

Attendance management system with a fingerprint sensor using Arduino Uno

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Abstract

This science investigatory project aimed to produce an attendance management system with a fingerprint sensor using Arduino Uno. The goal was to benefit schools, organizations, and workplaces, particularly teachers and monitors, by creating a product that would reduce the time teachers and class monitors spend monitoring attendance. The results were obtained using descriptive statistics that determined the effectiveness of the attendance management system with a fingerprint sensor using Arduino Uno in terms of accuracy, convenience, and efficiency. The study's findings revealed that the product saves information accurately, provides convenience for class monitors and teachers, and is efficient when checking attendance. Moreover, the result shows a significant difference between the attendance management system Arduino Uno and manual checking regarding its speed of taking attendance. The attendance management system is user-friendly based on the ability to recognize fingerprints easily, enrollment of fingerprints, and the effectiveness of signals from the LED and LCD. The Attendance Management System with a fingerprint sensor using an Arduino Uno proved more efficient than the manual attendance checking method. The researchers recommend using a much more advanced product like the Arduino Wi-Fi MKR1010 as an alternative to the Arduino Uno. For the fingerprint sensor, the researchers recommend using the Fingerprint R307 rather than the Fingerprint AS608 for a less sensitive one. The researchers suggest programming the system more complexly to produce a more detailed system.

Keywords: attendance management system, fingerprint sensor, Arduino Uno, user-friendly, experimental research

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1. Introduction

Using manual attendance checking is a hassle for the students, especially if they need to log in by signing or checking their names on a piece of paper. Manual attendance checking is also a hassle for the teachers or staff because it is time-consuming since they call the students individually. Manual attendance checking is time-consuming and has a lot of disadvantages. According to Thein & Tun (2015), attendance management monitors workers' presence or attendance at work to minimize productivity losses caused by worker absences. Every time a student attends a class, they must hand sign the attendance sheet according to the current traditional attendance procedure. Even though these systems appear conventional, they need to be more automated, which can lead to various issues. This includes the time that students needlessly look for and sign their name on the attendance sheet; some students may purposefully or accidentally sign another student's name. Furthermore, the attendance sheet can disappear. Students' attendance in class has become increasingly crucial for all organizations and institutions. It takes a lot of time and needs to be more secure to take attendance the old-fashioned way, which involves calling names or signing documents on paper. As claimed by Mahajan et al. (2019), in an era characterized by rapid technological advancement, the need for efficient and accurate attendance management systems has become paramount. Traditional attendance tracking methods, such as manual paper-based registers, are time-consuming and susceptible to errors and manipulation.

Since a fingerprint, unlike radio frequency identifications (RFID), cannot be copied or stolen by others, a fingerprint attendance management system is a trustworthy source. As stated by Walia & Jain (2016), most universities currently use paper-based attendance registers, which have drawbacks like centralized data, reduced lecture time, and fake attendance. Some use RFID swipe card systems, but these are complex and expensive. Biometric techniques can address these issues, such as fingerprints, face, hand vein, iris, retinal pattern, voice print, signature, and facial thermograms. Fingerprint biometrics are a reliable, mature, and legally accepted method, making them suitable for identifying students and monitoring university employee attendance. As vouched for by Ezema et al. (2015), student and staff attendance is critical at many institutions and organizations, with most management disapproving of absenteeism and penalizing those responsible. Collecting attendance was formerly done manually with a book for the physical register. Manipulation and impersonation are common with this approach. The attendance record can be misplaced, broken, or gone. As a result, several electrical approaches were created to address certain significant shortcomings in the conventional approach. These consist of RFID, biometrics, clocking machines, etc. Although clocking machines or RFID technology cannot adequately address impersonation, some individuals are concerned about the potential health risks of using biometrics such as face and iris scanners. Although computer support is always needed, fingerprint scanning has proven to be the most widely accepted biometric technology. It can eliminate all of the issues that have been documented thus far. Thus, the purpose of this study is to help the student-officer and teachers check attendance in a faster way using Arduino Uno.

Statement of the Problem - This study aimed to produce an attendance management system with a fingerprint sensor using an Arduino Uno and test its effectiveness in checking attendance. Specifically, the researchers sought to answer the following questions: (1) What is the level of effectiveness of an attendance management system with a fingerprint sensor using Arduino Uno in terms of accuracy, convenience, and efficiency? (2) Is there any significant difference between using an attendance management system with a fingerprint using an Arduino Uno and manual attendance checking? (3) Is the attendance management system with a fingerprint sensor using Arduino Uno user-friendly?

