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Wired Fingerprint-Based Classroom Attendance System for Secured Student Attendance Archiving Using Arduino UNO Microcontroller

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***Abstract:** This study, which successfully addresses the shortcomings of traditional attendance-checking methods, such as human error, that are inevitable in manual attendance systems given the fact that it is time-consuming. Paper-based systems can be susceptible to forgery, as students may attempt to sign in on behalf of absent classmates. This undermines the integrity of attendance records. Introduces a fingerprint-based classroom attendance system designed using the Arduino Uno microcontroller. The research explores the feasibility of fingerprint biometrics for identity verification in educational settings.*
Using Arduino Uno, Fingerprint Sensor, RTC Module, and the LCD Monitor the researchers successfully developed a working prototype for the Wired Fingerprint-Based Classroom Attendance. 600 tests were applied to collect the (1.0) lowest and (2.0) highest time of the fingerprint sensor and calculate its average (1.7). The developed system operates offline, storing data securely on an SD card, making it particularly suitable for institutions in areas with restricted internet access. Comparative performance evaluations against conventional pen-and-paper methods highlight the fingerprint-based system's notable capacity, accuracy, positioning it as a transformative tool to enhance attendance tracking procedures and eliminates attendance-related issues to improve overall classroom operations.

***Keywords:** Arduino Uno, Fingerprint, Attendance Checking, Attendance Archiving.*

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1. INTRODUCTION

1.1 Background of the Study

Fingerprints are the fastest and secure method for biometric identification, unique to each person and consistent throughout a lifetime. A fingerprint recognition system, utilizing an Arduino UNO, automates classroom attendance, eliminating time-consuming manual methods. Traditional attendance checking, particularly in large classes, is inefficient and prone to errors (Rahman, 2018). The Arduino-based system ensures accurate records, detecting bogus attendance and preventing cheating. Teachers, equipped with printed lists, often face challenges managing attendance. Fingerprint-based attendance, using an Atmel AVR ATMega328 microcontroller chip and a Micro SD Card for storage, offers a reliable solution. The system captures fingerprint patterns, processes them into biometric templates, and records attendance directly to the Micro SD Card (Vargas et al., 2019). The Arduino's benefits, including ready-made modules and USB communication capabilities, make it a suitable platform (Santoso and Sari, 2019). The proposed Fingerprint Classroom Attendance project reduces teachers' and monitors' obligations, providing an exact time of student arrival and minimizing the risk of manipulation. The system is designed for offline functionality, making it applicable to schools in rural areas without internet connectivity.

1.2 Objectives of the Study

The researchers aim to assess the effectiveness and quality of Fingerprint Based Classroom Attendance System Using Arduino UNO Microcontroller. Specifically, the study aims to:

1. Determine the materials needed to create a good quality of a working prototype;
2. Complete the codes for the automated fingerprint;
3. Assemble the components of Arduino UNO;
4. Design a schematic diagram of the prototype;
5. Create a working prototype of Fingerprint Classroom Attendance; and
6. Assess the effectiveness and quality of Arduino Uno in terms of Fingerprint sensor testing.

1.3 Significance of the Study

This study was conducted to create a Fingerprint Based Classroom Attendance System for students. This study will give significant benefits to the following:

Teachers Assigned in Rural Districts

The study is significant and will benefit the teachers assigned in rural districts, as this will give an easy and accessible way of checking attendance without a waste of time.

Future Researchers

The findings of this study can be used as a guide for future researchers studying programming commands in the Arduino uno Software system. The study findings may also provide preliminary data that the future researchers can use.

