# Child tracking system using smartphone

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**ABSTRACT**

The number of missing children and kidnapping is on the rise in recent years. Every parent wills definitely going through an agonizing experience to have their children missing. Therefore, there are many safety measurements to prevent this incident from happening. The help of modern technologies is one of the ways to reduce children missing and kidnapping. A child can be tracked by using the global positioning system (GPS) and global system for mobile communication (GSM) technology. Advanced child monitoring systems are expensive. Not all families have the same living standards. For this purpose, a low-cost child tracking system is proposed in this study. The implementation of the proposed approach is reported in real-time.



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## 1. INTRODUCTION

Global positioning system (GPS) is a space-based navigation system that provides location and data which can be used anywhere on earth [1]. The system is originally created for military force but then was made available to the civilian by the government of United States. Global system for mobile communication (GSM) is a digital mobile system that is used in the world. The system uses the variation of time division multiple access (TDMA) which is the most widely used among other telephony technologies [2]. The data of the GSM is digitized and compressed which is sending down a channel with two other streams of user data [3]. Normally, GSM will operate at either 900 MHz or 1,800 MHz frequency. Figure 1 shows the block diagram of the system to track the child [4]. Arduino Uno is used to trigger the GSM to send the location of the child to the smartphone [5]. Arduino Uno is a microcontroller board based on the ATmega328. The Uno differs from all preceding boards like the future technology devices international limited (FTDI), used universal serial bus (USB)-to-serial driver chip because ATmega8U2 is programmed which used USB-to-serial converter.

Missing children can be classified into two categories which are disappearance and abduction or kidnapping. According to the statistic compiled since 2004, more than 6,270 teenagers have been reported missing and out of these 4,620 of the missing children are teenage girls. This shows that the rate of missing children is increasing in recent years [6]. There are several factors that lead to this incident to happen. One of it is because of the parents could not supervise their children all the time [7], [8]. Kidnapping or abduction can happen anywhere and anytime whether in a shopping mall, supermarket, playground and even in their own house. Thus, a child tracking system can enhance their safety and help their parents by constantly emitting the location of their children only by a short message service (SMS) away. This system can help their family to monitor the children anywhere and anytime [9]–[11]. The main aim of this work is to design a child tracking system using GPS and GSM. The objectives are to design and test the programming inside Arduino for receiving and sending the coordinated location and to design and test the assembly of hardware, software and electrical part for child tracking system [11], [12]. In this paper, section 2 contains the system configuration, a description of control scheme, and different modes of operation. The simulation results of proposed system are reported in section 3. Section 4 is conclusion.


Figure 1. Block diagram of the system

## 2. METHOD

The main emphasize of this work is to design a child tracking embedded system which involves both hardware and software part. The scope of this work is as follows: i) to prototype a GPS/GSM transceiver hardware, ii) microcontroller Arduino is used and loaded using embedded ‘C’ language, iii) using the smartphone to send SMS to GSM to receive the location, iv) using Arduino programming as the interface programming between GPS/GPRS/GSM modem and Arduino Uno microcontroller, v) displaying the user location by using Google Maps, and vi) Proteus software is used to simulate the operation of the microcontroller design before constructing a physical prototype. The application will run on the Android platform. The GPS tracking technology will be used between different devices. The mobile app is in charge of finding out where the device is and putting it on a map. We have chosen the Android platform because it is a free and open platform where the library is easily accessible and because GPS is used to locate calls using a mobile phone. The device app updates the child's location using GPS technology and the global navigation satellite system (GLONASS) or general packet radio service (GPRS). In order to determine the user's location, case studies will be presented on the portable circuit Proteus software that works in real-time using Google Maps.