Significance of the Study - This study is important to different fields because it identifies the purpose of an attendance management system with a fingerprint sensor using Arduino Uno and also identifies its effectiveness

and accuracy. Schools will benefit from simply registering their fingerprints to document their presence. The research seeks to simplify the students' lives, the teaching and non-teaching personnel, and the administration. With the old checking method still in use, this research intends to relieve the burden of the attendance checkers. The students will benefit by automatically documenting their attendance on the fingerprint sensor and keeping track of their presence in a classroom. The data collected for this study and its conclusions will be helpful to the students. The system will become safe for users when exact time-stamped attendance recording is necessary through the fingerprint sensor. This study's findings can assist teachers in tracking student attendance. Because the technology will precisely track student attendance, this study will generate less work for the teaching staff. The results of this study will assist parents in keeping track of their kids' attendance. The study's findings will make it easier for medical and non-medical employees to keep track of their daily attendance. This research intends to make it easier for businesses to track patron attendance. This can also help administrators keep track of staff members' or employees' attendance. This study will benefit future researchers by providing information about the attendance management system with a fingerprint sensor using an Arduino Uno.

Scope and Delimitation of the Study - This study focused on producing the attendance management system with a fingerprint sensor using Arduino Uno and assessing its effectiveness by testing the attendance data's accuracy, convenience, and efficiency, aiming for security attendance tracking in educational institutions, workplaces, and events in San Jose, Occidental Mindoro. The attendance management system with a fingerprint sensor using Arduino Uno was tested specifically at Divine Word College of San Jose. Thus, it would be limited only to the following: the system would not use face recognition or RFID for authentication; instead, it would primarily rely on fingerprint recognition. The system's scalability will be restricted to a certain number of users to guarantee the best possible performance on the Arduino Uno. Basic reporting features that provide the necessary attendance data would be included. The initial scope would not include features for advanced reporting and in-depth analytics. The fingerprint cannot accommodate fingers with covers, dirty fingers, or sweaty fingers. The fingerprint would not recognize the fingers with dirt, sweat, and covers, even if the fingers are already enrolled. The fingerprint scanner can only enroll 147 fingerprints and recognize this number of fingers. To be able to enroll another fingerprint if the slot is already full, the researcher needs to delete an enrolled fingerprint to be able to register another one. The attendance management system with an Arduino Uno fingerprint sensor cannot identify if the student is absent. The system can only recognize the fingerprint that is registered during the day with a label of "on time" if the student was able to register his/her finger during the scheduled time and "late" if the student registered his/her finger during the scheduled time for the latecomers. This investigatory project was conducted within the time frame of August 2023 - April 2024.

2. Methodology

Research Design - The researchers employed an applied experimental design to develop an attendance management system with a fingerprint sensor using an Arduino Uno. This design aimed to give practical solutions to the problems of checking students' attendance. Moreover, the attendance management system and a traditional attendance checking method were compared to determine whether there were any significant differences in the accuracy and convenience of their performance.

Data Gathering Procedure - The researchers directly observed and tested the experimental device. It aimed to determine whether manual attendance checking is less accurate, convenient, or efficient than the attendance management system with a fingerprint sensor using Arduino Uno. The researchers observed and compared the two distinct methods for verifying attendance to get the data. Comparing the device to the usual method of checking attendance allows for an investigation and evaluation of the two different approaches to confirming attendance. As the researchers tested the product, they listed important data such as the time taken while taking attendance and the number of correct and incorrect identifications. This allowed the researchers to assess the product's accuracy, efficiency, and convenience. The product development phase began on January 17, 2024, and concluded on March 29, 2024. The subsequent experimental phase, employing a trial-and-error methodology, occurred from March 18, 2024, to March 24, 2024. Moreover, the researchers prepared an evaluation checklist to determine the

effectiveness and user-friendliness of the developed device. The evaluation checklist was validated by an expert in science and technology at Divine Word College of San Jose. It took two days to complete the validated evaluation checklist.

Research Process: Stage 1 Preparation and Gathering of Materials - The researchers ordered and bought the materials online and at a physical store in San Jose, Occidental Mindoro. The total cost of the materials is PHP 4,358. The following are the lists that were required by the researchers for the experiment: Arduino Uno R3, Buzzer, Fingerprint Sensor, Google Sheets, Jumper Wires, LCD Display, LED Light, and Paneling Board. The researchers used Arduino Uno as the product's main component, which controls the other device components. A fingerprint sensor is where people will register their fingerprints to confirm their presence. A Google sheet where the fingerprint data was processed. This is where you can see a table in real-time and the date the students, teachers, etc. came. The LCD Display is a mini-monitor that lets you see the real-time date and time you scanned your fingerprint. LED lights indicate whether you have successfully logged in or not.

