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# Enhanced Passive Keyless Car Door Locking System Using Fingerprint

**Muhammad Hazmie A Halim[1], Sim Sy Yi[1]***

[1]Department of Electrical Engineering, Faculty of Electrical and Electronic Engineering,
Universiti Tun Hussein Onn Malaysia, Batu Pahat, 86400, MALAYSIA

*Corresponding Author Designation

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**Abstract**: The method of using traditional keys these days is still convenient and acceptable as it is used widely worldwide by car users. However, the way of using traditional keys might cause theft as it faces several security issues and difficulties. So, this project will introduce an enhanced passive keyless car door locking system using fingerprints. By doing away with physical keys and implementing biometric authentication, the system seeks to offer increased security and convenience. This project uses Arduino Uno, a fingerprint sensor, a relay and an actuator car lock as the main components. The application of the system uses a fingerprint sensor to embed the car, and only a valid fingerprint has access to lock and unlock the car. The fingerprint is commonly used by enrolling the fingerprint by using a sensor for fingerprint recognition. A security system was also added to this proposed system as the buzzer will turn on when the invalid fingerprint is attached 3 times. These ideas are chosen due to the user-facing problems in unlocking the door as the key is missing or lost. This project will use a battery as the main supply and a car door lock actuator as the output of the project. To validate the outcome of the proposed keyless car door locking system, the actuator will lock and unlock when verifying the valid fingerprint.

**Keywords**: Fingerprint Sensor, Actuator, Traditional Key, Locking System

## 1. Introduction

In the digital age, technology has advanced rapidly to maintain the world economy. Car production, particularly state car production, has become a sophisticated and efficient means of transportation. The first vehicle powered by a gas engine was the Benz Patent Motor Car, invented by Carl Benz in 1886 [1]. The Ford Model T, developed in 1908, marked the first mass-produced vehicle on a moving assembly line. As technology advances, cars have become more sophisticated, with features such as radio, air conditioning, and airbags. Hyundai Motors, one of the world's largest car companies, has introduced a new feature called fingerprint unlocking and starter starting [2]. This involves placing a finger on a sensor on the door handle, allowing the driver to unlock the vehicle. The encrypted fingerprint information is then delivered to the fingerprint controller inside the vehicle. The ignition

*Corresponding author: sysim@uthm.edu.my

button is equipped with a fingerprint scanning sensor, making fingerprints a permanent identifier. Human fingerprints are appropriate as permanent identifiers of human identification because they are intricate, hard to change, and resilient throughout an individual's lifetime [3]. This project aims to create a locking system using fingerprints as an alternative to traditional keys for car security. This system would provide a secure and convenient way to unlock and start a car, ensuring the safety and security of the vehicle.

The traditional car key is a crucial safety feature in car security systems, but it can be difficult to open the car without it. Losing the key can lead to theft and increased criminal cases. This project proposes a fingerprint-based locking system as an alternative, allowing users to unlock the car without using a traditional key. Fingerprints are permanent identifiers, making them suitable for human identification and saving time in searching for keys. This innovative system aims to reduce the risk of theft and theft by detecting and preventing the loss of a traditional key.

The objective of this project is to design an alternative car key-locking system by using fingerprints. The second is to embed the proposed fingerprint-locking system into the car door prototype. The third is to verify the proposed fingerprint car locking system.

## 2. Materials and Methods

The materials and methods section, otherwise known as methodology, describes all the necessary information that is required to obtain the results of the study.

### 2.1 Circuit fingerprint sensor detection

Figure 1 shows the proposed project consists of fingerprint sensor AS608 and Arduino Uno which act as the main component to send data to the Arduino Uno. The fingerprint uses four useful inputs which are the first one is the module power supply (v+), ground, serial transmitter, and serial receiver. The finger will attach to the sensor surface of the fingerprint sensor.

