Design of GNSS Aided Inertial Navigation System

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Introduction

- INS is the inertial navigation system, the system that determines the position based on the output of the motion sensors: accelerometers and gyros. The INS implies a fixed inertial measurement unit(IMU), whereby the analytical picture of the navigation system is obtained from the integration of the gyros rates.
- Global Navigation Satellite Systems (GNSS) or satellite-based navigation systems is possible to make position and velocity fixes using the signals that are transmitted from satellites around the world. Among the satellite navigation systems, GPS, GLONASS, and Galileo are well-known systems. These navigation systems provide a position fix at each instant, so they are widely used to bind the errors of inertial navigation states.
- This project aims to combine GNSS and INS systems. The data received from the IMU (acceleration, orientation and angular velocity, magnetic field, pressure etc.) is analyzed, processed and feedback controlled on the board. The obtained data is combined with the position information from the GNSS, and thus accurate position information is obtained.

Specifications and Design Requirements

- INS-GNSS system weighs approximately 500 g (together with the powerbank).
- INS-GNSS system records navigation data for at least 48 hours.
- INS-GNSS system updates navigation data at 20Hz minimum.

Solution Methodology

Hardware used in this Project

- Arduino nano every
- Berryimu v3
- NeoGps 6m (with GPS antenna)
- SD card adapter
- Powerbank

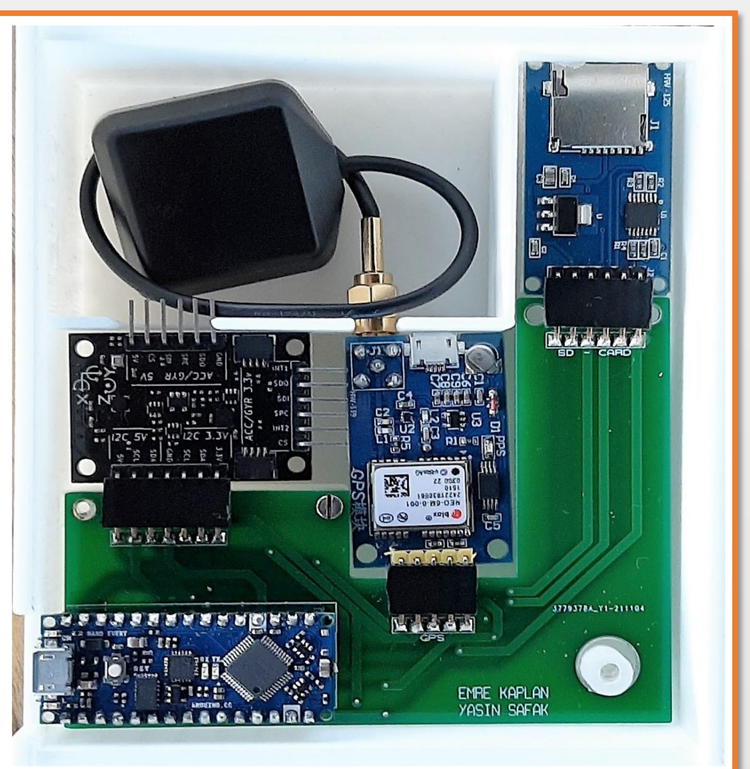

Figure 1 : Completed assembly of equipments used as hardware

While designing the software part of the system, it was first aimed to find yaw and pitch roll angles. These angles were found using the magnetometer and accelerometer and then combined with the data from the gyroscope. Then, using the matrix in figure 2, x,y,z axis acceleration data were converted to the North, east, down axes. Our system was finally completed by applying the flowchart in figure 2.

Get A_N, A_E, A_D

$$\begin{bmatrix} A_N \\ A_E \\ A_D \end{bmatrix} = \begin{bmatrix} cosYcosP & cosYsinPsinR - cosRsinY & sinYsinR + cosYsinPcosR \\ sinYcosP & sinYsinPsinR + cosRcosY & -cosYsinR + sinYsinPcosR \\ -sinP & sinRcosP & cosRcosP \end{bmatrix} \begin{bmatrix} AccX \\ AccY \\ AccZ \end{bmatrix}$$

