Vehicle Tracking System with Smartphone Integration

S Om Prakash, R Karthikaeyan

Abstract— Need for reliable management system of Vehicles in today's world has increased to a greater extent. By implementing the vehicle tracking system, you can ensure that you are getting the most productivity out of the vehicles. It is designed in such a way that the people can track every single vehicle movements in and around them in real-time. An appropriate real world scenario will be - Assuming we've setup the tracking device in a College Bus, A student can track his college bus via his smartphone and he can setup an alert if the college bus crosses his Pickup point ensuring that he doesn't miss his bus. In case if he misses the Bus he can check for other college buses around him and board that bus. This could be it thus making life easier. A vehicle tracking system is designed and implemented to track the movement of any vehicle from any location at any time. The system makes use of popular technologies that combines Hardware and software together. This will be easy to implement with inexpensive GPS systems in vehicles. This paper deals with how a vehicle is tracked via Smartphone app and a Web app. The vehicle tracking system use the GPS module to get geographical coordinates at regular time intervals. The GSM /GPRS module is used to transmit the GPS data to a Database setup in a web server. The vehicles can be monitored via a Smartphone app or Web app developed. The applications make use of Google Maps API to display the vehicle's location on a map. Thus, a user will be able to track vehicles in real time. In order to show the feasibility and effectiveness of the system, this paper presents experimental results of the vehicle tracking system and some experiences on practical implementations.

Index Terms— Client-server, college bus, google maps, gps tracking, HTTP request, location database, MCU, NMEA, parse data, Smartphone Integration, TCP server, vehicle tracking, web server, xml format

1 INTRODUCTION

A GPS (Global positioning system) can help us to determine exactly where we are at any given moment. Not only can a GPS give us the name of the street we might be traveling on, Ease of Use If a person is lost he/she can be easily tracked down using this system in real time and brought back to safety. Similarly here it helps the user to track his/her bus from his/her smartphone or a Web Application. The Global Positioning System is a satellite navigational system, predominantly designed for navigation. GPS is now gaining prominence as a timing tool [1]. Eighteen satellites, six in each of three orbital Planes spaced 120º apart, and their ground stations, formed the original GPS. GPS uses these "man-made stars" or satellites as reference points to calculate geographical positions, Accurate to a matter of meters. In fact, with advanced forms of GPS, you can make measurements to better than a centimeter [2]. GPSs are very quickly becoming a standard in most new automobiles, and are even finding their way onto a variety of new cell phones.

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Smartphone is becoming more personal day by day to every single people in this world.

To make use of that we bring tracking to Smartphones. Smartphone being a device for ease of communication we developed an Application to track and manage vehicles in and around and keeps us updated in real time. Unlike the conventional system of tracking here we use the latest technologies of the smartphone. For example previously the GPS Co-ordinates are sent to user via SMS or it is shown in Serial Display thus user cannot appropriately locate the vehicle properly. In our case we use an Application which runs in our smartphone displays the Vehicle's location in Custom Google Map. Doing so we overcome the difficulties of vehicle tracking. This is even a low cost solution requires very less Hardware components which are cheaper and accessible by everyone. Whereas in software side the data consumption for tracking the vehicle is very less as compared to others. Thus this mode of tracking makes use of best technologies and makes it easier for people to track vehicles at low cost.

2 PURPOSE OF STUDY

The general objective of the development of this system is to help people track things in more efficient way and effective way resulting in greater reliability. In real life, when a freight service provider wants to track his/her shipment service which is been carried by a vehicle. It's really difficult to manage all those fleet of vehicles which is in movement in whereas corners of the city. By attaching this GPS device, it'll be

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easier to track them via Smartphone app and Web app. Thus, monitoring them in real time 24x7.

2.1 Issues in Tracking

Vehicle tracking systems can bring a wealth of benefits to businesses of all sizes but that doesn't mean they are completely problem free.

