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DEVELOPMENT OF A MODERN GPS TRACKING SYSTEM

Shuva Das[1,*], Sajal Chandra Banik[2], Md. Ruhul Amin[3] and Ahamed Nasif Hossain Aoyon[4]

[1-4]Department of Mechanical Engineering, CUET, Chittagong 4349, Bangladesh

[1,*]shuvome08@gmail.com, [2]baniksajal@yahoo.com, [3]ruhul_cuet08@hotmail.com, [4]aoyon7@gmail.com

Abstract*- This paper proposes a system to trace the user's precise location and any location requested by the user, using the GNSS (Global Navigation Satellite System) network. This network incorporates a range of satellites that use microwave signals which are transmitted to GPS devices to give information on location, vehicle speed, time and direction. So, a GPS tracking system can potentially give both real-time and historic navigation data on any kind of journey. It does so using a process of trilateration, which works on the premise that, if the location of at least three satellites above the user is known and the distances between user and each of those satellites are known then location of the user is easily deduced. It will also enable the user to playback the recent travelling directory when needed. And as this nascent technology of GPS is gaining popularity in cars, findings of this study expect that the automobiles of Bangladesh will be augmented with the capabilities of automated navigation system.*

Keywords: GNSS, GPS device, Microwave signals, Trilateration, Travelling directory.

1. INTRODUCTION

GPS tracking means to trace something or someone with the global positioning system, which consists of a set of 31 operational satellites and land based control stations. GPS tracking System is one of the most rapidly growing technologies around the world. Most developed countries have focused on the GPS technologies in resolving some of their inherent security problems. That is why the GPS is considered the gateway to the future and there remains no alternative without practicing GPS. Among the numerous applications of GPS, modern vehicle tracking systems commonly use GPS technology for locating the vehicle. Vehicle information can be viewed on electronic maps via the Internet or specialized software. That means GPS technology requires internet facility to view the users position on a mapping program. In that case, GPS tracker becomes a little bit costly whether for a country like ours, this cost should be minimized.

Taking the above challenge, this project aims to design and develop a smart, compact and user friendly GPS data logger based on GNSS, to be installed in the cars, which log GPS data for the entire journey without any connections from internet. Once all these logged GPS data are stored in the memory card, one can take a tour of the entire journey completed as well as the nearby places just by inserting the memory card in a laptop or smartphone, with the help of internet for a while. The best suited GPS module for this purpose is a GPS receiver with an external antenna specially recommended for automobiles. The antenna is to be mounted on the top of the car to have the clear view of sky and to receive radio wave signal from the satellite transmitter. When all these functions are well synchronized in a GPS unit and installed in a car, simply makes the car augmented with the capabilities of automated navigation system.

2. OVERVIEW OF GPS TECHNOLOGY

Long gone are the days, GPS technology started its journey, but it is worth noting that, still there are a numerous of studies running over GPS for the further and further improvement.

Eric M. Conway (2008) noted that the U.S Department of Defense first launched a Global Positioning Systems (GPS) satellite in 1978 and achieved a full constellation of 24 satellites in 1994, which the U.S. government has named Navstar [1]. Today, GPS is used for both civil and military purposes and is controlled by a joint civilian/military executive board of the U.S. Government. The system is maintained by the U.S. Air Force on behalf of all users. GPS relies on three components: a constellation of satellites (currently 27) orbiting about 20,000km (11,500 miles) above the earth's surface which transmit ranging signals on two frequencies in the microwave part of the radio spectrum, a control segment which maintains GPS through a system of ground monitor stations and satellite upload facilities, and user receivers (civil and military).Originally conceived by the U.S. Air Force for military purposes in the 1960s, it was commercially released in 1995.

In 2000, selective availability was turned off, providing consumers the same level of accuracy as the U.S. military. Since that time, mobile business applications based on GPS and cellular network technologies have proliferated. The rate of innovation has been high, and the level of adoption has been steadily increasing, showing a great deal of promise for the small start-up companies which are targeting GPS solutions at families, enterprises, and security-related government initiatives.

By 1972, the U. S. Air Force (USAF) and the U. S. Navy had been studying for several years the possibility of improved satellite-based radio navigation. The main reasons for GPS development were the need to deliver weapons precisely on target and to reverse the proliferation of navigation systems in the U.S. military. For Bangladesh perspective, a notable performance is observed in OSM (on street mapping). Android application were developed that can help a blind people to find the destination [2].

