Motorcycle Engine Shut-off Device

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Abstract: The Motorcycle Engine Shut-off Device was developed for the security and tracking of motorcycle against thieves and intruders. The device was capable of remotely stopping and starting the motorcycle engine through Short Message Service (SMS), and locating its whereabouts in real-time by using Global Positioning System (GPS) module. Locally available materials were used in the fabrication of the prototype such as Arduino Nano, relay, GPS module, Global System for Mobile Communications (GSM) module and Subscriber Identity Module (SIM) card. The developed prototype was tested for its functionality, compatibility, and durability. The result of the functionality test showed that the device was able to send and receive SMS, therefore enabling the engine of the motorcycle to start or stop; also, the device was able to track the location of the motorcycle being tested. The compatibility test showed that the device was fully operational on selected motorcycle and tricycle models. For the durability of the device, it was installed on a motorcycle and tricycle and tested on a maximum of 30 km distance. The result showed that the device was still working with no loose wirings and components. The performance of the developed prototype was evaluated by 20 respondents which composed of IT experts, Rosario Traffic Management Office personnel, police officers, motorcycle/tricycle owners, and other possible end-users, according to its quality, durability, safety, functionality and economy. The prototype gained and overall mean score of 4.65 with a descriptive rating of "Excellent" signifying that the prototype met its objectives and that the evaluators were satisfied of the outcome and capabilities of the Motorcycle Engine Shut-off Device.

Keywords: anti-theft, kill switch, GPS, SMS, motorcycle

Introduction

The California Motorcycle Handbook defined motorcycle as a motor vehicle with a seat or saddle for the rider designed to travel on not more than three wheels [1]. It is a two-wheeled vehicle that is powered by a motor and has no pedals. Basically, motorcycles served as means of public transportation nowadays. Due to incurable traffic situation in the streets, people would rather ride a motorcycle to speed up their way. Almost every corner of the street, there is a motorcycle rider avoiding the fatal traffic congestion. With this, motorcycles gained its advantage over taxis, buses, and other public utility vehicles. Its commercial purpose has extensively impacted the society and economy. Apart from its purpose as means of transportation, motorcycle symbolizes different things to different kinds of people. For some, motorcycle encompasses mobility. At this age of industrial revolution, mobility is a necessity. Having a motorcycle also means expression of freedom of being where people want to be when they want to be there. It also represents the high spirits of power and speed. Thus, it offers an exciting satisfaction and pleasure than any activity a person can engage in.

The Philippines is most likely one of the countries in the South East Asia with many motorcycle owners and riders. In fact, the Region IV-A has recorded a total of 360,297 registered (new and renewal) motorcycles based on the Semi-Annual Report 2018 of the Land Transportation Office [2]. Because of this, motorcycles have been the common target of thieves and intruders due to its abundance. Incidents of car theft are undeniably a persistent dilemma in the country. Records from the Philippine National Police Highway Patrol Group (PNP-HPG) showed that 5,363 carjacking incidents were documented in 2017, compared to 7,680 car thefts that took place in 2016. Most that were stolen are motorcycles at 4,939 while the rest are four-wheeled vehicles at 424 [3]. That is why, the PNP has urged the car and motorcycle owners to be vigilant and to install security alarms and similar devices on their vehicles.

With the increasing number of motorcycles stolen across the country, the researchers proposed a prototype called Motorcycle Engine Shut-off Device. There are various alarm systems and anti-theft devices in order to prevent to prevent thieves and intruders from stealing motorcycles. Among these are: brake disk lock alarm, simple alarm, GPS tracker alarm, motorcycle decoy alarm, kill switch, etc. [4]. A kill switch is a hardware or software that immediately stops an operation [5]. It interferes with the car engine's combustion process and is engineered to shut it down in the quickest way possible. Depending on their design, different types of kill switches can stop the car through several different mechanisms. One of the most common ways involves the spark plug, and other methods can activate based on a certain number of engine revolutions [6].

The proposed device was composed of these major components: Arduino Nano, relay, GPS module, GSM module and SIM card. The Arduino Nano is the central processor that controls the device. It is a small, complete, and breadboard-friendly board based on the ATmega328 or ATmega168. Its small form factor makes it perfect for use in more finished projects [7]. The relay switches on/off the engine of the motorcycle. The GPS module is the hardware for navigational system which uses satellite signals to locate the real time location of the motorcycle [8]. The GSM module is the hardware for digital mobile network that is widely used by mobile phone users while the SIM card stores data for GSM cellular telephone subscribers. This innovation in motorcycle security system has the capability to turn on/off remotely the engine of the motorcycle through SMS, and track the location of the motorcycle in real-time. The motorcycle owner controls the operation of the device using mobile phone.

