

Automatic Door Lock Based on Knock Pattern and Face Detection

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Abstract. One of the crimes that often occurs is the case of theft in the house, actions like this are usually done by breaking into the door of the house or through the window, Cases like this often occur when the home owner is not at home. With this high number of cases, the need for a home security system is absolute or very important to pay attention to. This research is specifically directed to the use of the case study method. Therefore, an innovative automatic door lock system is needed and secures the house from criminal acts. that often happens, one of them is by using a tap pattern system and a face detection system. With a concept like this, breaking into a door is not easy to do, because a system like this requires facial recognition and knocking patterns. For future researchers, hopefully, what has been done by previous researchers can be developed.

Keywords: Piezoelectric Sensor, ESP32-Cam, Solenoid Door Lock.

1 Introduction

Most of the day's activities are completed outside of the house. This circumstance arises in all big cities. As a result, it is determined that many vacant homes' tenants must depart during business hours; this is especially true during the holidays, such as Eid, Christmas, and New Year's. Thieves find vacant property to be an easy target, especially if there is little security [1]. Stealing from a house is one of the most common crimes that happen. These crimes are typically committed by forcing entry through the front door, back door, or windows while the owner is away. Given how frequently these incidents occur, having a home security system is absolutely necessary. Or very important to be considered attention [2]. One way to ensure door security is to build a door security system by replacing conventional door locks (mechanical locks) with technology-based electronic locks [3]. The technology available at this time is still in the form of automatic locks on doors using radio cards. automatic locks on doors using Radio Frequency Identification (RFID) cards, passwords and etc. [4]. As mentioned earlier, until currently the world of security or the world around security, has not been able to conclude which smart door locks which is the perfect and most efficient, because among every invention that have existed to date are still considered to have shortcomings of each other [5]. Therefore, an innovative automatic door lock system is needed and secures the house from criminal acts. securing the house from acts of criminality

that often occur, in this research, researchers tried to develop a tool [6], one of which was by using a hand knock system and a face detection system. With this concept like this then breaking into the door is not easy to do, because systems like this face recognition and hand knocking are needed ease of use

2 Related Work

We have heard far too many stories in the media these days about theft, break-ins, and other illegal acts that result in losses and damage to private and public property in our neighborhood and beyond. Even with security precautions in place to stop them from happening, these kinds of incidents nevertheless happen occasionally. The frightening need to increase the capability of the current security and surveillance systems to ensure maximum security is the result [7]. Currently, there are many methods that are used to perform an automatic security key work automatically, including by means of PIN (Personal Identification Number), digital image processing, RFID (Radio Frequency Identification), and barcodes. The use of digital image processing is part of computer vision to analyze an image to produce information. analyze an image to produce information that can be used by humans [8]. The first research uses face detection as the main system automatic locking system. In this study, researchers made a backup of the security system using a keypad password. security system using a keypad password. So that users can use 2 options to open the door, namely with face detection and keypad. keypad. This research is quite good but using a keypad can still be breached. break its security because it is easy to remember a password if other people know it and can be widely disseminated [2]. In the second study using hand taps as an automatic door lock system and solenoid door lock as an actuator. The main component of this automatic locking device uses piezoelectric and also uses an Arduino Uno atmega 328P microcontroller. This automatic door lock is used to replace the conventional door lock. This tool works optimally with 20 knocks if the knock is more than that then the system does not read the knock. and also, researchers said the recording sound from the cellphone because it was not enough vibration to be read by the system from piezoelectric. The system can also read loud or slow taps [6]. In addition to using face detection, keypads, and also knock sensors. Many studies also use finger print sensors and RFID cards, such as those conducted by research. In the study, the researcher discussed the work system of the finger print sensor, the information system of the information system of this research he uses IPS LCD 16x2, LCD displays the menu finger print registration to input fingerprints to be stored in the program [9]. In other previous studies, namely automatic door locks using QR code, in this study the authors made a tool for automatic door locks in the office so as not to easily lose office data. the author's design uses raspberry pi and data base on MySQL and to access it requires an application on a smartphone [10]. Based on previous research, the author will make an automatic door lock based on hand tapping and face detection. Of course, this research is expected to be better than previous studies and more secure in a security system.

