Fingerprint Doorlock and Home Security System by Using Arduino and IOT

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Abstract The number of burglary cases are increasing day by day and owners surely don't want their home to be intruded. So, the aim of this project is to create a security system for home and door-lock with fingerprint detection feature to unlock the door in order to increase the home security and at the same time, it will be more convenient. This project consists of fingerprint sensor that detect the owner's fingerprint then the solenoid door-lock will be unlocked. The fingerprint sensor is connected with Arduino Uno as the brain of the system that helps the fingerprint pattern recognition. This system also equipped by ESP32-CAM module in which its function is to receive and send the signals to smartphone through BLYNK application that can be downloaded into smartphone from Playstore. In this project, ESP32-CAM is used to capture the photo of people or object that presence in front of the door. The presence of people or objects will be detected by the sensor. There are two sets of sensors with different function set up in this prototype. The functions are to send the signal to ESP32-CAM so the image will be taken and to send the signal to alarm system as the buzzer will buzz. The light resistance diode module (LDR) and Laser module is used as the sensor. The LDR module detect the presence of light and laser module provide the laser beam. For this project, the laser beam is pointed to the LDR module. If the laser beam to LDR module is interrupted, the LDR module will produce the signal and send to the system. The system can be reset by reset button that is installed in the prototype or by using smartphone. There are six relay modules used in this prototype as relay system, reset system, switch for door lock solenoid and switch for the buzzer. For the future project, the improvement can be made by adding face recognition system to increase the security.

Keywords: Fingerprint, Security, Door.

1. Introduction

Nowadays, the use of technology has become vital in human life. The use of technology is to make human life become easier. Thus, in the case of this project, there is also the use of technology that will help the human to improve their life quality. This home fingerprint door-lock and security alarm using

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Arduino is combination of technology in which the task is to secure the house from burglary. This system is equipped ESP32-CAM to provide the Internet of Things feature. IOT feature is chosen for this because the internet connection available almost everywhere in this world. As a result, the owner can be notified from wherever they go. The internet connection from the Wi-fi is important in this project. It is because the system needs to send or receive the signal from smartphone through the internet. This prototype has the ability to capture the image and send it directly to the smartphone from anywhere as long as there is internet connection. This system also equipped by light resistance diode modules (LDR) and laser modules as sensors. The advantage of using LDR module and laser module as intrusion sensor is the laser beam can be reflected by using the mirror to any part of the house that we want to secure and finally to LDR module. In other word, the laser module and LDR module is useful to detect the intrusion from many parts of the house and yet could reduce the cost of the project.

Other than securing the house, the product of this project is also convenient to the owner as this system is using biometric lock concept instead of iron key lock. The fingerprint sensor is equipped for this prototype. It is used to detect owner's fingerprint to unlock the door-lock solenoid. The door lock solenoid is powered by four 9 volts batteries. A relay module is used as switch for the door-lock solenoid that will be activated when receive the signal from Arduino Uno. The Arduino Uno produce the signal if the fingerprint pattern is recognized by fingerprint sensor. the buzzer is used in this project for the alarm system. The buzzer will be activated when the sensor detects the intrusion until the system is reset. There are two ways of resetting system were developed for this project. Which is the system can be reset by reset button or by using smartphone. This prototype is powered by 3 V power adapter.

This project is designed to provide the security to the house and using fingerprint sensor as the key instead of iron key as it will become more convenient to user. The IOT concept is applied in this project because it can be useful to notify the owner of the house when the intrusion of the house happens.

2. System Development

2.1 Materials

The material of this project has been selected based on requirement for the prototype that has been designed. The Arduino Uno and ESP32-CAM is used for this project as the microcontroller. Arduino Uno is used for fingerprint pattern recognition system and will produce the signal when the fingerprint is recognized. ESP32-CAM is used in order to fulfil the concept of Internet of Things. The ESP32-CAM is used in this project to send or receive the signal from the smartphone via the internet connection. The ESP32-CAM will capture the photo when receive the signal from light resistance diode module (LDR) and send the image to the smartphone. The photo also will be capture by ESP32-CAM manually through smartphone by tapping the take photo button from the designed BLYNK application.

