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Analysis of Selected Parameters of Single Frequency Receiver in GPS and GAGAN Modes

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Abstract: Global Positioning System (GPS) is a global satellite navigation system developed by United States. It provides position, velocity, and time information in all the weather conditions anywhere on or near the earth. Currently this system s in operation with 31 satellites in space. Similar to GPS, Globanaya Navigatsionnaya Sputnikovaya Sistema(GLONASS) is a Russian satellite navigation system which is a global navigation system. Apart from that European GALILEO satellite navigation system still is in development stage. The other regional navigation satellite systems are Indian Regional Navigation Satellite System (IRNSS), Japanese Quasi Zenith Satellite System (QZNSS), which are in their development stages. The IRNSS is developed by Indian Space Research Organisation (ISRO). This system transmits in both L &S band. To improve the accuracy of GPS, SBAS is used across the world. Various SBAS are being developed. The Indian SBAS is known as the GPS Aided Geo Augmented Navigation (GAGAN). In this work, the Single frequency GPS/GAGAN receiver is being used in GPS/GAGAN modes to obtain latitude, longitude, PDOP, accuracy, visible satellites under various conditions such as height, environment conditions. The comparative analysis is carried out for these two modes of these selected parameters.

Keywords: GPS, GLONASS, GALILEO, IRNSS, QZNSS, GAGAN

I. INTRODUCTION

Global Navigation Satellite Systems (GNSS) mainly consists of satellites, ground stations and user equipment to determine positions anywhere on the world and are now used across many areas of society GNSS GPS (USA), GLONASS (Russia), GALILEO(Europe), Augmentation Systems (SBAS, GBAS), IRNS (India), QuasiZenth (Japan). GPS with 31 satellites, it uses L band. GLONASS from Russian government. GLONASS with 24 satellites and uses L1 and L2 band for broadcasting [4]. GALILEO with 18 satellites an it uses L1, E5, E6 bands [5]. And the regional navigation satellites like IRNSS with 6 satellites in orbit out of 7. The satellite based augmented systems, collectively all the navigation satellite systems are referred as global Navigation Satellite System. GNSS consists of three major segments GPS those are, Space Segment, GPS ground Segment, user segment. The space segment nominally consists of 24 satellites, currently there are 31 active GPS satellites [3]. User segment consists of GPS antennas & receiver/processors. It gives position, velocity, precise timing and it is mainly used by Aircraft, Ground vehicles, Ships and finally Individuals. Ground control segment consist of Master control stations, five monitoring stations, three ground antennas and backup control system. The signal structure contains two frequencies L1 carrier 1575.42MHz and L2 carrier 1227.60MHz[1]. And also it uses separate codes for civil (CA Code uses L1) and Military (P(Y) Code uses L1& L2). The GAGAN GEO satellites will broadcast its SBAS navigation data using L1 and L5 signals, with Global Positioning System (GPS) modulation. Airport Authority of India aircrafts equipped with SBAS receivers will be able to use GAGAN SiS in Indian airspace for provide route navigation and non-precision approaches without vertical guidance[6]. The GAGAN also consists of three major segments [7]. In this paper mainly we are concentrating on the PDOP, accuracy, No.of visible satellites in a 3 floor building of ECE department, in Osmania University. This can be done with help of single frequency receiver by operating it in SBAS and GPS mode of operation.

II. Methodology

The Juno single frequency receiver used for measuring the latitude, longitude altitude, PDOP, and accuracy, azimuth angle, elevation angle, C/No, no. of visible satellites. The Trimble Juno SA handheld is a durable, compact field computer and can be operated in GAGAN and GPS modes. It is the affordable way to arm an entire data collection workforce with a reliable and accurate professional GPS handheld incorporating an industry

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standard Windows Mobile 6.1 platform. This single frequency receiver uses L1 frequency band. It is shown in Fig.1. in this work that the single frequency receiver is operated in GPS and GAGAN modes at various heights, the work is carried out at The Department of Electronics and Communication Engineering, University College of Engineering, Osmania University, Hyderabad the "Advanced GNSS Research Laboratory" (AGRL).the building consists of the ground floor, first floor, second floor and it contains one tank on rooftop. The height of the building is 37 feet 6 inches. The experiment is carried out at various points Point A, Point B, Point C, Point D, Point E, Point F, Point G, Point H. Point A is placed on the tank of the building, Point B & point c are place at the distance of 140cms on the rooftop of building. The Point D is located in second floor, Point E is located at first floor, Point F is placed at ground floor, Point G is considered in the open sky in front of the building, and Point H is place at Under Tree. At all the points single frequency receiver is operated in GPS/GAGAN modes to obtained various parameters. And analysis is carried out.