Objectives

The general objective of the study was to develop a motorcycle engine shut-off device. Specifically, the study aimed to:

1. Design a Motorcycle Engine Shut-off Device capable of turning on/off the engine of the motorcycle through Short Message Service (SMS), and tracking the location of the motorcycle in real-time.
2. Fabricate a device using locally available materials such as Arduino Nano, SMS module, GPS module, and SIM card.
3. Test and improve the developed prototype using functionality, compatibility and durability tests.
4. Evaluate the performance of the device in terms of quality, durability, functionality, safety, and economy.

Methodology

The researchers used the developmental type of research to conduct this study. This approach employed thorough planning and analysis to develop the prototype. The conceptual model, as illustrated in Figure 1, shows the different blocks significant in achieving the objectives of the study. Moreover, the following stages were considered by the researchers: design stage, development stage, testing and improvement, and evaluation.

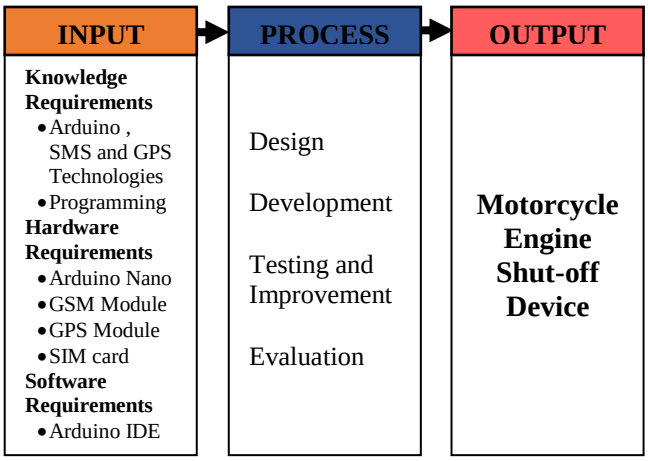

Figure 1. Conceptual Model

Design Stage

This phase focused on identifying the essential information such as knowledge, hardware and software requirements needed in the development of the device. The device specifications and programming langue used were also identified. The researchers also came up with the working layout of the device. Figure 2 presents the design layout of the motorcycle engine shut-off device.

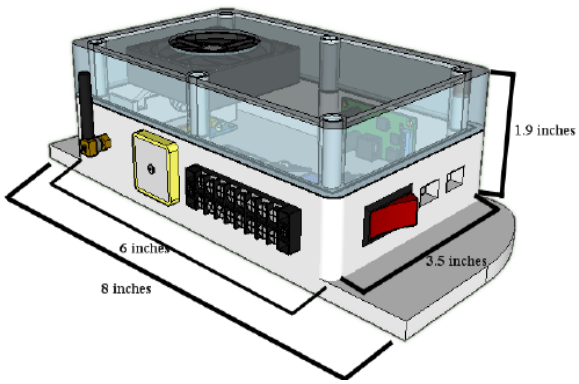

Figure 2. 3D layout of the prototype

Figure 3 shows the block diagram of the Motorcycle Engine Shut-off Device. The process starts when the user sends a code to the GSM module. The buzzer alert when the GSM module has a signal. The GSM module will receive it and send data to the Arduino Nano, then it controls the on and off switching of the relays and starts to track the location. Once the relay turns off, the buzzer has 10 seconds of delay. To track the location, the user sends again SMS to GSM module it will send 10 messages indicating the location of the motorcycle to the mobile phone.

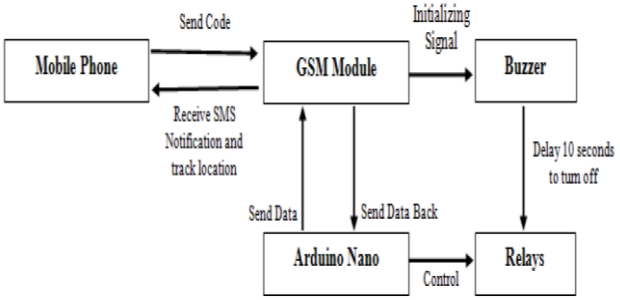

Figure 3. Block Diagram

Development Stage

This phase covered the fabrication of the device considering the design specifications. Locally available materials were used in the fabrication considering their availability, quality and cost. Table 1 shows the list of supplies and materials used in the development of Motorcycle Engine Shut-off Device.