- Vehicle tracking does not generate a tangible income; rather it identifies areas where money can be saved and opportunities to increase profits.
- The GPS receiver attached to the vehicle may not be able to see the satellites clearly when the climatic conditions are cloudy, foggy, rainy etc. For getting an accurate location the GPS requests signals from multiple satellites revolving around the earth's orbit. In case if signal from any one of the satellite fails due to climatic conditions then it will result in inaccuracy of location.
- In order to transmit data to the TCP server we use GSM module. The GSM module gets activated if and only if there exists a cellular base station in its vicinity of 5Km radius.
- In case if the vehicle enters a signal less area, it becomes impossible for the end users to track the Vehicle remotely via a smartphone or a Web application.

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3 SYSTEM ARCHITECTURE

It consists of two units one is transmitting side (vehicle unit) and other one is monitoring side.

3.1 Architecture of Vehicle tracking system

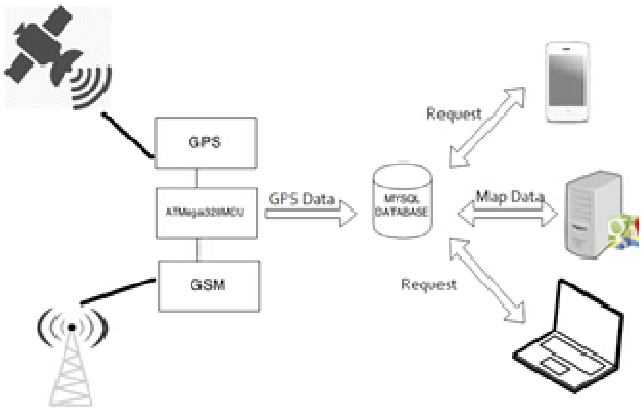

Fig1. Architecture of vehicle tracking system

The hardware used here are GPS Module, GSM Module and ATMega328 Microcontroller.

The GPS Data is sent to a Location Database. The user Requests for Map data of a vehicle. Then it is fetched from the Location Database and sent to Google Maps server for further process. The rendered map will be sent back to the client who requested for Vehicle's Location.

- **GPS:** GPS modules are popularly used for navigation, positioning, time and other purposes. GPS antenna receives the location values from the satellites.
- **GSM:** GSM modem is used for transmitting and receiving the data. SIM 800 is a Quad-band GSM/GPRS engine. It works on various frequencies i.e. EGSM 900MHz, DCS 1800MHz and PCS 1900MHz. The GSM module requires a Mobile IP and Internet connectivity to transfer the data to TCP Server.

  I. Mobile IP & Internet

  Mobile IP (or MIP) is an **Internet Engineering Task Force** (IETF) standard communications **protocol** that is designed to allow mobile device users to move from one network to another while maintaining a permanent IP address. [3] The Internet is a global system of interconnected **computer networks** that use the standard **Internet protocol suite** (TCP/IP) to link several billion devices worldwide. It is a *network of networks* that consists of millions of private, public, academic, business, and government networks of local to global scope, linked by a broad array of electronic, wireless, and optical networking technologies. [4]

- **Microcontroller:** The system uses a CMOS 8- bit microcontroller. It is based on RISC architecture. It comprises of 16k bytes of flash program memory, 1K byte internal SRAM and 512 bytes EEPROM.
- **MAX232:** It is used for GSM, GPS and microcontroller to communicate serially. A 9v battery is used to power up the circuit.