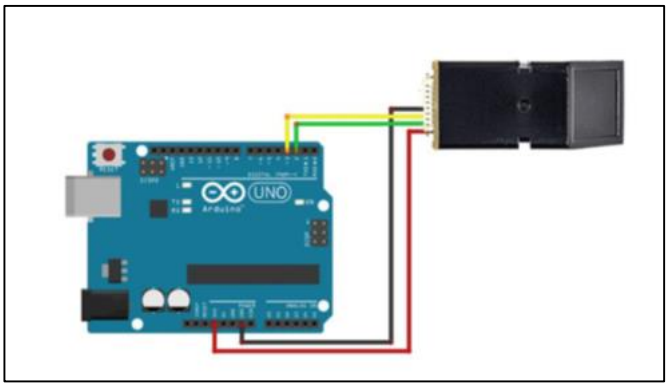



**Figure 1: Connection of fingerprint sensor**

### 2.2 Circuit car door locking system using fingerprint

Figure 2 shows a proposed project consisting of a 25V – 30V trigger delay relay timer module, Arduino Uno, a fingerprint sensor, a car battery, a car door lock actuator, an LED, and a buzzer. The fingerprint sensor will detect the fingerprint, and the actuator will operate the system that unlocks and locks as the fingerprint sensor detects the valid fingerprint. The flash memory on Arduino Uno will save the valid fingerprint data.

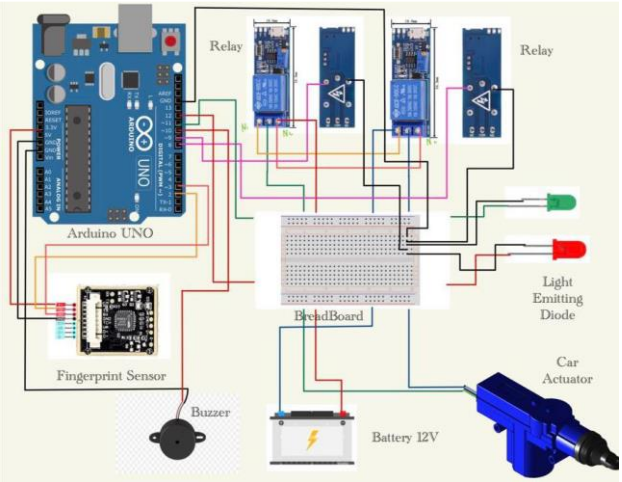
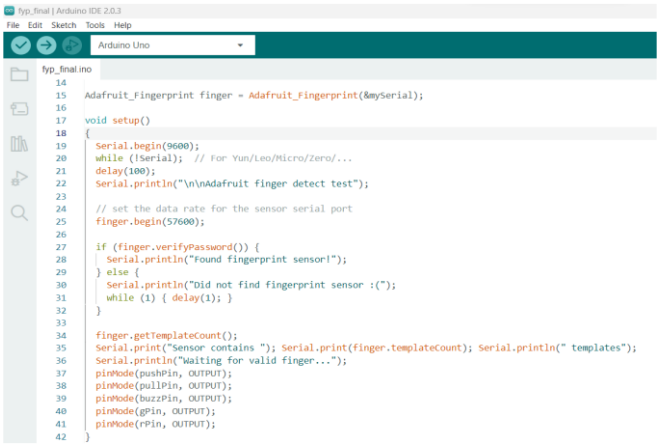



**Figure 2: Connection of fingerprint sensor**

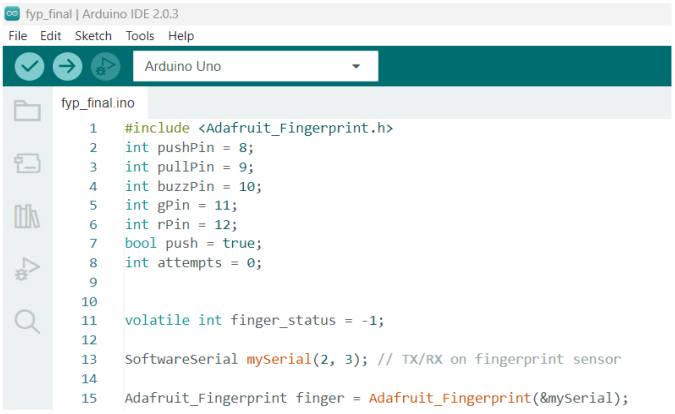
2.3 Code of project (Arduino IDE)

