GPS Data Analysis and Acquisition Software over IP Platform

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Abstract – This paper presents an innovative platform to acquire and analyze many GPS data from an electronic receiver, it is able to extract a great variety of information remotely and being possible monitoring from Internet. Some other technologies are needed like a Web server and ZigBee antennas to be tested in a homing robot. The graphical interface design is presented describing which data are acquired. Finally the results of confirm the GPS location according the dispersion index in real time.

Keywords – GPS Data Sentences Analysis, Wireless Technology, Homing Robot, Internet Server, ZigBee.

I. INTRODUCTION

Frequently there are so many places with hard difficulty to access them for different circumstances or reasons like its topology, weather or nature formations. With the GPS invention have been possible give to users more reliability finding routes or roads, however sometimes is necessary make identification or recognition of geographical zones to acquire data for research. The GPS technology allows applying it to monitoring and making a data acquisition remotely. The integration of recent telecommunication technologies such as ZigBee wireless antennas and the use of networking in creation of web server made possible to monitor remote signals from Internet anytime anywhere.

The application presented involve a constant monitoring of a certain place by means wireless technologies, navigation and GPS not documented before, however there are some similar developing in this area [e.g. 2 - 5].

The information obtained from GPS represented by an electronic receiver, is able to calculate and process a data variety of satellites signals reception of NAVSTAR GPS system [1], this receiver has a wireless communication with the monitor station developed in LabView® of National Instrument which has been used in measurement instrumentation widely [2].

The control station requires a Web server to access it by Internet, figure 1 depicts the communication stages. The first stage is the segment space composed by a constellation of 24 satellites [1], therefore the GPS receiver is joined to the communication system which links with the next stage, the control station. At last, the object of this application is the user who can access the acquisition software with internet connection.

This paper is organised as follows, first is presented a GPS introduction, then some system features are explained and the software GPS analysis are shown with a verification test using a homing robot.
The GPS achieve to calculate those data with the distance determination according to some mobile points which are the satellites. Other systems based on relative distances used the emitted signals by reference station well known. Also, they used absolute temporal references due to it was necessary to know the satellite clock states exactly, it was not enough with the measurement of relative delays between the signals.

Whether is used just one satellite and is known the location and the separation distance it will be obtained the position in an uncertainty area which is geometrically a sphere. With two satellites and knowing the locations and the distances it will determine the position along a circumference as is depicted in figure 4.

![Figure 4. GPS location computes from two satellites](image1)

If another satellite is involved the position will be determined in one of the intersection points of the spheroid (generally one of this points are so far of Earth surface and is rejected for inconsistent), this is depicted in figure 5.

![Figure 5: GPS location compute from three satellites](image2)

### III. MONITOR AND ACQUISITION DATA STATION

In order to connect the GPS receiver with the monitor station in wireless, is used transmission antennas and a microcontroller which allows a correct communication of the system; the antennas in this application use Zigbee technology and IEEE 802.11 protocol. Figure 6 depicts the composition system.

![Figure 6. Transmission System](image3)

These Xbee modules operate like a direct media transmission, in practice is understood as if the microcontroller and control station has been connected using a serial interface. The control station software design is based on the GPS receiver interaction, with the possibility to acquire information from this.

The software interface is designed to act together with a microcontroller (FreeScale® MC68HC908AP16®), in which depending its internal communication protocol system, it realise some indicated actions, for example receive data and transmit it, or maybe stay in a standalone state, the program algorithm (figure 7) show those actions more detailed.

![Figure 7. Monitor station algorithm](image4)

In this application sum up the information acquired with NMEA (National Marine Electronics Association protocol) protocol from a GPS receiver, the data obtained with it is listed below:

- DGPS (Differential Global Position System) data record correction: Show the time in seconds since its last data update, this data is present meanwhile a DGPS Station is linked to GPS receiver [4].
- DGPS Station ID: Shows the DGPS station identification number associated with the module, it is a number from 0000 to 1023, is present while there is a DGPS station associated to the receiver.
- Speed on Earth in knots
- True route in degrees
- Magnetic declination in degrees
- Magnetic declination reference
- Geoidal Separation
- Geoidal Separation Unit
- Speed on Earth in km/h
- Linked satellites number: show the number of satellites being linked by GPS module receiver [4]
- Satellite PRN Code: Pseudo random code which identifies each satellite individually [4]
- Satellite Elevation Position: Shows the elevation in degrees of a specific satellite[4]
- Satellite SRN: Signal to noise ratio of a specific channel satellite [4]
- PDOP: Dilution of precision
- HDOP: Horizontal Dilution
- VDOP: Vertical Dilution
UTC (Universal Time Coordinated): Continuous system based on universal coordinates.
- Date
- Latitude
- Latitude Reference (North, South)
- Longitude
- Longitude Reference (West, East)
- Altitude
- Altitude Unit
- Mode: M (manual), A (Standalone 2D/3D) [4]
- Current Mode: 1 (Image Not Available), 2 (2D), 3 (3D)
- State: A (Right), V (Receiver Alert Navigation) [4]
- Current Mode: 1 (Image Not Available), 2 (2D), 3 (3D)
- GPS quality: 0 (Image Not OK), 1 (GPS Mode), 2 (DGPS Mode)
- Positioning System Mode: A (Standalone Mode), D (differential mode), E (computed), M (manual input), S (Simulated Mode), N (Data Not OK) [4]