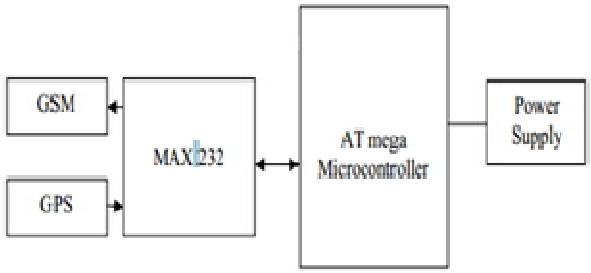

Fig2. Architecture of transmitting unit

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3.2 Vehicle tracking server

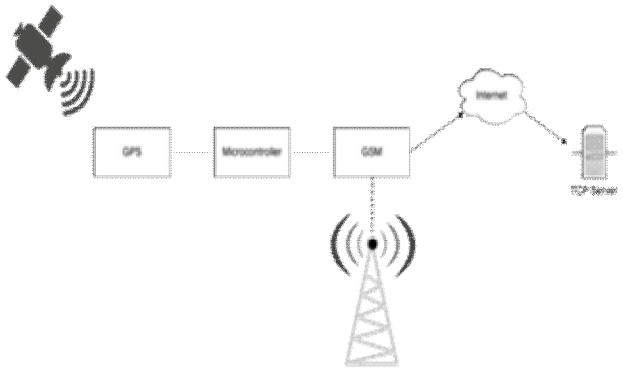

Fig3. Architecture of Vehicle tracking server

In order to send Geo data to web server the GSM Modem contacts the TCP Server being setup via Internet

The above Figure depicts the working of Hardware unit of the Vehicle tracking system. The GPS data is saved in Microcontroller's buffer at specific time intervals, as soon as the GSM module gets activated the GPS data in the MCU's buffer is sent to the nearest Base station and in turn the data is sent to a TCP server which is connected via Internet. Here the TCP server is responsible for interfacing the Hardware and Software.

3.3 Client-Server Architecture

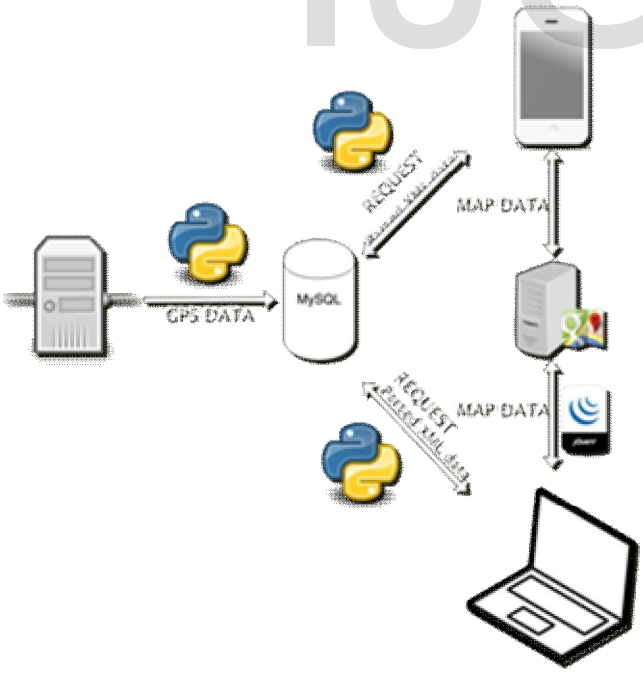

Fig4. Client-Server Architecture

Client requests for Vehicle's Location Geo Data are fetched from Location Database and the Map is rendered in Google Maps Server.

The Figure 4 depicts the **client-server** architecture of Vehicle tracking system as mentioned previously the TCP server acts as a medium to connect the Hardware and software. The TCP server connects to the web server being setup. The web server stores the GPS data in a location database containing the location information of vehicles.

In the client section a user with smartphone or a PC can check for location of vehicles by generating a HTTP request to the web server. The Web server fetches the result from the location database and contacts the Google map servers for Map overlays. At the end the Map is rendered and is displayed to the user via smartphone or web application

4 FUNCTIONALITY

The working of Vehicle tracking system is purportedly showed in two different formats.

