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Comparison of Battery Electric Power Consumption in a Fingerprint System or a Motor Manual Lock System

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***Abstract* – Motorcycle security systems using fingerprint sensors are needed to avoid theft because of their high level of security compared to manual systems. This study underscores the importance of using this fingerprint sensor for motorcycle security. The formulation of the problem in this study is how much electricity is required in the motorcycle battery for this fingerprint security system. This system uses various components, such as the R503 fingerprint sensor, Arduino Uno, buzzer, 4-channel relay, ignition key, and motorcycle starter. Testing of this system is performed by inserting a finger in a wet, oily, dusty, or normal condition, and the result is that this sensor is capable of detecting the entire condition of the finger. Attempts to start a motorcycle with all ten fingers showed that the left index finger started faster under normal conditions, in 1.55 seconds compared to the manual method, which took 2.05 seconds longer. It also measures power consumption and calculates how long the battery can power this device. The result is that the battery can power this device for 180 hours without interruption.**

Keywords: Electric power; fingerprint sensor; motorcycle; motorcycle security system.

I. Introduction

Motorcycles are a popular mode of transportation in Indonesia, particularly among the poor. This is because the price is reasonable and the fuel consumption is low. A motorbike's shape and dimensions are not as large as those of a car, making it a very flexible mode of transportation that can save the user time [1].

Motorcycles offer various advantages, but they also have several disadvantages, particularly in terms of security, because they still employ manual ignition. Manual ignition, as we now know, is less effective in its use. This is because many people are careless in placing or preserving it, so it takes time to find it at first. Even more risky, many motorists still fail to remove the motorcycle ignition key or the motorcycle seat ignition key, which results in motorcycle theft. [2].

Vehicle security is critical for all owners of private and public vehicles. As a result, many security systems have been developed; nevertheless, the majority of these security systems are costly, sophisticated, and best suited for automobiles. Several automotive security systems have been developed in order to improve security by using biometric techniques like face detection and fingerprint detection [3]. Another security system is equipped with a tracking system using the Global Positioning System (GPS) and has the ability to turn off the vehicle engine remotely via text message. [4]. In the case of motorcycles, standard and affordable security systems only provide siren indications and create a lot of noise, which disturbs the community**.**

Because anyone can no longer access motorcycles, replacing the manual key with a fingerprint sensor is a very effective option. Because it can only be accessed by those whose fingerprints have been imprinted in them, this fingerprint sensor is a relatively precise technology. This is due to the fact that everyone's fingerprints have differed since childhood. Another advantage of using the fingerprint sensor, specifically when turning on and off the engine of a motorcycle vehicle, is that we can reduce the occurrence of misplacing the motorcycle key in the ignition or the motorcycle seat, which can lead to motorbike theft, because we have used the fingerprint sensor to turn off or turn on the engine. [5].

Several technologies are used to create motorcycle security systems, including the use of Radio Frequency Identification (RFID)[6], [7]; *fingerprint* sensor [8], [9], [10]; using password [11]; and *Global Positioning System* (GPS) module [12], [13].

Several earlier studies on vehicle security systems have been conducted, including the development of motorbike security systems based on IoT (Internet of Things) [14], [15], [16]. The study's findings include statistics on the system's average response time whileprocessing data, both in the form of fingerprints on the fingerprint module and when entering passwords and PUK codes presented on the LCD screen. Other research can use the SM630 fingerprint sensor as input to distinguish fingerprints from motorcycle users [17]. This fingerprint system also works with the Arduino Uno kit, which uses the ATmega328 microcontroller as its brain to process data from the fingerprint sensor to the LCD panel, motorbike, and alarm [18], [19].

Other researchers have employed the fingerprint sensor as a lock in accordance with this approach. If a motorcycle rider wants to start or crank his motorcycle, he must first scan his finger and then turn it on by pressing the start button, which should be direct when the rider wants to start the motorcycle engine. enough to scan his finger without having to first press the start button [8].

Another study conducted by Rizkyana et al in 2021 concluded that if a registered fingerprint is coupled to the fingerprint, the motorcycle engine will start. Unregistered fingerprints will not start the motorcycle engine and will activate the motorcycle alarm. To begin, the registered fingerprint motorbike engine must be clean and dry (not wet) [9].

