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Cost-effective and user-friendly vehicle tracking system using GPS and GSM technology based on IoT

Nazmul Islam Akanda[1], Md. Alomgir Hossain[2], Md. Mazharul Islam Fahad[1], Md Nur Rahman[1], Khairunnaher[1]
[1]Department of Computer Science and Engineering, College of Engineering and Technology (CEAT), International University of Business Agriculture and Technology (IUBAT), Dhaka, Bangladesh
[2]Department of Computer Science and Engineering, Faculty of Computer Science and Engineering, International University of Business Agriculture and Technology (IUBAT), Dhaka, Bangladesh

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ABSTRACT

Security is very apart important for vehicles to prevent the injury as vehicle theft is very common phenomenon now a days. We can ensure the security of our vehicles via monitoring our vehicles 24/7. There are many possible ways to track a vehicle. A few groups do not concern about the users need. Our research is about the tracking vehicle according to user's demand. We are concerning on low budget, better geographic coordinate and easy user access. The system needs global positioning system (GPS) and global system for mobile telecommunications (GSM) technology. User can access the system by short message service (SMS) on a mobile phone. GSM module communicate with the user and GPS module communicate with satellite to get latitude and longitude coordinate. Location of vehicle's on earth is determined using Google Maps.

Corresponding Author:

Nazmul Islam Akanda
Department of Computer Science and Engineering, College of Engineering and Technology (CEAT)
International University of Business Agriculture and Technology (IUBAT)
The 4 Embankment Drive Road, Sector-10, Uttara Model Town, Dhaka-1230, Bangladesh
Email: tech.nazmul.akanda@gmail.com

1. INTRODUCTION

Vehicle tracking is the method of remotely determining location of vehicle. Technology does have an impact on how we think and live. It is now possible to follow a vehicle. Nowadays, there are numerous options for tracking a vehicle. They are classified in two categories: i) passive-when a global positioning system (GPS) unit collects data from the tracker that needs to be downloaded; and ii) active- "Active" trackers are GPS trackers that work in real time.

Theft of vehicles is a major concern. Vehicle theft is a crime, but it is linked to more serious crimes such as drug trafficking, arms smuggling, people smuggling, and international terrorism. From 2006 to the previous year, the rate of private car theft in our country was 0.8 per 100,000 people. If we can spread the use of tracking systems, we will be able to reduce this type of crime. Vehicle tracking systems are also advantageous in fleet management and driver monitoring. The government and military of the United States built GPS, which was supposed to be used for surveillance. The GPS was created as a result of a collaboration between the US Dr. Ivan and the Department of Defense Developing a satellite-based course planning system that is mostly used for navigation. GPS project entailed the development as well as launch of 18 satellites. Each orbital planes, there are six spaced 120 degrees apart, and their positions on the ground, cost around $12 billion at the time. These satellites are used for a variety of purposes reference points on a

map using GPS to obtain and display precise geographic coordinates. The idea for a global positioning system was conceived during the Cold War to be used by military and intelligence organizations, and was inspired by Sputnik, a Soviet-launched spacecraft. Since its launch in 1960s, GPS has grown into a larger and more sophisticated satellite network constellation that orbits Earth at fixed places in space, broadcasting signals to anybody with a GPS receiver. The GPS signals include a time code and a geographic data point, allowing us to show a device's exact location anywhere on the globe and store the informations on cloud. Ground-based radio navigation systems like long range navigation (LORAN) and the Decca navigator, which were developed in the early 1940s and used throughout World War II, are based on the same concepts as GPS. In 1957, the Soviet Union launched the first Sputnik satellite, which delivered additional inspiration for GPS system. Sputnik's radio transmissions were being monitored by a team of US scientists led by Dr. Richard B. Kershner. They noticed that frequency of Sputnik signal increased as satellite reached them and reduced as it traveled away owing to the Doppler Effect. They realized that because they knew their exact location on earth, they could establish where the satellite was along its orbit by analyzing the Doppler distortion. In 1960, a successful test of the first satellite navigation system took place. It produces a five-satellite constellation that provides a navigational fix once every hour. US Navy launched the timation satellite in 1967, which is employed by the GPS system, demonstrated the capacity to set exact clocks in space. The ground-based Omega Navigation System, which was based on signal phase comparison, became the first global radio navigation system in the 1970s. During the early stages of the tracking, only two radios used to relay information. The car had one radio and the base station had another, allowing drivers to communicate with their bosses. Throughout their journeys, the fleet operator could keep track of their progress. Early technology has its own set of constraints. In terms of accuracy and more engagement between drivers and fleet operators, the distance constituted a stumbling barrier. The driver provided information to the base station, and a big fleet could not have been run only by humans. The landscape of vehicle tracking changed with the arrival of GPS technology. As a result, the use of manpower has been reduced. Computers were used to track the majority of labor. When it comes to managing a large fleet of vehicles, computers came in helpful. The information was also given more credibility as a result of this.

