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GPS Based Automatic Object Tracking System

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Abstract: The process of tracking an object on the Earth's surface has been a much needed demand since the development of satellites. With the advent of GPS it has became an easier process. The combination of GPS, GSM and Arduino can be effectively utilised to aid in efficient tracking of an object. The location coordinates of the object such as latitude and longitude are sent to a preset mobile number in SMS format. A simple click will redirect to Google maps and yield the exact location. Continuous position information of an object for a particular interval of time gives the trajectory of the object over time. Thus, the particular object of interest can be tracked.

Keywords: GPS, Tracking System, GSM, Arduino, NMEA

I. INTRODUCTION

Object tracking is a process of locating a moving object over time i.e. the relative location of an object within an interval of time. Currently object tracking is being used in traffic control, fleet management etc. Earlier only two radios were used to obtain data from units. With the advent of GPS the entire system has undergone a revolutionary change. With the help of GPS the object of interest is located. The GPS comprises of a constellation of 27 Earth orbiting satellites. Each of these satellites revolve round the globe at around 20,000 kms above the surface of the earth. These are solar-powered and make two complete rotations each day. The orbits are so arranged that at anytime, anywhere on earth, there are at least four "visible" satellites in the sky. A GPS receiver's job is to locate and find four or more of these satellites and figure out the distance from them. This information is used to deduce its own location. This operation is based on a mathematical principle called Trilateration. In this paper, a GPS receiver, a GSM modem and an Arduino board have been used. The whole system is attached to the vehicle selected for tracking. At the other end, one GSM mobile phone is attached to a mobile application. The GSM modem receives the location coordinates corresponding to the position of vehicle from the GPS system. In our system we have used SIM 900A module to transfer the data captured by the GPS module to the user via SMS. Arduino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, USB connection, power jack, an ICSP header and a reset button.[13] The Arduino acts as a bridge between the GPS and GSM module. The GPS first transmits the data captured by it to the Arduino in NMEA code format. The Arduino compiler consists of all the library functions used for extracting valuable data from the NMEA code format. After decoding the data the arduino transmits the data to the GSM module and the GSM sends the data to the registered mobile via SMS. The whole process is accomplished through proper programming. The location information of the object being tracked will be available at the vehicle on an LCD display. A place name is assigned for each longitude and latitude. The device is password controlled in order to increase the security. In case of any mishap or unfortunate incidents such as fire, theft etc. the device will automatically send an alert to the registered numbers. The rest of this paper is organized as follows. Section II briefly discusses the related work in this field. Section III describes the system overview with block diagram and circuit diagram. Results obtained are presented in Section IV. Section V concludes this paper and outlines future research followed by references.

II. LITERATURE SURVEY

Discussions on a number of vehicle/object tracking devices exist in the literature. In [1] tracking/navigation is implemented by fetching the information of the vehicle like location, distance, etc. by using GPS and GSM.

In the paper [2] the authors have used an FPGA Spartan processor .instead of Arduino for vehicle tracking and accident warning. It manages all the parts responsible in system according to the program.

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In another paper [3] the tracking system consists of an on-board module which is mounted on the vehicle to be tracked. This on-board module consists of GPS, a GSM modem and an ARM processor. The GPS satellites are used to compute the longitudes and latitudes of vehicle coordinates, then transform it into the short message form and the message is then sent to the monitoring centre.

The design and development of a GPS-GSM based tracking system is presented in paper [4]. Here also Google map is used for monitoring. This system can also be used in tracking the theft of the vehicle.

The paper [5] presents a GSM and GPS based vehicle location and tracking System. In this paper an RF transmitter is attached with the vehicle which gives its own identification. The data are continuously transmitted to the RF receiver that is connected to a microcontroller. The receiving unit triggers a signal to the microcontroller, and from this signal we can identify the stolen vehicle's location.

A laptop embedded with Google Earth is used for tracking and viewing the location of a vehicle in paper [6]. When a vehicle's ignition is turned on, the vehicle's owner receives a confirmation SMS that the vehicle is now running. If the access to the vehicle is illegal, the vehicle's owner sends an SMS to turn off the vehicle.

The system in paper [7] uses a Kalman filter to reduce positional error and thus improves the accuracy of the position determination.

Vehicle tracking systems based on social network services such as Twitter and Facebook has been proposed in [8]. In this case in-vehicle device has an account of any of the social network and thus identifies the vehicle location on a regular basis.