According to the description above, one way to prevent motorcycle theft is to use intelligent security system technology. This study underscores the importance of using this fingerprint sensor for motorcycle security. The formulation of the problem in this study is how much electricity is required in the motorcycle battery for this fingerprint security system. Because every human's fingerprints are different, the results of this study are expected to generate a system that can replace the motorbike engine starter mechanism, which still employs buttons, with a finger print sensor, increasing security and lowering the possibilities of motorcycle theft.

II. METHOD AND DESIGN

This research is experimental in nature, with observations made on testing designs to examine how to improve a motorcycle security system. Where the author employs the technology of this fingerprint sensor, everyone's fingerprints have been different since birth, thus their level of likeness to other people is quite tiny. It not only uses the finger print sensor to switch on and off the motorcycle contacts but also to lock the motorcycle handlebars and turn on and off the motorcycle. As a result, the level of motorcycle security increases because motorcyclists still utilize the switch button to turn on the motorcycle, where security is still lacking. This study also analyzes whether the power needed by this system can be supplied by a motorcycle battery or not. The block diagram of the design and manufacture of this system can be seen in Figure 1.

The Arduino Mega 2560 microcontroller was used in the design of this utility. The Atmega 2560-based Arduino Mega 2560 is a microcontroller board. The Arduino Mega 2560 contains 54 digital input and output pins, including 15 PWM outputs, 16 analog inputs, 4 UART (portserial hardware) connectors, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. [21].

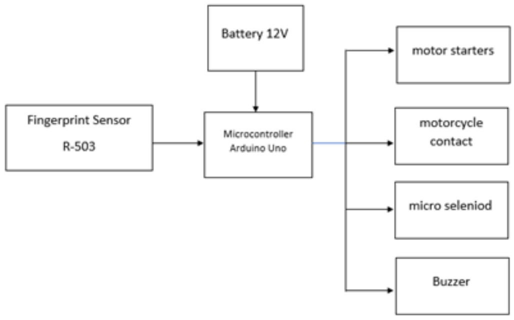


Figure 1. Block Diagram for Making a Motorcycle Security System

The R-503 fingerprint sensor contains 6 pins, of which only the RX and TX pins are used for serial communication, i.e., exchanging data between the Arduino circuit board and the serial device. This pin is also a signal to Arduino to run existing programs, and it is coupled to Arduino pins 5 and 6. The remaining two pins, VCC and ground, are also connected to the Arduino Uno's 3.3V and ground pins. The buzzer has only two legs, which are the IN and ground pins. For this experiment, the IN pin is linked to Arduino pin 7, and the ground is attached to the Arduino Uno's Ground pin. Figure 2 shows a flow chart from the research that was conducted.

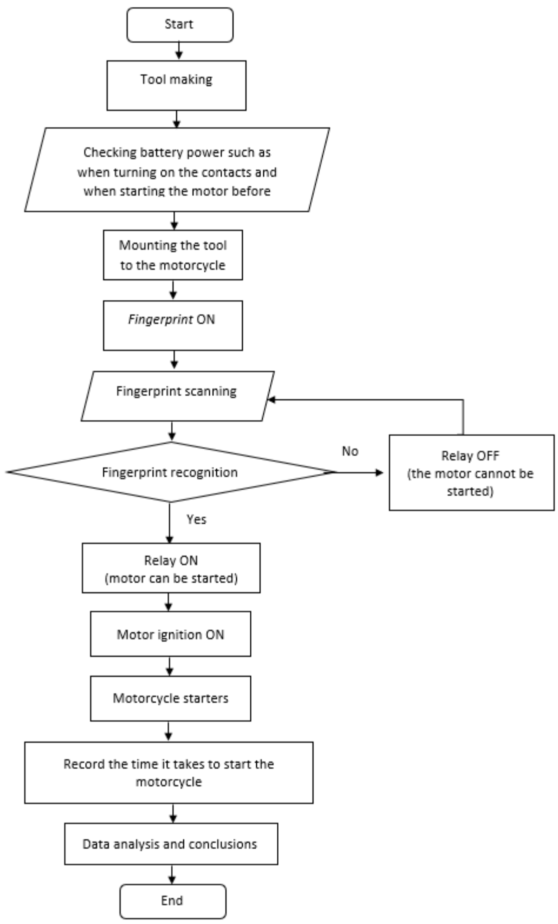


Figure 2. Research Flowchart

This system employs a buzzer as an alarm to indicate if there is something wrong with the input we enter, in which case it will issue a sign in the form of a large sound or sound, and if someone else tries to access the installed fingerprint by scanning their fingerprint, the buzzer will issue a sound or sound.

