Smart Door Lock Using Face Recognition Access Based on Internet Of Things (IoT)

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Abstract

Security is one of the basic things that humans need. In relation to a house or room, the focus of security is on the door lock. Various types of door locks have been created, ranging from conventional ones with physical keys, to modern types. This modern type of door lock is also made with various ways to open it. Some use a series of codes (keypad), some use card sensors, fingerprint sensors, to the use of face recognition technology. Several door lock technologies with face recognition have also been created, but they are still expensive. The other problem is that those devices are not equipped with some fail-safe mechanisms, in case there are troubles with the device. This smart door lock is made using face recognition technology based on the Internet of Things. This lock is equipped with an ESP32cam camera integrated in the ESP8266MOD module that can recognize faces that have been registered in the database on the website. In addition, the door is also equipped with a push button to open the door from the inside, and a button as a backup if there is a malfunction of the face recognition feature. The device test indicates no apparent issues and operates smoothly. The accuracy test for the camera yields positive outcomes, reaching up to 100% in normal lighting conditions, and dropping to around 60-80% in blur condition. Accuracy is further compromised, potentially dropping in dim light that the images are only reached 40-60% for clear images and 20% in blurry images.

Keywords: Smart Door Lock, ESP32cam, ESP8266MOD, Push Button, Keypad

I. INTRODUCTION

Information technology that supports the industrial revolution 4.0, is fast, efficient and reliable. Based on the observations of experts, the rapid progress of information technology at this time is very fast and almost complete in all circles and all fields. The use of information systems to support organizational performance is increasingly necessary because information is an important resource in modern management. Driven by the sophistication of information technology now, this helps the development of increasingly sophisticated information systems such as websites or mobile [1].

In the current era, almost all fields have used information technology, for instance, in the field of public services. Public security and order is the reason in the National Police Chief Regulation No. 23 of 2010 [2], which states that Kamtibmas is a condition for one of the prerequisites in a dynamic society for the implementation of the national development process. Security and order is very important in the continuity of social activities, because if it is not controlled it will result in conditions that are not conducive to the community itself and even the outside community. Lonely places, and lack of security can be a source of criminal acts or actions that are contrary to the ethics and norms of society, such as: theft, robbery, robbery, even persecution. In this case, it will encourage the development of security aspects in society in order to prevent noise or acts of bad behavior in the surrounding environment [3].

The importance of security has become a common concern for everyone, given many cases of rampant theft. The National Police cracked down on 58,208 people who were reported for theft with aggravation. The motives varied from stealing in

empty houses to pick-pocketing. The reported perpetrators were sentenced to 12 years in prison. The data was obtained from the e-MP Robinopsnal Bareskrim Polri [4] for the period January 2019 to February 14, 2023. The number of reported law-breakers tends to increase from year to year. In 2019, a total of 7,316 people were reported in connection with theft crimes. This number increased until 2021. However, in 2022, the number reported decreased to 15,441 people. Meanwhile, from January to February 14, 2023, the number was 1,698 people. This condition then will create an insecure feeling both in personal and society level, and finally will lead to several changes in society [5].

With so many crimes, we should have a security system that can suppress worry and anxiety, to be able to freely leave the house with peace of mind. Human-based security systems such as housing security and siskamling may help, but we need a tool that is very reliable in doing its job [6].

Conventional security that we often encounter to lock the house includes locking the door leaf and if the user wants to add some extras to increase security the user can use a padlock with an additional key [7]. This leads to a lack of efficiency in locking the door, we can carry the house key but when we lose the additional lock key then we will struggle in opening the door. Moreover, the longer the key is use the less accurate the function, if we buy a cheap door lock, the material used is usually a mixture that is less qualified for long-term use, often examples of problems that arise are broken keys when trying to open the door. This means that to overcome this we need to also carry a spare key even though we also carry the main key, because if we put the spare key in the house then we need to enter the house in a locked state, then the solution is actually not very effective to solve possible problems that arise in the future [8].

There have been many developments in locking systems both mechanically and those that have been integrated with more modern technology. Call it keyless technology where the locking system no longer uses a physical key but is integrated with a system. Keyless systems have many types such as finger print-based locking systems [9], [10], key passwords [11], and special cards [12]. All of these strive for guaranteed security as well as flexibility. However, it should be realized that technology-integrated locking has a price that is not cheap, this becomes market segmented with differences in economic value, so people still stick with conventional locking systems.

Face recognition doorlock was also made and researched, such as by [13], [14], and [15], but those researches do not provide a safe plan if in their implementations, those systems experience failures. Some failures that might occur, such as failed circuit, drained battery, or jam in its locking mechanism.

