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# Two-Way Motorcycle Authentication with Alerting and Tracking System Using Mobile Application

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***Abstract*****—** *With the great population of motorcycle users' motorcycle in the Philippines, stealing is a common term for crimes involving theft in motorcycles apart from car-napping which involves the cars itself. This has become a common crime that has been existing in the Philippines since motorcycles became a prevalent means of transportation due to its mobility and cost-effectiveness. However, with the privilege to purchase these types of vehicles comes with the higher risk of crimes, thus the need for security to keep vehicle safe from robbers. The purpose of this research is to develop alerting and tracking system intended for motorcycles. More importantly, it is to prevent motorcycle stealing from happening and instantly and automatically alerts the motorcycle owners likewise informs the situation so that a quick-response will be taken. The design is composed of two components: the TWAMATS (Two-Way Motorcycle Alerting and Tracking System) device and the TWAMATS mobile application. The device is composed of an alarm system, fingerprint sensor, Wi-Fi module, accelerometer and gyroscope sensor and GPS locator, of which all of these will be controlled by a microcontroller. The information that is being sent and received by the database from the device can only be accessed by through TWAMATS mobile application that is understandable by the user. The TWAMATS lets the user view images, to keep track of location history and register fingerprints.*

***Keywords*****—** *Alerting System, Mobile Application, Motorcycle authentication, Tracking System*

## I. INTRODUCTION

The Philippines has approximately 5,329,770 motorized 2-wheeler and 3-wheeler vehicles [1]. With these numbers, the Philippines is being ranked as the top 10th country in Asia with the most number of motorcycle users according to the Global Status Report on Road Safety, WHO 2013 made it hit its mark on crimes relating to motorcycles, "motor-napping" for one as an example. Motor-napping is a common term for crimes involving theft in motorcycles apart from car-napping which involves the cars itself.

This has become a common crime that has been existing in the Philippines since motorcycles became a prevalent means of transportation due to its mobility and cost-effectiveness. However, with the privilege to purchase these types of vehicles comes with the higher risk of crimes and the need to for maintenance, thus the need for security to keep your vehicle safe from robbers.

An average of one motorcycle unit is stolen every day in Central Visayas. In every month of 2018, there are 30 cases recorded but only 11 were solved [2]. What we thought as safe for our motorcycle might be the contrary to the strategies of a professional motorcycle theft. Simple passive devices against theft might work against an amateur, but for a pro, even removing a clutch lever will just be a walk in the park inside a gated apartment complex.

If you are planning to own one of those motorcycles and still new to the road jungle, consider getting additional layers of security to your vehicle. Passive security can be helpful but getting an active security will make it harder to steal it delaying the crime and makes it easier to get the thief being caught in the act.

Henceforth, on the following pages will provide an in-depth proposal of how we can stop if not, minimize the increasing rate of motor-napping crimes in the Philippines and protect the welfare of most Filipinos using this type of vehicle not just as a means of transportation but as well as a means to earn a living.

## II. RELATED STUDIES

### A. Techniques that a Theft Used in Stealing Motorcycles

There are several techniques that a common theft would do to be able to steal a parked motorcycle. This might involve being witty, with strategy or with other ways.

1. A motorcycle can be stolen by breaking the steering lock. In doing this, the front steering portion of the motorcycle is forcibly moved to break the iron -made lock inside thus, letting loose the lock.
2. Forcing the ignition to turn on using a key.
3. If the motorcycle is left unlocked, they proceed with tinkering the electrical wirings to turn on the motorcycle.
4. If the motorcycle is unlocked and the theft isn't good with wirings, he may drag the motorcycle somewhere out of sight and proceed with dismantling the parts or what not.
5. The motorcycle can be stolen by putting it inside a carrier van or a truck [4].

### B. Factory-Installed Anti-Theft Devices

There are existing devices that are factory-installed devices and provides security from thieves.

- Electrical System Lock: It is the lock that comes pre-installed with the motorcycle. The motorcycle's whole electrical system is controlled by the key. The electrical system will not function if the key is not in the "ON" position, making it impossible for the motorcycle to start its engine.
- Steering Lock: The motorcycle has a mechanical lock that was placed at the factory to prevent the front wheel from freely turning in any direction. No one can operate the



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motorcycle if the lock is not unlocked using the unique key. The steering lock and the electrical system lock are currently at the same position and using the same lock, but the steering lock's key position is one step above the electrical system lock.

- Main Stand Lock: It is a mechanical lock. The main stand lock, for which the manufacturer has already provided a position from the factory, must be supplied by the motorbike owner. The motorcycle is rendered immobile by locking the main stand. A front wheel will be elevated off the ground by the main stand while parked in this manner.
- Wheel Lock: It is sometimes referred to as "Disc brake lock." A mechanical lock is used. To stop the front wheel and back wheel from turning, the owner must supply the lock for the front-wheeled disc brake.
- Chaining and Locking the Motorcycle with the Pillar or Floor: The owner must supply the chain and lock for a specific component in order to secure the motorcycle to a pillar or floor, or they must use the factory compact lock set to secure the wheel to the ground [5].
- Mechanical Lock: A lock is any device which prevents access or use by requiring special knowledge or equipment. Mechanical locks are mechanical devices which secure an opening by keeping a door closed until a release mechanism is activated; usually a lever, knob, key, or thumb turn [6].

These existing factory-installed security locks have deficiencies. The weakness of electrical system lock is that the ease to bypass the motorcycle engine starter while the mechanical lock is not complex and powerful to be not dismantled using simple tools. The police recommend having a “layered approach” to prevent theft. The more layers you have, the less likely your bike will be stolen. Therefore, installing an anti-theft security system can deter thieves to stole motorcycles.

