Smart Localization and Detection System for School Children

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***Abstract*—The lack of parental supervision in the past few years, contributes to the increasing number of crime against children. Many cases of missing children are reported by PDRM every year and have become a vital concern to the society. Hence, this paper presents a smart localization and detection system for school children to overcome the issues of missing children. The proposed system is implemented for tracking and notifying the location of the children using SIM908 Global Positioning System (GPS) Module with Global System for Mobile Communication (GSM) technologies and Arduino Mega 2560 microcontroller board. The module kit is placed inside the children's school bag while they are going to school. The children positioning information is sent through GSM to the parent's smartphone via Short Message service (SMS) that is linked to Google Map. It allows parents to know their children location on a real-time map. Thus, it can help the parents to monitor their children everywhere. The proposed system is proven to be efficient, reliable and low cost.**

***Index Terms*—Location; Children; Global Positioning System; Global System for Mobile Communication.**

I. INTRODUCTION

Nowadays, parents are worried about the safety of their children. It is because the missing children cases have increased rapidly. The missing cases always happen, especially to school children. Based on the statistics from Royal Malaysian Police (PDRM), in between 2011 until 2015, the year of 2012 shows the highest number of missing cases which is 2193 [1].

Children tracking system is implemented all over the world due to its advantages of easy and simple in locating children position [2,3]. Several studies have been made by previous researchers in developing children tracking system. Idachaba proposed a system using parallax GPS module to track the location of stolen item, kidnapped and missing person. The system monitors the signal strength of GSM. If the signal is below from the threshold value, the last five locations are sent to the mobile phone to notify the object or person is out of the GSM coverage [4].

Wong et al. applied Bluetooth module and GPS receiver as an alternative solution to the missing children cases. The data are extracted from the received signal strength indicator (RSSI) using a Bluetooth connection. Then, the data are used as information to determine the distance between children and parents using a GPS tracker to identify the location of the children. If the children are far from the designated range, an alert message is sent to mobile phones to notify parents about the children location [5]. In the paper by Song et al., the problem of kidnapping crime issues is prevented by proposing a real-time children location detection system in school zone using the combination of GPS and ZigBee modules. The alarm data are transmitted to the remote center that connects to a closed-circuit television (CCTV) system when the children are a presence in the school. The ZigBee is used to track and locate the position via received signal strength indicator (RSSI) method [6].

Studied made by [7] proposed vision-based tracking system using color segmentation method to estimate the exact location of the vehicle. The captured image from the KINECT sensor is converted into red, green and blue color for feature extraction. The advantage of the vision-based tracking system is the position of the object can be tracked in three-dimensional resulting accurate estimation of object location [8]. However, using vision-based tracking system leads to complexity in the analysis as the image acquisition and pre-processing of the image is converted into a small size to reduce the complexity and segmentation of image color as well as noise filtering. In addition, researchers in [7] concluded the system is lack robustness for aggressive maneuvers which is not suitable for portable use, especially for school children.

The system developed by Saranya and Selvakumar used GPS and GSM for tracking every child attending school. The GPS is implemented to track and locate children position. First, the children voice is recorded and stored in the database system. Then, the system is tested by matching the recorded children cry voice with the children in school. The voice playback is operated when the sensor sense the voice of children cry and automatically sent the message to the parents [9]. The previous systems proposed by researchers are summarized in Table 1.

Table 1
Summary of Previous Research

Author	Operation	Limitation
Idachaba	The system is operated when the signal strength is below than the threshold value.	Low response time. Location coordinate is less accurate.
Wong et al.	The location is identified by using the data from the RSSI and Bluetooth connection.	The range for children transmits data are limited only 10 meters.
Song et al.	In transmitting the data, a CCTV is applied to detect the presence of the children. The location of the children can be traced using the RSSI.	The data rate can only be transferred in short distance.

Author	Operation	Limitation
Jurado et al.	The vision-based system will track the location of the vehicle from the image captured using the KINECT sensor.	Complex in image analysis. Nor suitable for aggressive maneuvers.
Saranya and Selvakumar	The message is sent when the voice playback senses the children cry voice.	Cannot differentiate between a cry and background voice.

As the increment of children cases, this paper is conducted to develop a smart localization and detection system for school children. In this paper, the system is designed for the implementation of hardware and software. The aim of this project is for parents in locating missing children. The system consists of notification function to remind the parents about their children location in a wide area.