In this tool, there are 3 types of loads that are used, namely micro solenoids, motorbike contacts, and engine starters. The three loads move if the relay is on or off.

The micro solenoid is used as a motorbike stand lock in the initial load. Whereas the motorbike stand was previously locked using the manual technique put in the motorbike lock house, if we want to make this system electrical, it must be replaced with a microselenoid to lock the motorbike stand so that it can be driven by an Arduino as the controller, which is the relay. Later, as a source of power for the micro selenoid.

After the static lock is opened using the fingerprint sensor, the relay will supply power to the motorcycle contact for the second time, allowing us to only start the motorbike, although we may still use the manual ignition key to turn on the motorcycle contact because the feature is still present.

Using the third load, we add voltage, specifically for the motorcycle engine; in order to drive the motorbike, the engine or motorcycle engine must be turned on. Prior to installing this tool to start the motorcycle, it was customary to use the start button on the motorcycle, press the brake, and raise the standard of the motorcycle, so the researchers parallelized this tool so that the old motorcycle key could still be used as a backup if the voltage on the battery suddenly wasn't enough. After installing this tool, you can still use the usual method to start the motorcycle, but you can also use another method, namely scanning the user's fingerprint and continuing to press the brake and the standard lever of the motorcycle, so that you no longer need to use the key to start the motorcycle. If the user wishes to turn off the engine, simply scan the fingerprint again, which is right, and the motorcycle engine turns off. To re-lock the motorbike stand, simply point it as usual, scan the fingerprint again, and the microselenoid will lock the motorbike stand.

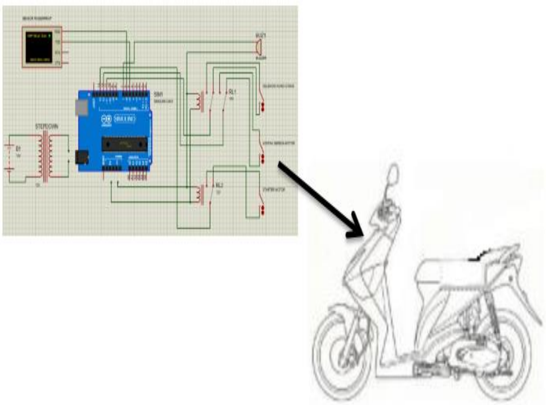


Figure 4. System schematic

Following the formation of the block diagram, a hard design is required to determine what the role of each component is and what type of components I will use in constructing this tool, as well as the layout of the components later so that I may save more on the use of cables on the tool. Figure 4 depicts an overview or form of the tool simulation circuit

The devices used in the system to be built can be seen in the schematic diagram in Figure 4. The Arduino UNO, R-503 Fingerprint Sensor, 12V/3A Buck Converter, Buzzer, and 4-Channel Relay are the major devices in the schematic picture above.

The 12V/3A Buck Converter component has two inputs and outputs, with two positive and two negative legs. The positive and negative poles of the battery are linked to the two input legs of this component. The pin out is connected to the power jack on Arduino Uno, which serves as a power supply to Arduino, ensuring that the voltage remains stable at 5 volts.

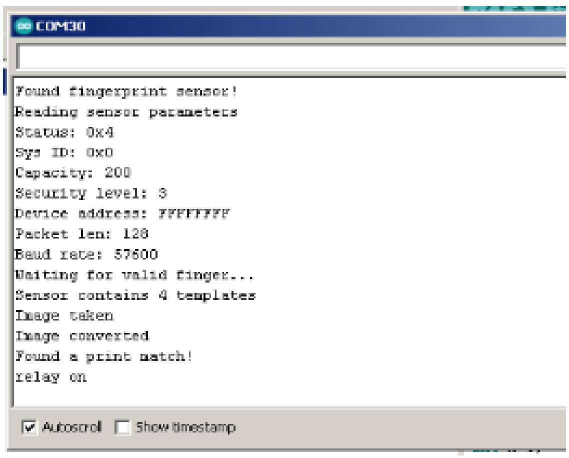
The buzzer has only two legs, which are the IN and ground pins. For this experiment, the IN pin is linked to Arduino pin 7, and the ground is attached to the Arduino Uno's Ground pin.