### *C. Modernization of Vehicles*

There are many ways for a thief to stole a motorcycle. In order to prevent this, owners trust the factory-installed security devices but these are not effective to deter a theft from stealing. One of the best securities to install on a device is fingerprint. Most of the devices today like smartphones, watches, automated doors use fingerprints as security system. This time motorcycle is using fingerprint as ignition. Fingerprint is a type of biometric that is unique to every human even identical twin with identical DNA, have different fingerprints. The unique nature of a fingerprint makes it ideal for use in automated recognition systems.

Car company like Hyundai Motors has launched a keyless ignition of their SUV. It recently announced the world’s first smart fingerprint technology. Drivers can use this security feature to start their cars as well as unlock the doors. The most recent cellphones on the market today are compatible with this innovative technology. Only the driver's finger needs to be put on the door handle scanner. The fingerprint controller inside the car will subsequently be able to recognise and receive the encoded fingerprint data. Once inside the car, you can start the vehicle with ease by just putting your finger on the sensor located on the dashboard [7].

But applying this biometric causes auto companies to halt their project using fingerprints because of weather. One of the key reasons fingerprint technologies have not been widely adopted by the auto industry is that it had to be robust enough to work under extreme conditions (rain, snow, heat, freezing temperatures) [8].

In addition to modernization, vehicles have already factory-installed GPS module and accelerators. Global Positioning System or GPS is already prevalent in every modern devices today. GPS tracking system developed that transmit vehicle’s data in real time via cellular or satellite networks to a remote computer or data centre [9]. Vehicle tracking system signifies the monitoring and management of vehicle, trucks, etc. by using GPS system to get the current location, situation, history and control them [10]. Not only it can track location but it can also calculate velocity and time travelled. Even today’s cars are already factory-installed with GPS modules. In comparison to motorcycles, it does not come with GPS module when you purchased one.

Forces may be static, the constant force of gravity that pulling your feet to the ground, or may be dynamic, forces by movement or vibration that can be detected by accelerometers. This device measures the amount of static acceleration due to gravity, can find out the angle of the device when it is tilted with respect to the earth. The purpose of the accelerometer system is to monitor vehicle acceleration (forward-backward, up-down and side-to-side) as well as vehicle attitude (nose-up, nose-down, bank, etc). The system can also detect vehicle movement while in a low power mode and act accordingly. The accelerometer system is responsible for processing the raw signals from the accelerometer hardware into signals representing the vehicle's frame of reference [11].

Integrating these three important modules, fingerprint, GPS and accelerator, with camera can lessen motorcycle thefts.

## III. Results, Design and Discussions

This study scrutinizes quantitative research method. An evident-based study only focuses on empirical data that were gathered through surveys and interviews by the researchers. While qualitative research method was utilized to obtain information from the Highway Patrol Group VII (data of motor vehicles incident reports) to further the observations and study insights.

### *A. Research Design*

The network of the study, selection of the proper hardware components and software functions. Designing the system is the foundation of integrating the hardware specifications and software specifications.

### *B. System Design*

This study aims to enhance the authentication starter of the motorcycle units. Using this method owners can assure that the motorcycle won’t be used easily by anyone for the initiation starter switch uses a fingerprint. If someone wants to

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use the motorcycle unit, he/she need to register his/her fingerprint. In order to register a fingerprint, the proponents designed a mobile application which will be connected to the device.

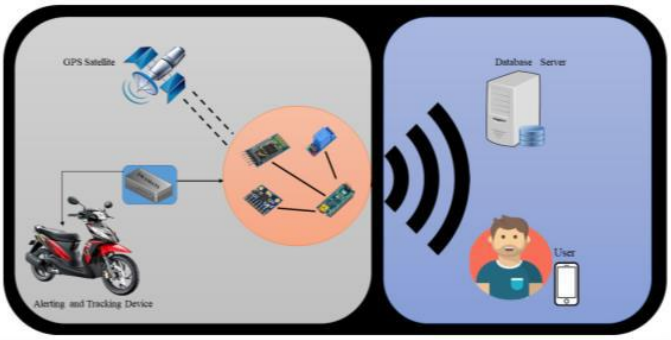


Fig. 1. Network design of the system.

The device will gather data from its module installed and then send it to the database. These data from database can only be harnessed by an especially designed mobile application. The system also uses a movement sensor of which it will detect the motion of the motorcycle. This to pair with the GPS (Global Positioning System) locator and camera. The GPS locator installed in the system is real-time tracker. The device will only detect GPS location when it is seen by the satellite. Although, sometimes the GPS losses its signal as the time it connects again to the satellite it will just continue to gather location. All of the data gathered will be sent to a database and can only be access using internet connection.

*C. System Flow*

This study has flow chart establish best understanding of the system flow.

