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Anti-Theft Motorcycle Alarm System Using GSM and GPS

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Abstract: This study is related to motorcycle anti-theft system which is a system that can increase awareness of the users on their vehicle. The system can prevent the motorcycle from being stolen easily by making a call to the owner's cell phone through the Global System for Mobile Communication (GSM). Existing alarm system in the market slowly shows its disadvantage. This is when the thief tried to steal a motorcycle, the system will produce a loud sound. People at the surrounding tend to ignore the noise and assume nothing is happening to the motorcycle. So, this project is conducted to improve the existing alarm system. Several types of sensors that suitable to use in the proposed system have been installed which are shock and vibration sensor, tilt sensor and ultrasonic sensor. These sensors will be placed in hidden places in the motorcycle to avoid the thieves from noticing it. So, when a thief tries to steal the motorcycle, the alarm system will be activated and GSM will make a call to the motorcycle owner. Another helpful device has been used in this system which is Global Positioning System (GPS) shield. This device will read the location of the motorcycle accurately and send it through GSM when the owner makes a request to the system.

Keywords: Arduino UNO, Global Positioning System (GPS), Global System for Mobile Communication (GSM).

1. INTRODUCTION

The production of vehicle manufacturing has been risen up day by day. A lot of vehicles were produced including cars, motorcycles, buses, and lorry. But, some people take advantage of this technology. They steal the vehicles and sell them to their customers inside and outside the country. The most reported cases regarding stolen vehicles are motorcycles. The unreported cases have not been calculated yet, but the numbers of stolen motorcycles already in a big numbers. So, a security motorcycle alarm system has been implemented years ago. But, the existing alarm system is less efficient as it only produce high pitch siren when the motorcycle is being disturbed. So, an improved alarm system was proposed to increase the awareness of the owner about their motorcycle's condition.

The sensors used in this project are shock and vibration sensor, tilt sensor and ultrasonic sensor. The first sensor, which is shock sensor, will be located at the bottom of the motorcycle seat. So when the thief sits on the motorcycle, the activated sensor will detect shock and send command to Arduino UNO to trigger the Global System for Mobile Communication (GSM) to make a voice call. As for the ultrasonic sensor, it will be located at the body of the motorcycle. The GSM will make a voice call if the sensor detects someone is approaching the motorcycle in a really close distance. The third sensor, which is tilt sensor, will be installed at the motorcycle stand. This is to detect if the stand is tilted, which mean the thief is trying to steal the motorcycle. The Arduino UNO will then trigger the GSM to make a voice call to the owner. Additional feature, which is Global Positioning System (GPS), has been added in this system. This feature allows the owner to track his motorcycle anywhere and anytime he wants. The owner just needs to make a voice call to the phone number in the system. Then, the system will send a Short Message Service (SMS) containing latitude, longitude, altitude and a Uniform Resource Locator (URL) of the location in the form of Google Maps through GSM shield.

This kind of alarm cannot 100% guarantee that the motorcycle is not being stolen and the thief can be captured. But, this system can help the owner by preventing the motorcycle from being stolen easily.

2. PROJECT OVERVIEW

The anti-theft system uses Global System for Mobile Communication (GSM) network to notify the motorcycle owner when someone is trying to steal the motorcycle by making a voice call and Global Positioning System (GPS) to track the motorcycle's location. These networks are triggered by shock sensor, ultrasonic sensor and tilt sensor. All the process will be controlled by microcontroller installed in Arduino UNO board.

2.1 Global System for Mobile Communication (GSM)

Global System for Mobile Communication (GSM) is the second-generation (2G) digital cellular networks used by mobile phones. This network replaces the first generation

(1G) analog cellular network. The frequency bands supported are 850 MHz, 900 MHz, 1800 MHz or 1900 MHz [1]. But, different country are using different frequency band. The proposed system is targeted to be implemented in Malaysia which is an Asian country where most of the Asian countries use 900 MHz or 1800 MHz bands. Meanwhile 850 MHz and 1900 MHz bands are used in Canada and United States to communicate using 2G cellular network. The GSM network can be used anywhere in this world as long as the country supported the frequency band mentioned. GSM use Time Division Multiple Access (TDMA) Technology that allows several users to share the same frequency channel by dividing the signal into different time slots [2]. The structure of the GSM network is shown in Figure 1.