Stage 2: Building and Development of the Project - First, the researchers used Arduino Pro Mini to gather the materials needed for the location alert device for child safety. Next, they soldered and connected all the electronic components. It took the researchers two weeks to finish the coding. Then, they encoded the program and tested it through the electronic device for another two weeks. Once the program was tested and functioned as intended, the electronic device and non-electronic materials for the housing were assembled and glued together.



Figure 1. Actual Product of Attendance Management System with a Fingerprint Sensor using Arduino Uno

Stage 3: Experimental Stage, Observation and Data Recording - The researchers developed, tested, and observed the attendance management system with a fingerprint sensor using an Arduino Uno to determine the product's functionality. The researchers assessed the product's effectiveness and compared its performance to the manual attendance check. They initially tested this attendance management system with a fingerprint sensor using an Arduino Uno and assessed the device's potential impact on time-consuming. The researchers also directly observed the product's effectiveness in accuracy, convenience, and efficiency to identify areas for improvement. Thus, it aimed to make a product that would be useful for students and teachers. The Arduino Uno, breadboard, jumper wires, fingerprint scanner, and other components that would aid in the researcher's identification are required for the product, an attendance management system with a fingerprint sensor using Arduino Uno. The fingerprint data was transferred to a Google Sheet. The researchers utilized the Arduino IDE software for both product testing and coding. They also observed the data in Google Sheets to verify whether this program encodes it appropriately. The researchers used their fingerprints to test whether the fingerprint scanner could reliably identify their fingers. In the final step, the researchers examined the finished product. Direct observation is the method used to acquire and gather data. After the trial, the researchers compiled all relevant product performance data.

Statistical Treatment of the Data - The researchers used frequency distribution and weighted mean to determine the level of effectiveness of the attendance management system with a fingerprint sensor using Arduino

Uno. Moreover, T-test analysis was used to assess if the means of two unrelated groups differ statistically significantly. The independent T-test would determine the difference between the attendance management system with a fingerprint sensor using an Arduino Uno and manual attendance checking's effectiveness in accuracy, convenience, and efficiency.

3. Results and Discussions

Table 1

Mean Level of Effectiveness of an Attendance Management System with a Fingerprint Sensor using Arduino Uno

Indicators	4 (SA)	3 (A)	2 (DA)	1 (SDA)	Weighted Mean	Descriptive Indicator
The product is accurate when it comes to saving information.	6	1	0	0	3.86	Strongly Agree
The product provides convenience for class monitors and teachers.	7	0	0	0	4.00	Strongly Agree
The attendance management system, which has a fingerprint sensor and uses Arduino Uno, efficiently checks attendance.	7	0	0	0	4.00	Strongly Agree
Overall Mean					3.95	Strongly Agree

Legend: 3.26 - 4.00 Strongly Agree, 2.51 - 3.25 Agree, 1.76 - 2.50 Disagree, 1.00 - 1.75 Strongly Disagree

Table 1 shows the mean level of effectiveness of the attendance management system with a fingerprint sensor using Arduino Uno as tested by the researchers. Based on the data, it reveals that the product is accurate when it comes to saving information (3.86), the product provides convenience for class monitors and teachers (4.00), and the attendance management system with a fingerprint sensor using an Arduino Uno is efficient when checking attendance (4.00). This implies that the developed product performs well in accuracy, convenience, and efficiency. This aligns with the findings of Olagunju et al. (2018) that the attendance management system can help teachers check their students' attendance. As specified by Linyage & Linyage (2018), the current biometric system requires greater resources than the prior manual approach. Thus, the developed device was presented for easier use and easy student monitoring in the classroom.

