Smart Car-Security System Using Global System for Mobile and Global Positioning System

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Abstract—**In Malaysia, car stolen cases are considered high even that recent statistic has shown that the percentage has decreased. The percentage of stolen car is decreasing because of the number of cars being registered on the road is high every year. To prevent the cars from being stolen, car manufacturer has equipped each car that they produced with a simple one-way communication alarm system. This factory-equipped system is not enough to prevent the car from being stolen. The objective of this research is to provide a system that can prevent the car from being stolen or relocating the car after it has been hijacked. The proposed system is designed by taking advantage of the Global Positioning System(GPS), and Global System for Mobile Communication(GSM) technology.**

I. INTRODUCTION

A car security system is an essential item to have when a car is manufactured for the user. The main point of having a car security system is to ensure that the car is secured and it is safe from car thieves. In Malaysia, car theft cases are very common. Statistic has shown that a car gets stolen every 24 minutes[1]. From the statistic, it can be concluded that it would take only about 3 minutes to get a car stolen and most of the stolen cars are shipped to other countries to be sold at a cheaper price or stripped down for spare parts[2][3].

Most of the car security system that is offered by the car manufacturer has only one-way communication which can only activate and deactivate the car security system. There is also an option to install an aftermarket two-way alarm system where the user can get a feedback about the car. But alarm systems has the same limitation for its range of communicating which is between the remote and alarm module[4].

For the one-way alarm system, the maximum range is 1000m, and for two-way alarm system, the maximum range is 3000m[5]. After the car is outside the range from its transmitter, it cannot interact with each other. This is because the alarm system is using normal radio frequency to interact, and it can easily be duplicated by thieves[4]. By using short message service(SMS) of the GSM module, the limitation of the original equipment manufacturer(OEM) alarm module can be overcome[5][6].SMS function operates in the range of network provider cellular coverage[7].

In most cases, stolen car cannot be detected[1]. Additional features like global positioning system(GPS) tracking and remote immobilizer is incorporated with the existing OEM alarm module. A GPS module works by sending and receiving data with a time-stamp from at least 3 of its satellites[8]. The data is then translated in terms of longitudes and latitude. The global positioning system can have accuracy issue but it helps a lot in minimizing the search location of the car.

This project is designed to control the car security system by using short message service and phone call function. The existing OEM alarm system will be used together with this project. After integrating both systems together, user will be notified when the car is being stolen by SMS. Remote immobilizer can be activated by a single phone call to the GSM module used in the project. User only need to send a SMS to the GSM module to activate the GPS module and acquire the GPS coordinate of the car.

II. METHODOLOGY

The development of this project can be divided into two sections, which is hardware development and software development. The hardware development must be completed before any software development can be performed for this project. The software development must follow the circuit which has been designed in the hardware development process.

Hardware development of the Security System involves the process to interface between the Arduino UNO R3

microcontroller pin and the car wiring harness. For this project, a remote control car is used to test the system. The component selection for this project must be done carefully since the Arduino UNO R3 runs on a 5V DC voltage while the car can supply up to 14V DC voltage[9]. The excess voltage may be harmful to the microcontroller circuit. The datasheet of the components needed for the project is studied carefully before any decision is made.

After the development of the hardware is completed, the software development process can be started to interface the hardware that has been connected. The Arduino UNO R3 can be program using the Arduino 1.0.1 software which is supplied from its manufacturer. The Arduino UNO R3 use C language for programming purpose. The universal serial bus(USB) interface, makes the Arduino UNO R3 an user-friendly microcontroller.

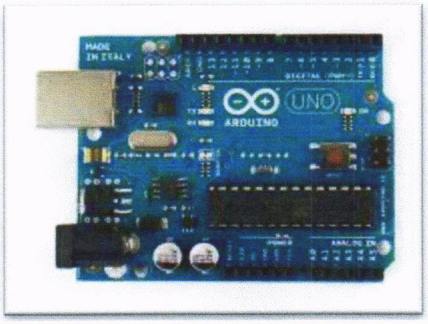

Figure 1: Arduino UNO R3

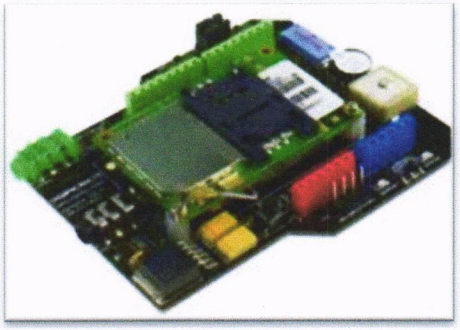

Figure 2: DFRobot GPS/GSM/GPRS Module

To interface the GPS/GSM/GPRS Module(Figure 2) with the Arduino UNO R3(Figure 1), the GPS/GSM/GPRS Module was stacked on top of the Arduino UNO R3 board[10]. Both boards have been designed to fit each other without any modification. Since the microcontroller circuit only uses 5V DC voltage supply, relays will be used to interact the Arduino UNO R3 with the car wiring harness because the car voltage supply is between 12 - 14V DC with high current. A 12V rechargeable battery is also needed to ensure that the voltage supply for the security system will not be interrupted.