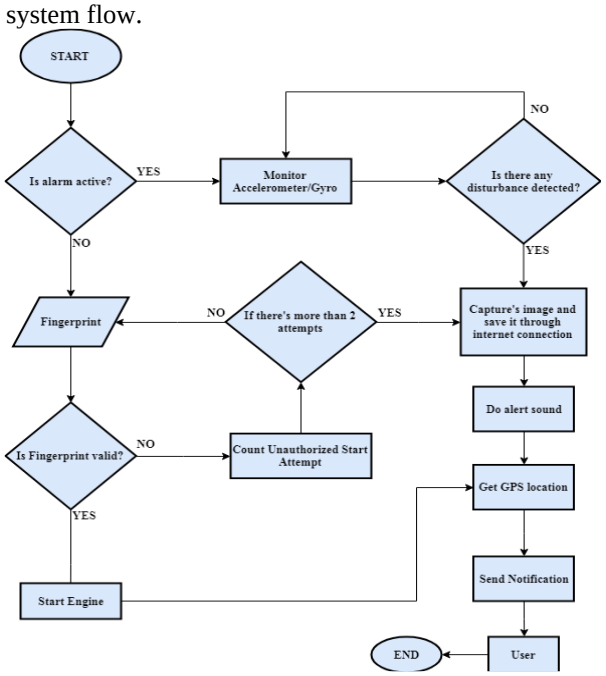


Fig. 2. Flowchart of the system

In Figure 2, it describes the workflow of the setup and on how owners can register their fingerprint. To register their fingerprint, turn on the device of the motorcycle so that it will be searched by the application installed on the phone. If the two devices are connected, enter the given pin and register fingerprint on the scanner of the motorcycle. Owner can register up to three fingerprints on the motorcycle. Owner can also register up to two other fingerprints, as registered trusted contacts, in which these contacts will also receive alerting messages when thieves attempt to steal the motorcycle. After the fingerprint is detected, enter the pin again to finally register the fingerprint.

The owner will start with inserting the key in the ignition. After inserting the key, it will capture image and owner then enter the registered fingerprint to start the engine of the motorcycle. The LED (Light Emitting Diode)-Green will blink when the fingerprint scanned is valid, whilst validating, the system will capture image, gets the GPS location and sends the data to the owner. In this manner, the main user is knowledgeable who uses it. The LED-Red will blink if the user's fingerprint cannot be verified by the system as registered user or contacts while simultaneously capture images of may be "intruder", gets the GPS location and sends the data to the main user if the fingerprint is invalid, but if the fingerprint exceeds more than two attempts the alarm will turn on and sends data to the owner. When the motorcycle is on stand by and someone moves it, the sensor will detect the movement. It will capture image and gets data location then will notify the owner. The alarm will also produce audible sound to alert the surroundings. The owner or the registered users has the right to activate or deactivate the device.

*D. Block Diagram*

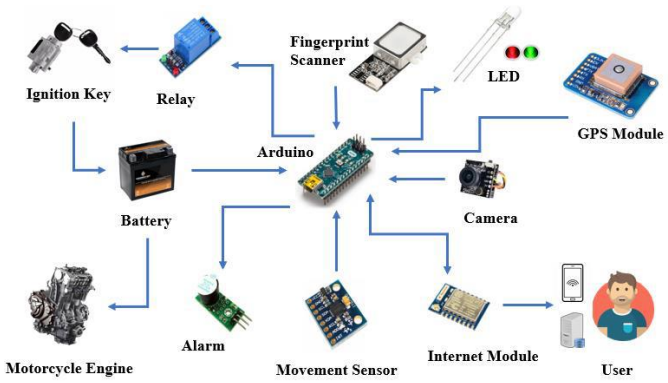


Fig. 3. Block diagram of the system

In Fig. 3, it shows the block diagram and system diagram of the motorcycle's device. The block diagram is especially designed for motorcycle units. The motorcycle will be installed with a system that contains an Arduino that will serve as microcontroller of the system. Data that have been gathered, like GPS, images, and movements will go through to the Arduino then the Arduino will assess how to respond to it. The system will help the communication of the main user and the motorcycle unit through a mobile application that is installed on the owner's phone.



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*E. Software and Hardware Design*

*a) Hardware Design:* Based on the physical of the motorcycle, researchers planned to create the device as small as possible so that the thefts will not easily recognize that there is an electronic anti-theft installed on the motorcycle they are attempting to steal. As for the fingerprint initiation switch researchers have already decided that it should protected from the sunlight and rain since the fingerprint won't work if it will expose to these most especially to the rain.

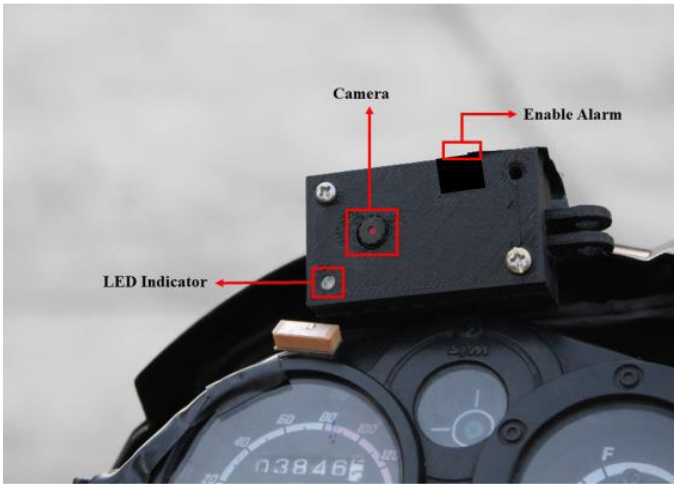

Fig. 4. Main system placement.

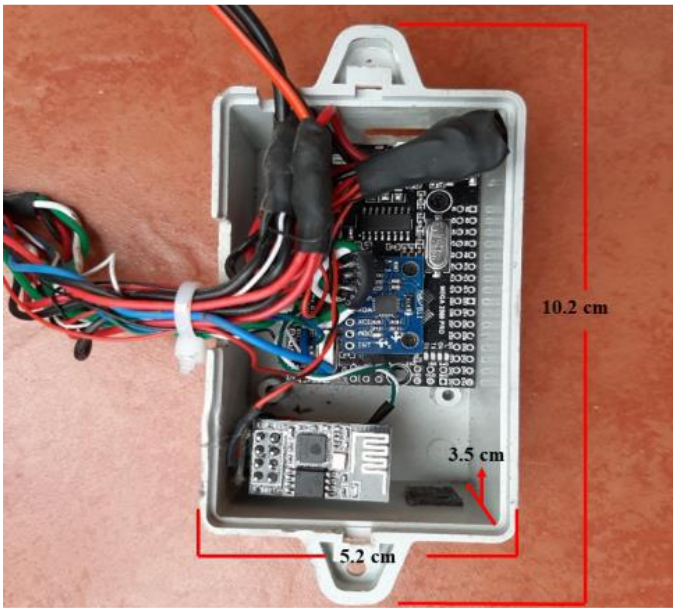

Fig. 5. Main system device box.