3 Purposed Systems

3.1 Modeling and functionally of the suggested systems.

Improving the door locking system's security is the primary goal of this article. The suggested system's hardware and software specifications are displayed in [11]. This section will discuss the block diagram with the working principle of each block diagram. The block diagram consists of an activator block design (voltage source), input block design (input), process block design, and output block design (output) [12].

Table 1. Hardware and software requirement.

Category	Component	Function
Hardware	ESP 32 Cam	As a suitable face detector
	Arduino Atmega 2560 Pro	As a data processor
	Relay	As a voltage retainer so that the solenoid works according to the direction or program
	Solenoid 12 V	As a conditioned door lock
	Buzzer	As an indicator of a tool
	LED	As an indicator of a tool
	Step Down Regulator	As a voltage reducer or safety
	Battery 12V	As the main source
	Module Charge (TP4056)	As a charger for the battery
	Piezo Sensor	As a vibration detector
Software	Button	As a new knock pattern maker
	Arduino IDE	To write and send programs to hardware
	Web Server	To store face data on ESP 32 CAM

Table 1. The tool will work through a system that has been integrated between ESP 32 CAM and Arduino Atmega 2560 Pro as a microcontroller. previously the system stored face data in the esp32 cam internal database and Arduino Atmega 2560 Pro stores the desired data through piezo sensors. the use of these two systems to provide security that is stronger than conventional locks.

3.2 Implementation of the proposed system

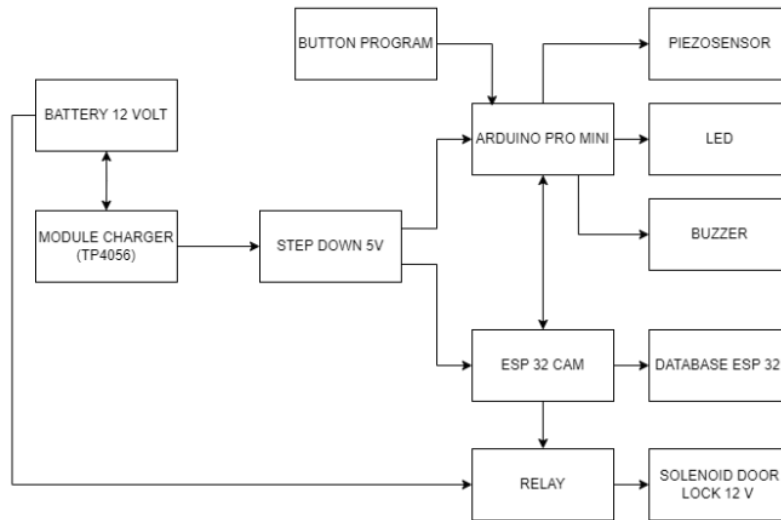


Fig. 1. Block diagram of the proposed system.

Fig. 1 Show the block diagram of the automatic door security system using knock pattern and face detector, as we can see in figure 1, the block diagram of the system is integrated with each other. by thinking of ways to be easy to use by the user, the researcher prepares the concept carefully, such as the presence of a 12-volt battery as a backup power when the main source cannot be used. the selection of component selection is also considered in order to minimize the cost of use.

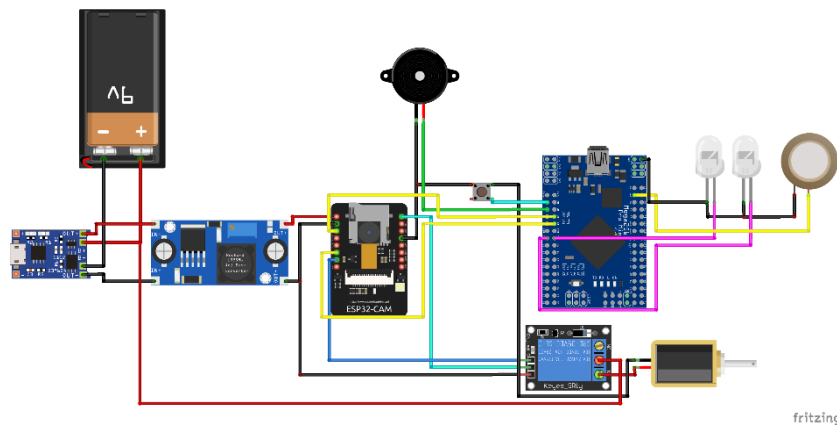


Fig. 2. Hardware circuit connection of the proposed system.