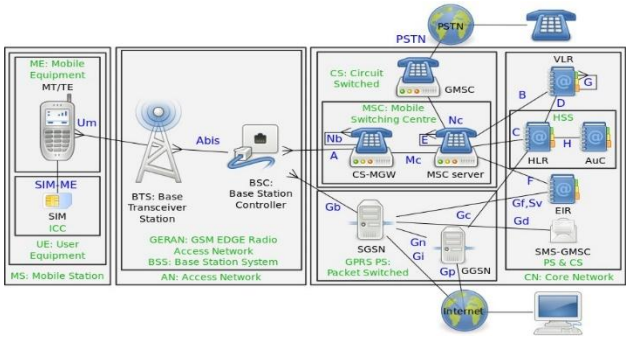


Figure 1. Structure of a Global System for Mobile Communication (GSM) network [3]

2.2 Global Positioning System (GPS)

The Global Positioning System (GPS) is a system that allows people to get an accurate position on the Earth anytime and anywhere depends on the weather at that location. Bad weather will not guarantee the accurate position reading as the GPS needs at least four or more GPS satellites signal. In other words, GPS needs a clear sky view to get the exact data [4]. The parameters that can be collected by GPS are latitude, longitude and altitude. Latitude is measured in angle which range from 0º to 90º (North or South). When the point is in the North Pole from the equator, the angle will be positive and it will be negative in South region. The locations that located lower than the equator will have negative angle and vice versa. Meanwhile the range for longitude is from 0º to 180º. Same as latitude, the positive and negative angle indicates different region on the Earth. But, the different is angle of latitude is determined by East and West region. East region will has positive angle and West region will give negative value. So, in order to have a coordinate to track particular location, both latitude and longitude as shown in Figure 2 and Figure 3 are needed.

2.3 Shock Sensor

Shock sensor in Figure 4 is the most popular sensor that being tested and installed in vehicle alarm system. The force in the forms of shock will be measured by the shock sensor, and if it is sufficient, signals will be sent to Arduino UNO through the output pin [6].

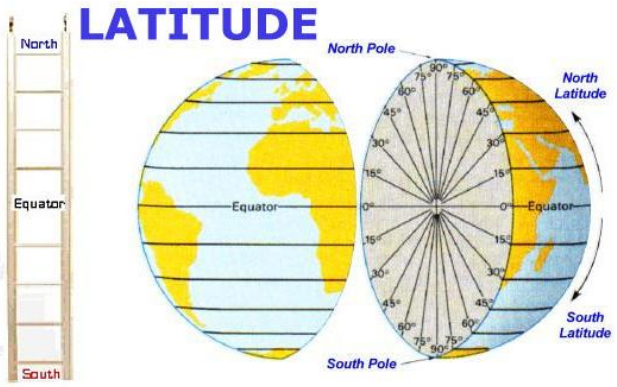


Figure 2. Latitude [5]

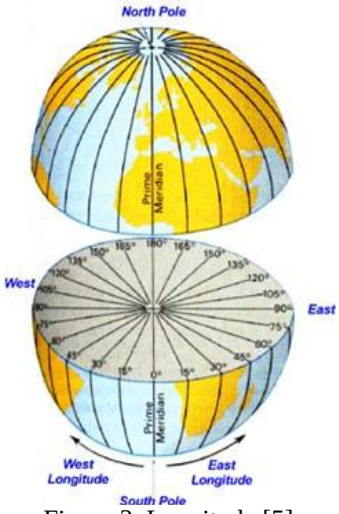


Figure 3. Longitude [5]

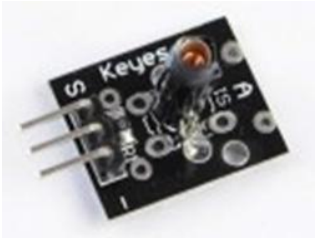


Figure 4. Shock sensor [7]

2.4 Ultrasonic Sensor

Ultrasonic sensor as shown in Figure 5 is widely used in robotic projects as it can avoid the obstacles in front of it [8]. In this project, the sensor will detect the distance of human approaching the motorcycle. The concept used to measure the distance in this sensor is reflection [9].The transmitter will reflect the echo to the receiver.

Figure 5. Ultrasonic sensor [10]

2.5 Tilt Sensor

Tilt sensor as shown in Figure 6 can measure tilting of an object. The sensor will be considered tilted when the tilting angle exceeds the threshold angle. The threshold angle is between 45 to 130 degrees.

Figure 6. Tilt sensor [11]

2.6 Arduino UNO Board

Arduino UNO in Figure 7 uses the Integrated Circuit (IC) of ATmega328P as the microcontroller. The recommend input voltage for this board is between 7 to 12 Volts. There are two choices to give the input to the UNO board which is Universal Serial Bus (USB) connection or external power supply. But, if the external voltage input is insufficient which is less than 7V, the Vcc port (+5V) at the Arduino board may supply less than five volts and the board may become unstable [12]. But, if the voltage is exceeding 12V, the voltage regulator may overheat and damage the board [12].