As a modern locking solution, the team designed a door locking system that will combine Internet of Things (IoT) and Artificial Intelligent (AI) technology. The operation concept of this design is to use ESP32cam for an AI-based facial recognition system that can be reached on a web application (websoftware) as an integrated security access rights regulator. This system is also equipped with an ESP8266MOD, based on IoT that can be connected wirelessly as a concept of data communication between devices. This idea is expected to make keyless door lock technology more optimal and more economical than other locking methods, so that door security can be increased and flexible but with more economical devices. Based on the above analysis, the team made a Smart Door Lock device using IoT-based Face Recognition Access.

II. RESEARCH METHOD

The research method used is R&D (Research and Development) with a prototyping development model. The stages and activities carried out are the needs analysis stage, design and design of the Smart Door Lock system, making system prototypes, testing until the validation stage. This research uses the Research and Development type of research because it is considered in accordance with the objectives of the study, namely to produce and know the results of testing on the development of IoT-based Smart Door Lock using the ESP8266MOD microcontroller (Figure 1).

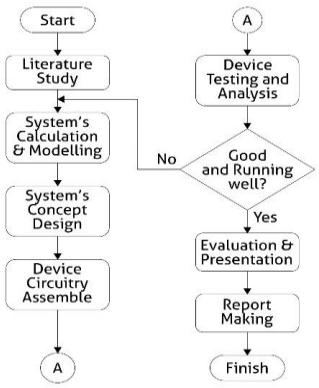

Figure 1. Research's Flow Diagram

This activity begins with searching for literature from books, journals, and articles in print and online media. Looking for the theory of smart door lock application using ESP8266MOD to open the door automatically. As well as conducting literature studies on the calculation of electrical loads that will be used, especially DC electrical power management systems. Furthermore, calculations and system modeling are carried out to obtain a Smart door lock prototype. The first calculation aims to determine how much electrical power consumption. The second calculation is done to find out how much DC voltage is needed.

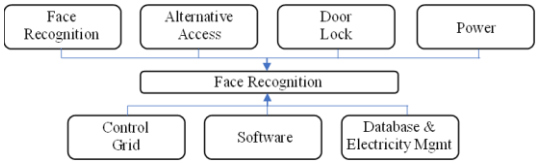

Figure 2. Smart Door Lock Scheme

In designing a smart door lock using IoT-based face recognition, it consists of various system reviews as shown in the Figure 2 above which includes: 1) Face recognition is a system design from a camera device that main feature is to scan

faces to match database faces and regulate access (Figure 3 and 4), 2) The fail-safe button is an alternative security design to open the door without using the IoT. For example, if some electrical problems happened, or when the person is not familiar to the system.

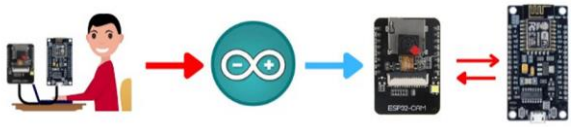

Figure 3. Illustration of the ESP Device Programming Process

Figure 4. Illustration of Face Registration Process in Face Recognition Database

Furthermore, 3) Door lock is a door lock system that uses a solenoid device. This system is equipped with an electromagnet as a Solenoid lock driver, 4) Smart Door Lock is a door lock design using IoT access, 5) Electricity management is a design to regulate electricity flow so that it can meet the electricity needs of the load, 6) Software is an SDL system design, and 7) Control is the design of software integration and Solenoid lock.

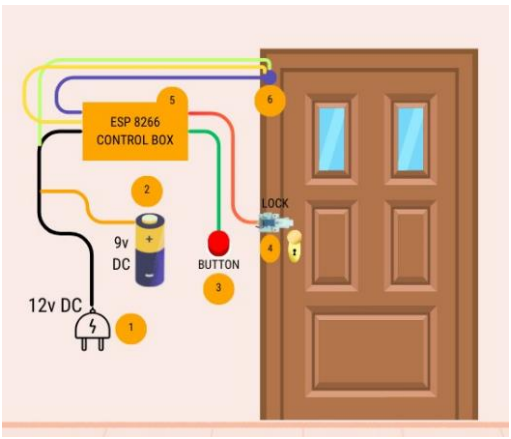

Figure 5. Inside Installation Sketch of the Device

Figure 6. Outside Installation Sketch of the Device

The process of designing the tool circuit is carried out after the calculation and modeling of the system and 50% of the tool design has been completed. An overview of the technology to be developed is below. The design of the tool circuit is divided into 3 main parts, namely: ESP programming, power-signal distribution system, and mockup design (miniature simple door) as shown in Figure 5 and 6.

