Design and Application of a Portable Fingerprint System for Web-Based Student Attendance and Telegram Using Raspberry Pi

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Abstract. This paper presents the results of the portable fingerprint system design that is specifically applied for student attendance. The purpose of designing this system is to make it easier for teachers or school administrators to monitor and to process student data so that it can be shared via websites and telegram applications. In addition, there are also features for parents to monitor their child's online presence at school. The methods used were the design and implementation method. The design of this system was built using hardware from Raspberry Pi, where students fingerprint is recorded and can be sent to the website, and also through the telegram application. The system built has been able to function and be implemented properly. The system test results showed a percentage of success of 100% from a number of student entry samples. The fingerprint application that has been made is expected to be used by schools to expedite the process of recording student attendance, and also parents of students can monitor the presence of their children in real time in the teaching and learning process especially in Indonesia.

1. Introduction

The attendance list is one of the most important things in every activity, whether at the company, at the university, or at school, and others. The school attendance list is evidence that students have attended school or not. Most schools in Indonesia still use a manual system in the process of recording student attendance, so student attendance data is only known by the school. Sometimes parents of students also want to know whether their children really come to school or not. But they are constrained by the manual system. At this time if parents want to see the attendance list of their children, they must first contact the school to make an appointment to come to school so this method is not effective. Therefore, to overcome this, we need a system application that can check student attendance in real time and the latest attendance data.

In the paper made by Shah et al., they are working on a biometric system that can utilize unlimited cloud computing resources and the striking features of flexibility, scalability, and reduction in biometric systems. They used the Raspberry Pi to build a low-cost biometric system [1]. Saker, et al., made a prototype of a smart attendance system to overcome the inconvenience of using attendance records that are still traditional in Bangladesh. Their aim is to overcome the slowness of the existing system [2]. Shetty et al., created an automated biometric attendance management system that aims to reduce manual work by transferring data to the server with the help of the internet. They use Raspberry Pi to recognize fingerprints as authentication [3]. Srivastava et al., created a presence management system using barcodes and Raspberry Pi. This system is enabled by the presence of lectures to overcome false attendance in class [4]. Sadikot designs and builds economical biometric systems. The system functions
to monitor attendance remotely. They use fingerprint biometric technology based on Raspberry Pi [5]. Reddy, presents a faculty attendance recording system. The aim is to replace the manual system by addressing the paper presence lost and damaged. This system uses a biometric based fingerprint system [6]. Shekhar et al., built a system that monitors class attendance using RFID. Register attendance can be immediately obtained by parents through the application on their smart phone [7]. Wadhwa et al. proposed a system that is portable and more efficient using the automatic attendance system of biometric fingerprint sensor technology [8]. Muchtar et al. built a fingerprint sensor system that functions to monitor and identify attendance. The system is centrally managed using the Arduino processor and Raspberry Pi [9]. Yadav et al., explained about the project aimed at automating the attendance procedure in the classroom by using an 8051 microcontroller-based fingerprint recognition module [10]. Ezema, et al., presents a fingerprint attendance system that is stand-alone and handheld based on the 89S52 microcontroller which is designed to be able to operate as an attendance system [11]. Vidyanikethan, proposed an attendance management system using RFID per user based on Raspberry Pi, and storing attendance data in a database and occasionally sending to parents using a cell phone [12].

However, this study discussed about how to design and apply an attendance recording system. This system is specifically intended for high schools to record fingerprints of students when they want to enter the classroom. This system, in addition to being monitored by the school concerned, can also be monitored by parents’ portable devices via the web and through the telegram application.

2. Methods
The system is built using Raspberry Pi with ZFM-60 fingerprint sensor, where the component is programmed using the Python language, then for the website will be built using PHP with the CodeIgniter framework. To run certain events on a web page, use an AJAX method from JavaScript with a library that has been provided by jQuery. Furthermore, for DBMS, MySQL is used. The design of the system block diagram is shown in Figure 1.

![Figure 1. System block diagram](image)

2.1. Raspberry Pi Design
This design uses a Raspberry Pi 3 Model B + which is the latest version of the Raspberry Pi 3 series. Pi 3B + has a shape and size that is identical to the Pi 3B, but when compared to the Raspberry Pi 3 Model B, Pi 3B + has increased in several parts of hardware, starting from the 64-bit processor which now has a maximum clockspeed of 1.4 GHz (formerly 1.2 GHz on Pi 3B), has Gigabit Ethernet (PoE support) which is certainly much faster than the previous version, has a heatsink on the processor for better heat distribution, and supports dual band 5 GHz and 2.4 GHz WLAN.

