Motor Vehicle Security using Microcontroller, GPS and Android as Innovation to Prevent Motor Thieves

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Abstract. Nowadays, transportation plays a big part in our daily lives. Everyday, people in Indonesia are increasingly using vehicles especially motorcycles. Unfortunately, along with the increasing number of motorcycle users, motorcycle theft has also increased. In this paper, we propose the prevention of theft and recovery of motorcycles by using sensors and microcontrollers connected to smartphones. In case of theft, the sensor will be activated automatically and the user will be notified by this system via an alarm warning. Users not only can see the location of the motorcycle at this time but also can turn off the engine through a smartphone even though the distance is long as there is an internet network. The results showed that the system can turn on/off motorcycle engines automatically using an Android Smartphone. The vibration sensor could activate the alarm and send a notification to the owner of a motorcycle. The motorcycle can be monitored by GPS devices that have been embedded on a motorcycle.

1. Introduction

Most of our daily activities take place outside our home. Therefore, transportation greatly influences aspects of life to carry out daily routines. Transportation has contributed a lot to daily activities. In Indonesia, one of the current transportation is motorcycles and becoming the most common means of transportation. The motorcycle is one of the cheapest modes of transportation. But unfortunately, it is easily stolen, and easily dismantled. When the motorcycle industry is growing rapidly, motorcycle theft is also increasing in different ways.

The Indonesian National Police (INP) has recorded a periodic increase in cases of stolen motorcycles across the country. The INP said that in 2017 up to 2018, they recorded the cases of stolen motorcycles increase by 45.7% in a number province of Indonesia. Motorcycle theft indeed has become a big problem in the community. Although the authorities are said to be doing the best they can to stop these thieves, it still ranks high up in the list of crimes committed in the streets every day.

Security plays a vital role in today's society. The safety of vehicles is extremely essential for every private and public vehicle owner. For this reason, several ways to deal with theft have been carried out, but most of these security systems are expensive and complicated. Many motorcycle security systems have been put in place to improve the security system, but theft still remains [1].
Another security systems use GPS to turn off a motorcycle engine remotely via text message. But if the person is far from the location of the motorcycle, he could not hear alarm sound. The prevention of physical types is also used such as padlocks, disk brake locks, and others [2]. In [3] proposed GSM and GPS technology, used to send information messages to emergency services in the event of an accident. While in [4] proposed an accident location detection system. This system includes an accident tracking device, an accident management website, and an SMS system in the event of an accident. The authors in [5] described the vehicle positioning system using an accelerometer sensor which is connected to the android. This technology is used to detect accidents using sensors to determine location. The authors in [6] proposed a vehicle anti-theft system based on sensor networks. Here, sensors are installed on the vehicle, then the possibility of vehicle theft is monitored by detecting a vehicle transfer. The authors in [7] described RFID applications in-vehicle networks and regulate vehicles in the community, detection of vehicle theft and speed violations. The authors in [8] proposed the design and implementation of GSM-based digital fuel and detection of fuel theft using a microcontroller. The amount of fuel in the tank is displayed digitally. Every time a fuel theft occurs, a text message is sent on the cellphone to the owner.

One of the existing solutions for motorcycle security available in the market today is the Scorpio Ride “Core” Cellular Motorcycle Alarm. It uses iOS or Android app and a module installed inside the bike. It sends a Short Message Service (SMS) alerts to notify the user for any tampering of the motorcycle. It has also the ability to track a vehicle's location. This system does not have enough preventive measures during theft attempts.

Therefore, this study proposed to develop the security system solutions to motorcycles. This study also to develop and improve its functions to better suit its purpose. This innovation of a vehicle security system has the ability to turn off the vehicle engine and send real-time alerts to the vehicle owner. Thus, preventing the theft from taking the motorcycle.

This security system also provide the features which able to locate the motorcycle and turn-off the motorcycle. This is possible through the use of Global System for Mobile communication (GSM), Global Positioning System (GPS) technology, sensors, mobile phone. Vertical information from GPS data is crucial for constructing the top depth of the fault [8]. The user controls the whole system using a mobile application. Variation or change in charging voltage is required for the tracking of maximum power points using the Pertub & Observ algorithm [9].

2. Methodology

2.1. System Architecture

Based on Figure 1, the system is divided into two parts: Hardware and Software parts. The hardware module of the system is embedded with Micro-controller, Global System for Mobile (GSM), Global Positioning System (GPS) technology, engine immobilizer or turn-off switch, and mobile application. Micro-controller serves as the main control of all the operations of the hardware components. GSM module acts as an intermediate between the vehicle and the owner, providing a two-way communication, and connects the hardware and software modules of the system. It is also responsible for sending and receiving Short Message Service (SMS) and Multimedia Messaging Service (MMS) to and from the user. The GPS module is used to obtain the vehicle’s location coordinates (Longitude and Latitude).

The engine immobilizer or turn-off switch is used to immobilize the vehicle engine upon the Alarm System activation to prevent a thief from taking the vehicle or by riding the vehicle. The hardware module will be installed inside the vehicle. The software module of the system is the mobile
application, which will be the medium of communication of the user to the vehicle and will also serve as the master control of the whole system.

Figure 1. System Architecture of Motorcycle Theft Prevention Security

2.2. Hardware Design

We have assembled the hardware and electronics needed for this project. Some of the components needed for installation are Arduino Uno, SIM 808 Module, StepDown DC, Relay, and Vibration Sensor. The microcontroller and component circuit is shown in Figure 2.