Table 1. List of Supplies and Materials

Quantity	Unit	Description
1	pc	Arduino Nano
1	pc	Battery Case
1	pc	Battery Charger Module
1	pc	Buzzer
1	pc	Casing
1	pc	DC – DC Step Down Converter
1	pc	GPS Module
1	pc	GSM Module
1	pc	Relay
1	pc	SIM Card
1	pc	Switch
1	pc	Terminal Block
5	meters	Wire
1	pc	9V Battery

Testing and Improvement

In this phase, the developed prototype was tested for its functionality, compatibility and durability to ensure that it will work in accordance to the objectives of the study. The functionality test was conducted to ensure that major components of the device were operational. The components being tested were GSM module, relay, and GPS module. Moreover, the compatibility test was performed if the prototype will be able to work in other motor vehicle such as tricycle. Furthermore, the durability test was conducted to guarantee that the developed prototype has a high quality of workmanship, that it can withstand wear, pressure or damage. The device was installed on both motorcycle and tricycle and travelled the Rosario, Batangas to Sariaya, Quezon route.

Evaluation

The evaluation instrument used by the researchers has five (5) major criteria such as quality, durability, safety, functionality, and economy. The device was evaluated by twenty (20) respondents composed of ten (10) technical experts such as IT experts, Rosario Traffic Management Office personnel and police officers; and ten (10) possible end-users such motorcycle and tricycle owners.

Results and Discussions

The developed Motorcycle Engine Shut-off Device aimed to turn/off remotely the engine of the motorcycle through SMS, and track the whereabouts of the vehicle being tested in real-time using GPS. The actual prototype is presented in Figure 4. The device is composed of the following major hardware components: relay, terminal block, Arduino Nano, GPS module, GPS antenna, GSM antenna, buzzer, GSM module, fan, step-down power supply, casing, and switch. All components were enclosed in a 6"x1.9" casing.

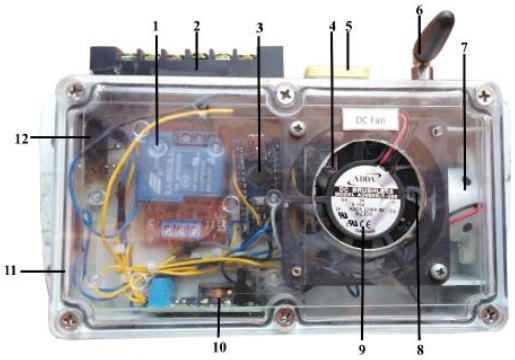

Figure 4. Motorcycle Engine Shut-off Device

Figure 5 shows the installation of the Motorcycle Engine Shut-off Device in the motorcycle u-box. The device has a kill switch function to remotely turn on/off the engine of the motorcycle in case of theft.

Figure 5. Installation of the device in the motorcycle u-box

Table 2 lists the parts and functions of the developed Motorcycle Engine Shut-off Device.

Table 2. Parts and Functions of the Device

Parts	Functions
1. Relay	Turns on and off the engine of the motorcycle
2. Terminal Block	Connects the wires from the battery and engine of the motorcycle to the prototype
3. Arduino Nano	Controls the operation of the device
4. GPS module	Finds the location of the vehicle and transmits it to the microcontroller
5. GPS antenna	Establishes signal to the GPS module
6. GSM antenna	Establishes signal to the GSM module
7. buzzer	Alerts the motorcycle rider when turning off the engine of the motorcycle
8. GSM module	Serves as communication link to the mobile device to send/receive SMS
9. fan	Prevents the device from overheating
10. step-down power supply	Supplies power to the Arduino Nano
11. casing	Encloses the components of the device
12. switch	Serves as on/off button of the device

Test Results

The developed Motorcycle Engine Shut-off Device was subjected to functionality, compatibility, and durability tests respectively in order to find out the capability of the device.

Functionality Test

Table 3 depicts the result of functionality test. The device was installed in two (2) motorcycles and two (2) tricycles. This test was performed if the device can receive SMS notification, turn on/off the engine of the motorcycle, and track the location of the vehicle being tested. The functionality of GSM module, relay, and GPS module were tested here. It can be gleaned from the table that the device was able receive SMS, turn on/off the engine, and track the location of the vehicle being tested.