Based on the physical of the motorcycle, researchers planned to create the device as small as possible so that the thefts will not easily recognize that there is an electronic anti-theft installed on the motorcycle they are attempting to steal. The preference of the dimension of the main device system box is 10.2 centimeters by 5.2 centimeters by 3.5 centimeters. With this dimension, the box housed properly and securely the hardware components without interrupting and interjecting the system's process.

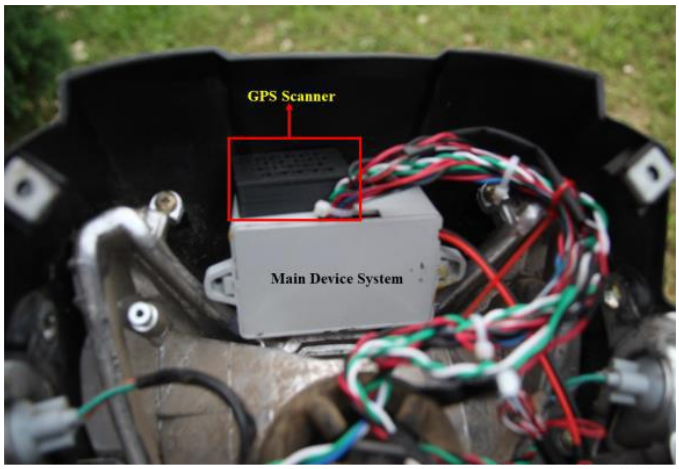

Fig. 6. Main system and GPS scanner underneath the motorcycle's headlights

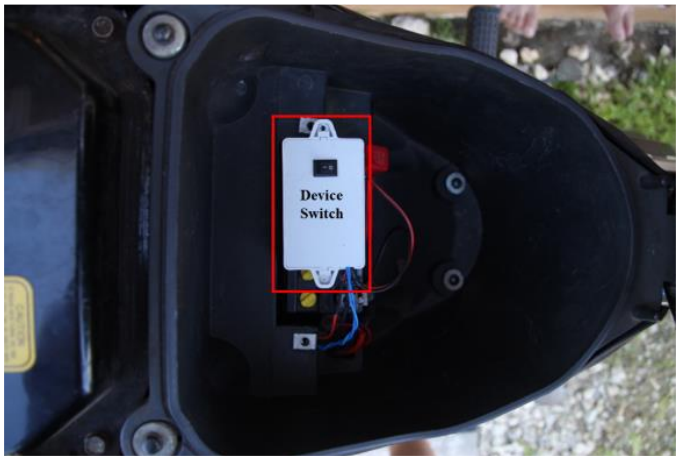

Fig. 7. Device switch.

Placed the device switch on the u-box (refer to Fig. 7) of the motorcycle this way the owner can promptly turn on/off the device when he opens the u-box. Based on the interview most of the motorcycle owners open the u-box before riding and after parking the motorcycle. Thus, placing the device-switch on the u-box is the best place to choose.

Fig. 8. Fingerprint scanner when the main switch is turned on



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The prototype uses the fingerprint sensor module that light up when it is connected to the supply. This prototype is connected to the device switch, that is directly connected to the battery of the motorcycle. A RGB LED serves as indicator. Once the device switch is on logic high. When the tact switch is pressed, enabling the alarm. It shows blinking red for 5-10 seconds for its calibration (shown in Fig. 9) then shows green after its calibration (shown in Fig. 10). The alarm enables when the tact switch is pressed (shown in Fig. 10). After pressing the switch, prompting the alarm to activate if one will try to move the motorcycle. The alarm can be turn on/off by the owner.

Fig. 9. During the calibration of the gyroscope (for the movement)