Figure 2. Microcontroller and circuit diagram of component

Figure 2, shows the microcontroller and other components will put inside of the motorcycle bagasse. This hardware as the master control of the security system. How the Alarm System initiates? Through the mobile application, the user can activate or deactivate the Alarm system remotely by sending text SMS. The commands are encrypted to avoid unauthorized access to the system using another phone. The sent SMS commands from the user will be received by the GSM module.
Hardware which assembled is placed in the trunk of a motorcycle right under the seat with a relay connected to the switch, starter, and alarm is connected to the motorcycle horn. The power supply is obtained from a motorcycle battery. The installation of tools on a motorcycle can be seen in Figure 3.

![Figure 3. Hardware Installation and Alarm Connection](image)

2.3 Software Support Design

We have designed the software called it **MC Controller (Motorcycle Controller)** to support this project. The software specification are as follows:

- We use Java language for Android and C language for Arduino Uno microcontroller programming.
- Using SIM 808 devices as GPRS / GSM and GPS.
- Using the Vibration Sensor Module as a vibrating detector that is connected to the horn (as a motorcycle alarm) and sending notifications to the Android smartphone as a notification if there is interference to the User.

3. Results and Discussion

3.1. The button of Ignition Key

The ignition key menu is used to control the motorcycle through a GPRS (General Packet Radio Service) that is connected to a server. The user can turn on/off the motorcycle engine switch by simply presses the ignition key once in the button menu, as shown in Figure 4.

![Figure 4. Alarm System Initiations of Motorcycle Security System](image)
Figure 4 shows, upon the Alarm System activation, the system obtains location coordinates (Latitude and Longitude) of the vehicle and enables the engine immobilizer or turn-off switch in order to avoid thief from riding the vehicle. The only chance of taking the motorcycle is by loading it to another vehicle. Therefore, the system provides the vehicle's location and continually monitors or checks and updates if there is a change in the vehicle's location. The partial key program code is shown in Figure 5.

![Figure 5. Partial Key Program Code](image)

3.2. **The Alarm Button and Location**

By using the alarm button menu, user can turn on the alarm when in the parking area or when it is parked, if on a motorcycle a vibration occurs then the alarm will sound (connected to the motorcycle horn) and will send a notification (vibration detected) to the android smartphone. The location menu shows the location of the motorcycle. The system will send the user the location of latitude and longitude to the Android smartphone in the form of Google Maps, is shown in Figure 6.

![Figure 6. The Motorcycle Location Point](image)

3.3. **The Motorcycle Position Testing Connected to Database Server**

We have tested several motorcycle position points via GPRS, measuring the distance between Android and Motorcycle and test results are shown in Table 1.
Table 1. GPRS Distance Measurement Results

| No | Distance (Meter) | Results   | Notes     |
|----|------------------|-----------|-----------|
| 1  | ± 5              | Connected | Quick response |
| 2  | ± 10             | Connected | Quick response |
| 3  | ± 15             | Connected | Quick response |
| 4  | ± 20             | Connected | Quick response |
| 5  | ± 25             | Connected | Quick response |
| 6  | ± 30             | Connected | Quick response |
| 7  | ± 35             | Connected | Quick response |
| 8  | ± 40             | Connected | Quick response |
| 9  | ± 45             | Connected | Quick response |
| 10 | ± 50             | Connected | Quick response |

3.4. The Vibration Sensor Testing and Notifications

We have tested the vibration sensor in order to identify the possibility of a motorcycle condition. The testing results are shown in Table 2.

Table 2. Vibration Sensor Testing

| No | Alarm | Trial             | Distance (Meter) | Alarm Response | Notification Response |
|----|-------|-------------------|------------------|---------------|-----------------------|
| 1  | Off   | Silent            | ± 5              | Off           | Off                   |
| 2  | On    | There is Vibration| ± 10             | On            | On                    |
| 3  | On    | There is Vibration| ± 15             | On            | On                    |
| 4  | On    | There is Vibration| ± 20             | On            | On                    |
| 5  | On    | There is Vibration| ± 25             | On            | On                    |
| 6  | On    | There is Vibration| ± 30             | On            | On                    |
| 7  | On    | There is Vibration| ± 35             | On            | On                    |
| 8  | On    | There is Vibration| ± 40             | On            | On                    |
| 9  | On    | There is Vibration| ± 45             | On            | On                    |
| 10 | On    | There is Vibration| ± 50             | On            | On                    |

4. Conclusion

Based on testing implementation, we concludes that the Motorcycle Theft Prevention and Recovery Security System is very helpful to prevent motorcycle theft. The engine immobilizer or turn-off switch feature and alarm system are very much useful to prevent a thief from stealing motorcycles. In cases of motorcycles that are completely taken, this study helps in the recovery through the use of Global Positioning System (GPS) technology that locates the location of the vehicle.

This study providing to connect the hardware modules of the system that corresponds with the proposed hardware design of the study. The hardware module is in a small size that allows the installation under the seat of the vehicle safe and easy. The engine immobilizer or turn-off switch is easy to install without the need for a physical change of the motorcycle. This study found some weak points in the system. The accuracy and response of GPS depend on a wide variety of factors.

The communication of the user and the motorcycle were made possible through the use of the Global System for Mobile (GSM). The medium of communication depends on the cellular network coverage. Under some circumstances, there are delays in delivering and receiving SMS text. Overall, the output results of the system meet the proposed output and functionality of the study.
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