1.4 Scope and Limitation

The study limits its coverage inside the School Campus of Bayugan National Comprehensive

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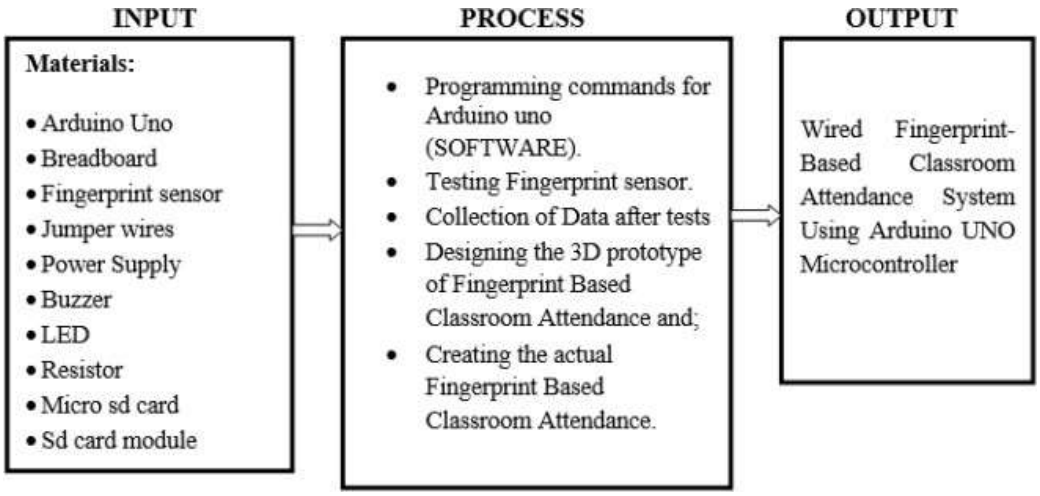
High School for testing the Fingerprint Based Classroom Attendance System. The study only aims to test and investigate the capability of Arduino Uno to create a working Fingerprint based system using its components and programmed commands. Thus, the researchers shall neglect any other alternative methods on creating Fingerprint Based System with the use of programming commands that are not available and applicable in the area. Specifically, the study will only take place in the municipality of Bayugan City, Agusan del Sur where the Bayugan National Comprehensive High School is located.

1.5 Conceptual Framework

Shows the output in conducting the programming of Arduino Uno and creating the working prototype of Fingerprint Based Attendance.

Research Paradigm



2. RELATED WORKS

Development of Attendance Management System Using Biometrics

Keeping track of an institution's student attendance data is a tedious task. It consumes both time and paper. The author designed an attendance board architecture that is already operational to automate and digitize all attendance-related tasks. It makes use of a special finger imprint differentiating framework that was developed for this objective. This framework for unique mark ID makes use of both new and current unique mark recognition and arrangement (Patra, G. & Mohanty, M.N., 2020)

Attendance Fingerprint Identification System Using Arduino and Single Board Computer

One of the most distinctive features of the human body that quickly and easily sets one individual apart from another is the fingerprint. A technology known as fingerprint sensors, which can automatically identify or recognize a person, supports this uniqueness.
However, the current fingerprint sensor is limited to identifying fingerprints on a single device.

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For the previously stated reason, we require a technique to identify every user in a unique fingerprint sensor. The goal of this project is to develop a fingerprint sensor system that will enable centralized fingerprint data administration and enable fingerprint recognition on each fingerprint sensor. The study's findings demonstrate that data processing. may be consolidated using Arduino and Raspberry Pi, enabling fingerprint identification in each fingerprint sensor with a 98.5% success rate for centralized server recording (M A Muchtar, 2018).

Fingerprint Based Biometric Student Attendance System

Attendance is a notion that is used to identify a person's presence at the beginning and end of the day in a variety of settings, including hospitals, institutions, and organizations. In the past and in many locations even today, names are called out in attendance registers to manually record attendance. Time and human labor are wasted because of this. Also, using a register leads to a lot of bogus difficulties. For instance, in a classroom, the teacher calls out each student's name sequentially and indicates their attendance after they respond.

An alternative method is for the instructor to circulate the attendance sheet throughout the classroom with the students signing it next to their names. Nevertheless, a significant disadvantage of these approaches is that students often respond or sign on behalf of their absent friends. If the strength of the class is great, these fraudulent issues might occur more frequently. Using an automated attendance recording system is one way to get around these issues. This research provides a fingerprint-based biometric system that automatically logs attendance in this direction.