2. BACKGROUND STUDY

Create a GPS-based tracking device to detect the precise location of a vehicle to which it is attached and transmits that information to a user over a global system for mobile telecommunications (GSM) modem [1] but they have not shown in which format user receive the data and they use SIM900D as GSM module and a separate GPS module which cost is much higher and complex to maintain. It is planned to use a real-time Google Map and an Arduino-based vehicle tracking system, although the user only receives latitude and longitude information and they use a GPS and general packet radio service (GPRS) shield which have no antenna thus it make a problem to placement and to get real location [2]. The vehicle tracking device is installed within the vehicle and offers accurate real-time location information. The information can also be saved and downloaded to a computer for future research. Like [3] the system relies on radio-frequency identification (RFID), it can only detect buses in a specific area. A bus transceiver was incorporated in the system, which provided pupils with information on the whereabouts of a bus on a predetermined route, but no map was utilized to determine a real-world location [4]. Use of a RFID technique requirements they are only demonstrating how RFID may be used to track a system; no implementation has been provided [5]. Vehicle tracking and location systems based on the GSM and the GPS added value by providing accurate, real-time vehicle location, mapping, and reporting data, as well as boosting the level of service given. The GPS-based vehicle tracking system is designed to determine any vehicle's exact location and send an short message service (SMS) on a mobile phone.

GSM module communicate with the user SMS alert to the necessary authorities. Early technology had significant limitations as well. In terms of accuracy and more engagement between drivers and fleet operators, the distance constituted a stumbling barrier. The driver provided information to the base station, and a big fleet could not have been run only by humans. The landscape of vehicle tracking changed with the arrival of GPS technology. As a result, the use of manpower has been reduced. This concept will continuously track the location of a moving vehicle and provide on-demand updates on its status [6]. The majority of labor was tracked using computers. Computers came extremely handy when it came to handling a huge fleet of automobiles. As a result of this, the information gained more credence. Automobiles are required for the transportation of commodities from one place to another. Delays in the delivery of items can cause a slew of issues for customers. Drivers may have chosen erroneous or longer routes when delivering, causing the delay. The GPS is increasingly being used for fleet management, stolen vehicle recovery, mapping, and surveillance to address these concerns [7], Adafruit FONA 808 GSM+GPS Shield use by this system which cost is above BDT 3000 and also it provide GPS and GSM with very short antenna. Real-time vehicle tracking system of GPS and GSM technology based on ARM7 is presented and it uses the SIM 900 A

chip, which is substantially more expensive because GPS must be purchased separately [8]. System in [9] use ATE command to Arduino UNO to track the location of your vehicle, the GPS and the GSM technologies with short antenna. And we are concerned with a minimal budget, improved geographic coordinates, and user accessibility. Zhian and Han [10] describes a bus management system that executes the fundamental duties of an intelligent public transportation management system in a fixed route using ZigBee and GSM/GPRS. Also, scholar bus monitoring system with a set route was created for this referenced paper [11]. New examples of applications arose as wireless communication technology advanced, such as the use of public network text messages to communicate mobile location information, referred to as the first generation of GPS dynamic positioning technology [12]. Morallo [13] implemented a tracking system using GPS module (NEO-6m), SIM900 GSM module which have higher price as separately we have to buy GPS and GSM module. GPS module (NEO-6m) provide a very short antenna thus it makes a problem for the system to capture GPS location. Also, user get only latitude and longitude value. RFID based tracking system developed in a fixed route [14]. System in [15] use GSM/GPRS module with SM5100B which provide a tiny antenna that can make problem to setup and get the accurate signal. System in [16] use separate GPS and GSM module that cost is higher and data received by the user is not shown in this paper. An ideal theoretical idea was developed to track vehicle [17]. Two type o tracking system (RFID and GPS) used in one system but exactly which module is used not clear [18]. Demonstrate of low cost vehicle tracking and its need but no implementation [19]. A hypothesis of low cost tracking system was published for user desire location for vehicle [20]. Paper [21], [22] doesn't make clear about the GPS and GSM exact version and user get only latitude and longitude. Reseachers [23], [24] use separate GPS, GSM and we are concerning combine. U-Blox NEO-7M GPS and SIM900A GSM based tracking system is expensive one [25].