### 2.1. System overview

This work is about the child tracking system via GPS and using GSM. In this application, the GPS is a radio navigation system that is used to determine the exact location (longitude and latitude) of a child and to track the child in a particular area. Then, the information of the position will be delivered to smart phone via GSM modem. The GSM modem is programmed to enable two-way communications between the modem and child to determine the child’s position [13], [14]. The programming of this work uses an Arduino Uno. The advantage of this programming is its low cost, easy to learn, and extremely efficient. In this chapter the details on designing and constructing the child tracking system completed with the programming [15]–[17]. To achieve the objectives of this work, the work has been divided into 2 main parts which are hardware and software and the overall work system block diagram is shown in Figure 2 and the work flow was described [18]. The hardware covers from selection of suitable and appropriate components used, circuit construction and prototype of the system [19].

The main objective of this work is to develop a position data acquisition system for child tracking system. In Figure 2 system overview was establish for the work. It takes the child address by sending “SMS” from mobile phone to GSM and GSM send the information to Arduino [12], [14]. Function of Arduino is to control between GSM and GPS then GPS take address in same place based on latitude and longitude location. Process for sending address to mobile phone is GPS take the address in that place based on latitude and longitude sending location then send it to Arduino programming which control between GPS and GSM. GSM send the SMS the information to smart phone [20]. This work was divided into two parts which are the tracking part and the displaying part. The tracking part is responsible for obtaining the user location while the control and displaying part is for displaying the detected location on the Google Map through the Arduino programming. The hardware devices that are used in this work are the GPS/GPRS/GSM module V3.0, and Arduino Uno microcontroller [21], [22].

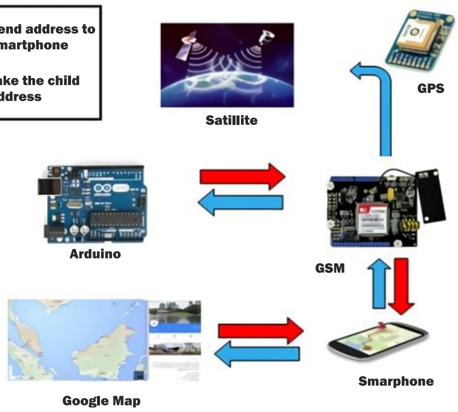


Figure 2. Overall system block diagram for child tracking system

### 2.2. Circuit design

Furthermore, for the hardware part which includes electronic, selection of suitable and appropriate components used for the whole work were carried out and purchasing of all the items which were required. The flow of the circuit and operation of all components as understood before the construction of the circuit begin, to make sure that the circuit functions well and prevent failure occurred if there was a short circuit due to wrong connection. Information searching such as the specifications, failures and functions off all components have been carried out. Moreover, programming using Arduino microcontroller, circuit construction using Proteus software and each sensor circuit to the microcontroller and output [23]–[25].

### 2.3. Circuit construction and testing

For the circuit, this work used 12 V DC supply connected to real time strategy (RTS) on GPS and GSM module. The output produced 5 V, for the Arduino to control between the GPS and GSM. Ports of Arduino that were used are port B, port D. Port B3 was used to connect transmit data (TXD) on GPS. While port D1 was used to connect receive data (RXD) on GSM. Port D0 was used to connect TXD as shown in Figure 3. When finished the simulation, the circuit was successfully running in Proteus software and the circuit construction for child tracking system was done using the breadboard. After that, the same program has been loaded into Arduino microcontroller to test the work again.

The results obtained in the hardware will be compared with the simulation results in Proteus software to make sure that the results obtained are the same. The simulation results from the Proteus software. Figure 4 show the connection of GSM pins RX and TXD connected to the Arduino and GPS pins RX and TXD connected to GSM module. The test circuit connection used in the study is shown in Figure 5. Figure 6 is the Arduino control between to GSM and GPS, when GSM on to register with the simcard.