Figure 7. Arduino UNO board [12]

3. METHODOLOGY

3.1 Hardware Development

This project is divided into two main parts which is hardware and software components. The hardware used in this system consists of shock and vibration sensor, ultrasonic sensor, tilt sensor, Arduino UNO board, SIM900 GSM/GPRS Shield and GPS Shield. Only Arduino Software (IDE) has been used in software development.

Figure 8 shows the overall hardware development process. When the motorcycle alarm system is activated, the sensors will detect if there is anomaly to the motorcycle. If yes, the GSM will reach the owner's cell phone by making a voice call to notify him about his motorcycle's condition. While the sensors continuously read the input, the GPS will keep reading the data. If there is a request from the owner, GSM will send the location that collected by the GPS to the owner.

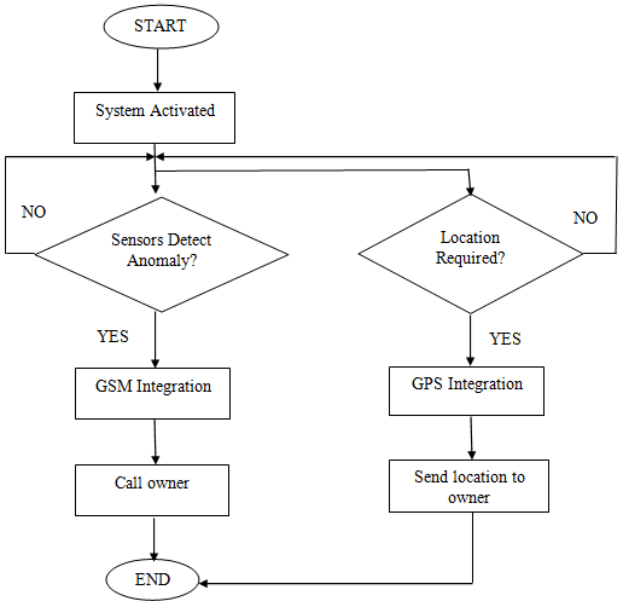


Figure 8. The flowchart of sensors working principle

3.2 Software Development

The only software that being used in the proposed system is Arduino Software (IDE). This is where all the codes will be programmed by using C programming language. The code for the sensors to read the input, GSM make a call automatically after it was triggered by the Arduino UNO and GPS read the data from the satellite signals has been developed successfully. Figure 9 shows the Arduino sketch to write the code in the system.

4. RESULT AND DISCUSSION

The system has been successfully developed and all the results have been recorded. The result for shock sensor and GPS location of the motorcycle are included in this paper.

4.1. Shock Sensor

Figure 10 (a) represents the shock sensor has been activated and the indicator is the red LED has been lighted up. In addition, the serial monitor has displayed the sentence "Motorcycle Alarm System". This sentence indicated the motorcycle alarm system has been activated. At this moment, no disturbance was detected and the GSM will not do anything.

But, after the sensor detects shock as in Figure 10 (b), the orange LED will light up. The displayed phone number at the serial monitor indicates that the GSM is calling the owner to notify him about the situation. Figure 10 (c) shows that the owner received an incoming call from the GSM Shield as displayed on the cell phone screen. The "call ended" at the serial monitor indicates the call is ended by the GSM Shield after 30 seconds. The shock sensor will trigger the GSM Shield to make a voice call every time the sensor detects disturbance in the form of shock as long as the sensor is activated.

