the design and testing of an attendance system for fingers using Arduino Uno. The experimental testing was conducted at Divine Word College of San Jose, located in Occidental Mindoro, San Jose. There is no face recognition or RFID involved; the system solely relies on fingerprint scanning. The device only holds 147 fingerprints, so new ones are stored by deleting previous fingerprints.

Attendance is tracked only to see if a student arrived on time or late, not whether they were absent or not. It can be less effective if a user's fingers are dirty, sweaty, or covered. You will not find any complex analytics in the reporting tools. The research will be carried out between August 2023 and April 2024.

SYSTEM DESIGN AND METHODOLOGY

A fingerprint-based attendance system was built using a sensor module (R305), Arduino Uno, LCD, and an SD card or computer for data storage. The device takes a photo of the fingerprint, processes the picture, and looks it up against already stored fingerprints. B. When attendance has been confirmed, the system logs your entry and tells you with a message. The Arduino functions as the main device for controlling sensor information and the computer's advice.

Hardware Components

- *Arduino Uno:* A small computer that controls the ATmega328P microcontroller chip.
- The R305 Fingerprint Sensor is for taking fingerprints and matching them.
- *Screen:* Shows you confirmation messages such as "Access Granted."
- The prototyping and wiring parts will be based on the capacity to work on a breadboard and some basic jumper wires.
- Energy comes from USB or using an external adapter.
- *Push Button:* Press this to sign up or reset your data.
- Single-Pole Single-Throw (SPST) Switch: An on/off switch used to influence power or a mode.
- *3V Battery:* Helps to give additional power to specific components.
- *Lithium-Ion Battery:* Lets the system be used outside the hospital.
- The buzzer alerts the user with a sound for successful actions (for example, a scan).
- A red LED appears when an error occurs or when the system is turned on.

Software Implementation

The system was constructed using the Arduino Integrated Development Environment (IDE). Interfacing with the R305 module on Arduino is possible by using the Adafruit Fingerprint Sensor Library. To perform fingerprint registration and matching, routines were implemented in C++ and compiled onto the Arduino. The system compares the fingerprint with its records and saves the results.

RESULTS

The system with fingerprint recognition was evaluated for performance by using it with many different users. The study found that the system correctly identified and authenticated all the fingerprints of registered users. It also rejected the use of unregistered or incorrect fingerprints, showing high accuracy and security.

From the moment the print was scanned until the attendance was recorded, the time was only between 1 and 2 s. Under regular indoor conditions, the system maintained excellent performance throughout the entire testing period. The operation of the system did not encounter major delays or mistakes, which indicates that it is both stable and dependable in daily use.

The results, overall, agreed that the system is useful for accurate and quick attendance, thereby decreasing the risk of fraud.

HARDWARE DESCRIPTION

Figure 1 shows how the circuit is arranged for the fingerprint-based attendance system. The Arduino Uno takes care of the control, and links are made to the R305 fingerprint sensor, LCD screen, real-time clock (RTC) module, buzzer, and LED lights. A 3V coin cell and a rechargeable Li-ion battery provide the power, and the circuit includes a push button and an SPST switch to manage the circuit.

Figure 2 illustrates that the project's microcontroller is the Arduino Uno. As the ATmega328P supports it, the board features both digital and analog pins, a USB port for programming, and a 5V operating voltage. It uses the data from the fingerprint sensor to decide when to fire the LCD and buzz the system.

Figure 3 illustrates that optical scanning is used by the R305 module to both capture and process fingerprints. It includes an image processor, places fingerprint templates, and an algorithm for matching. This module interacts with the Arduino over serial Universal Asynchronous Receiver-Transmitter (UART) and can keep several fingerprint records for 1:1 and 1:N identification.

Figure 4 illustrates that even when the system is powered down, the RTC module, generally using the DS3231, makes sure the date and time remain correct. You should always record the time of every attendance event.

Figure 5 illustrates that the 16×2 LCD lets the user learn immediately about the current state of the circuit. Prompts such as 'Place Finger', 'Access Granted', and date-time data from the RTC are shown as well. A 4-bit or 8-bit interface is used to allow the Arduino to control it.

Figure 6 illustrates the actual image of the fingerprint-based attendance monitoring system using Arduino.