Fig. 2 Shows the hardware circuit of this study. The circuit starts from the main power source, namely a 12 volt battery which is connected to a charger module so that it can be recharged. Then from a battery will flow to a stepdown and also to a relay. Why a

stepdown is needed ? because a microcontroller can only receive a maximum voltage of 5 volts. After that we also have two microcontrollers, namely ESP32 CAM and also Arduino Atmega 2560 Pro which later ESP 32 CAM as a face detector and also Arduino Atmega 2560 Pro as a microcontroller of a piezo sensor or knock pattern sensor, and do not forget there are also several indicators such as buzzer and also LED as a detector if the input given by the user is correct or wrong. Push button is used to reset or give input again to a microcontroller without having to reprogram the code. This tool works if the two systems used have been given the correct input, if the input given is wrong then the door lock or solenoid door lock will not work because the relay does not receive input from ESP 32 CAM and Arduino Atmega 2560 Pro which integrate with each other in order to become 1 system with strong security.

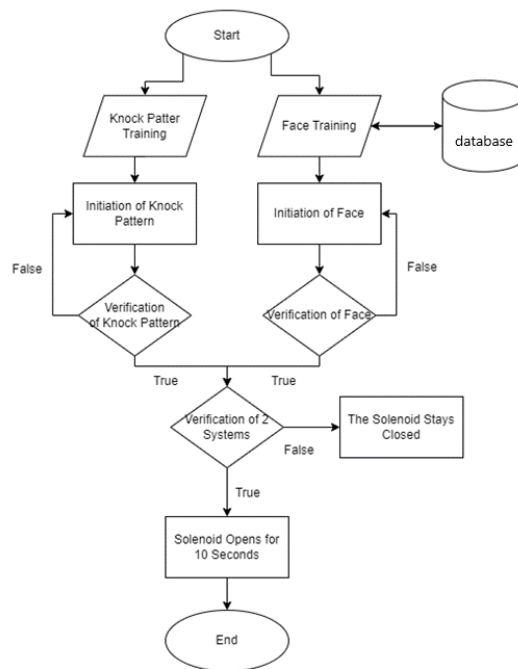


Fig. 3. FlowChart Of The Proposed System.

Fig. 3 Shows a flowchart, which is a step-by-step approach followed in writing an automatic door security program, which allows the execution of a command desired by the author.

Broadly speaking, the program design consists of four stages of design, namely designing flowchart, the use of Arduino IDE software, and the design of tools and materials in the circuit. Each step in the design of the system requires foresight, accuracy and accuracy because the initial design will determine the end of a design in the process of making tools. The initial design will determine the end of a design in the process of making tools. If the design stage we do well and meet the specified standards, then the designed tool will operate as expected [15].

4 Result

In this section contains the results of a tool with an automatic door lock system using face detection and knock patterns, testing is carried out by testing the face detection system and knock pattern system. Things that will be tested are the accuracy of face detection and the accuracy of knock patterns.

4.1 Tool design result.

The design of the tool consists of several components that are assembled on one hollow PCB board, this tool uses 2 microcontrollers, namely Arduino Atmega 2560 Pro and ESP 32 Cam. The voltage source needed in this tool is 5 volts for the microcontroller and 12 volts for the solenoid door lock as well as for other components such as LEDs, Piezoelectric Sensors, Buzzers, Relays, buttons using a 5 Volt input.