Fig1.Single Frequency Receiver

III. Experiment Setup

The AGR laboratory consists of Four Dual frequency IRNSS/GPS/GAGAN receivers, one GPSTATION6 Dual frequency receiver (which can receive signals of GPS/GLONASS/GALILEO and GAGAN) and one single frequency GPS/GAGAN receiver.

Fig.2.A296,A297 IRNSS Receivers ,GPS Station 6 Receiver.

The GP Station 6 receiver is shown in fig.3. Trimble single frequency receiver is equipped on GP Station 6 to know all the parameters.

Fig.3.Single Frequency receiver placed on GP station 6.

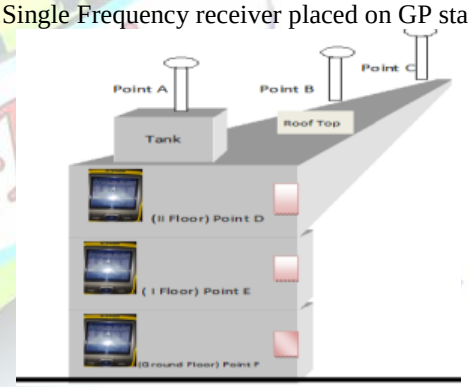

Fig.4.The Department of Electronics and Communication Engineering, University College of Engineering, Osmania University,Hyderabad.

The department of ECE building of 3 floor ground, 1st floor and second floor structure is shown in fig.4,the height of the building is 37 feet 6 inches. Each floor is having 12 inches and the slab of 6 inches each.

IV. Results

In this section the observation were presented for the rooftop of department of ECE building by placing the single frequency receiver on the three receiver 2NO'S IRNSS receivers and one GP Station 6 receiver. The observation are placed in the below tables.

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Table 1 .Parameter readings for Point A.

S.No	Parameter	SBAS(GAGAN)	GPS
1	Latitude	17 º24'28.320"N	17 º24'27.312"N
2	Longitude	78º31'04.419"E	78^0 31'04.520"E
3	PDOP	1.44	1.44
4	Altitude	454.41mHAE	452.29mHAE
5	Accuracy	2.6m	5.0m
6	Visible satellites	11	9

Table 2 .Parameter readings for Point B.

S.No	Parameter	SBAS(GAGAN)	GPS
1	Latitude	17º24'28.190"N	17º24'27.934"N
2	Longitude	78º31'04.299"E	78º31'04.252"E
3	PDOP	1.44	1.44
4	Altitude	443.09mHAE	445.24mHAE
5	Accuracy	2.9m	5.0m
6	Visible satellites	11	9

Table 3 .Parameter readings for Point C.

S.No	Parameter	SBAS(GAGAN)	GPS
1	Latitude	17º24'27.945"N	17º24'27.934"N
2	Longitude	78º31'04.332"E	78º31'04.252"E
3	PDOP	1.44m	1.44m
4	Altitude	449.75mHAE	449.26mHAE
5	Accuracy	2.9m	5.0m
6	Visible satellites	11	10

Table 4 .Parameter readings for Point D (II Floor)

S.No	Parameter	SBAS(GAGAN)	GPS
1	Latitude	17º24'28.394"N	17^0 24'28.100"N
2	Longitude	78^0 31'04.139"E	78^0 31'04.225"E
3	PDOP	1.44	1.44
4	Altitude	454.94mHAE	460.94mHAE
5	Accuracy	8.1m	9.0m
6	Visible satellites	7	6

Table.5 .Parameter readings for Point E (I Floor).

S.No	Parameter	SBAS(GAGAN)	GPS
1	Latitude	17^0 24'28.592"N	17^0 24'27.786"N
2	Longitude	78^0 31'03.909"E	78^0 31'04.422"E
3	PDOP	3.24m	3.61m
4	Altitude	483.27mHAE	428.18mHAE
5	Accuracy	15m	17m
6	Visible satellites	7	4

Table.6.Parameter readings for Point F (Ground Floor).