Table 3. Functionality Test Result

Vehicle	**GSM module** sends and receives SMS?		**Relay** turns on/off the engine?		**GPS module** tracks the location of the vehicle?	
	Yes	No	Yes	No	Yes	No
Motorcycle 1 (Kawasaki Fury)	✓		✓		✓	
Motorcycle 2 (Suzuki x4)	✓		✓		✓	
Tricycle 1 (Suzuki x4)	✓		✓		✓	
Tricycle 2 (Suzuki Smash)	✓		✓		✓	

Compatibility Test

Table 4 shows the result of compatibility test. Two (2) motorcycles and two (2) tricycles were subjected to this test if the performance of the device works well with different vehicle models. The device was installed and tested on Kawasaki Fury, Suzuki x4, and Suzuki Smash. After series of tests were performed, the device was found to be compatible on the selected motorcycle/tricycle models. Compatible means that the device was able to work well on selected vehicle models.

Table 4. Compatibility Test Result

Vehicle		Remarks
No.	**Model**	
1	Motorcycle 1(Kawasaki Fury)	Compatible
2	Motorcycle 2(Suzuki x4)	Compatible
3	Tricycle 1(Suzuki x4)	Compatible
4	Tricycle 2(Suzuki Smash)	Compatible

Durability Test

Table 5 shows the result of durability test. The device was installed on a motorcycle and subjected to test in 10 km., 20 km., and 30 km. distance. The motorcycle travelled from Rosario, Batangas to Sariaya, Quezon. The device was also installed on a tricycle and travelled the same route. It can be gleaned from the table that the device was durable and worked well despite of the long distance and partial rough road it travelled. The device was able to withstand significant deterioration, has high degree of workmanship, and has resistance to the effects of heavy use, wear, pressure or damage.

Table 5. Durability Test Result

Vehicle	Distance (km)	Route	Route Description	Remarks
Motorcycle	10	Rotary Club to Alupay, Rosario	Concrete highway with partial rough road	Durable
	20	Alupay, Rosario to Ang Dating Daan, San Juan	Concrete highway with partial rough road	Durable
	30	Ang Dating Daan, San Juan to Sariaya, Quezon	Concrete highway with partial rough road	Durable
Tricycle	10	Rotary Club to Alupay, Rosario	Concrete highway with partial rough road	Durable
	20	Alupay, Rosario to Ang Dating Daan, San Juan	Concrete highway with partial rough road	Durable
	30	Ang Dating Daan, San Juan to Sariaya, Quezon	Concrete highway with partial rough road	Durable

Evaluation Results

The developed Motorcycle Engine Shut-off Device was evaluated by 20 respondents using an evaluation instrument with the following criteria: quality, durability, safety, functionality, and economy. Table 6 presents the summary of evaluation.

Table 6. Summary of Evaluation

Criteria	Mean	Descriptive Rating
Quality	4.70	Excellent
Durability	4.60	Excellent
Safety	4.62	Excellent
Functionality	4.77	Excellent
Economy	4.58	Excellent
Overall Mean	**4.65**	**Excellent**

Based on the evaluation results, the functionality obtained the highest mean score of 4.77 with a descriptive rating of "Excellent". This implied that the device worked well in turning on/off the engine of the motorcycle, sending SMS notification, and tracking the whereabouts of the vehicle being tested in real-time. However, the economy of the device acquired the lowest mean score of 4.58. Although it has a descriptive rating of "Excellent", the evaluators were not satisfied of its economic value.

The overall rating of the device obtained an overall mean score of 4.65 with a descriptive rating of "Excellent". This indicates that the evaluators were satisfied of the outcome and capabilities of the Motorcycle Engine Shut-off Device.

Conclusions

In accordance to the objectives of the study and the results of evaluation conducted, the following conclusions were drawn:

1. The Motorcycle Engine Shut-off Device was successfully designed to turn on/off the engine of the motorcycle through Short Message Service (SMS), and track the location of the motorcycle in real-time.
2. The device was fabricated as designed using locally available materials such as Arduino Nano, SMS module, GPS module, and SIM card.
3. The device was successfully tested and improved for its functionality, compatibility and durability.
4. The device was rated "Excellent" with an overall mean score of 4.65 by experts and possible end users based on the results of evaluation conducted.

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Author Profile

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