Fig. 10. After the calibration of the gyroscope

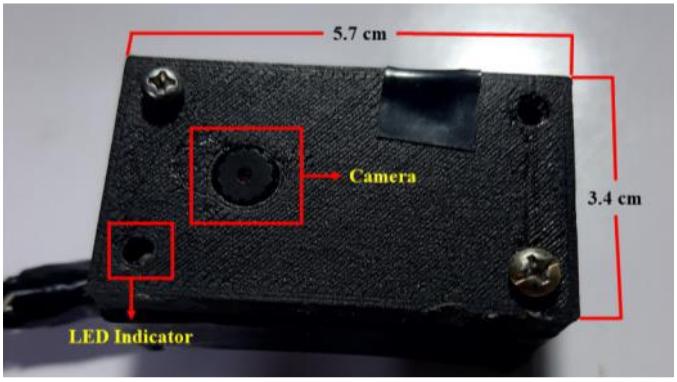


Fig. 11. Enclosure of the camera, enable alarm and LED indicator

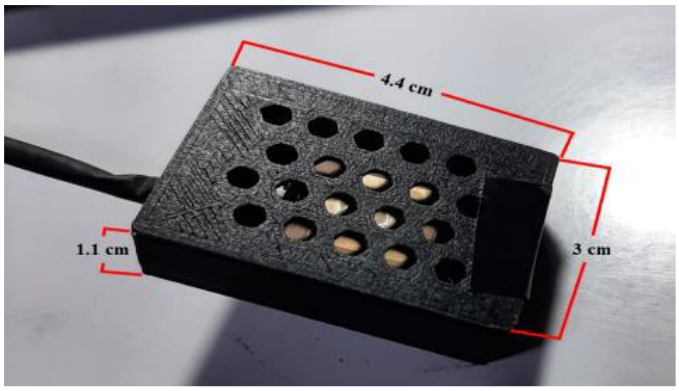


Fig. 12. GPS module's enclosure

As shown in Fig. 13, when the owner decides to park the motorcycle, the owner can resets the alarm through switching "on" the device switch, that is connected to motorcycle's battery. There is no "disable" switch to disable the alarm. This is to prevent thieves from disabling it. The motorcycle can be located whether it is alarming or not and keeps logs of the location.


Fig. 13. Enable/disabling the alarm

*b) Software Design:* The software system that the user will use to register fingerprint, locate the device, reset alarm and view the captured image is the Two-Way Authentication Motorcycle and Tracking System or TWAMATS User Interface. As shown in Fig. 14 is the graphical user interface (GUI) that is linked with a database.

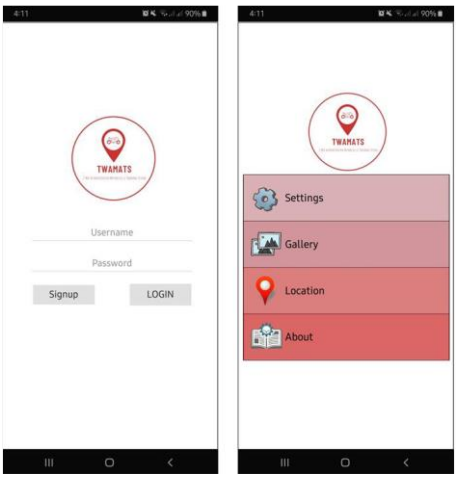


Fig. 14. Startup page: login/signup (*left*) and logging in page (*right*)



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This mobile application can only be accessed with a connection from the internet. The device will send data according to its sensors. These structured set of data is held by a database and can only be accessed through TWAMATS mobile application that is intended to provide understandable information for the user to be able to view image and location and register fingerprints. Upon opening the mobile application the sign up page will be the first to display together with Signup and Login (refer Fig. 14).

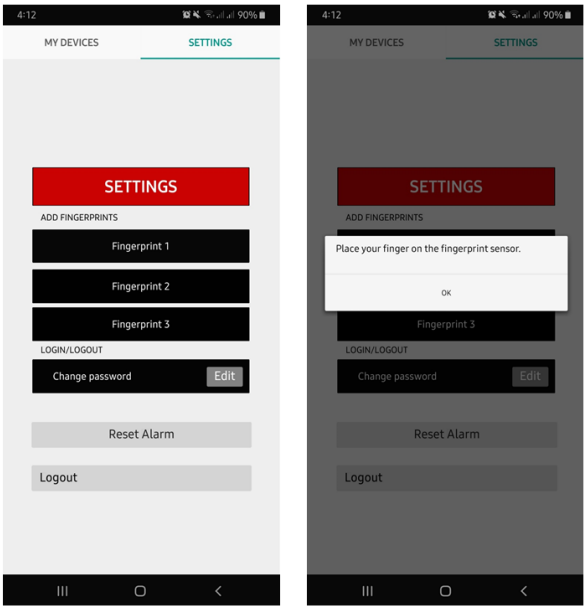


Fig. 15. Settings page

The owner can register up to three fingerprints and/or add another device to the TWAMATS (see Fig. 15). The Fig. 16 display the log of captured image and will be automatically saved to the mobile phone while Fig. 17 is the location log.

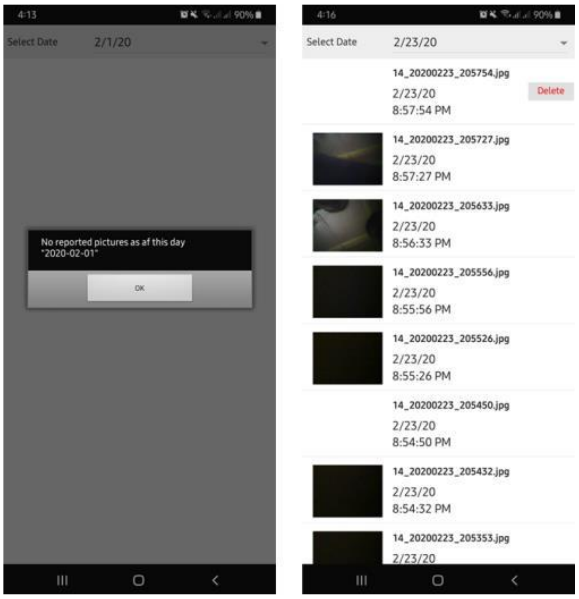


Fig. 16. Captured image log

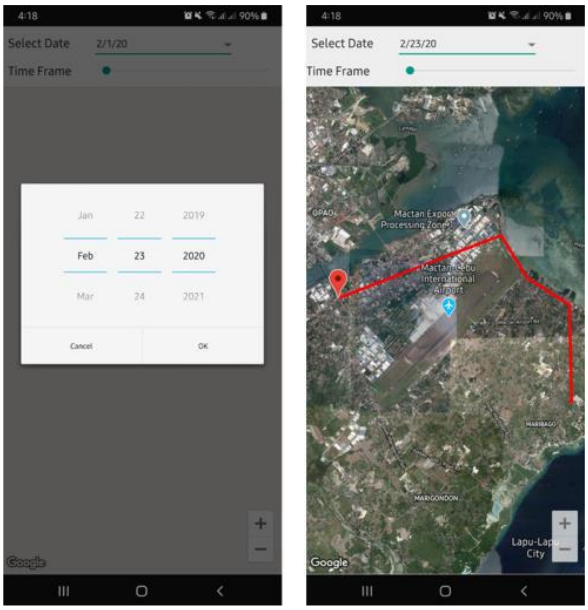


Fig. 17. Location log

The alarm, fingerprint sensor and camera will work even without internet connection. However, the location, notification on mobile application and registration of fingerprint will not function. These features needed an internet connection because the data that will be gathered from these modules will be saved to the database.