The project includes children module transmitter and parents' receiver. The transmitter of children module contains Arduino Mega 2560 microcontroller board and SIM908 GPS module with GSM modem as shows in Figure 1.

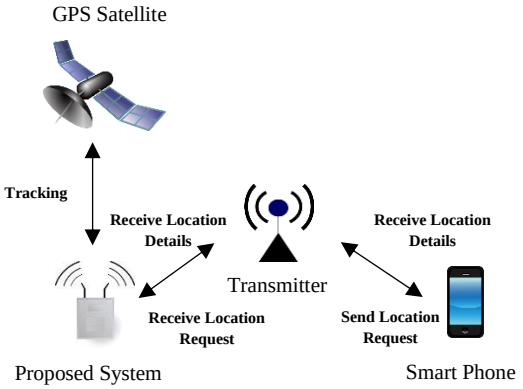

Figure 1: System overview

The receiver includes parent's smartphone as a monitoring system. Consequently, this project will allow parents to send a location request concerning their children through SMS. The Arduino microcontroller forwards the GPS data (latitude and longitude) to GSM board. The GSM will send the position of the moving children to the receiver. The SMS received by parents contain a Google Maps link, which enables the parents to view the exact location of their children on Google maps using an internet browser. By determining the location, parents can call and inform the police the exact location of their children if their children are missing. The result shows that the proposed system is capable of determining the location of the children accurately.

This paper is organized as follows. Section I is an introduction to the proposed project. Section II describes and illustrates the hardware and software development. Section III is the analysis of the experimental result. Section IV is an overall conclusion about this paper.

II. METHODOLOGY

In the development of a smart localization and detection system for school children, hardware and software implementation are required. The flow of the process is shown in Figure 2 starts with the hardware connection of the SIM908 GPS module with Arduino Mega 2560. Then, the GPS module is integrated with Arduino Mega using C language. The system works when parents send a request SMS through a smartphone. The GPS module will locate the current position of the children from the measurement of longitude and latitude. Notification of Google Map link message will be sent as an access to the children location.

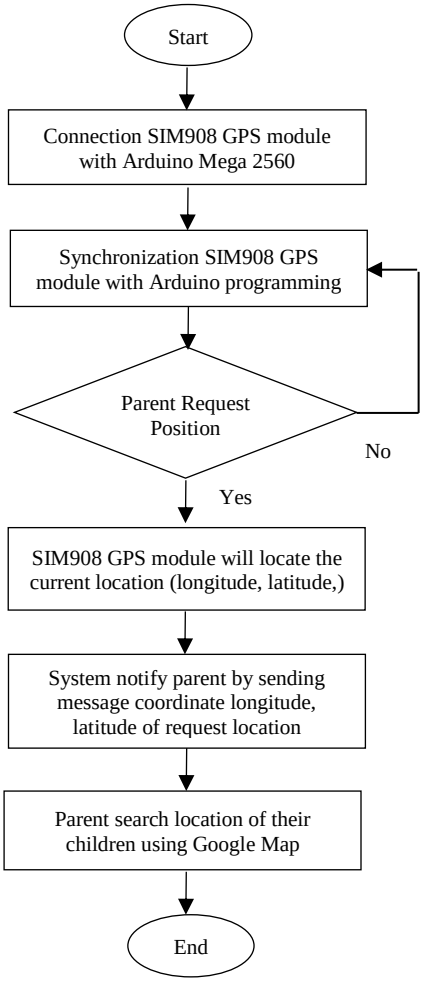

Figure 2: Flowchart of the system

A. *Hardware Implementation*

A hardware implementation is used in electronic devices include an Arduino Mega 2560, SIM908 GPS module with GSM and GPS antenna. Figure 3 shows the physical devices of this project. The device consists of the start button to turn on the system, power switch to power up the system and GPS antenna to find the GPS signal.

