

Innovation of Motorcycle Anti-Theft Device Using Embedded Systems and Internet of Things (IoT) Technology

Muhammad Arif Syafiq, M.^{1,*}, Muhammad Amirul Sufian, MY.², and Norul Amin, H.³

¹ aremint99@gmail.com

* Correspondence: aremint99@gmail.com.

Abstract: Motorcycle theft cases in Malaysia is very significant increase with many cases reported every day. In most cases, motorcycle thieves will remove only the necessary motorcycle components while discarding the unnecessary parts. Therefore, a motorcycle anti-theft device (MATD) was innovated with the aim of preventing and reducing motorcycle theft cases. MATD was built by using the embedded system and internet of things (IoT) technology. It was driven by a microcontroller chip and other modules. MATD is equipped with the main function to turning ON and OFF the motorcycle engine using wi-fi. While the other functions are tracking and sending location, sending notification notices and taking static photos. These functions are received by using the Telegram application on a smartphone. MATD is built using ESP32, NEO-6M, 4G LTE modem and ESP32 CAM modules. All these modules are integrated by using an Arduino IDE as a programming language. Basically, MATD will work when the user realizes his motorcycle is stolen. By using a smartphone, the motorcycle engine will be turned OFF immediately. At the same time, the user will receive a notification along with the latitude and longitude of the motorcycle's location. The location of the motorcycle can be tracked using the Google Maps application. The camera will record the face of the thief and deliver the image to the smartphone using the Telegram application.

Keywords: Motorcycle theft; Motorcycle anti-theft device; Embedded system; Internet of things.



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1. INTRODUCTION

In today's era of computing technology, embedded system technology is very popular in helping humans do tasks intelligently and automatically. Embedded systems are part of the "Internet of Things" (IoT) which combines electronic technology, semiconductor components and computing. This system consists of four parts namely processor, memory, input-output and software. Devices produced through this technology can be used in various fields such as manufacturing, transportation, surveillance and others.

1.1 Problem Statement

As many motorcycle manufacturing companies introduce fast and attractive models, motorcycle theft cases show an increase. Most motorcycle thieves will remove essential components and sell them on the black market. The price of motorcycle spare parts on the black market is cheaper than the price at a workshop or service centre. Therefore, a motorcycle anti-theft device or MATD was innovated with the aim of preventing and reducing motorcycle theft cases.

1.2 MATD Structure

MATD is built using embedded system technology and IoT driven by a microcontroller chip and several other modules. MATD operation are programmed using the Arduino IDE programming language because it is easy to maintain and modify. MATD is equipped with the main function of turning ON/OFF the motorcycle engine using wireless-fidelity or wi-fi. While other functions are tracking and sending location, sending notification notices and taking static photos. These three functions are received by using the Telegram application on a smartphone. MATD is built using ESP32 module as microcontroller unit (MCU), NEO-6M module for global positioning system (GPS), 4G LTE module for wi-fi modem and ESP32 Cam module to take static photos.

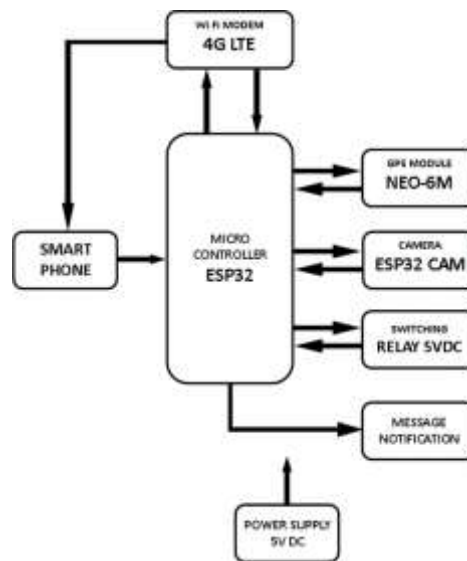


Figure 1. Motorcycle Anti-Theft Device (MATD) block diagram.

1.3 MATD Operational

Basically, MATD will work when the user realizes his motorcycle is stolen. By using a smartphone, the motorcycle engine will be turned OFF immediately. At the same time, the user will receive a notification along with the latitude and longitude of the motorcycle's location. The location of the motorcycle can be tracked using the Google Maps application. The camera will record the face of the thief and deliver the image to the smartphone using the Telegram application. All the actions implemented by this device will prevent the thief from fleeing the motorcycle and in addition to the recorded facial image can help the authorities catch the criminal. The motorcycle engine can be turn ON again by sending a command, also via smartphone.