Then, the sensor unit of this prototype are fingerprint sensor, LDR module and laser module. The function of fingerprint sensor is detecting the fingerprint. The fingerprint sensor is connected to Arduino Uno for the fingerprint pattern recognition process. While, LDR module and laser module act as intrusion sensor. The laser beam of laser module will be pointed to LDR module. When the beam is interrupted, the LDR module will produce signal.

Other than that, the electrical component of this prototype is door-lock solenoid and relay module. the task of door-lock solenoid is to lock or unlock the door. The relay is function as the switch of the door-lock solenoid. The relay also used for other task in this project such as providing the relay, to reset system, and so on.

For the notification system, buzzer is used as an alarm system and will be activated when the intrusion sensor detects the intrusion. Smartphone is also the part of notification system in which the notification will popped up on smartphone when the laser beam of intrusion sensor is interrupted. The

door lock solenoid is powered up by four 9 volt batteries and the system is powered up by 5 volt power adapter. The table1 has shown the list and quantity of components needed for this project.

Components needed for this project and their function:

- Automation based kits
  - Arduino Uno and ESP32-CAM
  - Act as brain of the whole process of this project
- Sensor Unit
  - Fingerprint scanner, LDR module and laser module
  - Function as the pass key and detect the present of someone or something.
- Electrical component
  - Solenoid
  - Relay module
  - Lock or unlock the door
- notification
  - Smartphone and buzzer
- Power source
  - 9-volt batteries
  - And 5 V power adapter

Table 1: List of components needed in this project

No	Items	Quantity
1	Arduino Uno	1
2	Fingerprint Sensor	1
3	ESP32-CAM	1
4	Buzzer	1
5	LDR Sensor	2
6	Solenoid Door Lock	1
7	Jumper Wire	3set
8	Breadboard	2
9	Laser Module	2
10	Relay Module	6

2.2 Methods

2.2.1 Operation of Fingerprint Door-lock and Home Security System

There are 2 microcontrollers used in this project. Which is Arduino Uno and ESP32-CAM and each of them have different tasks. First of all, the system needs to be activated via smartphone. The system activation process is helped by the ESP32-CAM. A first relay module is connected ESP32-CAM to receive the signal from it. The function of the first relay module is to connect or disconnect the power supply of all other relay module. in other word, the first relay module able to start or reset the whole system. The Arduino Uno is working for fingerprint pattern recognition process. It is connected to fingerprint sensor in order to make it possible to complete fingerprint recognition process. When the fingerprint pattern is recognized by the Arduino Uno via fingerprint sensor, the Arduino Uno will produce the signal to send to a relay module. The relay module which function as the switch door lock solenoid will be activated when the signal received from Arduino Uno. As the result of it, the circuit for door lock solenoid and 9 V batteries will be closed and the door-lock solenoid will be unlocked.