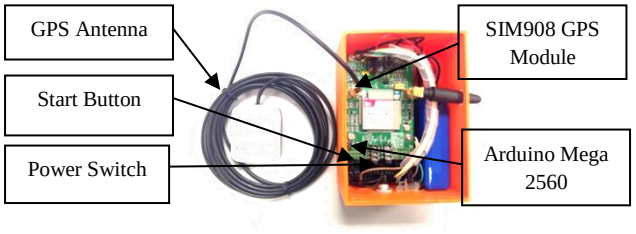

Figure 3: Physical device

B. *Arduino Mega 2560 and SIM908 GPS Module*

The Arduino Mega 2560 based on the ATmega2560 microcontroller is used to control the operation of the system [10, 11]. As a microcontroller, Arduino Mega have 54 digital pins and each pin could be as an input or output using

pinMode(),digitalWrite() and *digitalRead()* functions. They will operate at 5V as an input or output. Each pin also can provide and receive a maximum current of 40mA [12]. When the code is embedded in the controller, the interfaced modules generate an appropriate output at the receiving end [13].

GPS is a satellite-based navigation system consists of a network of 24 satellites located in the orbit [14]. The system provides critical capabilities to military, civil and commercial users around the world [15]. An SIM908 GPS module is a combination of GPS and GSM together [16]. It is used to track the location with its antenna and send data to the location to the Arduino board through serial communication. Then, the information will send to the registered mobile number in SMS. While testing the module at first, the physical connection should be done. They are only 5 pins used in Arduino Mega such as pin 0, pin 1, pin 19, pin 18 and GND. All pins are in the digital part of the Arduino. Figure 4 below shows the connection pin between Arduino Mega and SIM908 GPS module.

SIM908 GPS		**Arduino Mega 2560**
GPRS RX		pin0 (RX0)
GPRS TX	Connect to	pin1 (TX0)
GPS TX	⇨	pin19 (TX1)
GPS RX		pin18 (RX1)
GND		GND
SIM908 GPS		**Arduino Mega 2560**
GPRS RX		pin0 (RX0)
GPRS TX	Connect to	pin1 (TX0)
GPS TX	⇨	pin19 (TX1)
GPS RX		pin18 (RX1)
GND		GND

Figure 4: Connection pin between Arduino Mega and SIM908 GPS

C. GSM

GSM provides terminal mobility, with personal mobility provided through the insertion of a subscriber identity module (SIM) into the GSM network (mobile station) [17]. The SIM carries the personal number assigned to the mobile user. GSM uses Time Division Multiple Access (TDMA) technology as the air interface standard. It serves as a medium between transmitter and receiver.

D. GPS Antenna

GPS is a multiple satellite-based radio positioning system. Hence, each GPS satellite transmits a signal to indicate the current position above the earth. GPS antenna is used to collect device location and coordinate through a satellite signal. Then, the information is forwarded to SIM908 GPS module.

E. Software Implementation

The software implementation is needed to activate the module. AT commands are used in activating the SIM908 GPS module. Basically, each of command needs to be declared at the top of the coding. At the first part, GSM and GPS will activate. Once the SIM908 is turned on, the module starts to configure GSM and GPS network. Figure 5 shows the source code to power on and configure SIM908 GPS module.

```
//*************************************************************
void setup() {
Serial.begin(9600);
pinMode(PWR, OUTPUT);
pinMode(LedConfig, OUTPUT);
power_on();                    // Power on Module SIM908
init_SIM908();                 // Configuration GSM and GPS for Module SIM908
erase_buffer();
}
//*************************************************************
```

Figure 5: Source code to power on and configure SIM908 GPS module

After the network is configured successfully, the system will send a message to inform the parents that the hardware is ready to be used. AT command of **AT+CREG** is applied to connect the GSM with the network as shown in Figure 6. The command **AT+CMGF=1** is used to set SMS in text mode, but when it is set to 0, it will go to protocol data unit. **AT+CMGS** is used to indicate the GSM function is ready to send a message.

```
File  Edit  Sketch  Tools  Help
sketch_may22a §
    }
    }}}
//*************************************************************
void init_SIM908() {
  digitalWrite(LedConfig, LOW);
  do { answer = sendAT("AT+CREG?","+CREG: 0,1",1000);} while(answer==0);
// config GSM
  do { answer = sendAT("ATE0","OK",1000);} while(answer==0);
  do { answer = sendAT("AT+CMGF=1", "OK",1000);} while(answer==0);
  do { answer = sendAT("AT+CNMI=2,2,2,0,0", "OK",1000);} while(answer==0);
  sprintf(aux_string,"AT+CMGS=\"%s\"",number);
  do {answer = sendAT(aux_string,">",2000); } while(answer==0);
   Serial.println("GSM function is ready");
   Serial.write(26);
```