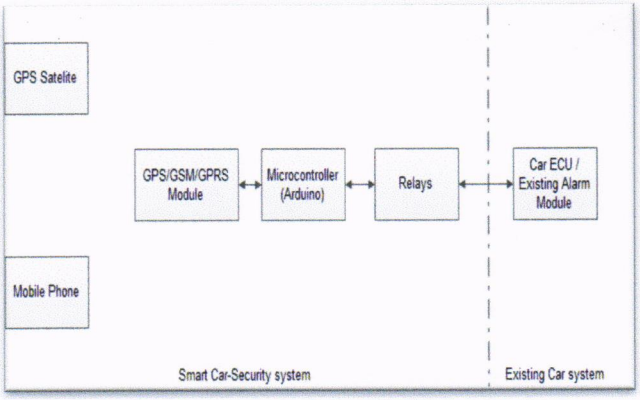

Figure 3: Block diagram of Car GPS Security System

Figure 3 shows the main components that are being used in the development of this project. The block diagram explains the connection between the components.

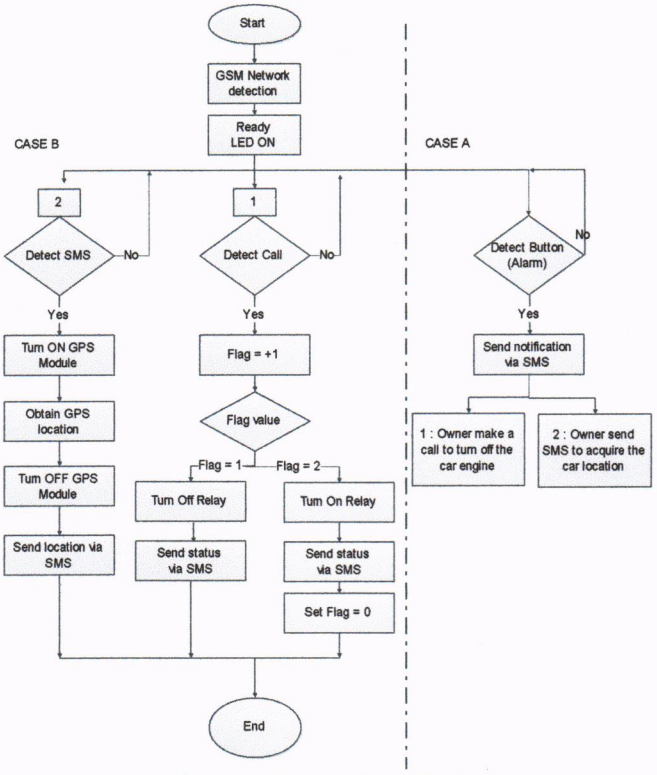

Figure 4: Process flow chart

In figure 4, the flow chart of the security system mechanism is shown. Two case studies is considered in the flow of the system workaround.

Case A

- Car stolen cases that triggered the existing alarm system.
- Cases of force entry into the car.

Case B

- Car is stolen without triggering the existing alarm system.
- The car is most likely to be towed away.

For case A, the security system is waiting for an input signal that is triggered by the existing OEM alarm module, for example in the case of forced entry where the windows were broken, or the doors were forced to open. For this project, an input button is used to simulate an intrusion. A SMS will be send to the car-owner's phone number which has been programmed into the microcontroller to inform the intrusion. After that, the system will wait for the user's further instruction.

In case B, the car is being stolen without force entry. For example, the car is being towed away, or, in the case where the thief successfully turned of the OEM alarm system. The owner will then decide the next action to be taken upon realizing the case. If the owner decides to make sure the car is stopped, the owner will have to call the GSM module, which brings the workflow to case B(1). For case B(1), when the system detects a phone call that is made to the GSM module, it will then add 1 to the flag counter. If the flag value is equal to 1, the system will turn off the relay and send a SMS notifying the user that the car engine has been turned off. After the car is safely found, the owner can activate the car engine system by calling again, and upon receiving the second call, the flag value will turn to 2. If the flag value is equal to 2, the system will turn on the relay and send a SMS notifying the user that the car engine has been turn on while flag counter reset its value to 0.