The Arduino Software (IDE) includes a text editor, message box, terminal, toolbar, and menus for programming. It connects to Arduino hardware, enabling programming upload and communication. Figure 3 shows the void setup in the Arduino IDE that will be used for a code conduct for the locking system using fingerprint followed by Figure 4 as the Arduino IDE display and Figure 5 shows a void runlock as one of the main functions for the system.



```
Adafruit_Fingerprint finger = Adafruit_Fingerprint(&mySerial);

void setup()
{
  Serial.begin(9600);
  while (!Serial);  // For Yun/Leo/Micro/Zero/...
  delay(100);
  Serial.println("\n\nAdafruit finger detect test");

  // set the data rate for the sensor serial port
  finger.begin(57600);

  if (finger.verifyPassword()) {
    Serial.println("Found fingerprint sensor!");
  } else {
    Serial.println("Did not find fingerprint sensor :(");
    while (1) { delay(1); }
  }

  finger.getTemplateCount();
  Serial.print("Sensor contains "); Serial.print(finger.templateCount); Serial.println(" templates");
  Serial.println("Waiting for valid finger...");
  pinMode(pushPin, OUTPUT);
  pinMode(pullPin, OUTPUT);
  pinMode(buzzPin, OUTPUT);
  pinMode(gPin, OUTPUT);
  pinMode(rPin, OUTPUT);
}
```

**Figure 3: Void setup**



```
#include <Adafruit_Fingerprint.h>
int pushPin = 8;
int pullPin = 9;
int buzzPin = 10;
int gPin = 11;
int rPin = 12;
bool push = true;
int attempts = 0;


volatile int finger_status = -1;

SoftwareSerial mySerial(2, 3); // TX/RX on fingerprint sensor

Adafruit_Fingerprint finger = Adafruit_Fingerprint(&mySerial);
```

**Figure 4: Arduino IDE display**

```
void runLock()
{

  if(push)
  {
    digitalWrite(pushPin, HIGH);
    //preset relay
    delay(100);
    digitalWrite(pushPin, LOW);

    push = false;
  }else{

    digitalWrite(pullPin, HIGH);
    //preset relay
    delay(100);
    digitalWrite(pullPin, LOW);
    push = true;
  }
```

**Figure 5: Void unlock**

2.4 Flowchart

Figure 6 shows the flowchart of the proposed car locking system. It starts with scanning the fingerprint on the surface of the fingerprint sensor. Then, Arduino Uno takes a second to read the data of the fingerprint from the flash memory. When the fingerprint is valid, the relay will function and work. When the car prototype is in lock condition, the relay will function and the green LED will be on then the actuator will lock the car. But when the car is on in the unlock condition, the relay will function the green LED will be on then the actuator will unlock the car. But different methods when the fingerprint is not valid. When a fingerprint is not valid, the Arduino Uno does not have the data of the fingerprint. When attempting 3 times and still does not work, the buzzer will be on and the red LED also will be on.