Kamel [9] has proposed a vehicle tracking system based on GPS and GPRS. An embedded GPS sensor is used to obtain the location of the vehicle. The author has used a modified coding method to encode and compress location data before it is sent. It offers cost effective usage of network traffic.

III. SYSTEM OVERVIEW

BLOCK DIAGRAM

There are certain steps that are followed when a desired object is attempted to be tracked. These steps are:

1. Data capture: Data in a vehicle tracking system is captured through a unit called automated vehicle unit. The automated vehicle unit uses the Global Positioning System (GPS) and is installed in the vehicle.
2. Data storage: In the memory of the automated vehicle unit captured data are stored.
3. Data transfer: Stored data are transferred to the computer server using the mobile network.
4. Data analysis: Data analysis is done through software application.

In this system, Arduino is used for controlling the whole process with a GPS receiver and a GSM module. GSM module is used for sending the coordinates to the user by SMS and an optional 16x2 LCD is also be used for displaying status messages or coordinates. After acknowledgment of the command that asks for the location, the GPS tracks its own location. The Arduino acts as a central controller that receives and then filters only the necessary data and passes it on to the GSM module. The GSM module is responsible for sending the entire location in SMS format to the preset mobile number. The Fig. 1 shows the block diagram of the system.

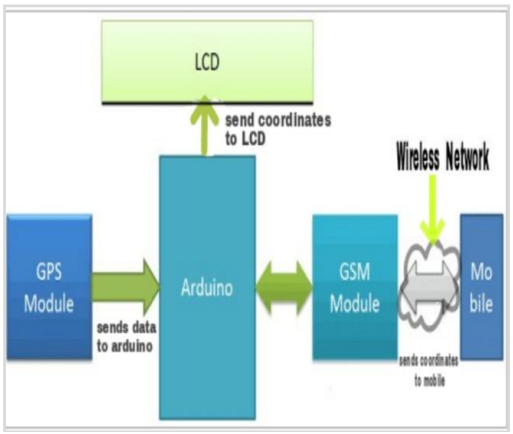

Fig 1: Block diagram of the system

DETAILS OF THE SYSTEM

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In our system, we have used UBLOX-NEO 6M GPS Module. The antenna is connected to the module using U.FL cable and it has four pins - Tx, Rx, Vcc and ground. The GSM Module used in this setup is SIM900A. It is compatible with Arduino, Raspberry Pi, ARM etc. It is also provided with the facility of microphone and speaker. The controller used is Arduino Uno which contains Atmega 328 microcontroller. The GSM modem uses AT commands to send the location messages about the object. When we are ready with our hardware after programming, we can install it in our vehicle and power it up. Then the program requires us to send a SMS,(viz. "Track Vehicle"), to the system that is placed in our vehicle. We can also use some prefix (#) or suffix (*) like #Track Vehicle*, to properly identify the starting and ending of the string. The message sent from the mobile is received by GSM module connected to the system and sends message data to Arduino. Arduino reads it and instructs the GPS to get the location information. Then Arduino reads the coordinates by extracting $GPGGA string from GPS module data. After that it sends the data to the user with the aid of the GSM module. This received message contains the coordinates of vehicle location. The Fig. 2 shows the actual picture of the system .

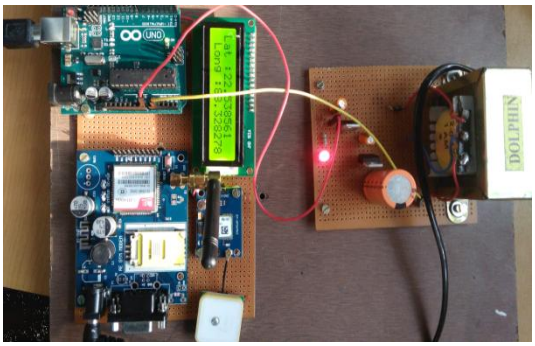

Fig 2: the actual picture of the system

CIRCUIT DIAGRAM

The GSM is connected to the Arduino with the aid of receiver and transmitter pin. The transmitter pin of Arduino is connected to the receiver pin of the GSM and vice versa. Similarly, the GPS is connected to the pin number 9 and 10 (the digital pins). We have made these pins receiver and transmitter pins with the help of software library. Hence the Arduino is acting as an interface. The LCD is connected to the Arduino via pin number 6 and 7. The circuit diagram is shown in Fig 3 [14].