- ***Algorithm***
- ***Sequence Diagram***

4.1 Algorithm

In Vehicle tracking system the working is divided into two views, one as an End user and the other is a Client side functions.

a) End User

- Select Mode of tracking i.e. via **Smartphone** or **Web application**
- If **Smartphone** Then
  - Request for locations of vehicles
  - Fetch information from Database
  - Start fetching GPS Data from Microcontroller's buffer via TCP server
  - Send GPS data to *Google Maps server*
  - Rendered map is sent back to Web server
  - The Vehicle's location is shown in Smartphone Application as Map View.

- if **Web Application** Then
  - Make an HTTP request to the Web server for locations of the vehicles
  - Fetch information from Database
  - Start fetching GPS Data from Microcontroller's buffer via TCP server
  - Parse data into XML Format
  - Send GPS data to *Google Maps server*
  - Rendered map is sent back to Web server
  - The Vehicle's location is shown in Web Application as Map View.

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b) Server Side Functionalities

- Power on the Device
- GPS receiver checks for signal from multiple satellites at Baud rate of 9600 bps
- GPS Receiver receives NMEA data
- NMEA data is parsed to get GPS Data
- GSM searches for Cellular Base station
- GSM makes a 3 way Handshake to the nearest Base station
- GPS Data from Microcontroller's buffer is transmitted to the TCP server via Internet
- TCP Server inserts GPS Data into the Database

4.2 Sequence Diagram

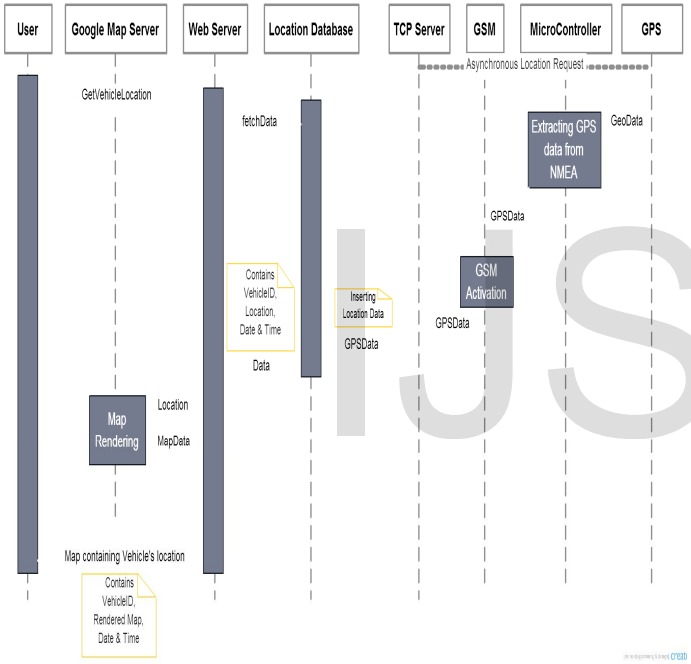

Fig5. Sequence diagram of Vehicle Tracking system

The above figure depicts the step by step action of a vehicle tracking system. A Smartphone user as two major advantages of using this Application. First one is whenever a vehicle is on a trip; he/she is able to record the vehicles geographical location on a website which is assisted by the administrator. The user can even set a Proximity alert in order to get an alert message whenever the vehicle crosses a specific location. The administrator function embedded in the GPS-Based Location Tracking System is to provide the functionality for monitoring the recorded footprints of each user individually on a computer screen. The application provides the administrator with the most recent location update.

5 GOALS OF THE SYSTEM

5.1 Individual task management

Often people are guilty of themselves that they forget the arrival of vehicle at a specific location.

To solve this problem, the proximity alert system helps you remind the vehicle's location on a location based alarm system. If you have assigned a task in the application to a location, then whenever the vehicle is near to your destination place, regardless of timing the application will issue you an alarm. Thus no task that is assigned to the phone once would be forgotten.