Other than that, another relay module will be activated to open the circuit for buzzer to make it malfunction during that time as long as the door-lock solenoid is unlocked in order to let the owner pass through the door. Both of relay module will be remained activated until the reset button is pressed or the system is reset through smartphone. Figure 1 show the flowchart of task of Arduino Uno.
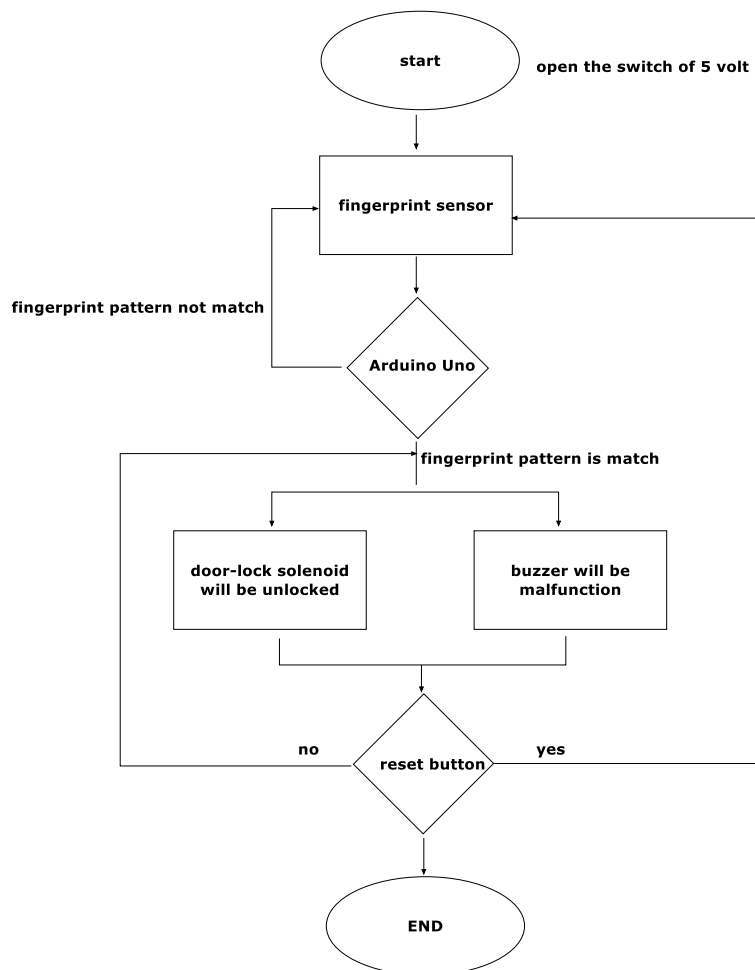