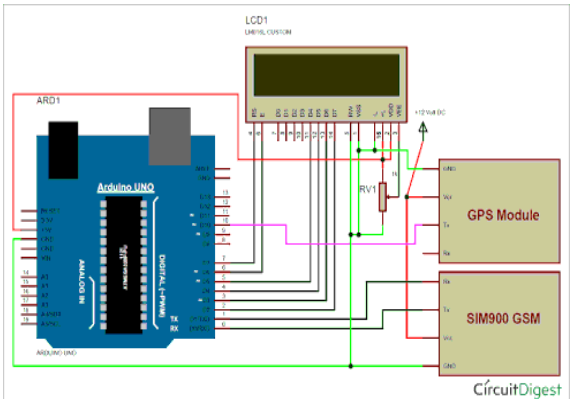

Fig 3: Circuit diagram of the system

IV. RESULTS

NMEA CODES

NMEA 0183 is a combination of electrical and data specifications for communication. It is used in marine electronics such as sonar, anemometer, echo sounder, gyro compass, autopilot, GPS receivers and various other types of instruments. It has been defined and controlled by the National Marine Electronics Association. It replaced the earlier

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NMEA 0180 and NMEA 0182 standards. The NMEA 0183 standard uses a simple ASCII, serial communication protocol. This defines how data are transmitted in a "sentence" from one talker to multiple "listeners"

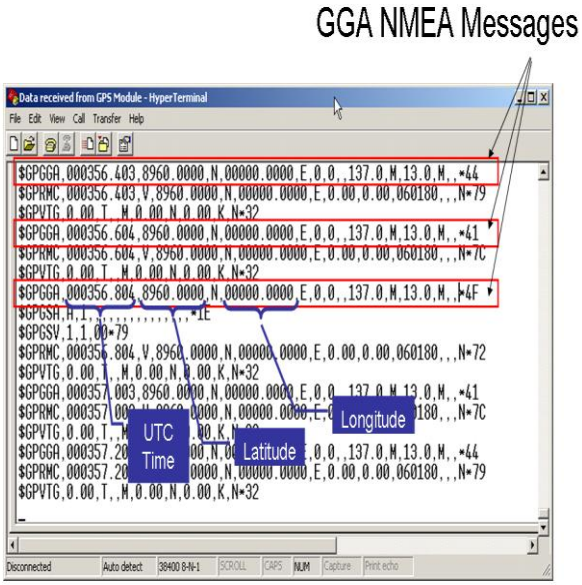

Fig 4: NMEA code formats

The data format in this code consists of string starting with $GPGGA. This consists of the UTC time, latitude and longitude of the object being tracked.

MAPS

By clicking on the link that is received in the preset mobile number automatically the location can be traced by attaching the link in a string format during the coding.

Fig 5: Screenshot taken from google map

The object was also tracked in a completely different location where it produced the desired result.

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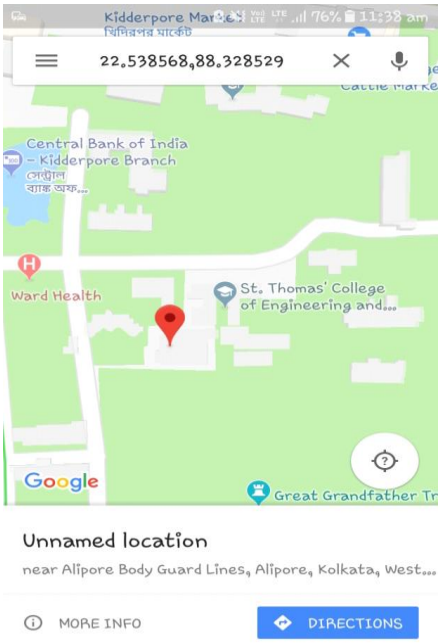

Fig 6: Screenshot of location of the object [12].

V. CONCLUSION

The object tracking system is very useful in the present world where continuous communication among different points on the Earth is the foremost requirement. Complete knowledge of the entire terrain of the surroundings of an object is essential. Considering the myriad number of applications, novel approaches with the same objective is made. In the proposed system we successfully obtained the desired location of the object by clicking on the link of google map. The accuracy of the GPS improved considerably when taken outdoors. This same project provides us with a lot of future prospects and keeps a few sectors where development is possible. We can use the EEPROM to store the previous navigating positions up to 256 locations and we can navigate up to N number of locations by increasing its memory. Another important aspect in any kind of setup is the physical dimensional constraint. We can reduce the size of the kit by using GPS and GSM on the same module.

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