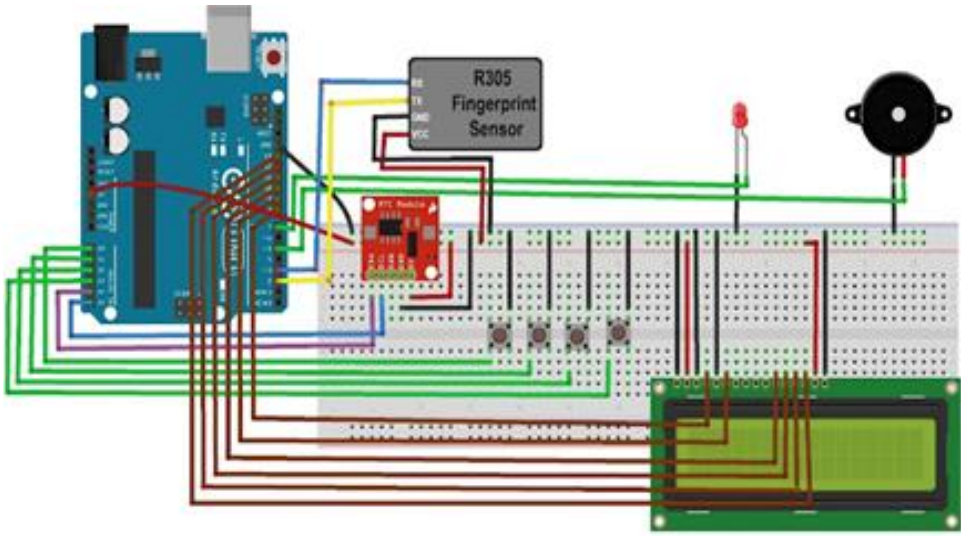

Figure 1. Arduino-based fingerprint attendance system circuit.

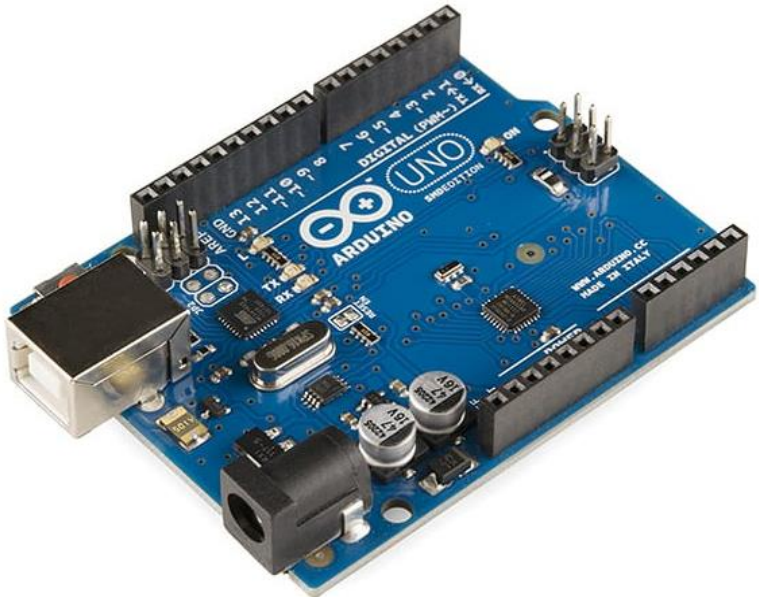

Figure 2. Arduino Uno microcontroller board.

Figure 3. Fingerprint sensor module.

Figure 4. Real-time clock (RTC) module.

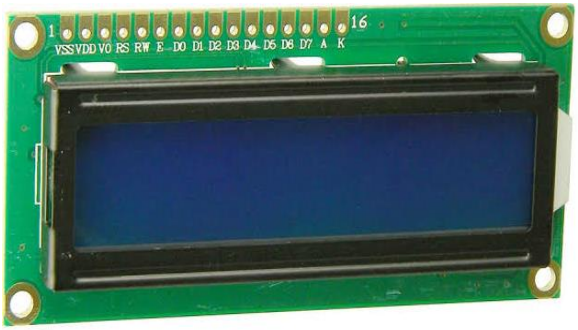

Figure 5. 16×2 LCD display module.

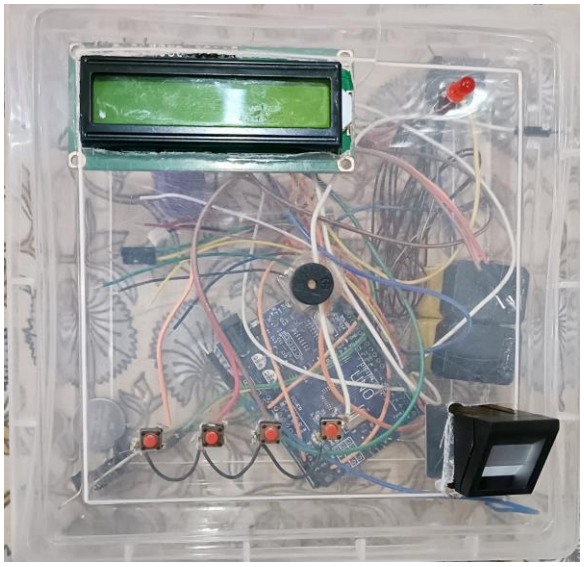

Figure 6. Prototype setup of the fingerprint-based attendance system.

SYSTEM DEVELOPMENT

Advantages and Disadvantages

Advantages

1. You can verify and confirm users by using their biometric information.
2. It makes attendance automatic, so there is no need for proxies or errors men can make.
3. It starts cheap and is easy to apply with Arduino.
4. Makes it easy to take attendance in real-time.