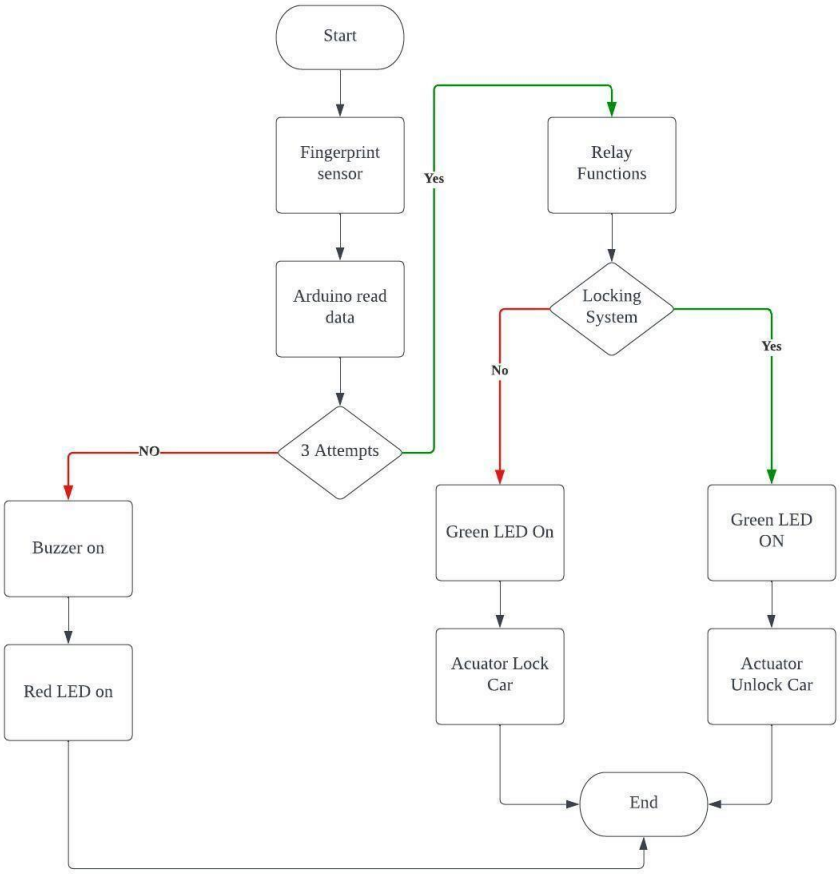



**Figure 6: Flowchart project**

## 3. Results and Discussion

The results and discussion section presents data and analysis of the study. This section can be organized based on the stated objectives, chronological timeline, case groupings, experimental configurations, or any logical order deemed appropriate.

### 3.1 Fingerprint installation

Figure 7 shows the way to store the data for the user's fingerprint. The fingerprint of the user is stored in the Arduino Uno. The fingerprint sensor will detect the user's finger as the user's identity and the Arduino Uno will store the user's fingerprint data.

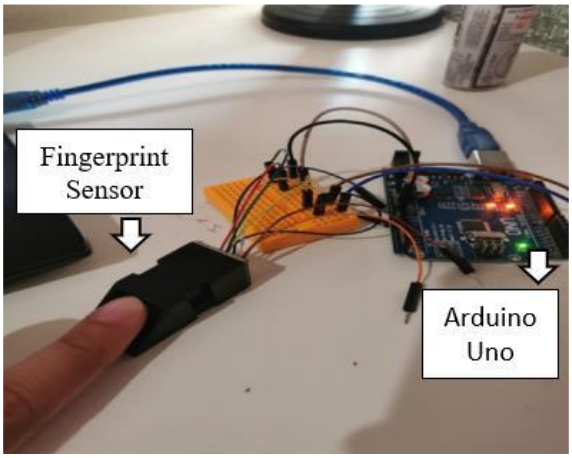



**Figure 7: Fingerprint detection**

3.2 Enrolment test on the fingerprint sensor

The enrolment test assesses fingerprint sensor detection and enrollment into flash memory, scanning, analyzing, and storing fingerprints in a secure database. As shown in Figure 8 the fingerprint data was stored after the valid finger was registered in the serial monitor at Arduino Uno.