*c) Hardware and Software Integration:* With the availability of the hardware and software actuality integration of the two is the most crucial part of the study. With a modem or anything that can produce internet connection the registration of fingerprint and tracking feature of the system will function

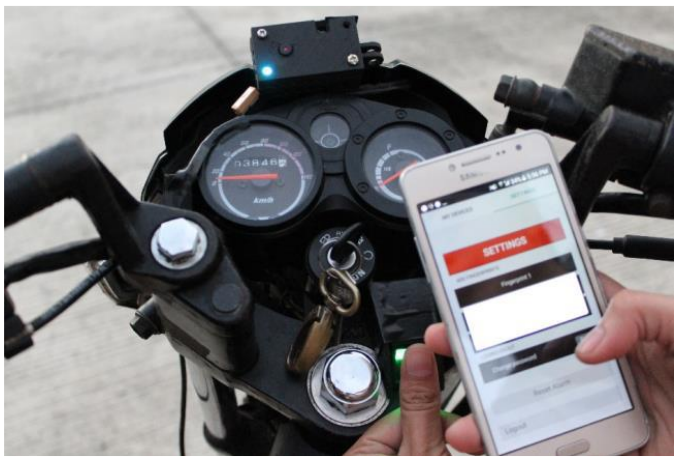


Fig. 18. Fingerprint registration

During registration of a fingerprint, blue light appears the after (refer to Fig. 18). A green light displays when a registered fingerprint is scanned this will initiate the motorcycle (refer to Fig. 19) while a red light (refer Fig. 20) is visible after scanning of a non-registered fingerprint for three times and is shown in Fig. 21 this activates the alarm whilst simultaneously capture an image and notify the owner through mobile application (refer Fig. 21).



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Fig. 19. Registered fingerprint

Fig. 20. Unregistered fingerprint

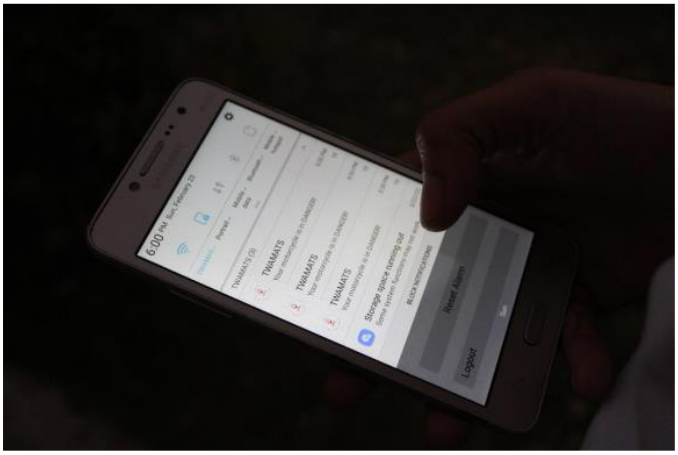

Fig. 21. Notification through the mobile application

## IV. Testing Results and Findings

Testing is not all about ensuring a system appears to function at the end of its development. It should involve different phases within the development process. Through this, not only it can fortify the system works correctly but also meets all the requirements needed to achieve. Five major phases took place for this system include the following:

1. Requirements Testing: The first level of testing and should take place while gathering the requirement specification from which the system or device will be yield. It is where the smallest testable parts of the system are independently tested. The advantage of this test is to detect errors early, by doing, it minimizes development risk and it saves time and money allotted on the project without having to go back and undoing the problems.
2. Design Testing: Intended to check the groups of modules functioning together correctly through the requirements specified in the previous level. This stage is decisive, as to when the developers can begin to code programs for each modules in the system to execute desired functions.
3. Unit Testing: Essential instrument to check that groups of modules work together correctly. This test occurs before integrating all modules into the final system. This reduces the possibility of more errors being passed onto the next phase of the system development.
4. Integration Testing: The objective of this is to test different parts of the system during combination of all modules to evaluate if they work together. By doing so, any faults during interaction can be identified. This test is the most crucial as units are usually produced independently and this is the instance in which they are joined together.
5. System testing: This stage of test validates the complete and full-integrated system. Not only it can ensure that the final system matches the specification on the requirements at the beginning of the project but also testifies that the system is fully functioning and is ready to use by the customers.

### *A. Requirements, Design and Unit Testing*

Test cases were implemented during test runs. The proponents used procedure based upon the given functionality required by panelists. The table shows the cases and description used in test run.