The testing phase is carried out to measure the success of the smart door lock as a modern door lock, which is minimalist, economical, portable, reliable, and efficient. Testing was carried out including to find out: 1) The level of success, and ease of access controlled by the Smart Door Lock electronic system, to open the door lock (solenoid lock, and ESP control system), and 2) Testing backup access as a backup-plan if a problem occurs when the door is locked, where the smart door lock must continue to function in various conditions, for the sake of room security.

Report writing is carried out after all stages are completed so that the results obtained from the design of the tool can be explained in detail and specifically in accordance with the data obtained. The results of the report will be submitted to clients and examiners for consideration.

III. RESULTS AND DISCUSSIONS

The tool development process is divided into 2 parts, namely the part of face recognition software (Figure 7) and the part of making and installing the tool on the door (Figure 8). In making face recognition software, the interface design is made in accordance with the existing design, so that the resulting display becomes as below:

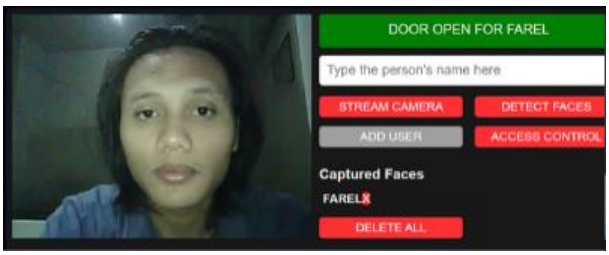

Figure 7. Face Recording Display in the Face Recognition Application

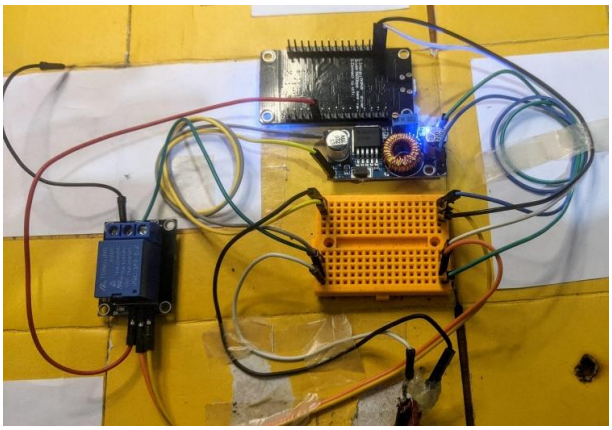

Figure 8. Circuit Sketch Result

Tests were conducted in several conditions, including lighting (sufficient and low light), front face side, and clipped objects. Tests were conducted on 3 objects with 5 tests each with different but similar objects as shown in Table 1-3 below.

Table 1. Testing Results Data of Personnel A

No	CONDITION		Object Personnel A		
			T	F	Acc
1	In a well-lit room				
	a	Front side	5	0	100%
	b	Blur object	3	2	60%
2	In a low-lit room				
	a	Front side	2	3	40%
	b	Blur object	1	4	20%

Capt.: T = True, F = False, Acc. = Accuracy

Table 2. Testing Results Data of Personnel B

No	CONDITION		Object Personnel B		
			T	F	Acc
1	In a well-lit room				
	a	Front side	5	0	100%
	b	Blur object	4	1	80%
2	In a low-lit room				
	a	Front side	3	2	60%
	b	Blur object	1	4	20%

Capt.: T = True, F = False, Acc. = Accuracy

Table 3. Testing Results Data of Personnel C

No	CONDITION		Object Personnel C		
			T	F	Acc
1	In a well-lit room				
	a	Front side	5	0	100%
	b	Blur object	3	2	60%
2	In a low-lit room				
	a	Front side	2	3	40%
	b	Blur object	1	4	20%

Capt.: T = True, F = False, Acc. = Accuracy

The test results of the device on several people whose faces have been recorded show that the system and its app have shown their jobs with a 100% success rate in normal room light conditions but decreased in the results of recording unfocused faces by 40% (60% success rate). While in low light conditions, the results obtained will further decrease, even on the front face object only up to 40% success and 20% on the unfocused object.

IV. CONCLUSIONS

An automatic door locking device has been made at a relatively low cost even though it has technology that is in accordance with current technological developments. Both the device and the facial recognition application function can function properly as long as the light conditions are good enough with a success rate of 100% in 3 different people with 5 trials. The keypad function as a backup door opener also works well, indicated by 100% success on 10 trials. Disadvantages exist in the quality of the camera which will decrease its performance when light conditions decrease, and the condition of the camera is not focused (blur). Making a smart door lock with better camera quality will increase the performance of this tool, so it will be able to make it more perfect.

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