A fingerprint sensor is part of this system, which is utilized to identify the user (Sogbodjor, 2021). The researchers used an embedded fingerprint-based management system utilizing the microcontroller-based system (EMFIBAMS) design. The system includes a fingerprint sensor, a GSM modem, an Arduino board, LCD, and other devices. During the comparison of this system and the manual method, the result shows that the average time taken per student using an embedded fingerprint-based attendance management system using microcontroller is much shorter than that of manual checking (Ikuomola, 2019).

The system addressed the problems associated with traditional attendance systems because provides faster and more accurate results the percentage of students who attend and the number of lectures delivered by a single lecturer, an effective means of registering students and managing their attendance that eliminates attendance-related issues like friend signing, loss of attendance sheet, and it will be easier to manage the percentage of students and teachers who skip lectures (Sambo et al., 2018).

The Use of Biometric Attendance Recording System (BARS) and it's Impact on the Work Performance of Cabanatuan City Government Employees

Biometric technology as a means of identifying and verifying an individual's characteristic is widely used in many aspects of peoples' lives nowadays. In this regard, the Local Government Unit (LGU) uses this technology to provide a more comprehensive system for monitoring employee attendance and how it may affect their performance. The study assesses the impact of the use of the Biometric Attendance Recording System (BARS) on the work performance of Local Government Unit (LGU) employees based on their Individual Performance Commitment Review (IPCR) rating and the respondents' self-assessment and perception. Noticeably, most of the

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respondents perceived that the use of BARS had a positive impact on work performance. Results also demonstrated a significant increase in respondents' level of performance (Gladys V. et al., 2018)

Enhanced Attendance Monitoring System Using Biometric Fingerprint Recognition

In this study, an improved system for tracking and monitoring staff attendance at Callang National High School, District 04, San Manuel, Isabela, was implemented. It used biometric fingerprint recognition. Managing people is a difficult task for most firms, and keeping an accurate record of attendance is crucial. Regularly taking and keeping track of an employee's attendance by hand is a labor-intensive task that takes time. A useful system was created as a result. The main goal of the system's design and development was to leverage biometric technologies to manage employees' better leave and attendance records. It manages leave administration, keeps tabs on staff attendance, logs employee data, and uses fingerprint recognition to promote involvement. The system has a dashboard monitoring system that school directors can examine to keep track of the list of staff members, early birds (staff members that arrived early), staff members on leave, official business, and a statistical graph of the staff members' monthly attendance rate.

Additionally, staff can save time using the system's auto generated DTR instead of the manual method. Automated leave management, attendance monitoring, and system-generated reports are some of the ways in which innovation significantly impacts the enhancement of employee attendance. Using the first quarter attendance report of SY 2028-2019 as a base of comparison with the attendance rate of SY 2019-2020, when the system was installed, the influence of EAMS on the employees was determined. The result demonstrates that staff attendance has increased because of system use (Rivera, 2021).

Utilizing Convolutional Neural Networks for Fingerprint-Based Attendance Monitoring

Paper-based attendance sheets are a classic way of taking attendance that is prone to fraud, theft, and impersonation. Automatic attendance systems that use biometrics, touch screens, barcode badges, electronic tags, magnetic stripe cards, and other forms of identifying technologies have been put in place to address this problem. Biometric technology uses physiological or behavioral traits to identify a person. However, conventional biometric systems have drawbacks like being easily damaged or changing over time, and variations in lighting, occlusions, poses, and facial expressions can all have an impact on the accuracy of face recognition. To ascertain if two imprints of the friction ridges on human fingers or toes belong to the same person, fingerprint identification relies on the uniqueness of fingerprints. Fingerprints can be divided into five main categories: whorl, left loop, right loop, tented arch, and arch.

Numerous methods have been created to identify fingerprints by minutiae-based matching, which entails locating important characteristics such as bifurcation and ridge termination. Convolutional neural networks are deep learning algorithms that have been successful in increasing recognition accuracy by automatically extracting information from fingerprint photos. The importance of protecting personal information has grown recently, and the Convolutional Neural Network (CNN) identification method is advised for enhancing performance and accuracy.

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In this paper, a three-model fingerprint identification system based on CNN, Softmax, and Random Forest (RF) classifiers is proposed. The traditional method extracts features using CNNs and a dropout technique after separating the foreground and background regions using the K-means and DBSCAN algorithms. In a sense, Softmax is a recognizer. Using a public database, the suggested algorithm is tested and yields encouraging results, offering a reliable and effective biometric identification method (Saul et.al, 2023).