5.2 Safety tool

The application is very useful when the vehicle is in fleet services. On a trip, one can easily be lost and become unable to find a way to delivery point. This especially happens in rural areas. But if the GPS based tracking system is installed on the vehicle, it leaves it's footprints on a website which is monitored by someone who would be assisting you to the delivery point. So if there a problem occurs with the route, it can easily be found by the administrator simply by having a look at its current location. Thus the application provides location assisting in Unknown locations.

5.3 Administrative capabilities

Consider yourself as a Coordinator for a group of shipments that has gone for delivery. You are the person who has been assigned the job to look after the shipments and deliver all of them to the destination place safely. It is impossible for you to communicate with each vehicle individually. But if one of them is making a delay and no one is available there who can provide any sort of information about the shipment, then it is a serious trouble for you. Well, GPS Based Vehicle Tracking System is providing you the solution. Once each vehicle gets registered on the network, you don't need to worry about their location. All you need to do is to switch on your PC and all the registered vehicles will appear in one window with their most recent location update being recorded.

5.4 Feasibility

Depending on the results of the initial investigation the survey is now expanded to a more detailed feasibility study for "GPS based Vehicle tracking system via Smartphones". To develop this application, a High speed internet connection, a database server, a web server and software are required. The current project is technically feasible as the application was successfully deployed on Smartphones. The project is economically feasible as it only requires a mobile phone with Android/iOS/Windows Phone OS. The application is free to down-

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load once it is released in App Stores and Google Play store. The users should be able to connect to internet through mobile phone and this would be the only cost incurred on the project. It will need an internet connection to send the information to server. We need the server maintenance cost and Hosting. This is the basic operational cost which tends to very low.

6 SOFTWARE PROGRAM

The software programming is done in 'C 'language. Data (co-ordinates) received by GPS from The satellites are defined in the software. Decoding the NMEA (National Marine Electronics Association) protocol is the main purpose of developing this software. The mobile number of the User should be included in the software programming in order to receive the location values from the SIM card which we are using in GSM modem. The NMEA protocol consists of set of Messages. These messages are ASCII character set. GPS receives data and present it in the form of ASCII comma – delimited message strings. '$' sign is used at the starting of each message. The locations (latitude and longitude) have the format of ddmm.mmmm. i.e. .degrees minutes and decimal minutes. The software protocol consists of the GGA (global positioning system fixed data) and GLL (geographic position latitude/longitude). But in this system we are using GLL only.

6.1 Web application

The web application named as 'Tracking System' is shown in figures that represent the complete Output of the system. In this system two applications are developed that are linked to each other. First one is used to get the initial position of the vehicle (starting point) and as system will receive the different co-ordinates (longitude and latitude) switching to the next one will be done to get the distance travelled b/w the two positions. The application will run on XAMPP server and will run only if the internet is in use.

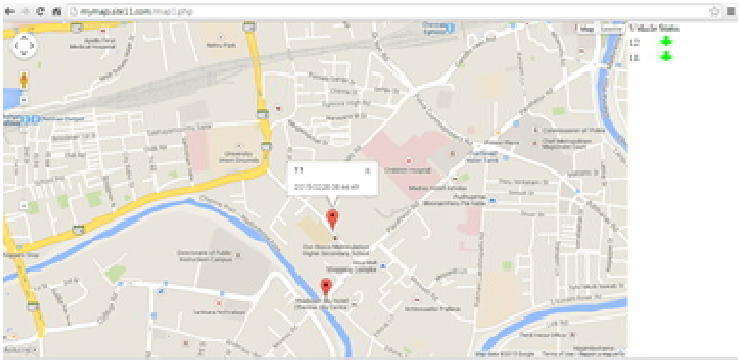

Fig6. Web application

Above figure shows two vehicles in transit

By clicking on the Markers you get the Vehicle ID and Time at that location. Both the applications are HTML based. PHP is also used for some modifications.