The relay has six IN pins, but only five are used in this study since we turn off the function of the other relay because the load is only four. Because the relay requires 5 volts of power to operate, two pins on the relay, VCC and ground, are linked to the Arduino on pins 5 volts and ground, respectively. As a signal to the relay, pins D1, D2, and D3 of the Arduino Uno are linked to pins 11, 12, and 13. All that remains for the output is to modify the positive and negative on the components it runs, such as the micro solenoid, motor contacts, and the starter at the relay output.

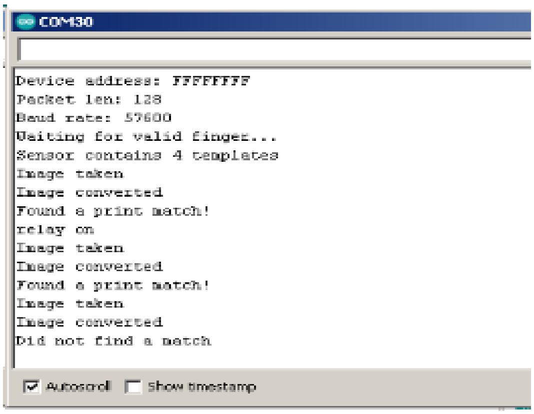
III. Results and Discussion

A. Testing On The Program

After creating the software and uploading it to Arduino, you may check the serial monitor to determine if the fingerprint works properly while scanning existing fingerprints. Figure 5. depicts the simulation results or the display of the Arduino serial monitor when reading fingerprints.



(a)



(b)

Figure 5. (a) Monitor serial display when finger is right and (b) wrong

Figure 5 depicts it. If the fingerprint submitted is correct, the serial monitor will display "found a print match" and turn on the existing relay. If the finger is entered incorrectly, the serial monitor will show: Because it did not locate a match, it will not switch on the relay. This program is also designed so that users of this tool can insert their fingers without the need for a laptop to retain their finger data..

B. Mechanical Testing Of Equipment

This tool is powered by an automatic Beat motorcycle. To save on wiring, all of the necessary components are put in front of the motor body. In its installation, the author retains the manual ignition on the motorcycle, so the author parallelizes the existing wiring on the motorcycle with the tool that has been made, so that the function remains, and when starting the motorbike, it remains as the standard that was previously made, namely that the motorbike standard must be increased first, and when starting the motorbike, you must also press the handbrake on the motorbike. The installation of the tools that have been made can be seen in Figure 6.

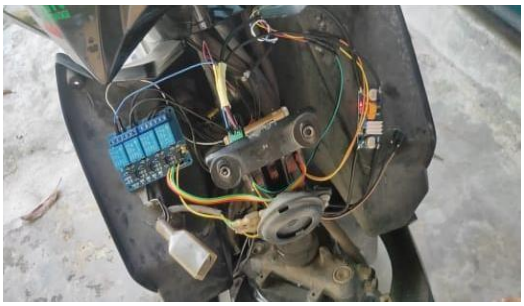


Figure 6. Form of Tool Installation

If the tool has been properly installed, it must be tested to see if it can run properly. Fingerprint reading under various finger conditions, such as when turning on the motorcycle and adding users or finger access in various finger conditions. This experiment is carried out to determine whether or not the state of the finger can inhibit fingerprint reading. Tables 1 and 2 show the findings of fingerprint readings.

Table 1. Fingerprint Readings When Turning on the Motorcycle

Finger state	***Finger states***
Normal	Detected
Wet	Detected
Greasy	Detected
Dusty	Detected
Crossed out	Detected

The experiment above shows that the R-503 fingerprint sensor can recognize fingers in a variety of states when starting the motorcycle, as shown in Table 1. Following the aforementioned studies, it is calculated how long it takes to start the motorcycle under various conditions, namely the finger, so that it can be compared to the duration when starting the engine in the traditional manner, namely the switch button. Table 2 displays the time calculation results.

Table 2. Time Required When Starting the Motor

How to start a motorcycle	Time (s)
Typical motor switches	2,05
Fingerprint (normal)	1,66
Fingerprint (wet)	2,10
Fingerprint (*Greasy*)	1,8
Fingerprint (dusty)	2,13
Fingerprint (*Crossed out*)	1,74

Because normal fingers have the fastest time, we will test the ten existent fingers under regular conditions to see if the type of finger used affects the fingerprint sensor's reading performance. Table 3 shows the outcome of tracking the time with ten fingers. The achieved speed varies, but not much, among the ten fingers that were recorded when they were started under normal finger circumstances. The fastest time is 1.55 seconds for the left index finger, and the longest duration is 2.29 seconds for the right little finger.