Table 2

Mean Level of Effectiveness of an Attendance Management System with a Fingerprint Sensor using Arduino Uno in terms of user-friendly

Indicators	4 (SA)	3 (A)	2 (DA)	1 (SDA)	Weighted Mean	Descriptive Indicator
The Attendance Management System with a Fingerprint Sensor using Arduino Uno can easily recognize fingerprints.	7	0	0	0	4.00	Strongly Agree
The fingerprint sensor can enroll fingerprints easily.	6	0	1	0	3.71	Strongly Agree

The users can easily hear the buzzer sound and see the signals from the LED and LCD.	6	1	0	0	3.85	Strongly Agree
Overall Mean					3.85	Strongly Agree

Legend: 3.26 - 4.00 Strongly Agree, 2.51 - 3.25 Agree, 1.76 - 2.50 Disagree, 1.00 - 1.75 Strongly Disagree

Table 2 shows the data gathered about the user-friendliness of the product. The table contains questions about how user-friendly the product is when it comes to the enrollment of fingerprints, recognizing fingerprints, and the visibility of lights, buzzers, and LCDs. The overall mean of 3.85 proved that the attendance management system with a fingerprint sensor performs well and is user-friendly. As Justina (2015) mentioned, one incredibly practical and trustworthy method of confirming someone's identity is fingerprint verification. Since it is thought that no two people on the planet have the same fingerprints, fingerprint identification and verification are the most widely used methods of confirming someone's identity or validity. According to him, employing fingerprint scanning and recognition systems is the most suitable among the many biometric technologies available for information security solutions. Compared to other methods, this one is more affordable, easier to utilize daily, and has a meager false acceptance rate. The overwhelmingly positive response favored the system's user-friendliness and effectiveness.

Table 3

t-Test Results in the difference between the Attendance Management System with Fingerprint Sensor using Arduino Uno and Manual Attendance Checking

t-Test: Two-Sample Assuming Unequal Variances		
	Attendance Management System with Fingerprint Sensor using Arduino Uno (Variable 1)	Manual Attendance Checking (Variable 2)
Mean	1.907143	4.348571
Variance	0.65959	1.356681
Observations	7	7
Hypothesized Mean Difference	0	
Df	11	
t Stat	-4.54903	
P(T<=t) one-tail	0.000416	
t Critical one-tail	1.795885	
P(T<=t) two-tail	0.000831	
t Critical two-tail	2.2000985	

Legend: *Highly Significant at $p \leq 0.01$ *Significant at $p \leq 0.05$

Table 3 shows the t-test results for the difference between the attendance management system with a fingerprint sensor using an Arduino Uno and manual attendance checking. The researchers conducted seven trials, each on the set. The first set, the attendance management system with a fingerprint sensor, has a total time of 13.53 seconds for seven trials. Manual attendance checking has a total of 30.44 seconds for seven trials. The statistical analysis shows that the absolute computed value (t comp) is 4.55, and the critical value (t crit) is 2.20. Thus, the researchers rejected the null hypothesis since the t comp is higher than the t crit value. Therefore, there is a significant difference between the attendance management system and a fingerprint sensor using Arduino Uno regarding the speed of taking attendance. As per Thein and Tun (2015), students' attendance in class has become more crucial for all organizations and institutions. The manual approach could be more efficient in verifying attendance by calling names or signing paperwork since it takes a lot of time and is unreliable.

4. Conclusions

Based on the summary of findings, the following conclusions were made about the problem: the level of effectiveness of the attendance management system, as assessed by the researchers, is accurate regarding logging data, convenient to use, and efficient. There is a significant difference between the attendance management system with a fingerprint sensor using Arduino Uno and manual attendance checking regarding the time taken while checking the attendance. The attendance management system with a fingerprint sensor using Arduino Uno is user-friendly based on the ability to recognize fingerprints easily, the enrollment of fingerprints, and the effectiveness of signals from the LED. The attendance management system with a fingerprint sensor using Arduino Uno is proven to be user-friendly. The attendance management system with an Arduino Uno fingerprint sensor is easy to use and can accommodate two or more students. Arduino Uno and fingerprint sensors are the most essential materials in making the product.

Recommendation - Based on the study results and the data collected, the following recommendations are made: the researchers recommend that the school administrators use the Fingerprint R307 to scan the fingerprint more accurately. Instead of using Arduino Uno, the researchers recommend Arduino Wifi MKR1010 for future researchers who will not use a laptop while using the product. The researchers suggest transitioning from an LCD to an OLED SSD1306 due to the OLED's capacity to exhibit text, images, and diverse patterns, which would significantly enhance an Attendance Management System with fingerprints using Arduino Uno, as opposed to the limited capabilities of LCDs. The researchers recommend that the school may use the RTC DS3231 with this GSM GPRS module because it adds features for future researchers. This eliminates the need for a laptop for real-time setup viewing; they can view it directly on the RTC DS3231 GSM GPRS Module. The researchers recommend putting a summarized narrative tally for the lateness and absences of the students below the sheet where the details are stored.

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