2.2. Sensor Design
The fingerprint reading process uses the ZFM-60 sensor which is connected to the Raspberry Pi via USB to TTL. The fingerprint sensor circuit is shown in Figure 2.
The pin connection from the ZFM-60 sensor to USB - TTL can be seen in Table 1.

| Pin USB to TTL | Pin Description | Pin of ZFM-60 | Annotation       |
|---------------|-----------------|--------------|-----------------|
| 1             | Power 3.3V      | Power 3.3V   | Voltage source  |
| 2             | GND             | GND          | GND             |
| 3             | RX              | RX           | RX              |
| 4             | TX              | TX           | TX              |

2.3. Connection from LCD to Raspberry Pi

Information from the website is displayed by a 3.5-inch LCD. Furthermore, this information is processed by Raspberry Pi. Raspberry Pi is connected to the LCD via RPI and also HDMI as shown in Figure 3.

2.4. Telegram

This study utilizes the Bot feature of Telegram which is used to response messages or questions from students. The user sends a message to the Bot account via the Telegram Client installed on the device used. The message will be received by Telegram Server and forwarded to Bot server. Bot server will process the message to be able to provide appropriate responses to students in the form of text messages or pdf documents. Responses are sent to the client via Telegram Server. Each message will act as a command that will affect the form of response to the client. Students can interactively respond to every message sent back by the server.

Telegram bot application uses the webhook method, where messages from the telegram will be sent to the telegram server and then forwarded to the URL that has been set previously. The message sent is json data. After the message is received by the system, the message is then converted first so that it can
be processed. After that the message will be broken into several parts and the system will process the
message depending on what was sent by the user.

3. Results and discussion
Tests carried out to determine the suitability of the design of the device made, whether the results are as
expected or not. The test also aims to determine the function of each component and the overall function
of the tool. The next step is to analyze the results of the test to find out the percentage of fairness of the
tools made. This test includes hardware testing and software testing.

3.1. Hardware Testing
Fingerprint testing is done by connecting the ZFM-60 fingerprint sensor using USB to TTL which is
connected directly to the USB port of the Raspberry Pi. Then fingerprint sampling is done by running
the program. The data that was successfully recorded and saved in template #2.

The results of the fingerprint recording using 10 different finger data samples are shown in Table 2.
The recording results worked well without errors, with a condition that the ZFM-60 sensor is in good
condition.

| Name | Thumb | index finger | middle finger | ring finger | little finger |
|------|-------|--------------|---------------|------------|--------------|
| A    | ✓     | -            | -             | -          | -            |
| B    | -     | ✓            | -             | -          | -            |
| C    | -     | -            | ✓             | -          | -            |
| D    | -     | -            | -             | ✓          | -            |
| E    | -     | -            | -             | -          | ✓            |
| F    | ✓     | -            | -             | -          | -            |
| G    | -     | ✓            | -             | -          | -            |
| H    | -     | -            | ✓             | -          | -            |
| I    | -     | -            | -             | ✓          | -            |
| J    | -     | -            | -             | -          | ✓            |

The following is a testing of the accuracy of the sensors used. In this test 10 fingers were used and
the input process was carried out 20 times. And the results are seen in Table 3.

| No. | Name | Total Success | Total Fail | Percentage of success (%) |
|-----|------|---------------|------------|---------------------------|
| 1   | Jari_A | 18            | 2          | 90                        |
| 2   | Jari_B | 16            | 4          | 80                        |
| 3   | Jari_C | 20            | 0          | 100                       |
| 4   | Jari_D | 15            | 5          | 75                        |
| 5   | Jari_E | 14            | 6          | 70                        |
| 6   | Jari_F | 16            | 4          | 80                        |
| 7   | Jari_G | 20            | 0          | 100                       |
| 8   | Jari_H | 15            | 5          | 75                        |
| 9   | Jari_I | 18            | 2          | 90                        |
| 10  | Jari_J | 18            | 2          | 90                        |
3.2. Software Testing

A. Testing on the Website Application
The following test is to display at attendance data on the website. This test is done by looking at student attendance data on certain subjects. Figure 4 shows the student attendance data for Bahasa Indonesia subjects for the R-Fing class.

![Form that functions to display student attendance.](image)

**Figure 4.** Form that functions to display student attendance.

Form testing on View Attendance Data based on Student ID (NIS). Tests carried out by looking at the sample attendance data for NIS: 10214001 (shown in Figure 5).
Figure 5. Student attendance based on NIS

B. Testing on the Telegram Application
Bot Server application is built using PHP programming language with MySQL database. Communication from the Telegram server to the bot server utilizes a webhook with the https protocol. In Figure 6 is an example of the results of testing bot communication with users. In Figure 6, shown the user sends the command "/ check 10214086" then the system responds by sending attendance data from the NIS that is sent.

Figure 6. Example of communication / interaction with a telegram bot.
4. Conclusion
Fingerprint sensor testing successfully recorded user fingerprint data with ten kinds of sample data. Fingerprint sensor also managed to search and retrieve the overall fingerprint data that has been recorded. The website and bot telegram application can fully respond to commands according to expected by the user, such as registering a telegram account and also checking student attendance with a success rate of 100%. The fingerprint application that has been made is expected to be used by schools to expedite the process of recording student attendance, and also parents of students can monitor the presence of their children in real time in the teaching and learning process especially in Indonesia.

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