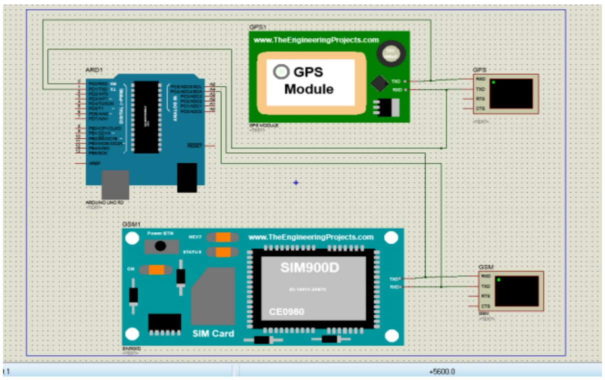


Figure 3. Circuit design using proteus software

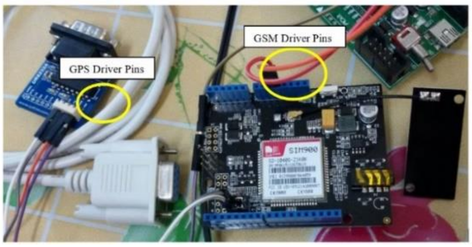


Figure 4. Initialized connection GSM, GPS, and Arduino

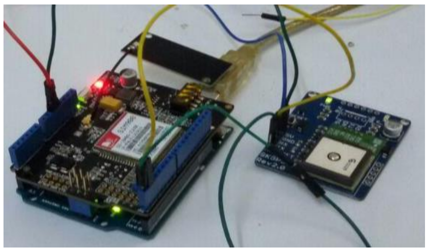

Figure 5. Test the circuit connected to PC

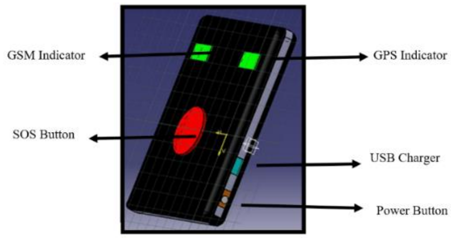


Figure 6. Isometric design

### 2.4. Hardware development

For the hardware part, there were processes to be done by the design model. Before doing the base model, study or research about how to make the hardware must be done. It is very important for this work because the model must be accurate to detect the location. Catia software was used to for design the hardware of child tracking system. Figure 6 shows the isometric design the hardware child tracking system with GSM indicator, GPS indicator, save our ship (SOS) button, power button and USB charger. Figure 7 shows the orthographic views of the hardware child tracking system. The orthographic view shows the top view, side view, and front view.

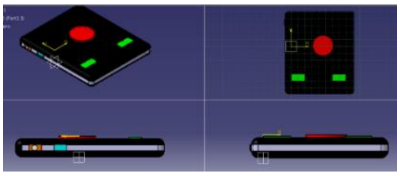

Figure 7. Orthographic views

### 2.5. Data collection

The data collection is a stage in any area of study. At this stage all the data related to the circuit and programming was collected. The program should be recorded from the Proteus software after it was successfully tested, or else the initial program should be recorded to carry out the troubleshooting process easily when an error happened. The program also has initialized and changed to improve the work operation.

## 3. RESULTS AND DISCUSSION

The device is consisted of GPS/GSM module which is responsible for tracking the location of the children by the user and the signal will be sent out by the GSM network. The simulation of the Arduino software has been done several times to ensure the functionality of the work. The GPS/GSM module is connected to the PC through the serial port. Interfacing of the GPS Module is done in the Proteus. Data is obtained from the RX pin of Arduino and sent to the serial terminal via TX pin. Virtual terminal is used to show the longitude and latitude getting from the GPS module. Using the code shown in Figure 8 which has been uploaded in the Arduino board the longitude and latitude of the GPS module received as shown in the virtual terminal in Figure 9. When the GPS was set to high in order to turn on the power of the GPS, it was able to receive the signal from satellite.

```
void power_onGPS(){

    uint8_t answer=0;

    // checks if the module is started
    answer = sendATcommand("AT", "OK", 2000);
    if (answer == 0)
    {
        // power on pulse
        digitalWrite(onModulePin,HIGH);
        delay(3000);
        digitalWrite(onModulePin,LOW);

        // waits for an answer from the module
        while(answer == 0){
            // Send AT every two seconds and wait for the answer
            answer = sendATcommand("AT", "OK", 2000);
        }
    }
```