3. OBJECTIVE

To create a vehicle tracking system that can controlled with smartphone or embedded device. Create low-cost, high-performance vehicle tracking system and implement it. To provide a user-friendly and safe system for controlling cars, with a focus on assisting individuals of all ages. We use GPS, GSM technology and Arduino UNO as microcontroller. Where the user may send a SMS request to GSM module, and system will respond with coordinate value latitude and longitude as well as a link of Google Maps, which is useful for finding the actual real-time location of vehicle and makes system more user-friendly. We are using SIM808-GSM/GPS/GPRS shield with antenna which come with combine GPS and GSM module with a sufficient price. GPS Antenna consumes roughly 10 milliamps and gives an extra 28 dB gain. Also, it has a 5-meter cord, allowing quickly reach where the sky view is better (as better sky view gives better coordinates) likely headlight of car, near to front and back glass wherever it is needed according to the vehicles structure. Because the antenna is magnetic, it can be attached to a vehicle's roof, truck, or other steel structure. It operates at frequency of 1575.421.023 MHz, with 2.5 V to 5.5 V voltage range and a current range of 6.6 mA to 16.6 mA. As a result, it is possible to measure location more accurately than others.

4. ENVIRONMENT SETUP

The design is embedded application, which continuously monitors moving vehicle and provides status reports on user demand. Arduino is serially connected with SIM808 GSM modem and GPS receiver in this system. Vehicle's latitude and longitude are sent from any remote location using GSM modem. Data is transmitted by the GPS modem, which comprises the vehicle's latitude and longitude. Hardware interfaces to microcontroller are SIM808's GSM modem and GPS receiver. DFRobot Library is used to interface the controller with the GSM modem and GPS receiver. When user sends request to GSM modem's number, system sends back message to that mobile, revealing the vehicle's latitude and longitude. On Google Maps, a program was designed to discover the actual location of the vehicle as well as the true traveled track of the moving vehicle as shown in Figure 1.

Flowchart depicts system's operation shown in Figure 2. The Arduino UNO is employed as the main control mechanism in this system. After user send initialize message to GSM module in this system, Arduino locates the message, and the software serial prints the vehicle position latitude and longitude. At the time, the user received a message with the vehicle's latitude and longitude as well as a Google map link. GSM has no effect if the GPS module does not receive the signal. As a result, users must wait for a signal from a GPS satellite.