Figure 1: Flowchart of Arduino Uno

The ESP32-CAM module applied in this project in order to fulfil the requirement of Internet of Things. By applying this module, the user will be able stay interconnected with the system via smartphone through the internet connection. The main function of ESP32-CAM in this project is to capture photo and send the image to the smartphone through the internet. In this system, the ESP32-CAM will capture the photo when the laser beam of intrusion sensor is interrupted as the LDR module will produce the signal and send it directly to ESP32-CAM. Other than that, the user will be able to take photo from ESP32-CAM by tapping the 'take photo' button in the designed BLYNK application on the smartphone. The ESP32-CAM also applied in this prototype for provide the ability to reset the system through the smartphone. A relay module is connected to ESP32-CAM to receive the signal from smartphone through the ESP32-CAM to open the circuit of the system. Figure 2 shows the flowchart of ESP32-CAM and figure 3 shows the circuit connection for the prototype.
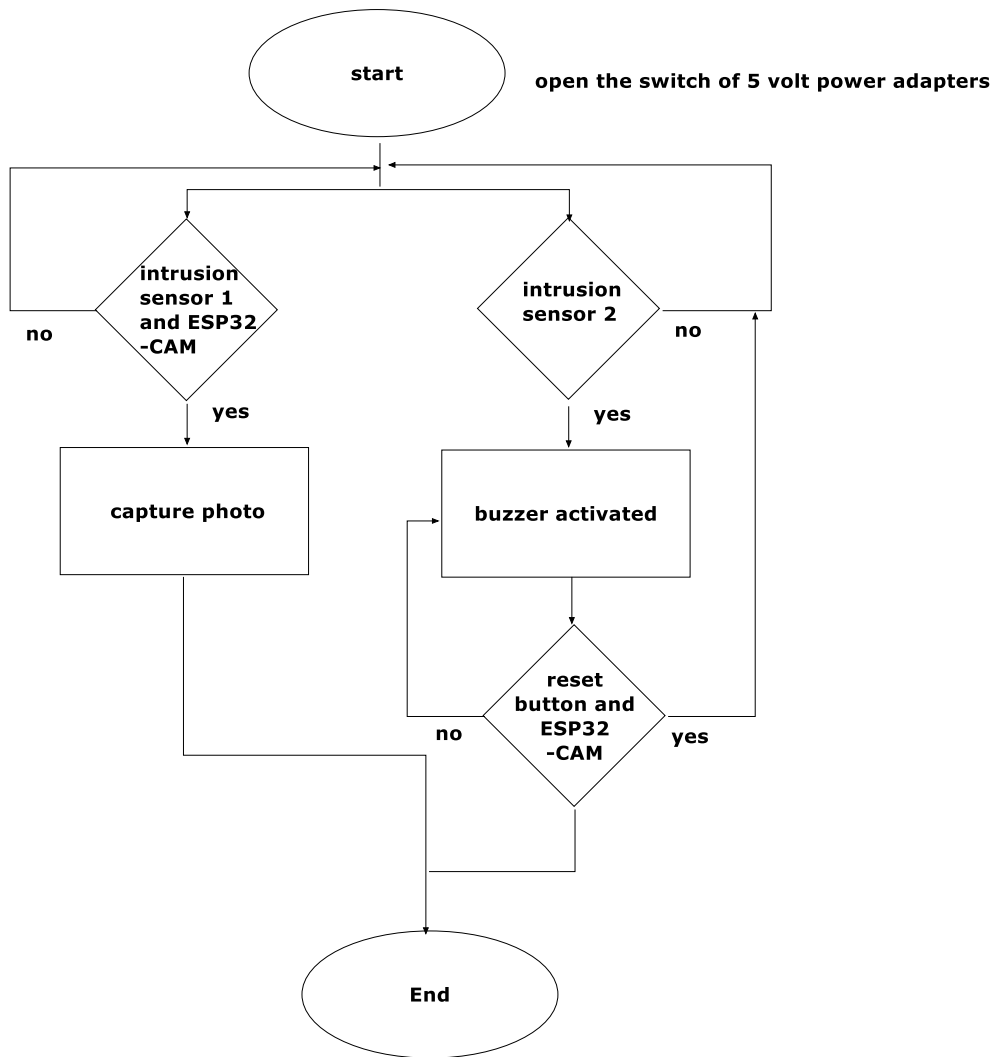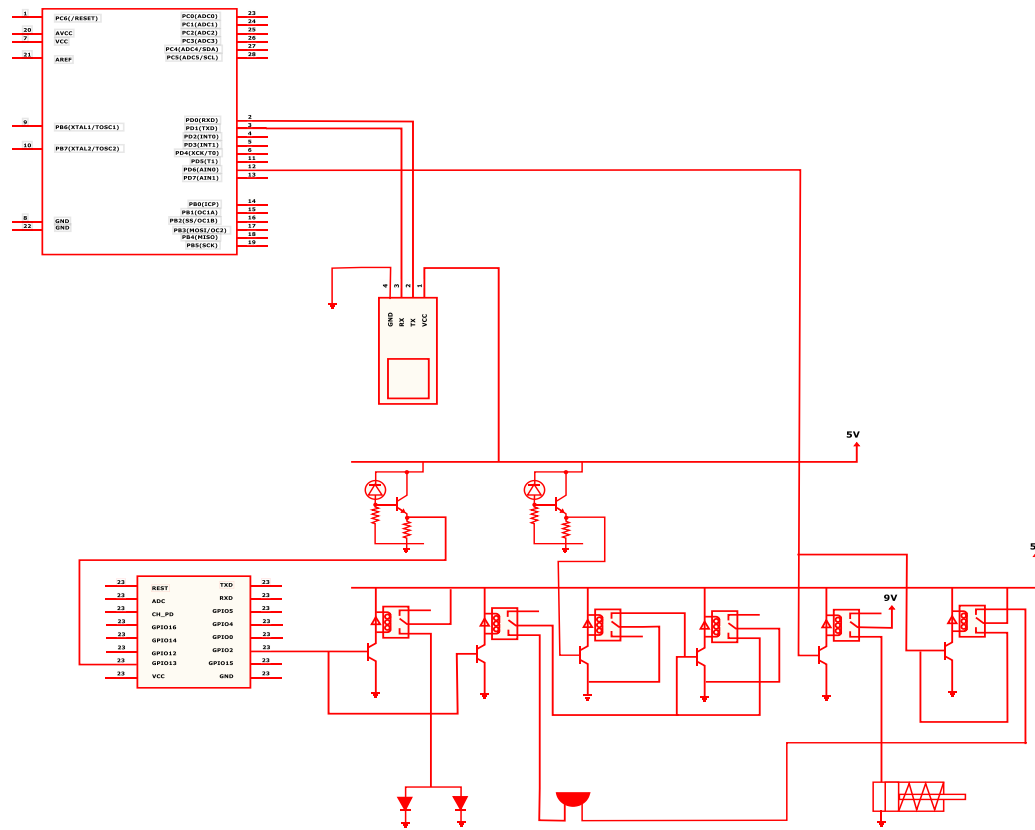
Figure 2: Flowchart of ESP32-CAM