For the results of the way the system works the same as in the initial design where we use 2 security systems to open a solenoid door lock. Here is a picture of the finished tool:

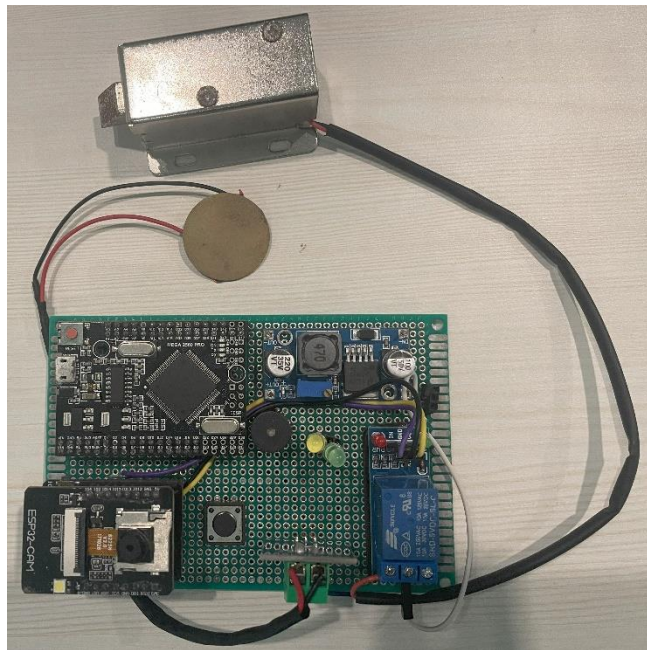


Fig. 4. Tool Result

In figure 4 we can see a tool consisting of several components that have been integrated. This automatic door lock system will work if 2 systems have been verified, namely face detection and also knock patterns that have been registered before. If the verified knock pattern is correct then LED 1 will light up and if the face detection is correct then LED

2 will light up, if both are lit simultaneously then the solenoid will open for 5 seconds according to the previous design.

4.2 Testing Face detection systems on the web

The first testing process is the testing of the system Face detection whether it can run well or not. Testing done by connecting the tool with A laptop or computer that can already upload programs into the ESP 32 – CAM controller. Because later there will be the web that can make our faces look at what Our face is registered on the system or not and can also Register our face on the system on the web. Before starting the tool testing, initialization is carried out face agar as a database of faces stored on the system.[2] The following are the steps to open the view face detection system:

1. Open the Arduino IDE App.
2. Connect ESP 32 Cam to a laptop/PC.
3. Make sure the program created has been successfully uploaded to ESP 32 Cam and make sure the connection to the Program and the connection using the PC / Laptop are the same.
4. Open the serial monitor menu in the Arduino IDE application.
5. Press the reset button on the ESP 32 Cam to display the IP Address on the serial monitor.
6. If the IP Address has appeared, then copy the IP address and paste it on the Web page.
7. After that, the web will bring up a page like the following.

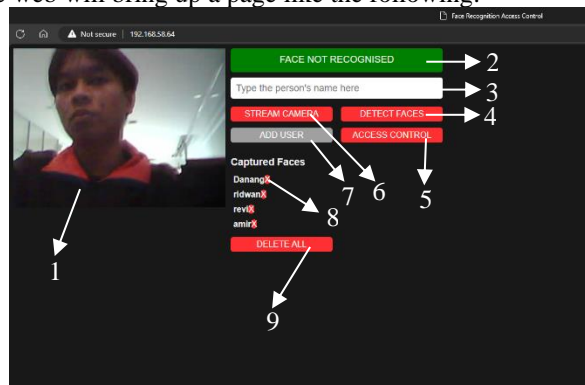


Fig. 5. Simulation Web View

On the web page, it can be seen that there are several things that we can see and know as in Fig 5. The following is the function of each of the elements:

1. Face display : This feature is used as the most important part that displays the face of the ESP 32 Cam.
2. Indicator Column : In this section is used as an indicator of the success or not of detecting a face.
3. Name Input : This feature is used to enter or register the name of the person who will be registered with the system.