1.4 Wiring and Installation

MATD installation on motorcycles is on the main ignition switch line. This ignition switch main line is cut and connected to the 5VDC relay. The relay will work as a switch to turn the motorcycle engine ON or OFF when receiving commands via the smartphone. The MATD and relay receive a 5VDC power supply from a power bank.

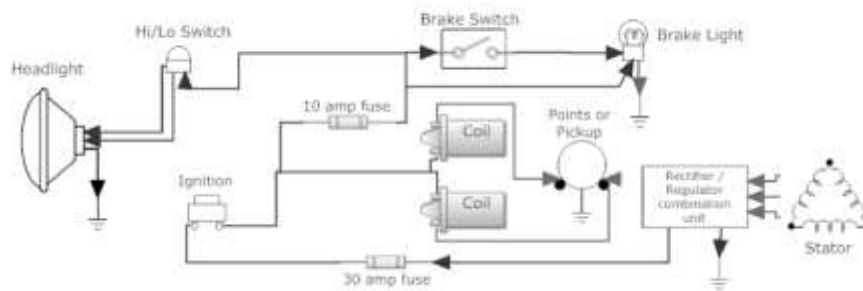


Figure 2. Basic circuit of motorcycle ignition switch wiring.
(Source: <https://m.roadkillcustoms.com>)

2. METHOD

According to Kamus Dewan (2010), methodology means a system that includes methods and principles used in an activity, discipline and so on. Therefore, this chapter will explain how the project implementation and development process is carried out. It covers flow charts, Gantt charts, construction phases of the project model and programming, testing sessions and test-runs as well as construction cost estimates.

2.1 Design Process Model

Process design is an approach to breaking down a large project into manageable chunks. Architects, engineers, scientists, and designers use the design process to solve a variety of problems. In carrying out project development work, "The Design Process" module was used. This model contains six steps for designing work in solving a project or problem. Referring to the "Chicago Architect Centre" (2019), the six steps are;

2.1.1 Define the Problem

Have a clear idea of the problem to be solved so that the solution can be determined easily.

2.1.2 Collect Information

Collect sketches, take pictures and collect data to start providing initial inspiration.

2.1.3 Brainstorm and Analysed Ideas

Start sketching, creating, and learning to understand how all the data and information gathered can affect the design that will be produced.

2.1.4 Develop Solutions

Take initial ideas and plan various solutions and produce small-scale designs.

2.1.5 Gather Feedback

Present the idea to as many people as possible such as friends, teachers, professionals, etc. to provide insightful comments.

2.1.6 Improve

Think about all the feedback received and decide if it can be used to improve the design to solve the problem.

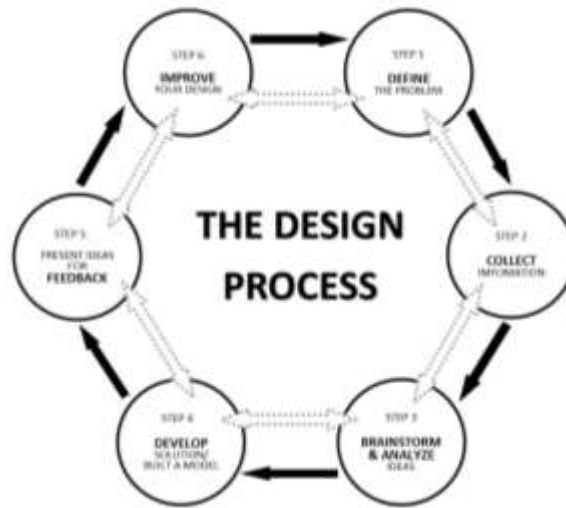


Figure 3. Sequence of the design process

2.2 Flowchart

According to Gilbreth & Gilbreth (1921), a flow chart is a type of diagram that represents the flow or work process. A flowchart can also be defined as a diagrammatic representation of an algorithm in which a step-by-step approach is used to complete a task. The steps of each work on the flow chart are shown through various box diagrams and the work instructions are shown by connecting each box with arrows. Briefly, the flow chart for building MATD products is divided into two processes, namely the process of building a MATD prototype and the process of developing a programming code for a microcontroller chip.