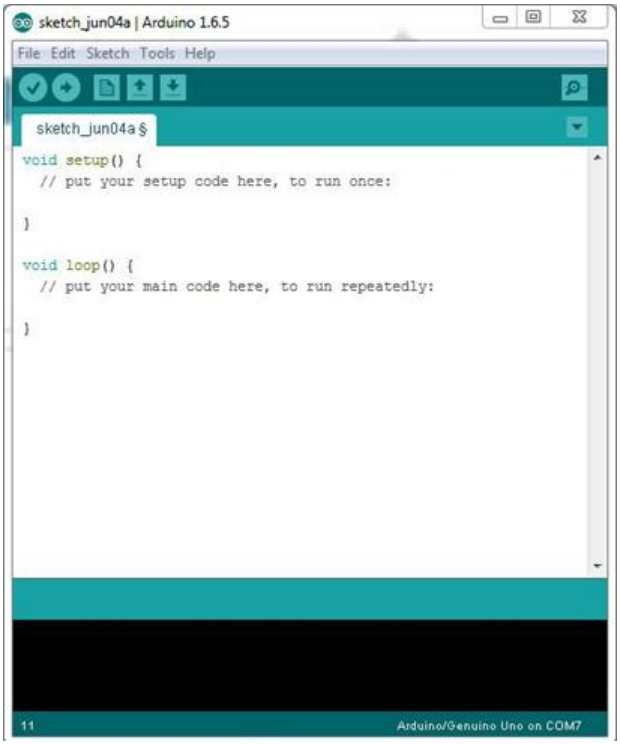
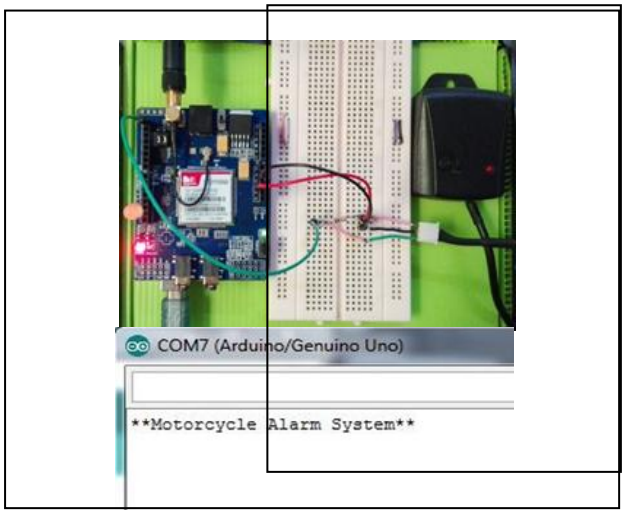
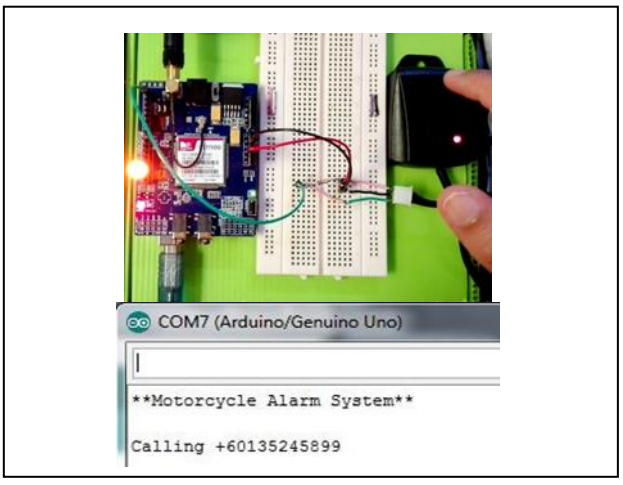


Figure 9. Arduino sketch for Arduino software



(a)



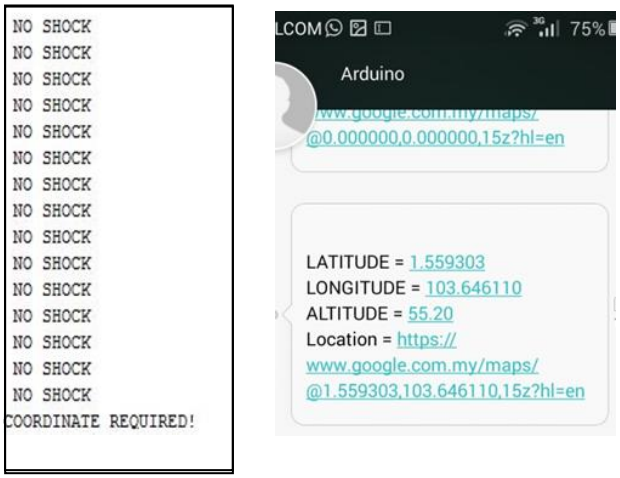
(b)

(c)

Figure 10 (a) System activated, (b) Sensor detects shock, (c) Owner received call

4.2. GPS Location

When the owner makes a request to get the current location of his motorcycle, the GPS will collect the data straight away and trigger the GSM to send the data. The data sent is not only in the forms of coordinate which is latitude, longitude and altitude, but also a Google Maps.



(a) (b)

Figure 11 (a) Coordinate required command, (b) GPS data received by cell phone

When the owner request for his motorcycle's location, the serial monitor will display the request made by the owner as shown in Figure 11 (a). "NO SHOCK" means that the shock sensor has been activated and continuously read the input of the sensor. The microcontroller, Arduino UNO also continuously read the request from the owner. The "COORDINATE REQUIRED" indicates the requested is made by the owner. So, the coordinate and a Uniform Resource Locator (URL) have been sent to the owner's cell phone as shown in Figure 11 (b). The coordinate contains of latitude, longitude and latitude while the URL is the address for the location in Google Maps form.

5. CONCLUSION

The developments of hardware and software have been successfully done and the system is running and working properly. The benefit of this system is the system is very useful to motorcycle owner as it can notify them immediately right after the sensors detect anomaly. The motorcycle location can be tracked through GPS and the GPS give an accurate location of the motorcycle when the owner makes a request to the system in the forms of coordinate and Google Maps. Furthermore, this system use a very low cost to notify the owners about their motorcycle condition by only calling the owner. This system can help increasing the users' awareness about their motorcycle's condition.

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