Figure 8. Coding for GPS module on

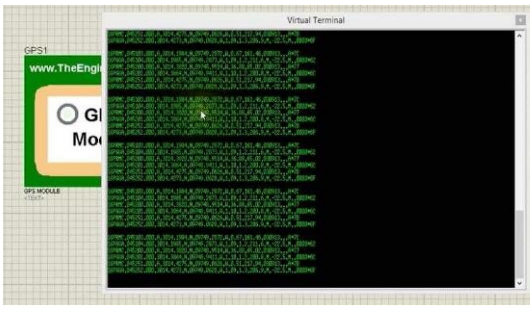


Figure 9. GPS on receive latitude and longitude

For GSM module, the GSM module was tested by sending the coding in AT commands as shown in Figure 10. The result obtained was the GSM sent a response "ok" and was ready to receive text message. Next, AT commands was sent to the GPS after it was ready to receive SMS. The AT commands was used to check the notifications that were obtained when SMS was sent to the GPS. When a message was sent to the GSM shield, notification was obtained as shown in Figure 11 and the full code can be referred.

Message received by the GSM SIM900 module was in a string which stored the mobile number of the sender and the body of the message. The string data obtained was extracted. The simulation of the circuit is using the Proteus software as the simulator for Arduino. The Arduino codes were written in the Arduino integrated development environment (IDE) software and then compiled to be put in Proteus to run the simulation. Full complete schematic diagram of the work is drawn in the Proteus. The .hex file was uploaded to the Arduino board and simulation was run. Figure 12 shows the simulated output of the work.

```
void power_onSMS(){

    uint8_t answer=0;

    // checks if the module is started
    answer = sendATcommand("AT", "OK", 2000);
    if (answer == 0)
    {
        // power on pulse
        digitalWrite(onModulePin,HIGH);
        delay(3000);
        digitalWrite(onModulePin,LOW);

        // waits for an answer from the module
        while(answer == 0){     // Send AT every two seconds and wait for the answer
            answer = sendATcommand("AT", "OK", 2000);
        }
    }
```

Figure 10. AT commands GPS on

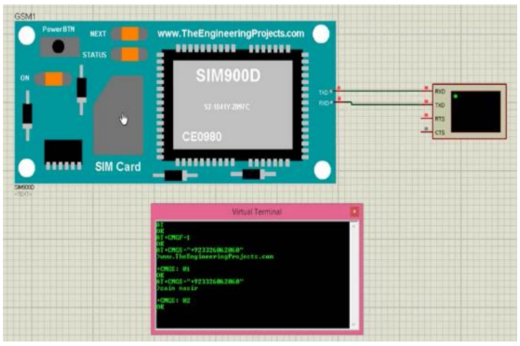


Figure 11. Message received and stored by GPS

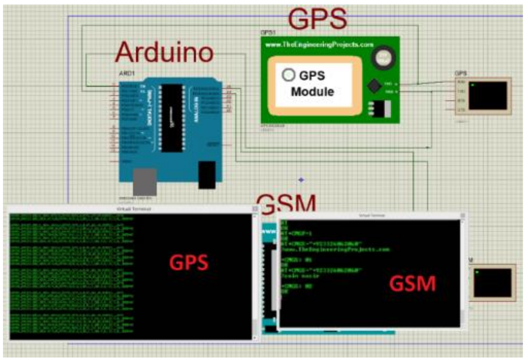


Figure 12. Simulation of proteus 8 professional software

Both GSM and GPS module functioned very well in the Proteus simulation. The GPS module was able to obtain the latitude and longitude while the GSM received and stored the message in a string data which had been extracted. This part discusses about the testing on the hardware and the output that was obtained. All steps taken in the hardware was analyzed.