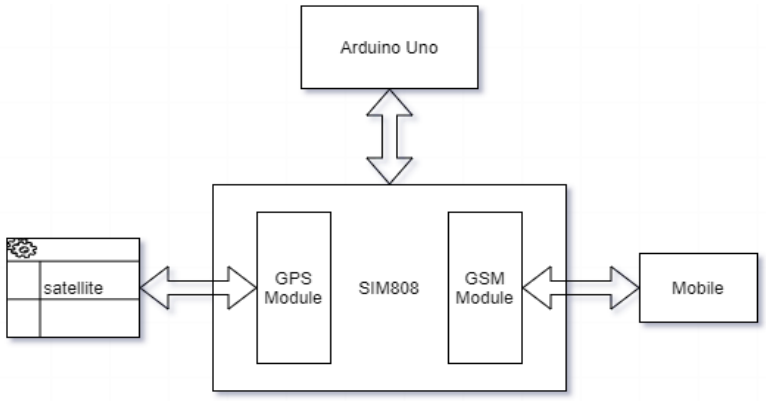


Figure 1. Block diagram of the system

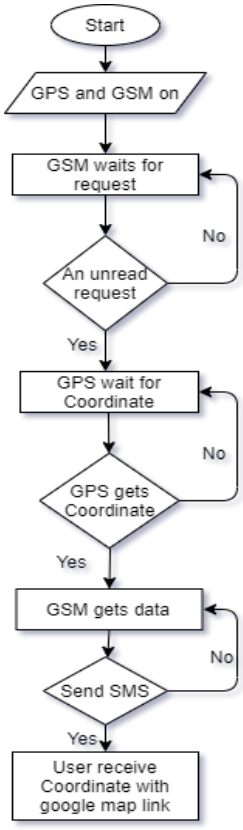


Figure 2. Flowchart of the system

5. IMPLEMENTATION

Include the DFRobot library programming for the SIM808, and define software serial communication. To facilitate serial communication on pins 10 TX and 11 RX, SoftwareSerial library is used. GND pin shared by common Arduino GND pins. When system is ready serial monitor will show open the GPS power success and Init success, please send SMS message to me! Otherwise, serial monitor will show open the GPS power failure. After serial monitor showing open the GPS power success and Init success, please send SMS message to me! if GSM get an unread request or message, system will start to get GPS latitude and longitude. Soon after finding GPS location a return SMS will send to user. If system doesn't get GPS location it will send nothing to user, so users need to wait until system get the GPS location in Figure 3. As we are producing good results without costing a lot of money the cost estimation as shown in Table 1.

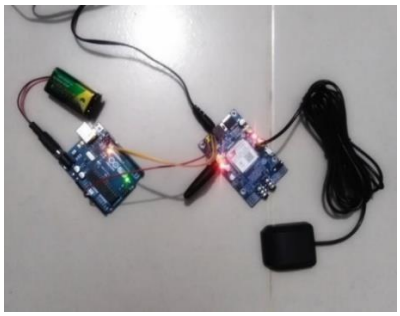


Figure 3. Implementation design of the system

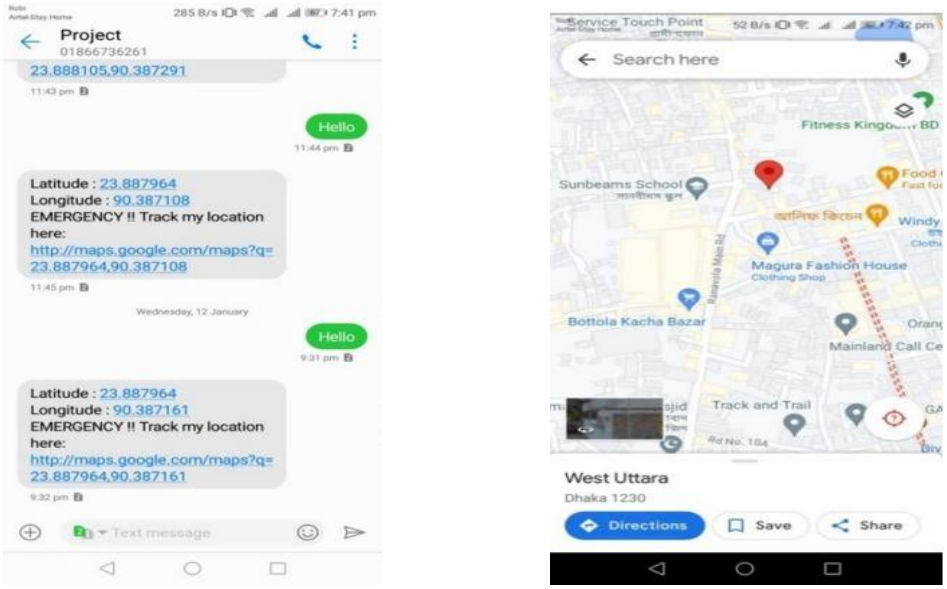
Table 1. The cost estimation table of the system

#	Component	Price (BDT)
1	Arduino UNO R3	609
2	9 V battery to 2.1 mm for Arduino UNO connector	20
3	Battery 9 V	49
4	SIM808 GSM/GPS/GPRS shield with antenna	1990
5	Jumper wires (M to F) 20 pieces	32
6	5 V 2 a power adapter (original)	194

Total cost-BDT 2894

6. RESULT AND DISCUSSION

The GSM module was used in this research to transmit and receive messages from another GSM number. If the vehicle owner wishes to know where their vehicle is, they must first send a message. The GSM module was functional at the time, sending SMS to the owner's cell phone number as shown in Figure 4. The GPS module is also used in this thesis, so the message includes latitude and longitude of vehicle's location like Figure 4(a). If owner wants to see their vehicle's location on a Google map, they can do so like Figure 4(b). As a result, the user is always aware of their vehicle's whereabouts. We have introduced a feature that send SMS to the user based on the user's request for vehicle's location monitoring. The vehicle's latitude and longitude are included in the SMS. The SMS also contains a link to Google Maps, with this user can utilize to view the location. The term "accuracy" refers to how closely a quantity's measured value corresponds to its "actual" value. The following Table 2 and Table 3 represents the accuracy of the system:



(a) (b)

Figure 1. User receive (a) text message with Google Map link to find and (b) location at Google Map

Table 2. The performance of the system 1st case

#	Latitude	Longitude
1	23.888449	90.387238
2	23.888338	90.387253
3	23.888262	90.387253
4	23.888266	90.387207
5	23.888273	90.387108

Table 3. The performance of the system 2nd case

#	Latitude	Longitude
1	23.887964	90.387161
2	23.887964	90.387108
3	23.887886	90.387321
4	23.888037	90.387253
5	23.887863	90.387108

7. CONCLUSION

The most crucial system for people nowadays is a tracking system; they want their car's security to be in good hands, and this is the major reason. As a result, vehicle tracking systems are becoming increasingly popular, not only in large cities but also in smaller towns. This technology is fully integrated, allowing user to easily track their vehicle position any time from any location. Vehicle theft is on the rise, but people have found a way to keep a watch on their automobiles without having to be in close proximity to them. These systems keep a tight grip on thefts and, to some extent, assist prevent them. We created vehicle tracking system and tested that can track exact position of moving and stopped vehicle in real time. This paper contains information about development and vehicle tracking system implementation. Smartphone and in-vehicle device make up the tracking system. The in-vehicle device in this study consisting of microcontrollers and SIM808 GPS/GSM/GPRS module that captures positions of vehicle data and transfers it through the GSM/GPRS network according the user's smartphone. The Google Maps application is utilized to view vehicle's geographic coordinates. A Google map link is sent to the user's smartphone, which displays Google Maps location of vehicles. In an experimental situation, the system is able to demonstrate ability to track vehicle's whereabouts at any time and from any location. Furthermore, due to the fact that our solution is based on commercially accessible electrical modules, it is low-cost. This procedure is dependable as well as safe. This setup is reasonably easy to modify, allowing to adapt to future needs without having to start over from the beginning, resulting in increased efficiency. In this study, the GSM module was utilized to transmit and receive SMS. 2G, 3G, and 4G networks may be supported using the GSM module. Our paper describes a tracking system at a minimal cost that uses the GSM network's GPS and GPRS for a diverse set of uses around the world. Use of GPS and GPRS together allows for tracking in real time and on a continuous basis. When compared to SMS-based tracking solutions, the cost is far lower. The usage of an hypertext transfer protocol (HTTP) link as a data transmitting technique improves the user-friendliness of the system. The full deployment of the suggested method is projected to better GPS location and lower the cost of SMS-based tracking systems in the long run.

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BIOGRAPHIES OF AUTHORS

Nazmul Islam Akanda has completed Bachelor's Degree in Computer Science and Engineering, College of Engineering and Technology (CEAT), International University of Business Agriculture and Technology (IUBAT), Dhaka, Bangladesh. His research area is IoT. He can be contacted at email: tech.nazmul.akanda@gmail.com.

Md. Alomgir Hossain is working as an Assistant Professor in the department of Computer Science & Engineering at IUBAT-International University of Business, Agriculture & Technology. He has completed Masters Degree in Computer Science from Jahangirnagar University His areas of interest are: Cloud Analysis, IoT, Machine Learning and Data mining. He can be contacted at email: alomgir.hossain@iubat.edu.

Md. Mazharul Islam Fahad has completed Bachelor's Degree in Computer Science and Engineering, College of Engineering and Technology (CEAT), International University of Business Agriculture and Technology (IUBAT), Dhaka, Bangladesh. His research area is IoT. He can be contacted at email: 18103200fahad@gmail.com.

Md Nur Rahman has completed his MSc in Information and Communication Technology from Bangladesh Uniersity of Professionals (BUP) and BSc in Computer Science and Engineering from IUBAT-International University of Business Agriculture and Technology. His research area is IoT and Machine Learning.
He can be contacted at email: nurrahamancse@gmail.com.

Khairunnaher is student at Department of Computer Science and Engineering, College of Engineering and Technology (CEAT), International University of Business Agriculture and Technology (IUBAT), Dhaka, Bangladesh. Her research area is IoT. She can be contacted at email: 18103154@gmail.com.