Figure 6: Source code of GSM function on SIM908

GPS also has their own AT command with a specific function. Figure 7 shows the source code to activate the GPS function on the module.

```
// config GPS
  do { answer = sendAT("AT+CGPSIPR=9600","OK",1000);} while(answer==0);
  do { answer = sendAT("AT+CGPSPWR=1","OK",1000);} while(answer==0);
  do { answer = sendAT("AT+CGPSRST=0","OK",1000);} while(answer==0);
  do { answer = sendAT("AT+CGPSOUT=32","OK",1000);} while(answer==0);
//  do { answer = sendAT("AT+CGPSSTATUS?","Location 2D Fix",5000);} while(answer==0);
  do { answer = sendAT("AT+CGPSSTATUS?","Location 3D Fix",5000);} while(answer==0);
  sprintf(aux_string,"AT+CMGS=\"%s\"",number);
  do {answer = sendAT(aux_string,">",2000); } while(answer==0);     // Send the SMS message to number after config GPS
   Serial.println("GPS function is ready");
   Serial.write(26);
  digitalWrite(LedConfig, HIGH);
  }
```

Figure 7: Source code of GPS function on SIM908

As a reminder, both Sim-card either on parent's smartphone or SIM908 GPS module must have a remaining credit to deliver the SMS. This system can operate only one telephone operator at one time. For a hardware implementation, the power switch is needed to turn on the module. Then, the start button is pressed for about 5-10 seconds to ensure the LED blinking which means the network is successfully configured.

III. RESULTS

The system hardware is initialized after the start button at the device is pressed. From the text message received as illustrated in Figure 8, the functionality of the GSM and GPS are informed to the parents. Then, a unique password is replied by the parents to get the current children location. Each child is differentiated by the password inserted. The

location of the children latitude and longitude are shown in a form of Google map link. Hence, a parent may directly click on the URL of Google Map to know their children location. The dot in Figure 9 represents the current location of the children in Google Map. Thus, the exact location of the children can easily to be traced.

Figure 8: Text message from both interactions

The dot in Figure 9 represents the current location of the children in Google Map. From the Google Map, the parent can determine the location of their children based on the latitude and longitude of the map. The use of navigation function is Google Map give benefit to the parent in tracking their children from parent to the children locations. Thus, the exact location of the children can easily to be traced.

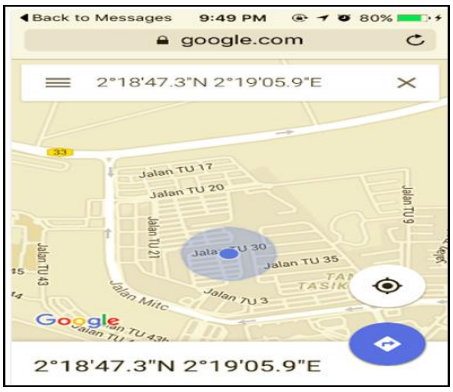

Figure 9: Google Map to determine the location

Performance verification is done to measure the accuracy of latitude and longitude of the device. In this project, two devices are compared which are SIM908 GPS and Google Map in order to analyze the accuracy. By referring to Table 2, three different places have been choosing as test locations for the field testing. The latitude and longitude for both devices seem to be closed for each other. Although there is less accurate in the latitude and longitude value, but the location of the children is still within the parameter. The result shows this device can locate and detect the place successfully.

Table 2
Testing of Accuracy Coordinate

Place	Device	Google Map	Achievement
Jalan 30,Taman Tasik Utama	2°16'40.9"N 2°17'54.2"E	2°16'40.8"N 2°16'54.2"E	Successful
MITC	2°16'37.9"N 2°16'54.5"E	2°16'37.9"N 2°16'55.5"E	Successful
Taman Botanikal	2°16'36.9"N 2°17'37.7"E	2°17'36.9"N 2°17'37.7"E	Successful

IV. Conclusion

In conclusion, a smart localization and detection system for the school children is developed to locate missing or lost school children. The system used Arduino Mega 2560 and SIM908 GPS module as a tracker. GSM and GPS are integrated with Arduino microcontroller to send and receive SMS. The location of the children is informed to the parents using Google Map application. The system helps in reducing crime against children and parents can always monitor their children anytime and anywhere. By using the same concept, this project can be applied to detect missing vehicle and also can be integrated into android applications.

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