A test was done to test the GPS module whether it can obtain the latitude and longitude of the location. The device was connected to the PC through a serial port. Then, the GPS/GSM module was turned on. GPS module need some time to warm up and became stable. The password to enable the system was sent via smartphone. After a few minutes, the SMS was received by the smartphone as shown in Figure 13. The password that had been sent to the GSM was set as “G37” and the numbers below was the location of the GPS in latitude and longitude. Next, a test is also done to identify the output obtained if the GPS was turned off. The same step was taken like before, the password was sent to the GSM via SMS by a smartphone. Few minutes later, the SMS received by the smartphone was as shown in Figure 14.

The GSM cannot send the location of the GPS when was turned off even if the password sent was correct. A SMS like in Figure 15 was received by the user which state that the device cannot take the location or an error occurred. Time for the GSM to response when receiving SMS from individual was recorded. Based on the observation done, the time taken for the GPS to response is starting from 30 seconds to maximum of 5 minutes. The capability of the GSM to response based on the GPS speed to receive the signal from the satellite which enables it to take the location.

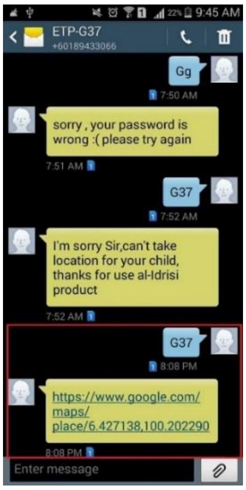


Figure 13. SMS sent and received when GPS on

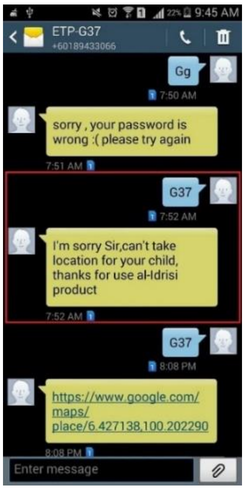


Figure 14. SMS sent and received when GPS off

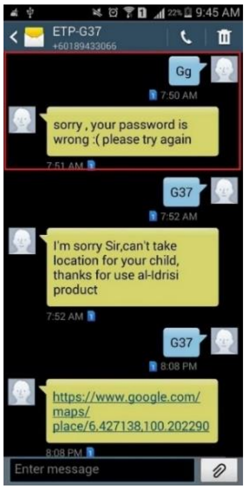


Figure 15. SMS sent and received when password incorrect

In addition, the work had been tested a few times in order to identify whether the GPS can obtain the latitude and longitude of the location when it was on the move. The results of the test were as shown in Table 1. The GPS was tested along the Changlun-Kuala Perlis Expressway to Arau, Perlis. Based on the results achieved, the work has no problem to obtain the latitude and longitude of the location when it was moving. The device has been set to operate only if the user sends the correct password to the GSM. The password and username were set in the programming for the Arduino. A test has been done to check if the password was working. A false password has been sent to the GSM and the GPS and a SMS was received that state the password sent was incorrect as shown in Figure 15.

Table 1. History of children navigation

| Child ID | Route | Child stops | Latitude | Longitude | Date | Time (PM) |
|---|---|---|---|---|---|---|
| G37 | Changlun-Kuala Perlis | Arau | 100.200926 | 6.406464 | 23.04.2016 | 4:08 |
| G38 | Changlun-Kuala Perlis | Arau | 100.200826 | 6.406465 | 23.04.2016 | 4:30 |
| G39 | Changlun-Kuala Perlis | Arau | 100.200735 | 6.406456 | 23.04.2016 | 4:45 |
| G40 | Changlun-Kuala Perlis | Arau | 100.200923 | 6.406496 | 23.04.2016 | 2:00 |

## 4. CONCLUSION

In this work, a GPS and GSM-based kid monitoring system is built. The suggested solution is compatible with both PIC and Arduino microprocessors. Arduino was selected because it is simpler to design than PIC microprocessor, despite Arduino being more costly. The outcomes of successfully implementing the Arduino-created system's real-time functionality are shown in the article. Additional features may be added to the suggested system for tracking children. This situation is entirely adaptable to the circumstances. With the suggested approach, it is possible to prevent child disappearances cost-effectively.

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