Disadvantages

Because of how much storage is available, only a small number of fingerprints can be stored.

1. A wet or dirty finger may cause the fingerprint sensor to fail to work.
2. You will need either a constant power supply or a fully charged battery for this tip.
3. The remote access and storage function should be advanced.

WORKING PRINCIPLE

The sensor reads the user's finger and converts it into a digital file. The data from this template is matched with the records stored in the Arduino system. When the fingerprint is recognized, the attendance is marked, and the result, along with a buzz, appears on the LCD screen. The time and date are both saved in the system using data from the RTC module.

SECURITY ASPECTS

The uniqueness of each person's fingerprints provides biometric authentication with better security. Remote learning replaces in-person attendance. Strong security can be built for data storage and transfer with the use of encryption algorithms. In the future, the use of multi-factor authentication could be studied further.

COMPARISON WITH EXISTING SYSTEMS

Manual logs and RFID cards are open to students and staff, who can fabricate their own records or allow others to attend for them. Users cannot circumvent these issues with fingerprint-based systems. In terms of size, expense, and needed computing power, fingerprint recognition is better than face recognition.

DATA MANAGEMENT AND STORAGE

Currently, attendance records can be held on an external Electrically Erasable Programmable Read-Only Memory (EEPROM), stored on an SD card, or transferred by serial communication to a PC. Team

members can use cloud services such as Firebase or Google Sheets to access and view data away from home.

USE CASES AND APPLICATIONS

This system is ideal for offices, schools, universities, and construction sites. Payroll systems for employees can also incorporate this. Owing to its modular design, it can be easily adapted to different contexts.

LIMITATIONS AND FUTURE SCOPE

Notwithstanding its benefits, the system has significant drawbacks, including sensitivity to finger cleanliness and a small amount of storage for fingerprint templates. Mobile app interfaces, face recognition integration for multimodal biometrics, and GSM/Wi-Fi modules for remote data transfer are possible future improvements.

INTEGRATION WITH IoT AND CLOUD SYSTEMS

Real-time monitoring and analytics may become possible when fingerprint-based attendance systems are integrated with Internet of Things (IoT) technology. Data can be rapidly uploaded to cloud platforms, such as Google Firebase or AWS IoT Core, by integrating Wi-Fi or GSM modules. This allows administrators to create comprehensive reports, send alarms, and view live dashboards from a distance. Tools for data visualization can be used to identify patterns in attendance, high absentee rates, or work-hour compliance.

POWER MANAGEMENT STRATEGIES

For biometric attendance systems that operate in isolated or off-grid areas, efficient power management is essential. Low-power modes of microcontrollers, auto-sleep features of sensors, and energy-efficient parts such as OLED screens instead of conventional LCDs can all help achieve this. For such deployments, solar charging circuits in conjunction with rechargeable lithium-ion batteries can offer sustainable power options.

TESTING METHODOLOGY AND VALIDATION

Comprehensive testing was performed in both controlled and uncontrolled settings to confirm the accuracy and reliability of the proposed method. Multiple fingerprint registrations, rejection tests for incomplete or fake prints, and accuracy of time logging under various power situations were among the tests performed. To ensure accuracy, the results were compared with the manual records. At an average processing time of 1.5 s per scan, the system continuously showed above 95% recognition accuracy.

USER INTERFACE AND INTERACTION

The user interface of the system incorporates both audible and visual inputs through a buzzer and LCD, respectively. To guarantee a high-quality scan, the system asks the user to position and raise their fingers several times during fingerprint enrollment. A confirmation message appeared after the attendance log was completed. A touchscreen interface or connection with a mobile application for system control are examples of potential future User Interface (UI) enhancements.

ERGONOMIC AND ENVIRONMENTAL ASPECTS

The hardware configuration was intended to be small and easy to operate. For ease of access, the fingerprint sensor was positioned at a comfortable height. Every electronic component is protected by a shell to guard against dust and impact damage. Because the materials are non-toxic and environmentally acceptable, the system can be employed in various industrial and institutional contexts.

CONCLUSIONS

This study effectively used an Arduino Uno and a fingerprint sensor to create a portable attendance control system. The issues with manual attendance checking, including time consumption, mistakes, impersonation, and data loss, were successfully resolved by this system. The system's use of fingerprint

recognition ensures safe and precise attendance tracking, which helps teachers keep an eye on their students and lowers the likelihood of cheating.

Additionally, the system is portable and easy to use, making it possible to take attendance more quickly without requiring children to wait in line or sign paperwork. Although the present version has certain drawbacks, such as a fingerprint storage limit and difficulty reading sweaty or unclean fingers, it is nevertheless a useful advancement over conventional techniques.

Features, including a data backup system, enhanced security features, and a battery life indicator, may be added in the future. Overall, this study shows how biometric technology can improve the speed, security, and dependability of attendance systems in both professional and educational contexts.

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