Figure 3: Circuit connection

3. Results and Discussion

3.1 Results

Figure 4 shows the prototype Fingerprint Doorlock and Home Security System using Arduino and IOT project. The prototype of this project is working as it designed to be. The first intrusion sensor will send the signal ESP32- CAM when laser beam is interrupted to capture the photo and the image will be send to designed BLYNK application on the smartphone via internet. While the second intrusion sensor will send the signal to relay module to activate the buzzer. Figure 5 shows the ESP32-CAM module capture the photo when laser beam interrupted and the image send to BLYNK application. While, Figure6 shows the activated relay module for the buzzer.
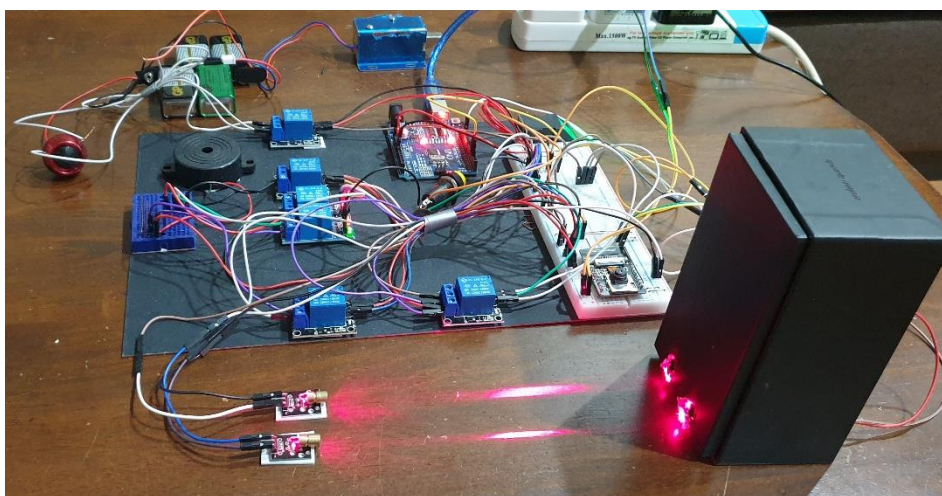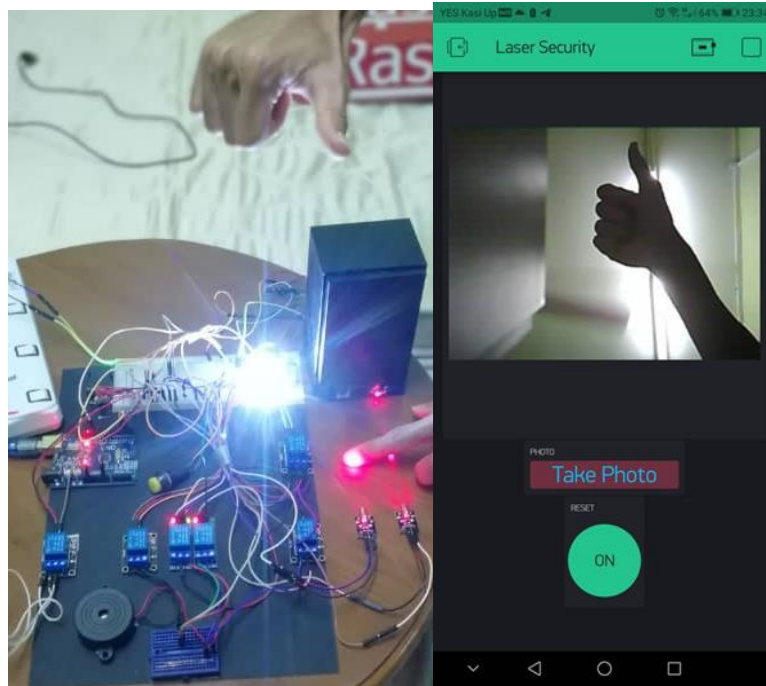