4. Detect Faces Column : This part is used as test material for face detection
5. Access Control Column: In this section is used as the final control so that the system is integrated into the microcontroller or so that the system can wait for other signals so that the tool works.
6. Stream Camera Column : This section is only used as a live video stream
7. Add User Column : This part of the add user column can be used if column 3 has been filled in by the function name at the same time as the name and face input.
8. Registered Name : This registered name is a database that has been registered and can be deleted by pressing the X button next to the name.
9. Delete Column : This feature is used to delete the entire database that has been registered.

So this web page can be used if the device or ESP 32 cam is turned on and the correct program has been uploaded and must be integrated with the same wifi between the ESP 32 Cam and the Laptop / PC used because each type of IP address signal will be different.

4.3 Face Detection Accuracy Testing

Starting with analyzing system requirements and then collecting data by searching for and studying data and theories related to door security systems. and studying data and theories related to door security systems using Face Recognition and ESP32Cam using current technology. which will eventually be used as supporting material in the design and implementation of technology, which will ultimately be used as supporting material in the design and manufacture of prototype

making a prototype tool for a face recognition-based home door security system [10].

This accuracy test was performed using 6 different facial objects that were pre-registered in the ESP 32 Cam internal storage system and 1 face was not registered as a trial.

This accuracy testing is by weighing the room light and the distance between the camera and the face, the tool used to measure light intensity is with the Lux Light meter application on a smartphone and the tool used to measure the distance is a 60-centimeter ruler. This test weighs the light of the room and distance due to the level of light and distance of what the tool works optimally so that when used daily the tool there are no problems outside the system.

Here is a table of accuracy test results from a face detection system using ESP 32 Cam:

Table 2. Face detection testing.

Registered Face	Ambient Light	Distance30 CM	Distance 60 CM
Danang	125lx	Undetectable	Undetectable
	180lx	Detected	Detected
Ridwan	130lx	Detected	Undetectable
	183lx	Detected	Detected
Revi	136lx	Detected	Undetectable
	183lx	Detected	Detected

Amir	136lx	Detected	Undetectable
	187lx	Detected	Detected
Rejak	106lx	Undetectable	Undetectable
	140lx	Detected	Detected
Fergian	150lx	Detected	Detected
	200lx	Detected	Detected
Galang (NoRegistered)	-	Undetectable	Undetectable

From the test results in Table 2, the author concludes that the face detection results on this system can be said to be quite successful. With testing on 6 registered faces, the results produced are quite accurate, but there are some things that happen that when the light occurs below the value of 140lx, the system will have difficulty reading the face at a distance of 60cm, but at a distance of 30 cm the face is still perfectly detected and if the light is below the value of 130lx then the esp 32 cam cannot detect faces at a distance of 30 cm or 60 cm, And also in this trial using an unregistered face and ESP 32 did not detect anything.

Here is some documentation of face detection test results using ESP 32 Cam on the Web Server and Light Value in the room:

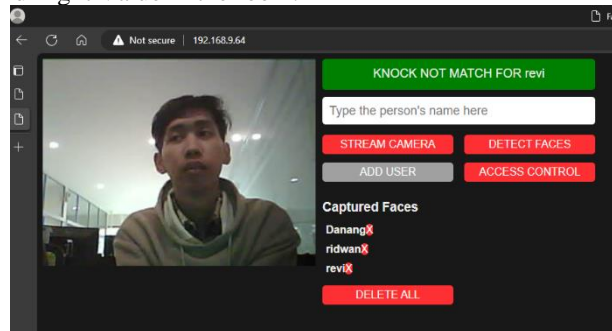


Fig. 6. Revi face object on web server.

Fig. 6. The documentation above is face detection on a web server that has enough lighting and distance to detect the face.

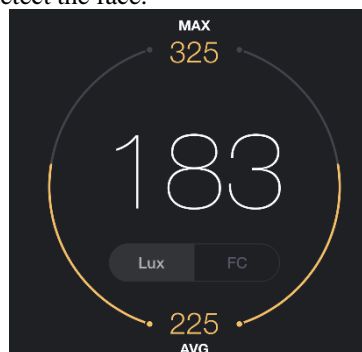


Fig. 7. Revi room light value in lux light meter application.

Fig. 7. The picture above is the room lighting value measured using the lux light meter application which was tested simultaneously with Figure 6.