Today is the age of fast and automated system and in every part of life people want the automated system. In communication system, this automated system is vastly needed. Good nautical charts and GPS mapping make planning easy. One can gather information about sights to see, places to visit, navigation waypoints, anchorage information, lists of marinas in the area, and a whole host of other information. By studying the charts of the region prior to departure, skipper can make a tentative route and can trace all of the alternate anchorages and approaches just in case he/she has to change his/her plans mid-trip. It works in any weather conditions, anywhere in the world, 24 hours a day. It receivers, normally hand-held battery-powered devices, take the information transmitted by the satellites and, using trilateration, calculate the user's exact location. The receiver compares the time a signal is transmitted by a satellite with the time it is received. It allows a person to know where he/she is without ambiguity.

GPS has proved a widely used aid to navigation worldwide, and a useful tool for land surveying, commerce, scientific uses, and hobbies such as geo coaching.

Today, GPS is used for both civil and military purposes and is controlled by a joint civilian/military executive board of the U.S. Government.

Global Positioning System (GPS) is increasingly being adopted by private and public enterprise to track and monitor humans for location based services (LBS) [3]. A location-based service (LBS) is an information or entertainment service, accessible with mobile devices through the mobile network and utilizing the ability to make use of the geographical position of the mobile device. LBS can be used in a variety of contexts, such as health, indoor object search, entertainment, work, personal life, etc. LBS include services to identify allocation of a person or object. They include personalized weather services and even location-based games.

3. MAJOR DESIGN TOOLS

For developing the GPS tracker, the following items are required:-

1. GPS receiver
2. GPS antenna
3. Arduino Nano V 3.0
4. Micro SD card with memory card
5. Breadboard
6. Connecting wires
7. Led

4. WORKING PRINCIPLE

Data loggers are usually the most basic type of GPS tracking; a GPS data logger simply logs the position of the object at regular intervals and retains it in an internal memory [4]. Usually, GPS loggers have flash memory on board to record data that is logged. The flash memory can then be transferred and accessed using USB or accessed on the device itself. Global Positioning System is a global navigation system. GPS receivers receive signal from GPS satellites and calculate their position using simple trilateration process. GPS satellites broadcast data and their signals are available for everyone across the world, free of cost. Using GPS receiver, one can find out their Longitude and Latitude position anywhere in the world [5]. GPS receiver has to know two things to get the users precise location:-

- The location of at least three satellites above user.
- The distance between user and each of those satellites

When distances from at least three satellites are known, using trilateration process GPS receiver calculates the user's precise location [5]. A block diagram corresponding to the functionality of GPS tracker is shown in Fig. 1

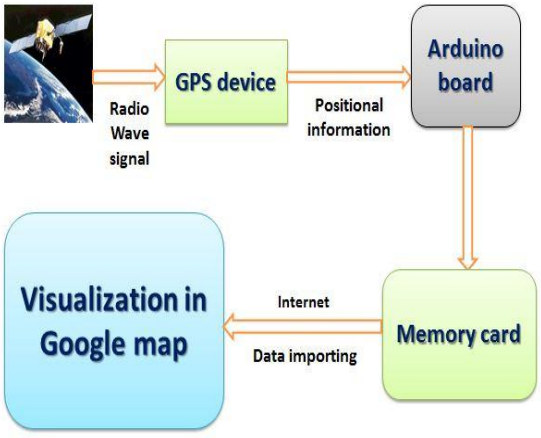

Fig. 1: Block diagram of the project

The positional information, when sent to arduino board where it is preprogrammed to be stored in the memory card as a recommended file format (.csv) compatible with Google map and there need no internet connections. With the help of internet, the logged data are imported into Google map and the user's position is visualized ultimately.

5. DATA INPUT AND VISUALIZATION

GPS tracker circuit (as shown in Fig. 2) once powered up and the satellites are fixed, GPS antenna receives radio wave signal from the satellites and sends those signal to the GPS receiver. GPS receiver sends those positional data to the microcontroller where it is programmed to be stored into the memory card inserted into the SD card. The higher the storage capacity of the memory card, the higher the amount of data it can store.

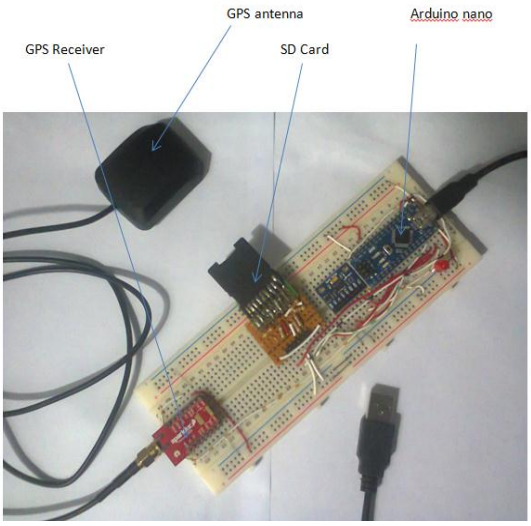

Fig. 2: Hardware connections of the GPS tracker

The stored file (.csv) is then imported (as shown in Fig. 3) in Google fusion table