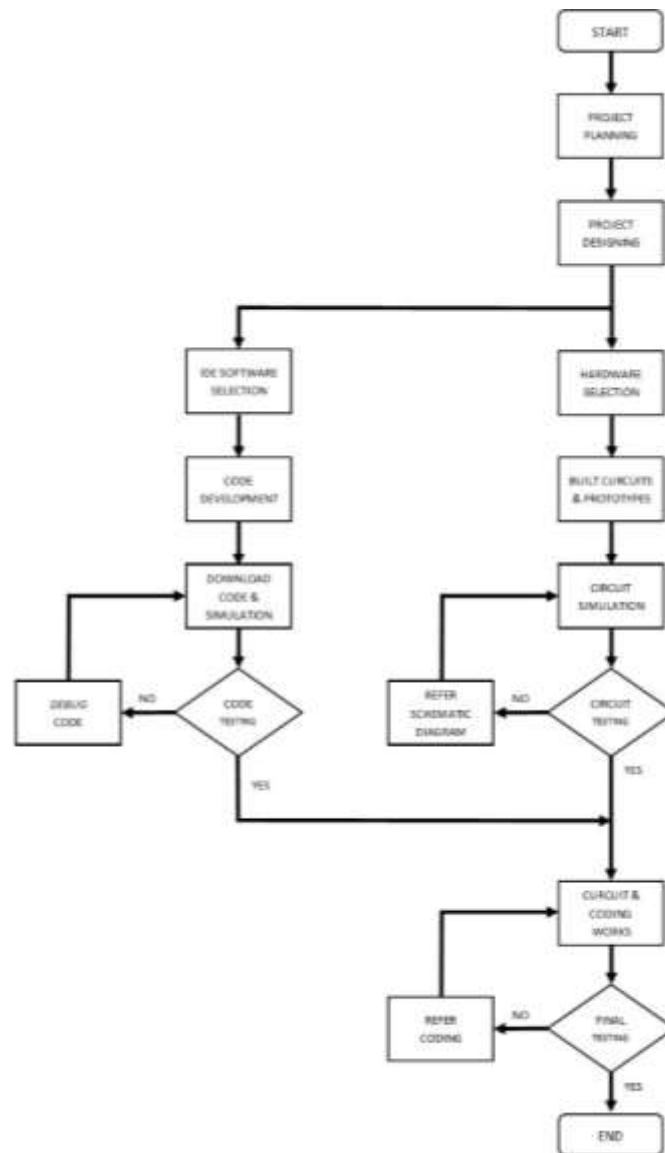


Figure 4. The flow chart of the MATD project.

3. RESULTS AND DISCUSSION

3.1 Product Testing Process

MATD products have undergone two types of tests, namely laboratory tests and test runs. Laboratory tests are performed throughout the development and construction process of MATD. This test is conducted to identify problems such as IoT module installation, circuit wiring and coding. For the test run, the MATD was installed on the motorcycle and its operational capabilities were directly tested. Among the operational abilities tested are ON and OFF the motorcycle engine, sending notification notices and location and capturing still images. Wi-Fi and internet network capabilities are also tested.

3.2 Test Result

The test results obtained are very encouraging. During the laboratory tests, all the problems encountered were solved successfully. Among the most common problems encountered are coding and

internet Wi-Fi capabilities. Meanwhile, the results of the test run show that all the features set on MATD work perfectly.

3.3 Discussion

Among the advantages of MATD is being able to turn ON/OFF the motorcycle engine at a long distance, capture still images clearly and send the latest longitude and latitude of the motorcycle's location. However, this MATD product also has a weakness, which is that all its functions depend on the internet network. In the future, this MATD product can be improved in terms of the use of IoT technology, sizing, coding and waterproof casing. Additional features can also be included, such as sending photos directly to the authorities.

4. CONCLUSION

After going through a series of testing processes, it can be concluded that this MATD innovation project has been successfully implemented. All the set criteria have been successfully proven through the display shown on the screen of a smartphone or tablet. Therefore, in order to ensure that this product achieves its objective, it needs to undergo a trial process by authorities such as PDRM, JPJ and Puspakom.

References

- Arsath Natheem, S. (2021). *Arduino Book for Beginners: Getting Started with Arduino Basics Programming with Projects*. Independently published.
- Chicago Architect Center. (2019). *Discover Design Handbook: What is the Design Process? Why is it helpful?* Retrieved from <https://discoverdesign.org/handbook>
- Getting started with ESP32. (2023) Retrieved from <https://dronebotworkshop.com/esp32-intro/>
- Gilbreth, F. K & Gilbreth, L. M. (1921). *Process Charts*. American Society of Mechanical Engineers.
- Henry, I. (2019). *ESP32 Development using the Arduino IDE*. https://oceanofpdf.com/authors/iain_hendry/pdf-epub-esp32-development-using-the-arduino-ide-download/?id=002072425116
- How to Wire Your Motorcycle or Rat Bike ~ Basic Wiring Diagrams: Retrieved from <https://m.roadkillcustoms.com/how-to-wire-your-rat-bike-or-motorcycle-project/>
- Kamus Dewan. (2010). Edisi ke-4. Retrieved from <http://prpm.dbp.gov.my/cari1?keyword=metodologi>