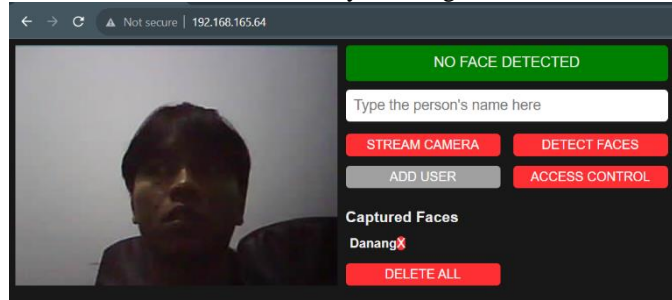


Fig. 8. Danang face object on web server.

Fig. 8. The documentation above is face detection on a web server that has insufficient lighting and sufficient distance to detect the face.



Fig. 9. Danang room light value in lux light meter application.

Fig. 9. The picture above is the room lighting value measured using the lux light meter application which was tested simultaneously with Figure 8.

From the image of the test results in fig 4,5,6,7, we can see the differences that occur according to table 2 that the author has made. Fig 4 registered face (Revi) with a distance of 60 cm and Fig 5 value of room light when the Revi face is accessed on the system, visible on the web server in the green column written (KNOCK NOT MATCH FOR Revi) which means the face is detected but waiting to be entered the tap pattern. There is also a comparison between Fig 4 and Fig 6. In Fig 6 the registered face (Danang) with a room light value of 125lx corresponds to Fig 7, it can be seen in the green column written (NO FACE DETECTED) which means the system cannot detect Danang's face in dark light even at a distance of 30cm.

4.4 Knock Pattern Accuracy Test

The accuracy of the knock pattern using piezoelectric is done using a stopwatch which is useful as a measure of the time between knocks and the piezoelectric sensor[8]. If the interval value meets the wishes of the program, the program will turn on the LED for 10 seconds and open the solenoid, but if the interval value does not meet the wishes of the program, the LED will only blink and the solenoid will not open. The following authors provide a table of the interval test results of the piezo sensor :

Table 3. Interval value data of knock pattern using piezoelectric sensor.

Interval	0 - 1 *ms	1 - 2 *ms	2 - 3 *ms	3 - 4 *ms	Results
Initial Value	710	760	780	780	Registered
Interval Value 1	580	660	760	750	Accepted
Interval Value 2	730	570	760	760	Rejected
Interval Value 3	860	830	810	910	Accepted
Interval Value 4	640	600	680	760	Rejected
Interval Value 5	700	650	800	850	Accepted
Interval Value 6	630	590	830	800	Rejected

We can see in Table 3 there is some data that has been made by the author, the following is an explanation of the data in the table :

1. Initial value = Initial knock input used as a reference for automatic door locks using knock patterns.
2. Interval value test 1, 3 and 5 = In the interval test this section has the same results, namely the microcontroller detects the same knock pattern between the initial interval value and the interval value of 1, 3, 5 with the highest interval value comparison, namely in the 3rd interval value test in the interval (0-1) which is 150 ms.
3. Interval values 2,4 and 6 = Test intervals in this section have the same results, namely the microcontroller does not read or reject the given knock pattern with the following comparison The rejected value is closest to the initial value of 160 ms at the 4th interval value, namely the beat pattern to (1-2) and the farthest comparison value is at the 2nd interval value of the beat pattern to (1-2) which is 190 ms.

So the conclusion of the piezosensor data is the maximum and minimum value of the interval is 150 ms if it exceeds 150 ms then the tone of the knock pattern is different and the microcontroller will respond that the beat pattern is not correct

5 Conclusion

This automatic lock system based on knock patterns and face detection has run properly according to the author's wishes, this lock system opens when both systems are fulfilled if only one of them then the automatic lock will not open. This tool is very strong in terms of security because to access both systems, one of them requires a database that

has been registered before use. So, it cannot be arbitrary people to unlock the door compared to conventional keys as usual. but to use the tools made by the author there are still many that must be improved from all sides to make it easier for users to use it.

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