The graphical interface application shows and classifies all that data which is possible gather together with the NMEA protocol. Next is showed the print screen of the interface:

Figure 8. Control Station Interface (in Spanish)

It is possible access to this application through a Web Internet Server. In figure 9 it is observed how with a common web browser it can monitor and command the application.

Figure 9. Application in Web browser

IV. HOMING ROBOT DESIGN

To demonstrate the correct performance of the platform application is designed a small terrestrial homing robot vehicle, with some electronic devices to navigate and send data to the monitoring station, those devices are a GPS receiver, some Xbee modules, a digital compass, a microcontroller and of course the mechanical system with its power driver (figure 10), to continue some characteristics are described briefly.

Figure 10. Navigation electronic devices

The microcontroller is the mainframe device that operate to communicate the other devices to command them depending of the user actions. ZigBee (Xbee PRO® modules) antennas provide the wireless interaction between the homing robot and the monitor station by means the IEEE 802.11 protocol [7 - 11]. GPS receiver (GPS TYCO® 1008A) is able to acquire information from NAVSTAR system. To build the mechanical structure is necessary have in mind the power driver allows to change the microcontroller orders in mechanical movements of motoreducers which makes acelerate, going back or forwards the mobile [6] and protect the other circuit of voltage and current peaks.

Figure 11. Mechanical System

V. DATA ACQUISITION TESTS

Is necessary to verify the accuracy and precision of the GPS module used in this implemented application [1, 12], due to is the electronic device which sample data periodically and allows to do a post processing analysis from data obtained from it. There is characterised a geographical point in Bogota, Macarena A (Universidad Distrital Francisco Jose de Caldas) which is has been measured in latitude and longitude during some studies, is a point with coordinates 4° 36,82736’ N, 74°03,8638’ W, with a height of 26,890.475 meters.

There has been realised positions measurement with this application during 1 hour and 10 minutes, to analyse the GPS receiver precision, figure 12 shows the latitude vs longitude where is observed some scattering points of dispersion in the sample time.
point as reference according to equation (3).

The next equation calculates the difference between the data acquired and the real values.

\[ x^\circ xx, xzxx' = y^\circ yyy'; yyyy' - z^\circ zz, zzzz' \]  

where,

- \( x \) is difference value,
- \( y \) is the measured data, and
- \( z \) is the real data.

When the difference in degrees and minutes found is converted in meters as follows:

\[ I' = 1850 m \]  

hence

\[ x_1 = \frac{x^*1850}{I'} \]  

Due to the GPS is in a static point, is assumed that the maximum limit of variability is 1 minute; the figure 14 and 15 shows the dispersion of latitude and longitude with the real point as reference according to equation (3).

With the data average obtained is calculated the latitude and longitude deviation, this is 1.2 meters and 1.34 meters respectively.

VI. CONCLUSIONS

In the GPS acquisition data is not possible speak about accuracy, the real term is precision in agreement with the weather variability (cloudy, cool, etc), and the quantity of linked satellites with the GPS; in the tests done, the first instants the GPS receiver was linked with few satellites (3 – 4), whereas in the last moments, was linked with more satellites (6 – 8).

The precision measure depends on sampling time too, for instance, if are taken every second, it will have a higher precision, in contrast with a large sample time like 20 minutes, it will have lower precision.

The accuracy is be based on the same factors that affect the precision (climate, satellites linked), however there are many others such as time delays produced by nature in the ionosphere; the way to increase the GPS accuracy is use some alternative methods, like DGPS or use signal reception of multiple frequencies how is used in military applications.

The whole system was built having in mind a modular concept integrating different devices such as a microcontroller, a GPS receiver, a transmitter element, also is developed a control station software, which makes this solution a unique development in hardware and software, with high adaptation for future needs because of the serial interface has an easy compatibility with other communication standards in order to improve the coverage or communication services offered by the mobile.

REFERENCES


[4] NMEA-0183 Messages, Guide for AgGPS Receivers, Trimble