Figure 4: The product of this project
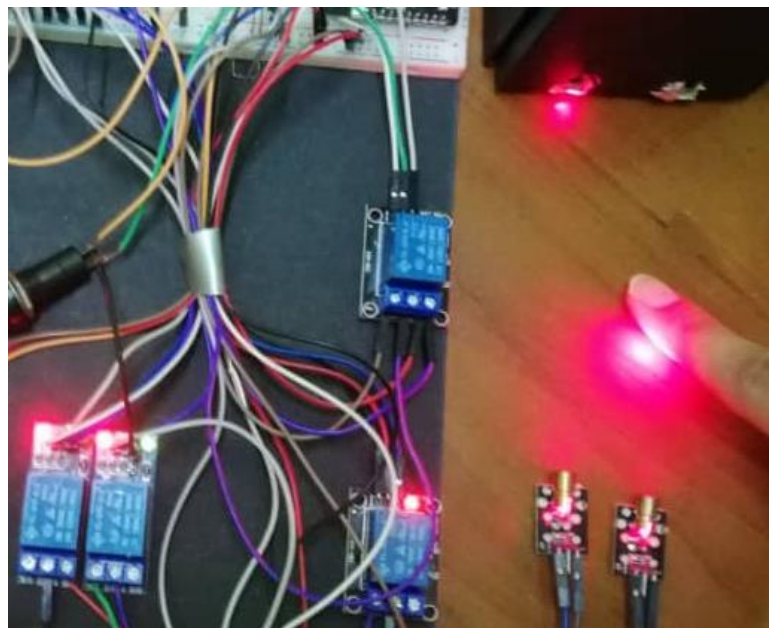
Figure 5: ESP32-CAM module capture the photo

Figure 6: activated relay module for the buzzer

The task of Arduino Uno is recognizing the fingerprint pattern captured by fingerprint sensor and send signal to 2 relay modules when the fingerprint pattern is recognized. One of the relay modules is to unlock the door lock solenoid and the other one is to open the circuit of the buzzer to make the buzzer malfunction while the door-lock solenoid is unlocked. Figure 7 shows the relay module for door-lock solenoid activated when the fingerprint pattern is matched. And Figure 8 shows the other relay module activated to open the buzzer circuit as the door-lock solenoid activated.
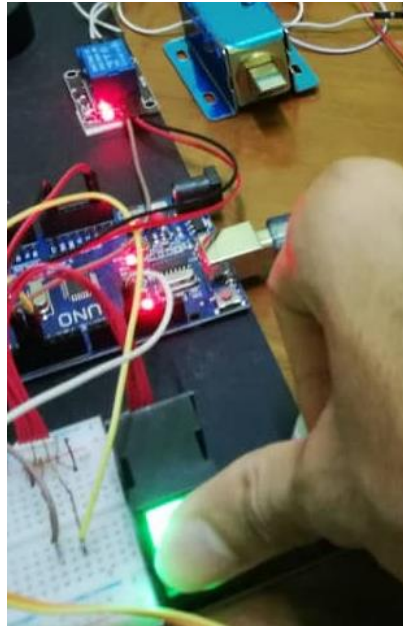
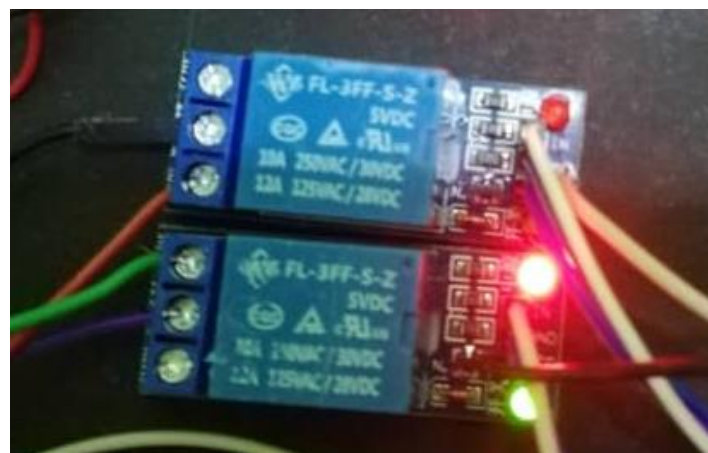**Figure 7: The activated relay module for door-lock solenoid**

