Attendance fingerprint identification system using arduino and single board computer

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Abstract. Fingerprint is one of the most unique parts of the human body that distinguishes one person from others and is easily accessed. This uniqueness is supported by technology that can automatically identify or recognize a person called fingerprint sensor. Yet, the existing Fingerprint Sensor can only do fingerprint identification on one machine. For the mentioned reason, we need a method to be able to recognize each user in a different fingerprint sensor. The purpose of this research is to build fingerprint sensor system for fingerprint data management to be centralized so identification can be done in each Fingerprint Sensor. The result of this research shows that by using Arduino and Raspberry Pi, data processing can be centralized so that fingerprint identification can be done in each fingerprint sensor with 98.5 % success rate of centralized server recording.

1. Introduction

Human beings have something unique that only belongs to them. This gives the idea of making the uniqueness of humanity as identity. Fingerprint is different to each of people, even for the twin. This makes fingerprints be appropriate used for biometrics technology. Another advantage of fingerprints is its practicality and durability [3]. Biometric fingerprint is a technology with physical characteristics of fingerprints. This type of biometrics is popularly used because it has a good performance and uniqueness. Moreover, fingerprints are permanent in one’s lifetime, quite immune to aging and biological changes [1].

Biometric technology has great potential in various technical fields such as network security, public security, and financial industry systems [5]. At this time, the most developed technology is fingerprint recognition by using fingerprint sensor. Fingerprint sensor is a sensor used to detect fingerprint using optical system, where the detection is done by reading the contours (high level of the surface) fingerprint and static electricity body. The match rate of False Acceptance Rate (FAR) is up to <0.001% and the match rate limit of the Average Rejection Rate (FRR) is up to <1% [2].

However, the fingerprint sensor can only identify the user's fingerprint registered in the sensor. Therefore, we need a method that makes fingerprint recognition using a fingerprint sensor to be centralized. With the Arduino and Raspberry Pi, supporting data can be centralized to identify the user's fingerprint entirely and can perform fingerprint recognition in different fingerprint sensors. Using WebSocket makes it possible to provide a variety of interactions between browsers and websites. In this way, two-way continuous conversations can be made between browsers and servers [4].

2. Research Methodology

The identification of fingerprints for the attendance system using Arduino and Raspberry Pi which is built on this research consisted of several stages. The first stage is done with the initialization of the Fingerprint sensor, Arduino, Ethernet Shield and Raspberry Pi. The next stage is Fingerprint Sensor.
this stage the Fingerprint Sensor will take the user's fingerprint extraction thrice in one time. Then change the fingerprint capture results into data form as much as 8 bytes. Fingerprint data collection will be converted into hexadecimal form which will then send fingerprint extraction result to Arduino. Then Arduino will forward the results of fingerprint extraction to the server via Ethernet Shield. The stored data will be displayed in the form of monitoring that can be viewed on a web page. The general architecture of the system to be built can be seen in Figure 1.

2.1. Sensor Design

The steps that will be done to design the fingerprint sensor system are as follows:

1. Communication Fingerprint Sensor

The pins on the fingerprint sensor are used to communicate between the Arduino and the Biosec OK-300 Fingerprint Sensor using serial communication. This fingerprint sensor scans user's fingerprint. This sensor will work if user’s finger is detected as well as the green LED lights on the sensor, further details, see Figure 2.

2. Arduino Communication with LCD

LCD, in the system which will be built, serves to display the circumstances that occur within the system. When Arduino sends fingerprint extraction result to the server, the extraction data will be matched then
the server will send ‘return’ to Arduino and Arduino will give command to LCD to show that command succeed. To see clearly LCD display can be seen in Figure 3.

![Arduino Communication with LCD](image)

Figure 3. Arduino Communication with LCD

After all the sensors can communicate well to the arduino, then a circuit will be made into a single unit by using PCB (Printed Circuit Board) as seen in Figure 4.

![Fingerprint Sensor Series](image)

Figure 4. Fingerprint Sensor Series

After all the hardware has been installed, attendance system design has been integrated, then the user’s fingerprint will be sent from arduino fingerprint sensor data via Local Area Network (LAN) to Raspberry server as designed in general architecture.

3. Result and Discussion

3.1. Fingerprint Identification Performance

This stage will display the results of fingerprint sensor testing during registration. In the designed system, registration mode is selected manually in the fingerprint sensor by pressing the button on the sensor and test results can be seen through Table 1.

| Steps of Registration Process | Image |
|--------------------------------|-------|
| Display the current running mode | ![Image](image) |
| Wait for the fingerprint to be pressed | ![Image](image) |

Table 1. Fingerprint Sensor Testing on Registration Process
At this stage, it will display the sample results of fingerprint sensor testing while matching. Further details of the test results can be seen through Table 2.

**Table 2. Fingerprint Sensor Matching Test**

| ID User | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|
|         | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  |
|         | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  |
|         | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  |
|         | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  |
|         | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  |
|         | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  |
|         | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  |
|         | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  |
|         | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  |
|         | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  |
|         | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  |
|         | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  |
|         | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  |
|         | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  |
|         | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  |
|         | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  |
|         | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  |
|         | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  |
|         | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  |
|         | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  |
Based on the testing done in matching process, nine of the fingerprints cannot be identified which are marked with "x". This case is because of various problem such as fingerprint is not in the correct position, wet or oily finger and thin finger surface. While the successful ones are marked with "√". From the matching fingerprint data in Table 2, it can be seen that the accuracy of the designed system is 98.875%. The accuracy value is obtained based on equation 1.

\[
\text{Percentage of Accuracy} = \frac{\text{number of successful fingerprint matching}}{\text{total number of fingerprint test data}} \times 100\% 
\]

Percentage of Accuracy = \frac{791}{800} \times 100 \% 
= 98.875 \%

3.2. Fingerprint Server Application

At this stage, it will show the results of the interface design implementation of the built system. Here is a built-in interface pageview:

1. Add User Page

On this page, admin does not need to fill the member ID and fingerprint data because the data is obtained when the user scans his fingerprint on the fingerprint sensor. The added user pageviews can be seen in Figure 5.

![Figure 5. Add User Pageviews](image)

2. User Data Pageviews

On this page, admin can view or search for information from users like identity number, name, gender, address and mobile phone number. Admin can also edit user data in case of errors while filling out data and delete users. On this page also provides a print menu that works to print user data into PDF form. Views of user data pages can be seen in Figure 6.
3. User Attendance History Pageviews

On the user attendance history page, the admin must select the user first. To view user history can be done when an admin clicks on one of the user on the user data pageviews. The provided information from this page is the description of the user’s attendance. This page shows processed fingerprint matching which have been processed and transmitted by the client arduino fingerprint system to the single board computer server. The pageviews of user’s history can be seen in figure 7.

4. Conclusion

The conclusions can be obtained from fingerprint identification research using Arduino and Raspberry for attendance system are as follows:

- Research of fingerprint identification in attendance system using Arduino and Raspberry is successfully implemented with 98.875% success rate of centralized server recording.
- Based on the results of this study, it can be concluded that fingerprint data processing becomes centralized.
- Attendance list can be done in any fingerprint sensor connected in one network.

5. Acknowledgement

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