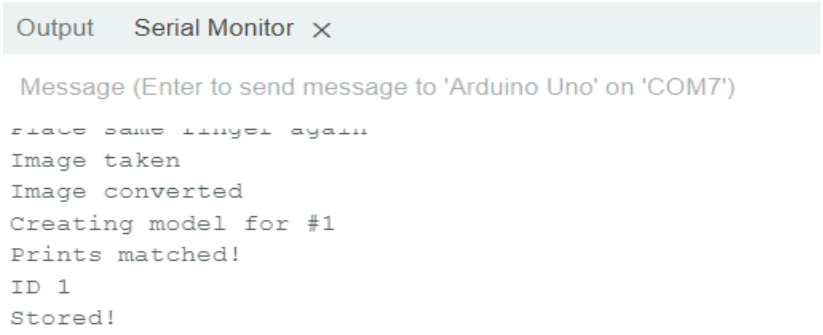



**Figure 8: Fingerprint stored**

Figure 9 shows the serial monitor writes 'Found ID #1 with the confidence of 124' after 'waiting for valid finger'. This means the fingerprint sensor detects the right fingerprint.

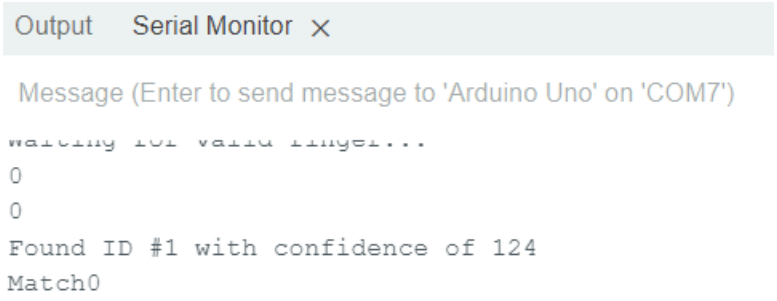



**Figure 9: Matched fingerprint**

3.3 Prototype development

Figure 10 and 11 shows a prototype of an enhanced passive keyless car door locking system using fingerprint was developed by using a fingerprint sensor and actuator car door lock as the main component. The system includes a relay, Arduino uno, buzzer, LED, and battery as a source. While Figure 12 shows the system design of the project. All the components are connected correctly.

**Figure 10: Prototype project from front**

**Figure 11: Prototype project from interior**

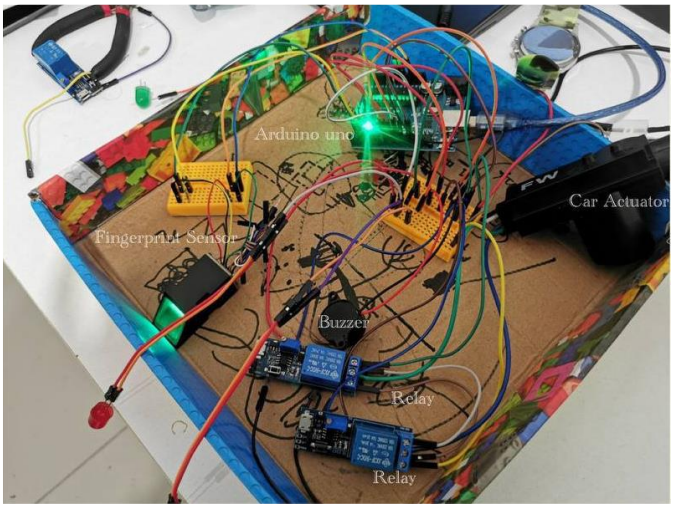



**Figure 12: System design**

3.3 Testing results on fingerprint

As shown in Figure 13, it shows a result when it verifies the valid fingerprint. When the fingerprint is valid, the green LED will blink. Figure 14 shows a condition when the invalid fingerprint is attached to the fingerprint sensor. When the fingerprint is invalid, the red LED will blink. Table 1 below shows the results of testing of 5 different fingerprints and Table 2 shows the outcomes parameters when testing the 5 different fingerprints.