3. METHODOLOGY

Modern solutions, such as the Wired Fingerprint-Based Classroom Attendance System, are made to improve the efficiency and security of student attendance records in educational settings. This system, which uses biometric technology, is based on the versatile Arduino Uno microcontroller, which guarantees a dependable and accessible platform for seamless integration. It shows the materials needed, their function for creating the fingerprint prototype, and the methods utilized in the study to test the efficiency of the wired fingerprint-based classroom attendance system.

Materials

Materials	Uses	Image
Arduino Uno	Programmed commands	
Breadboard	For prototype	
Power supply	Electricity source	
Fingerprint Sensor	Fingerprint recognizer	

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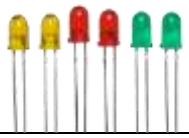
Jumper Wires	Connections of Arduino to breadboard to Sensor	
Buzzer (1)	Direction and instructions	
LED Lights	Function signal or sign	
Resistor	Passive two-terminal electrical	
Micro Sd Card	Storage for recorded files of fingerprints	
Sd Card Module	Arduino Connections	
Push Button (4)	Fingerprint Registration button	
LCD	Monitor	
RTC Ds3231	For timer	

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Instrumentation
Using an Arduino Uno with a fingerprint sensor, breadboard, power supply, buzzer, and LED is essential for a successful Fingerprint-Based Classroom Attendance System. This system streamlines attendance tracking, demonstrating how the system can be practically applied in education. Combining the Arduino Uno and fingerprint sensor swiftly identifies fingerprints for accurate attendance. The LED and buzzer give instant feedback when a fingerprint is recognized, making the system user-friendly.

4. RESULTS AND DISCUSSIONS

The following data shows the results and discussions of the research. The effects can be observed from the conclusions of related literature and will serve as great advantages for future research studies.

Results
Fingerprint-Based System
The fingerprint-based system stores student fingerprints in a geared sensor module before using a dual-process methodology to generate file outputs. This module, which is programmed with an Arduino Uno microcontroller, includes coded commands that set population limits for the fingerprint system. These boundaries, established by the programmed authorities, stop fraudulent scanning attempts beyond the specified student demographic. The highest possible student count is dynamically determined by incorporating unique codes that tell the system to ignore fingerprint scans larger than the predetermined population.
The second part of this two-way process involves gathering attendance information and carefully storing it in the SD card module along with exact timestamps that indicate the precise moment each student arrived. In particular, the recorded results from several tests demonstrate that the fingerprint system has a time duration collection feature:

Table 2. Fpt and Sd Card Tests

Sensor	Minimum	Maximum	Average
Fingerprint Recognition	1.0 s	2 .0 s	1.7 s

The machine has been limited to cater 60 persons maximum. With a total of 600 testing, the average rate of fingerprint recognition is 1.7s. The minimum rate being 1.0s, and the maximum rate of 2.0s.

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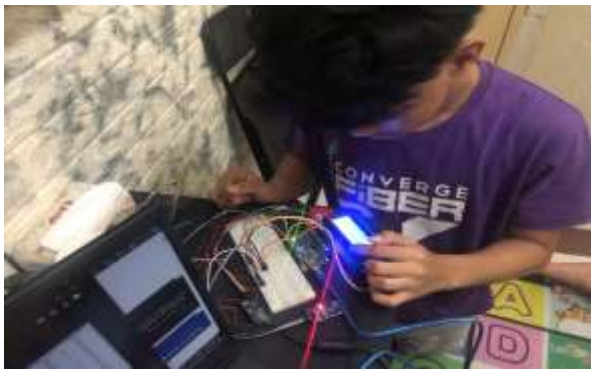

Figure 1. Fingerprint Testing

The Arduino uno programming system uses a command it gives to the fingerprint sensor. The outputs of the fingerprint system will be passed directly to the SD card, where all files are stored for attendance records.