TABLE I. Cases in Test Run

| Test Case | Description |
|---|---|
| Check Device Power Stability | Check if the device if it is able to turn on and stay on if it is plugged in over AC power. |
| Check Device Sensor Functionality | Check the data given by the sensors if it detects movement, fingerprints while device is running. |
| Check Device Alarm Functionality | Check if alarm buzzer sounds once the sensors detect movement and unregistered fingerprint/s. |
| Check Device Wi-Fi connectivity | Check the device if it is able to connect to an available Wi-Fi or the internet. |
| Check Device Indicator Functionality | Check RGB LED if it shows right color once the device is used. RED light is alarm. BLUE light is registration, and GREEN is REGISTERED. |
| Check Registry of Fingerprint Functionality | Check if the user's fingerprint and profile are successfully sent to the database after registration. |
| Check Login Functionality | Check if the registered account can successfully login to the application. |
| Check Database Response | Check the response of the database if there changes of data are successful or not while the system is running. |
| Check Data Gathering Functionality | Check gathered data from the sensors |



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| | |
|---|---|
| | if it gives alarm, capture images and notifications once the movement or unregistered fingerprint is detected. |
| Check Device Wi-Fi Connectivity | Check if the device is able to send data to the database. |
| Check Fingerprint Registration Functionality | Check if one can register its fingerprint through application. |
| Check Map Functionality | Check if the application opens the Map to view the exact location of the device. In addition, track where the map points the device stopped and moved again. Logs of the location. As well as the time and date, the alarm is triggered. |
| Check Enable Alarm Functionality | Check if the enable alarm button sets the alarm. |
| Check Reset Alarm Functionality | Check if the reset alarm on the mobile application is triggering the device to stop alarming. |
| Check Captured Image | Check if the application saves and logs the captured image when the alarm is triggered. As well as the time and date, the alarm is triggered. |
| Check Application Notification Functionality | Check response when the device is moved or someone is trying to tap the fingerprint. |
| Check Registered Fingerprint Starter Switch | Check if the registered fingerprint can start the motorcycle's engine. |

TABLE II. FIRST TEST RUN

| Test case | Remarks |
|---|---|
| Check Device Power Stability | PASS |
| Check Device Sensor Functionality | PASS |
| Check Device Alarm Functionality | PASS |
| Check Device Wi-Fi connectivity | PASS |
| Check Device Indicator Functionality | PASS |
| Check Registry of Fingerprint Functionality | PASS |

During the proponents' second initial test run, the software applications was finished but still polishing the map logs and image feature for a greater user experience. The device Table I show results description used in test run.

TABLE III. SECOND TEST RUN

| Test Case | Remarks |
|---|---|
| Check Device Power Stability | PASS |
| Check Device Sensor Functionality | PASS |
| Check Device Alarm Functionality | PASS |
| Check Device Wi-Fi connectivity | PASS |
| Check Device Indicator Functionality | PASS |
| Check Registry of Fingerprint Functionality | PASS |
| Check Login Functionality | PASS |
| Check Database Response | PASS |
| Check Data Gathering Functionality | PASS |
| Check Device Wi-Fi Connectivity | PASS |
| Check Fingerprint Registration Functionality | PASS |
| Check Map Functionality | PASS |
| Check Enable Alarm Functionality | PASS |
| Check Reset Alarm Functionality | PASS |
| Check Captured Image | PASS |
| Check Registered Fingerprint Starter Switch | PASS |

### *B. Integration Testing*

Integration testing of the actuality and reality of hardware and software components

TABLE V. RESULTS OF THE DEVICE EFFIECINCY TEST: REGISTERING FINGERPRINT

| Trial No. | Remarks |
|---|---|
| 1 | PASS |
| 2 | FAIL |
| 3 | PASS |
| 4 | FAIL |
| 5 | PASS |
| 6 | PASS |
| 7 | PASS |
| 8 | PASS |
| 9 | PASS |
| 10 | PASS |
| Total | 80% |

TABLE VI. RESULTS OF THE DEVICE EFFIECINCY TEST: CAPTURING IMAGE

| Trial No. | Remarks |
|---|---|
| 1 | PASS |
| 2 | PASS |
| 3 | PASS |
| 4 | PASS |
| 5 | PASS |
| 6 | PASS |
| 7 | PASS |
| 8 | PASS |
| 9 | PASS |
| 10 | PASS |
| Total | 100% |

TABLE VII. RESULTS OF THE DEVICE EFFIECINCY TEST: TRACKING

| Trial No. | Remarks |
|---|---|
| 1 | FAIL |
| 2 | PASS |
| 3 | PASS |
| 4 | FAIL |
| 5 | PASS |
| 6 | PASS |
| 7 | FAIL |
| 8 | PASS |
| 9 | PASS |
| 10 | PASS |
| Total | 70% |

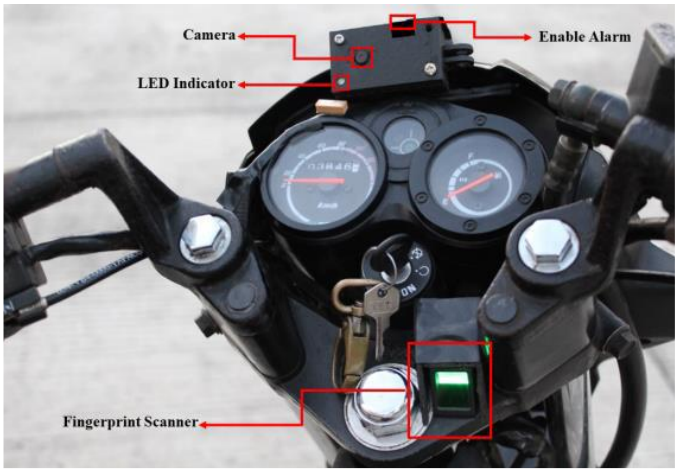


Fig. 23. The prototype is installed on the motorcycle

### *C. System Testing*

The system is fully implemented on a motorcycle as the scope of the study. A prototype was made for this study. This was programmed and setup first with desired information



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before the device was installed on the motorcycle, with wi-fi connection. Internet connection was also checked if it is capable for the device to send data to the database. The prototypes was installed on the motorcycle owned by one of the proponents. The device was positioned behind the headlights. This is to camouflage the device from the thieves. After the device was installed, it was tested to check its efficiency and accuracy.