To know the location of the car, the owner can send an SMS to the GSM module, which brings the workflow to case B(2) For case B(2), when the system GSM module detects an SMS,- It will then turn off the GSM module and then turn on the GPS module to connect with the GPS satellite[11]. After receiving the location data, the GPS module is turned off and the GSM module is turned on. A SMS with the location data in terms of latitude and longitude will be sent to the owner's phone number. Owner can use the coordinates receive to find the location of the car using the appropriate map software.

Since the GPS and GSM module is integrated in one chip, it shares the same serial communication pin to communicate with the microcontroller. So, only one function can be used at one time.

III. RESULT AND DISCUSSION

Figure 5 shows the hardware setup used in this project. As mentioned, for this project, the car intrusion is simulated by a push-button. In real life cases, when the intrusion happens, it will trigger the OEM alarm system, and the OEM alarm system will trigger the microcontroller of this project. Then the GSM module will send an SMS notification to the user mobile phone to notify about the intrusion. The example of the SMS is shown in Fig. 6.

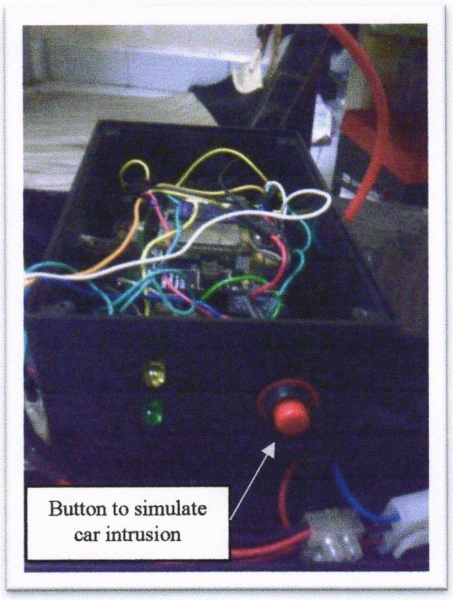

Figure 5: Hardware setup

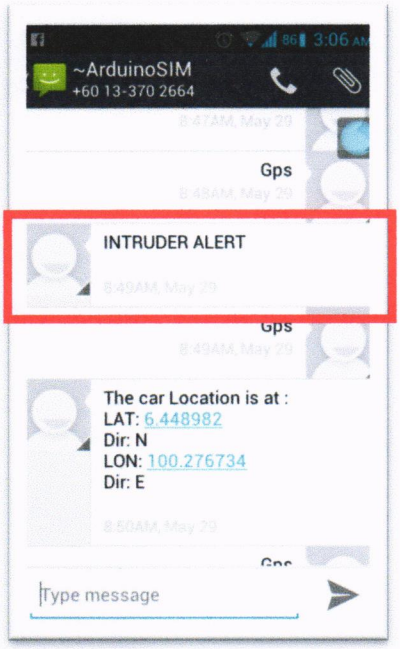

Figure 6: SMS notification for intrusion.

When the system detects a phone call, it will either turn on or turn off the relay to deactivate or activate the car engine and it will send a SMS notification to the owner.

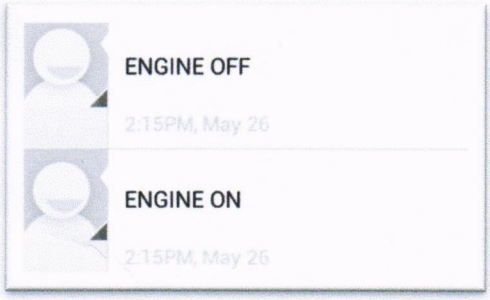

Figure 7: SMS notification for engine state

To activate the car GPS module and acquire the coordinate, a SMS is sent to the GSM module.

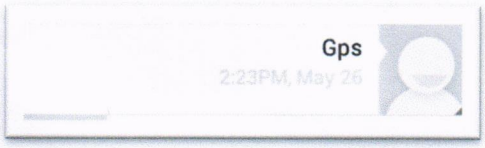

Figure 8: SMS to enquire GPS location

SMS reply of the GPS location inquiry is in form of latitude and longitude.