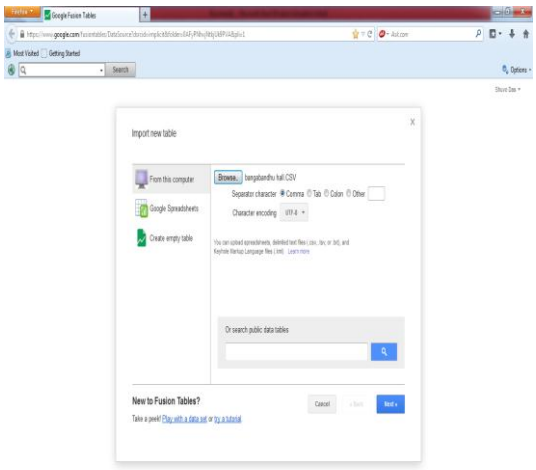

Fig. 3: Positional data importing

When importing is done, logged latitude and longitude data are shown in a table (as shown in Fig. 4) just before the map view.

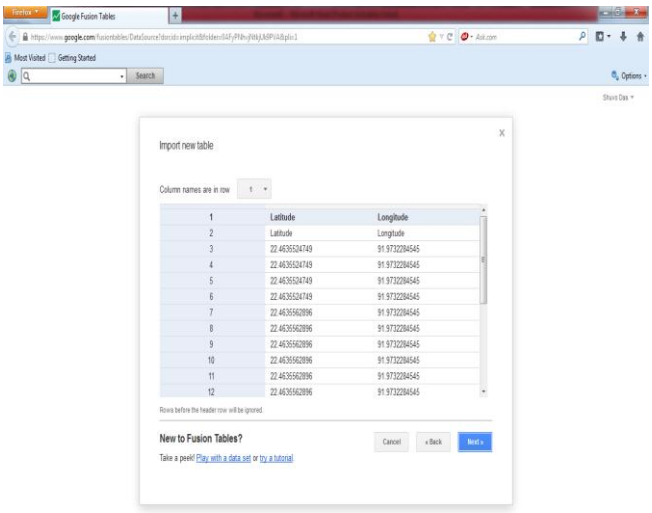

Fig. 4: Logged latitude and longitude data

And finally user's exact position is viewed in the mapping program (as shown in Fig. 5) e.g. Google map by the colored dots.

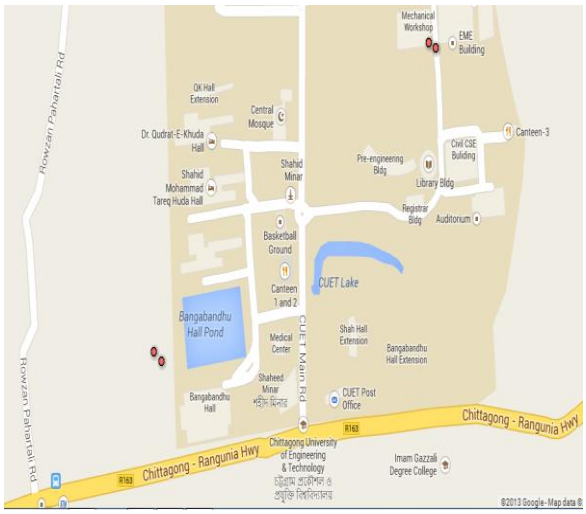

Fig. 5: Visualization in Google map

6. SYSTEM DRAWBACKS

The accuracy of GPS tracker depends mostly on the accuracy of the GPS module. Accuracy affected by clock errors, fluctuation in satellite orbit, disturbances of the atmosphere / ionosphere and multipath errors [6].

Satellite measures the distance using the formula:- Distance = Velocity of light × Time difference; Where time difference is the time gap between the satellite transmitters transmits the signal to the GPS receiver receives the signal. An error of 1 μs leads to a 300m inaccuracy [6]. For best synchronization Atomic clocks (used in satellite) are required at both ends which will make the GPS receiver much more costly. GPS receiver will work well only when it is in open space, exposed to sky, so that it can receive signal from satellites. It requires a minimum of 4-5 satellites in order to give accurate locations. It won't work inside buildings. In open space, It will work anywhere in the world. GPS Location accuracy is around 20 meters.

7. CONCLUSION

Global positioning systems (GPSs) are very quickly becoming a standard in most new automobiles. The use of GPS-aided technology for management of vehicle fleets has saved governments and businesses hundreds of millions of dollars by enabling more efficient planning of routes, monitoring misuse by employees, or locating stolen vehicles. As this nascent technology of GPS is gaining popularity in cars, the outcome of this project expects that the automobiles of Bangladesh will be augmented with the capabilities of automated navigation system.

8. REFERENCES

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