Figure 2 To 5. FP and SDC Codes





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Additionally, the buzzers of the fingerprint setup contain four (4) buzzers with personal functions connected to the Arduino Uno. The two buzzers on the left side are the fingerprint registration/back with the delete/ok option for mistake registration.
Fingerprints must be scanned and stored to avoid conflicts once used for the final testing. The fingerprints that are successfully registered in the buzzer are the fingerprints that can be recognized only by the sensor module and shall directly ignore those fraud-scanned fingerprints. The two buzzers on the right-side work as the direction and instructions of the system once it's used.

Discussions

Wired Fingerprint Prototype Testing

Two key findings highlighted the effectiveness and quality of the fingerprint sensor during the intensive trial-and-error testing phase of the Fingerprint-Based Classroom Attendance prototype. Interestingly, a quick message is sent to the Arduino receiver before the recognition process starts when a student's fingerprint contacts the sensor [1]. The system's overall effectiveness is increased by this ordered approach, which gives it an extra layer of responsiveness. During the rigorous trial-and-error testing phase of the Fingerprint-Based Classroom Attendance prototype, two critical findings demonstrated the quality and efficacy of the fingerprint sensor. Interestingly, when a student's fingerprint touches the sensor, a brief message is sent to the Arduino receiver before the recognition process begins [1]. This systematic approach adds an extra layer of responsiveness to the system and increases its effectiveness.

The researchers believed the primary duty was to assess the wireless fingerprint-based classroom attendance system early in the careful testing procedure. Their active participation guaranteed the developed prototype's functional dependability and safety. The researchers ensured they fully understood the fingerprint sensor's capabilities by closely monitoring and assessing every detail of its operation during this phase. Excellent results were obtained from the fingerprint sensor during capability and capacity testing. It demonstrated a strong ability to recognize and authenticate registered fingerprints, highlighting its dependability in a classroom setting. This accuracy in identifying fingerprints that have been registered adds a great deal to the system's overall reliability and strengthens its suitability for efficient attendance management.

Schematic Diagram

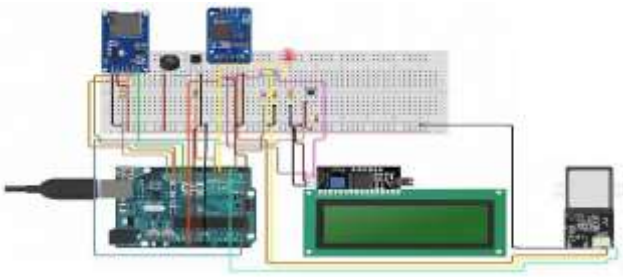

Figure 6. Schematic Diagram

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5. CONCLUSIONS AND RECOMMENDATIONS

Conclusions

To conclude, this research aimed to thoroughly investigate the accuracy of a Wired Fingerprint-Based Classroom Attendance System Using an Arduino UNO Microcontroller within the educational institution of Bayugan National Comprehensive High School. The study met its objectives, which included identifying the materials required to build a functional prototype, precise assembly of Arduino UNO components, accurate schematic diagram design, the efficient development of a fully operational Fingerprint-Based Attendance System prototype, and a thorough assessment of the Arduino Uno's performance in sensor testing. The biometrics system built with Arduino Uno efficiently tracked the attendance of the researchers as well as the students in the classrooms where the procedure was implemented. They are featuring critical features of precision, reliability, and capability. The results also showed that the system is competent and qualified for full implementation. Teachers and class monitors can save time and work by using the system's accurate and quick execution time in real-time attendance checking, which replaces the traditional/manual method. Teachers can devote more time to their lectures because there will be no disruption or waste of time in taking student attendance. This system is essential for precise and time-saving attendance checking in schools and universities.

Recommendations

Creating a wired fingerprint-based classroom attendance system using Arduino UNO microcontroller involves integrating various components for efficient operation. Recommendations include adapting the system for rural districts with limited internet connectivity, implementing robust data security measures to safeguard fingerprint data, and adhering to data protection laws. Additionally, establishing a regular maintenance schedule is crucial to prevent issues and ensure accuracy. Students are encouraged to actively participate in the implementation by cooperating with fingerprint scanning, while teachers are urged to embrace and adapt to the new system for efficient classroom attendance management.

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