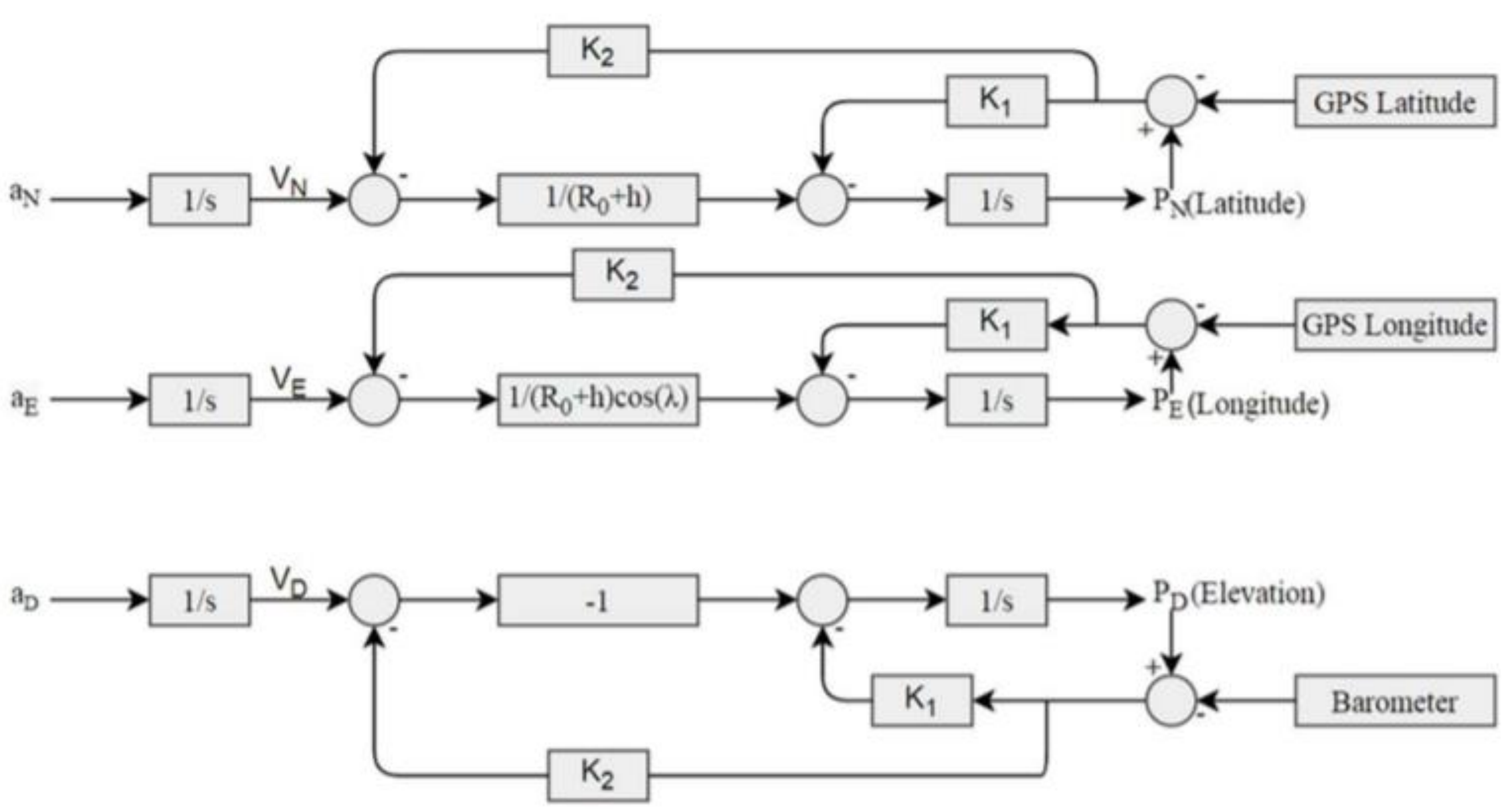

Figure 2 : Software's flowchart

Application Areas

- GNSS aided INS is importance for automatic machines, be it robots, aircraft, or other autonomous vehicles. Various systems are used in the navigation of aircraft, like inertial navigation systems (INS), global positioning systems (GPS), airdata dead reckoning systems, radio navigation systems, are a few among them.

Results and Discussion

- In the project, the position results are saved in .txt format on the sd card as in figure 3. Then the data was converted into .kml format and observed on Google Earth. The result are as in figure 4. As a result of the research, more filtering of the data from the sensors using different methods is required in order to obtain position results more precisely. Thus, the system can work more sensitively.

Latitude,Longitude,Elevation,Id
39.893043,32.721519,1002.21,1
39.893051,32.721523,1002.17,2
39.893058,32.721527,1002.20,3
39.893066,32.721534,1002.16,4
39.893074,32.721538,1002.20,5
39.893081,32.721542,1002.24,6
39.893089,32.721546,1002.28,7
39.893096,32.721553,1002.30,8
39.893104,32.721557,1002.32,9
39.893112,32.721561,1002.38,10
39.893115,32.721569,1002.41,11
39.893123,32.721572,1002.43,12
39.893131,32.721576,1002.44,13
39.893138,32.721580,1002.44,14
39.893146,32.721588,1002.45,15
39.893154,32.721591,1002.43,16
39.893161,32.721595,1002.40,17
39.893169,32.721603,1002.47,18
39.893177,32.721607,1002.43,19
39.893138,32.721435,1002.41,20
39.893142,32.721439,1002.41,21
39.893150,32.721446,1002.34,22
39.893157,32.721450,1002.27,23

Figure 3

Figure 4

References

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