TABLE VIII. ACTUAL RESULTS ON TWAMATS APP

| **Actual Testing Result for TWAMATS; Unregistered Fingerprint** | | | |
|---|---|---|---|
| Trial Number | 1 | 2 | 3 |
| Trigger Time (in seconds ) | 5 | 8 | 8 |
| Time that shows generating Alarm (in seconds) | 3.54 | 2.18 | 3.02 |
| Time that shows in TWAMATS app; Notification (seconds) | 35 | 30 | 30 |
| Time that shows in TWAMATS app ;Images (in minutes) | 2.46 | 2.05 | 1.30 |
| Internet Speeds of the Device (in Mbps) | 1.36 | 1.08 | 1.29 |

TABLE VIII displays the result in three trials on detecting unregistered fingerprint. It shows that during detection of unregistered fingerprint it function fast during on generating an alarm with 2.913 seconds while on notification the owner through TWAMATS application it takes an average of 31.667 seconds. In capturing images, it takes an average of 1.93 minutes to load the images. This is mainly because the mobile device has slow internet connection.

### *D. User Acceptance Testing Results*

The survey result has two parts. The first part is for the motorcycle club's response in the implementation and their overall experience with the system. The second part is the spectators' and device users' and police authority. For the survey of the system to the police authority, questions and ratings were asked to identify its overall user acceptance, with five (5) as the highest rating and one (1) as the lowest rating. Description of ratings is shown at TABLE XII. This rating was also used for the survey of the motorcycle owners, spectators and future motorcycle owners. The description of the categories will depend on the question on the survey, but the level of satisfaction is already understandable.

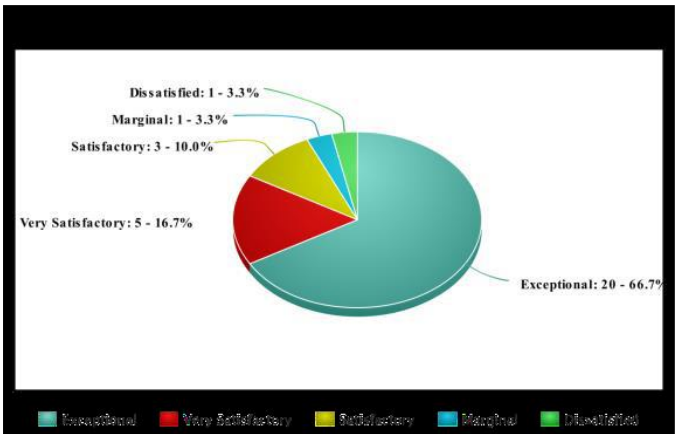


Fig. 24. Motorcycle owner rating

Fig. 24 displays the rating of the survey done to the motorcycle owners. The survey represents the data gathered from the motorcycle owners. About 66.7% or 20 out of 30 motorcycle owners would like to install the device. 5 out of 30 rated the system very satisfactory. Unfortunately, 1 out of 30 surveyed rated dissatisfied due to the device' pricing, uncertain of the functionality of the device, of which the proponents explained.

The proponents asked the police authorities if the system is helpful when a motorcycle stolen, they stated that it very helpful because it can capture image and locate the motorcycle which will retrieve the motorcycle units quickly and perhaps arrest the thieves.

### *E. Findings*

The experimental test results of the study concluded that the main factor of the delays and failures that the system encountered was greatly attributed to the stability of the internet connection and slow internet speed. This circumstance has a great consequence on alerting, notifying and real-time tracking of the device. If the internet speed is slower than 1.5 megabyte per second it is expected to have a minute to two minutes delay to produce an output on the mobile application.

## V. CONCLUSIONS, RECOMMENDATIONS

### *A. Conclusions*

Relevant to the current events and the rising rates of motorcycle napping in the Philippines, it is noted that this is due to the less security installed in the motor vehicles and how difficult it is to resolve crimes relating to these motorcycle incidents. The mobile application was developed to benefit of giving notification during alerts. It render different features that will aid the notification attribute of the device such as notification with accurate and real-time map location with history logs, using of fingerprint as initiation starter switch and registering a fingerprint, and captured images when there are unwanted fingerprint and movements are involve that automatically saved onto the user's mobile with logs of previous and present images.

The different test results display that the system an accurate, efficient, proficient detection of unwanted fingerprints and movements. Testing the fingerprint precisely distinguished the different fingerprints scanned. Assessing the movement emphasize its systematical detection of the unwanted movements. Real-time locations and captured images that were sent via mobile application displays an accurate and definite data. Survey results manifest an impressive data on whether the respondents would like to install the device on their motorcycle.

### *B. Recommendations*

Although, it shows that a minimal of doubtful respondents to install the device. With the authorities, they are overwhelmed that a device could be installed on the motorcycle. They approved and suggested that a device should be installed on the motorcycle so that it will be easily tracked and recovered when stolen. Practically speaking, installing an additional layer of security to a vehicle would cost some



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amount that not all motorcycle owners would gladly comply. As for the record, motorcycles in the Philippines are mainly used to aid in transportation in the middle of a traffic congestion, a source of livelihood or as for leisure or hobbies in which Filipinos consider valuable in their everyday lives.

Therefore, the recognition of having additional security to your motor vehicle to avoid or lessen crimes is one fundamental instrument not just as a counterpart in crime prevention but as well as a remarkable breakthrough in the civilian's peace of mind that their vehicles are safe in wherever location and whatever occasion it is.

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