S.No	Parameter	SBAS(GAGAN)	GPS
1	Latitude	17^0 24'26.888"N	17^0 24'27.560"N
2	Longitude	78^0 31'04.239"E	78^0 31'04.481"E
3	PDOP	2.16m	3.97m
4	Altitude	445.24mHAE	425.64mHAE
5	Accuracy	17	23
6	Visible satellites	4	4

Table.7Parameter readings for Point G (Open Sky)

S.No	Parameter	SBAS(GAGAN)	GPS
1	Latitude	17º24'26.632"N	17º24'26.846"N
2	Longitude	78º31'03.233"E	78º31'03.305"E
3	PDOP	2.16m	2.16m
4	Altitude	444.68m HAE	451.07m AE
5	Accuracy	8.4m	12m
6	Visible satellites	8	7

Table.8.Parameter readings for Point H (Under Tree)

S.No	Parameter	SBAS(GAGAN)	GPS
1	Latitude	17º24'27.505"N	17º24'27.670"N
2	Longitude	78º31'04.690"E	78º31'04.395"E
3	PDOP	5.05m	2.88m
4	Altitude	455.01m HAE	450.25m HAE
5	Accuracy	19m	19m
6	Visible satellites	6	5

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The single frequency receiver is placed at Point A, Point B, Point C, Point D, Point E, Point F, Point G, and Point H & operated in GPS/GAGAN modes. Each modes all parameters are noted. The analysis is carried out as per the following cases.

Case 1: In this case the variations of no. of visible satellites available at various points analysed. For Point A & Point B, the no. of visible satellites in GPS (9 satellites) and GAGAN (11satellites) modes shown in table 1,2. For point c is the maximum no. of satellites are available i.e. GPS (10 satellites), GAGAN (11 satellites) is shown in table 3. As we move from Point D to Point F that is second floor to ground floor in indoor area, the no. of visible satellites are decreased from second floor to ground floor as it is shown tables 4, 5, 6.

In the open sky i.e. point G the no. of visible satellites are GPS (7 satellites) & GAGAN (8 satellites) shown in table.7. Under heavy canopy the no. of visible satellites in GPS (5 satellites) & in GAGAN (6 satellites). It is observed that on the rooftop of building i.e. point c the maximum no. of satellite is visible for the both GPS & GAGAN modes. Hence the accuracy will be good. Even when ingle frequency receiver is operated in indoor i.e. in ground floor 4 satellites are still visible to the receiver

Case 2: In this case the variations of PDOP at various points analysed. For the Point A, Point B, Point C and Point D the PDOP is same there no variations and was shown in table 1,2,3,4. As we move to the point e, first floor the PDOP for GPS is 3.97 and for GAGAN is 2.16 it shown in table 5. PDOP is good for GAGAN as compared GPS. Open sky the PDOP is same for GPS & GAGAN mode of operation. Under canopy PDOP for GAGAN is 5.05 and for GPS is 2.88 as shown in table 8. Under canopy the PDOP of GPS is good as compared to GAGAN.

Case 3: In this case the variation of accuracy at various points is analysed. At point A the accuracy for GAGAN is 2.6m and for GPS is 5.0m. the accuracy of GAGAN is good when compared to GPS at rooftop of the building. For the Points A & B the PDOP for GAGAN is 2.9m and for GPS is 5.0m. As we move to second floor i.e. point d the accuracy for GAGAN is 8.1m and for GPS IS 9.0m .in indoor of the building the accuracy of GAGAN is good as compared with GPS. In the open sky the accuracy for GAGAN is 8.4m and for GPS is 12m also good. Under tree GPS and GAGAN accuracy is 19m .in all the points if we observe the accuracy for GAGAN is good as compared to GPS.

V. Conclusion

The GAGAN is augmentation system provides better accuracy when compared to GPS. In this work single frequency receiver is showing good performance, when it operated in two mode GAGAN and GPS at various heights. Even in indoor applications GPS and GAGAN are able to provide acceptable position accuracy, the best PDOP, accuracy when the receiver is kept in the rooftop of the 3 floor ECE building. When compared to open sky in the ground floor.

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