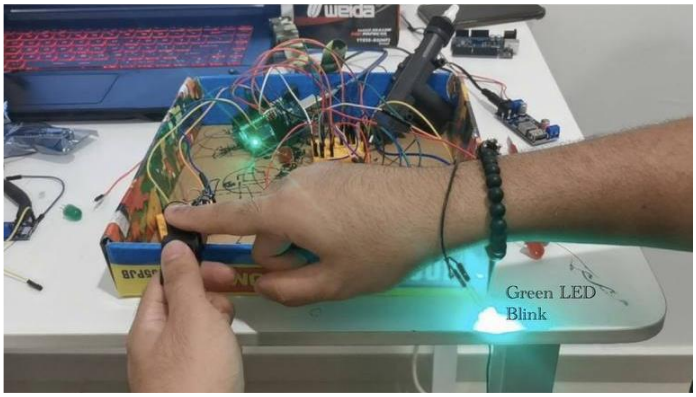



**Figure 13: Valid fingerprint test**

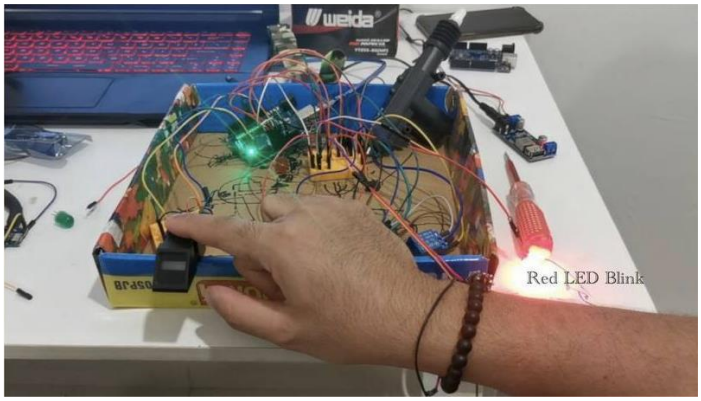



**Figure 14: Invalid fingerprint test**

**Table 1: Table of testing fingerprint**

| No | Fingerprint | Status |
|---|---|---|
| 1 | Fingerprint 1 | Valid |
| 2 | Fingerprint 2 | Valid |
| 3 | Fingerprint 3 | Valid |
| 4 | Fingerprint 4 | Invalid |
| 5 | Fingerprint 5 | Invalid |

Table 2 shows the result of testing fingerprints when several fingerprints were attached and attempted on a fingerprint sensor. By following the first fingerprint which is fingerprint 1, the result was valid as it registered in the coding and saved in the Arduino Uno memory as stated in Figure 4.4. The same goes for fingerprint 2 and fingerprint 3, which are also registered in the coding and saved in the Arduino Uno memory. As stated in the table above for fingerprint 4 and fingerprint 5, the status was invalid because the fingerprint was not registered in the Arduino Uno.

**Table 2: Parameter condition**

| No | Fingerprint | Actuator Condition | LED Condition | Buzzer Condition |
|---|---|---|---|---|
| 1 | Fingerprint 1 | Lock and Unlock | Green LED on | No Beep |
| 2 | Fingerprint 2 | Lock and Unlock | Green LED on | No Beep |
| 3 | Fingerprint 3 | Lock and Unlock | Green LED on | No Beep |
| 4 | Fingerprint 4 | No Function | Red LED on | Beeping |
| 5 | Fingerprint 5 | No Function | Red LED on | Beeping |

Table 2 displays the application's parameter conditions for fingerprints. If fingerprint 1 is valid, the actuator condition locks the door prototype after the first attempt, and the LED appears green, marking the fingerprint as valid. Fingerprints 2 and 3 act similarly, as they are registered in the Arduino Uno. If fingerprints 4 and 5 are invalid, the actuator condition does not function, and the LED continuously beeps red for 3 seconds. The buzzer also turns on and beeps after three attempts.

## 4. Conclusion

This project aims to develop a fingerprint-locking system to enhance car security and prevent theft. The project involves designing an alternative car key-locking system using fingerprints, embedding the system into a car door prototype, and verifying the system. The project involves using a fingerprint sensor to register the user's fingerprint, enabling the system to be integrated into the prototype car door. The fingerprint locking mechanism provides increased vehicle security through biometric authentication. The project's success can be applied to cars, as it offers high-security levels and prevents burglary cases. Overall, this project aims to make daily life easier and make cars more secure.

## Acknowledgement

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