Table 3. Starter Time Test with Several Finger Types

The type of finger used when in normal state	Time (s)
Little finger (left)	1,99
Ring finger (left)	1,83
Middle finger (left)	1,87
Index finger (left)	1,55
Thumb (left)	1,66
Little finger (right)	2,29
Ring finger (right)	2,13
Middle finger (right)	2,22
Index finger (right)	1,83
Thumb (right)	1,85

IV. VOLTAGE AND CURRENT MEASUREMENT

The motor's built-in battery, precisely 12V3Ah, is used in this test as the main power supply for the motor, thus it is also used to deliver voltage to the mounted device, because it uses a battery as a power source, so the tool used must require a modest current. This is due to the fact that the electric power in the battery is proportional to the amount of current in the battery.

It is possible to compute how much electrical power a value of 36 Wh is obtained by knowing the voltage and current on the battery nameplate. This states that the battery's electric power is 36 W for one hour, or that the battery can only last for one hour if the required current is 3 A. The battery we use only requires a very little current. Table 4. shows some of the outcomes of monitoring voltage and electric current.

Table 4. Voltage and Current Required by the Motor Before Installing the Tool

State of the Motorcycle	Voltage	Current (mA)
stand-by state	13,8 V	0
ignition ON	104,9 mV	20
when starting	4,6 mV	70

The stand-by voltage is measured directly on the battery, whereas the ignition and starter are measured at the position shown in Figure 7.

When Ignition is On

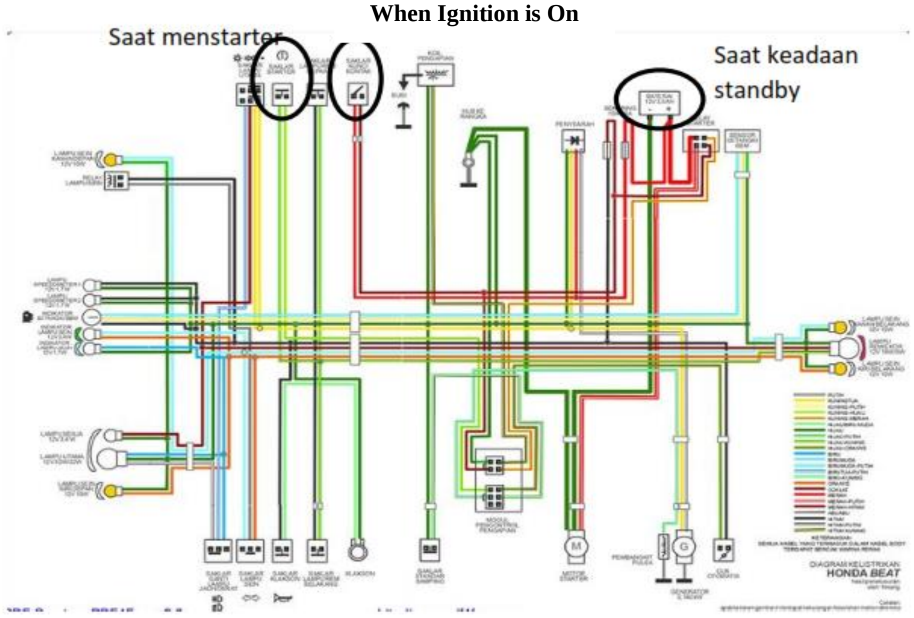


Figure 7. Place for measuring voltage and current before the device is installed

Table 5. Voltage and Current Required by Motor After Tool Installation

State of the Motorcycle	Voltage	Current (mA)
stand-by state	5 V	210
unlocking the handlebar micro solenoid	3 mV	40
ignition ON	3,7 mV	40
when starting	1,7 mV	40

Following the initial measurements, the authors take several measurements when the tool is installed on a motorcycle that runs on battery power; the measurement results require a maximum voltage of 5 V for stand-by and a minimum value of 1.7 mV when starting the vehicle; the results are shown in Table 5.

V. ELECTRICITY USE ANALYSIS

Based on the measured voltage and current values that have been obtained, it can be calculated how much the value of the electric power used by this tool. Based on the results of the calculation of electric power consumption before the device is installed, the comparison can be seen as shown in Figure 8.