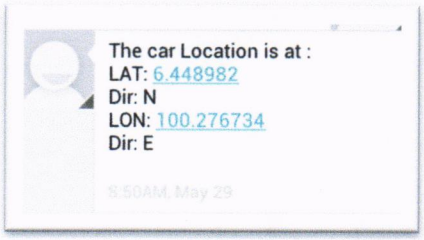

Figure 9:SMS reply for GPS location 1(Arau, Perlis)

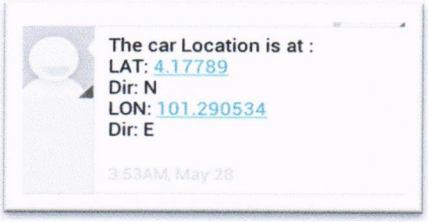

Figure 10:SMS reply for GPS location 2(Tapah, Perak)

This system was tested at a few places, for example at Arau and Tapah, as shown in Fig. 9 & 10. The coordinate received can be projected into local maps by using the appropriate software or web application for example Google Map, as shown in Figures 11 and 12.

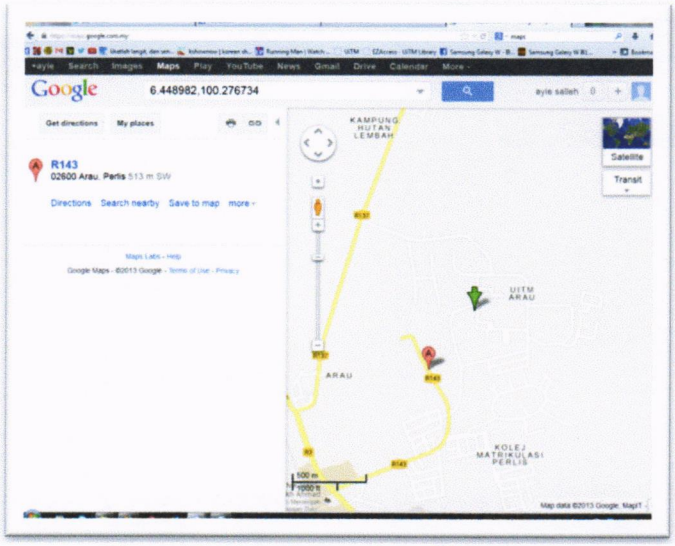

Figure 11: Google map view of location 1

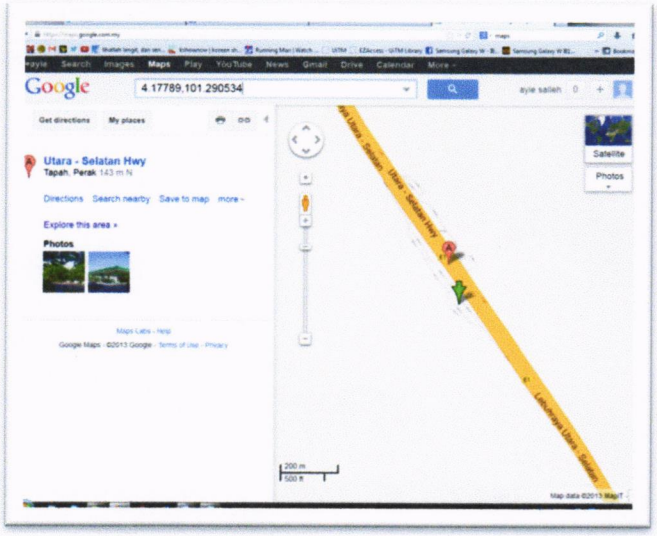

Figure 12: Google map view of location 2

The delay used in the development of this project plays an important role especially for the GPS function. The GPS module need times to lock-on to the GPS satellite signal before sending the SMS containing the GPS coordinates[11]. The minimum of 3 satellite are needed. The response time depends on some conditions like the weather and location. The appropriate delay time need to be set carefully so that the GPS module has enough time to get the data[8].

Condition	Weather	Time
Open space	Clear sky	< 30s
	Cloudy or raining	< 2m
Closed area (parking lot)	Clear sky	< 2m
	Cloudy or raining	> 3m

Table 1: GPS satellite response time.

IV. CONCLUSIONS AND FUTURE RECOMMENDATIONS

In this paper, a new system was designed to work with the existing car alarm system by using a microcontroller. The system was developed and tested. The objectives of the research had been achieved since it can notify the owner about car break-in by SMS function, remotely turned on and off the car engine by call function, and give out the location of the car by SMS and GPS function. The GPS function of the system has been tested in a few locations, and the accuracy of the signal is less than 100m of the real location.

To eliminate the delay time for GPS satellite lock-on, it is recommended to use two separate modules for the GPS and GSM. By using separate module and serial communication, the GPS module program can always loop itself to obtain new coordinate every second while the GSM module awaits instruction from owner. Using external antenna will also increase the efficiency of the GPS triangulation process[12].

The GSM module support call function, adding a microphone to the module will let the user to spy on the conversation that may take place in the car. Adding features like remote start via SMS, alarm arming and disarming via SMS can also be considered to expand this project.

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