Figure 8: Relay module for buzzer circuit

3.2 Discussions

This project is designed suitable for building like house. The light resistance diode module (LDR) and laser beam module has been chosen as intrusion sensor because it provide some advantage towards this project. As we all know, the laser beam can reach through long distance. From that case, this project can obtain the benefit from it as the laser beam can be reflected to many parts of the house that we want to secure by using the mirror to the LDR module. The buzzer will be activated when the laser beam is interrupted from any part of the house. Unlike motion sensor, it only require a pair of laser module and LDR module and mirror to secure all over the house while the amount of motion sensor required for the same task is more than what. As a result, cost for this project can be reduced by that case.

There are 2 way to reset the system of this prototype were developed to make it more convenient to the user. When the buzzer is activated, the system can be reset by pushing the reset button or tapping the reset button from smartphone. The benefit of it is the user will be able to reset the button from anywhere they go. The door-lock will open when the system receiving the matched fingerprint pattern detected by fingerprint sensor. Arduino Uno can store more than one fingerprint pattern. In other word, the fingerprint door-lock system can be set to be unlocked when receive any different fingerprint pattern that is stored in it.

Before the component assembling process is done, code has to be uploaded into Arduino Uno and ESP32-CAM. The code can be writen and uploaded from Arduino IDE software There is a couple of steps to store the fingerprint pattern into the Arduino which is fingerprint scanner has to be connected to the Arduino Uno during uploading process. Then, open the serial monitor after the code is uploaded into the Arduino Uno. After that, we have to follow the instruction appear on serial monitor after the code is uploaded which is to place the finger on fingerprint scanner.

4. Conclusion

The Fingerprint Door-lock and Home Security System by Using Arduino and ESP8266 project aim to improve the security of the house. The fingerprint sensor implemented in this project is to replace the iron key door lock which will make it more convenient. This system is equipped with ESP8266 in order to make the system be able to send a notification to the owner via the smartphone if there is an intruder. The microcontroller of the system is Arduino and it will be connected or installed with lock solenoid, fingerprint sensor, and buzzer. The Arduino will justify if the fingerprint detected by the fingerprint sensor is matched with the owner. The solenoid will open if the fingerprint is matched and will remain if the fingerprint doesn't match. The buzzer will buzz if the not matched fingerprint detected 5 times in a row. The owner is able to reset the system via smartphone and be notified if the door is opened. Other than that, laser cam security is the system that will capture a photo of the intruder. This system is run by ESP32 cam. The camera will capture the photo when the laser sensor cannot detect the laser light which is when someone or something blocked it.

Acknowledgement

References

[1]   S. Budijono, J. Andrianto and M. Axis Novradin Noor, "Design an implementation of modular home security system with short messaging system," EPJ Web Conference, 2014, vol68.

[2]   S. Wadhwani, U. Singh, P. Singh and S. Dwivedi, "Smart Home Automation and Security System using Arduino and IOT," 2018, pp. 1357-1359

[3]   Y. Yahya, "AUTOMATIC SAFE DEPOSIT BOX SECURITY SYSTEM USING," 2017, vol. 9, pp. 806-819.

[4]   S. Prasad, P. Mahalakshmi, A.J.C. Sunder, and R. Swathi, "Smart Surveillance Monitoring System Using Raspberry PI and PIR Sensor," 2019.

[5]   A. Nowicky, "BURGLAR ALARM SYSTEM", United States Patent (19), 26 JUN 1979.

[6]   I. Pyle, "HOME SECURITY SYSTEM", United States Patent(19), 1,MAY,1984

[7]   K. Liu, "WIRELESS HOME FIRE AND SECURITY ALARM SYSTEM", Vol. 1, 23 September 2003.

[8]   R. Data, Z. Semi, A. Computers et al, "USER-PROGRAMMABLE VOICE NOTIFICATION DEVICE FOR SECURITY ALARM SYSTEMS" issue 19, 14 September 1993