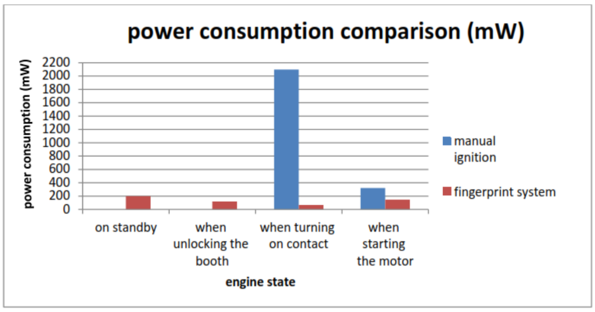


Figure 8. Comparison of Electric Power Consumption Before the tool is Installed

Based on Figure 8. it can be seen that before the installation of the tool on the motor, and in the standby state the power used here is not available because there is no running load. Meanwhile, when the box lock is ON, the power consumption is 2098mW and when the motor is started, it is 322mW. So that the total amount of energy used at one time is 2420 mW where the battery is able to provide power for ± 14.9 hours if we turn it on then turn it off and turn it on again continuously like that. The time calculation above does not include when we ride a motorbike, because when riding a motorbike, electricity no longer comes from the battery but from the engine on the motorbike.

After measurements and calculations have been carried out before the tool is installed, after the tool is installed, measurements and calculations are also carried out. From the measurement results in Figure 8, after the tool is installed, the electric power is obtained respectively in the standby state (200 mW), when unlocking the stand lock (120 mW), when the contact is ON (6 8mW) and when starting the motor (148mW). From these results the most power used is when the motor is in standby with an energy consumption of 200 mW, where this power is continuously used even though the motor is off. The total electric power used by this tool is 536 mW, which is 4x less than using a manual ignition. However, if you use this tool for a long time, it can be said to be a waste of energy, because when the motor is not used, the electric energy in the battery is still used because the energy is used during standby, namely for the Arduino as the controller, which must still be powered, while before installing the tool with the motorcycle in standby mode, no energy is used because there are no components that require electrical energy when the motor is not in use. Based on the battery power used is 36Wh and the maximum power consumption is 200mW, we can find out how long the battery is able to supply power to this device when it is on standby or when we are not using it, that is, the battery is able to provide electrical energy for ± 180 hours.

As a comparison, this tool with a manual ignition is not only seen from the total electric power used, but also in terms of the time it takes to start the motor manually and with several finger conditions. The results of the comparison can be seen in Figure 9.

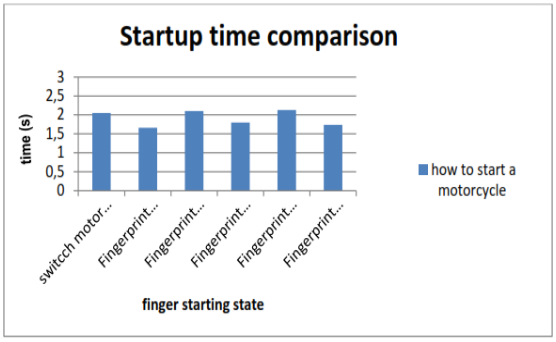


Figure 9. Startup Time Comparison

After doing it with 5 finger conditions, namely, wet, oily, dusty, crossed out and normal and the time when it starts with the normal button, you can see the difference in starting time is not too big. From the results of the comparison in Figure 9. it is found that this tool is able to start the motorcycle faster than the usual method, namely using the switch button on the motorcycle. This experiment also made a comparison of the time of the other 10 fingers with just one person, there was also a time difference that was not too significant, and the ten stored fingers could be read or detected in their entirety.

VI. CONCLUSION

The fingerprint security system is able to secure the motorbike very well because it can replace all the functions of the motorbike lock, such as locking the motorbike stand, motorbike contact, and starting the motorbike. Finger reading is also done when the finger is wet, oily, dusty, scratched or normal, all of which can be read by the R-503 fingerprint sensor. The test results have obtained the length of time required to start a motorbike for 1 person with ten fingers, but all ten fingers are normal, so the index finger (left) with normal conditions is the fastest to turn it on with a time of 1.55 s and the slowest is little finger (right) with a time of 2.29 s. This is faster than using the motor starter button which takes 2.05s. The use of electric power when starting the motor is very small compared to the ignition system, which only requires 200 mW of electric power. However, for long-term use it is still not possible, because this tool must continue to turn on the Arduino as the controller of this system to maintain the security of the motorbike even though the motorbike is not used, with the ability to last for 180 hours.

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