6.2 Android application

There's also a Smartphone Application being designed which helps the user to track those vehicles from a specially designed App. In the below figure 7, 8, 9 shows an Android application which is used to track the moving vehicle. The marker denotes the Vehicle. On clicking the Marker it shows the Vehicle Information and location of that vehicle at a specific Time. All three figures represents the location of the vehicle at various time period t = 0, 1, 2.

Fig7. Location of vehicle in Android app at time *t=0*

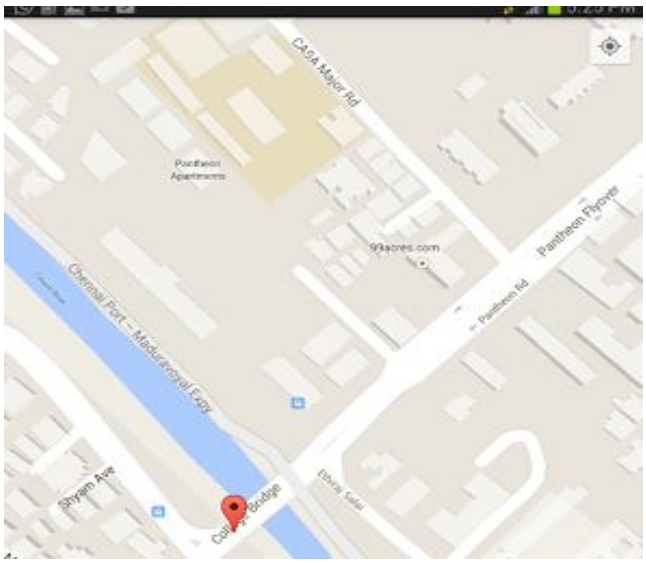

Fig8. Location of Vehicle in Android app at time *t=1*

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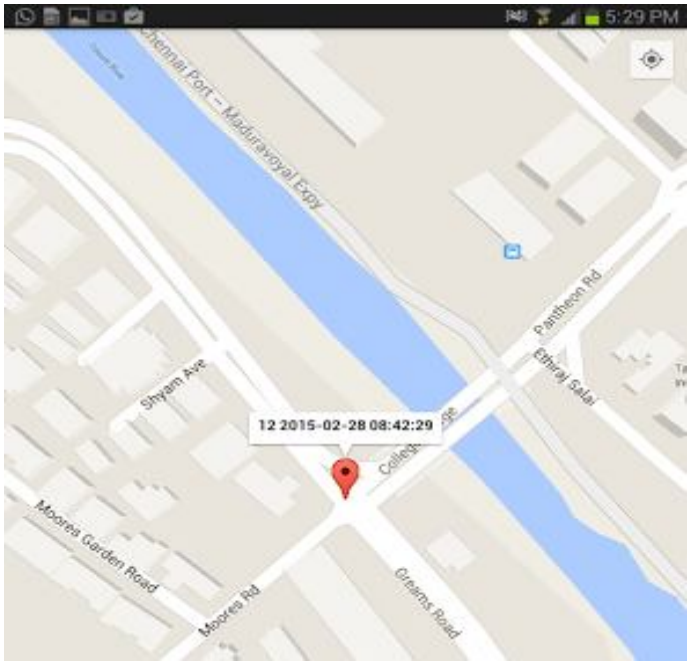

Fig9. Location of Vehicle in Android app at time *t=2*

7 CONCLUSION

As the dedicated GPS devices are costly we have designed our own GPS device resulting in lightweight and Low cost GPS Device. GPS device will find out the current location from satellite. Depending on certain condition the vehicle tracking server keeps sending the location again and again in a specific time period. We will plot this location to map. At the same time we will connect with an external web server to send this information there. The web server will store the visiting path as a summation of some co-coordinating points to draw a polyline. Actually, the web server is a restricted area. So we will have to use username and password to login that area. We can see the visiting path from the desktop or any other portable devices running Android operating system. We need to depend on Internet connection to store the information to the web server. If there is some problem With Internet connection, we may not be able to send the data correctly.

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