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Comparing the Reliability of Single Frequency Gps Receivers: A Field Study

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ABSTRACT
As GPS units are becoming smaller and less expensive, the use of GPS is becoming more common in land, air and marine navigation and surveying also the GPS has an an expanding number of applications in Commerce and government, transportation related studies, forestry, hunting, environmental issues etc. i.e. GPS is used in every aspect of today's world however the manufacturers of these GPS receivers only provide technical information on their respective receiver's accuracy under ideal conditions. This paper compares the reliability of three current global positioning system (GPS) Single Frequency receivers—Ashtech Promark 200, Trimble R-3Trimble and Sokkia GRX-2 receiver evaluated with different logging interval of 1 second to determine the reliability of these receivers in the normal work scenario. In this study the reliability of receivers were checked with the help of single receivers only without the use of Differential GPS technique by performing test-retest reliability. To compare the different GPS receivers a study was carried out at the roof of the Geomatics Engineering Department building, IIT Roorkee Campus, India. The points were taken at different dates with equivalent settings. . Results indicate that the reliability of the GPS receivers varies among the different models under time intervals with different logging rates and it was found that the highest reliability achieved for latitude is by Ashtech ProMark 120 (0.98287792) from 3pm-4pm for 10 second logging interval(Figure 3), for longitude by Trimble R-3 (0.972459028) from 1pm-2pm for 1 second interval(Figure 4)and for ellipsoidal height by Sokkia GRX-2 (0.974075585) from3pm-4pm for 1 second interval(Figure 5).
Keywords: GPS, Reliability

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I. INTRODUCTION

The GPS receivers has been widely in many fields over recent years. Applications such as in forestry, agriculture, recreational activities, environmental related studies, surveying etc. are benefitted greatly with the help of GPS. But the level of accuracy required from application to application varies greatly. And also it is very important to recognize the different grades of GPS receivers may it be consumer, mapping or survey grade and the ability of these receivers to accurately map the features with or without Differential Correction technique. The accuracies of these receivers varies from few centimeter to several meters for various applications making it necessary to check the reliability, accuracy and precision of these receivers for various applications and how these receivers are affected in various applications. So to check whether the GPS receiver is suitable or not for the particular application the reliability of the GPS receivers is an important parameter must be known because by knowing the reliability only one can decide whether the GPS receiver is suitable for that application or not.

II. METHODOLOGY

The study area was located at the roof of Geomatics Engineering Department building, IIT Roorkee Campus (Figure 1and figure 2). Position of various GPS receivers were fixed near the study area. The data were taken from each GPS receiver with1, 2, 5 and 10 seconds logging interval. The PDOP value for the study was taken as 13°.The observations were taken with Single Frequency GPS receivers (Table 1). The points were collected in WGS 84 reference system and Latitude, Longitude and Ellipsoidal Height were taken for comparing the GPS receivers under different time intervals of the day. The time intervals chosen for taking the reading were from11am-12pm, 2pm-3pm and 3pm-4pm.60 points were recorded each time the area was visited during these time intervals. The readings were compared by performing the test–retest reliability and Pearson's correlation coefficient was calculated to check the reliability of these GPS receivers.

Figure 1: Experimental Setup
Figure 2: Top View of the Study area

Following instruments were used for taking the readings:

Receiver	Manufacturer	Field Software	Processing Software
ProMark 120	Ashtech	ProMark Field	GNSS Solutions
R-3	Trimble	Trimble Field Book	Trimble Business Centre
GRX-2	Sokkia	Magnet Field	Spectrum Survey Office

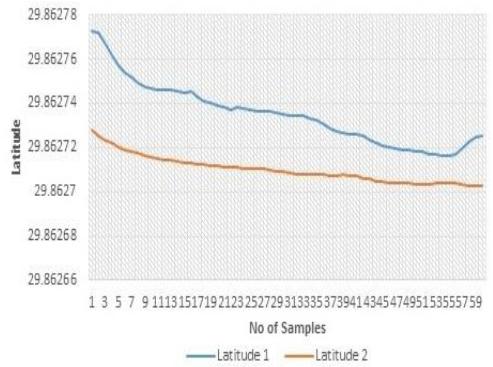
Table 1: Instruments used for comparison

III. RESULTS

		1 Second	2 Second	5 Second	10 Second
11 AM-12 PM	Latitude	Ashtech	Sokkia	Trimble	Trimble
		0.799005784	0.759773453	0.766510244	0.74547974
	Longitude	Ashtech	Ashtech	Trimble	Ashtech
		0.454590704	0.974498806	0.45906504	-0.837175392
	Ellipsoidal Height	Ashtech	Ashtech	Ashtech	Sokkia
		0.84402819	0.962121819	0.726890821	0.936651871
1 PM-2 PM	Latitude	Trimble	Sokkia	Ashtech	Trimble
		0.883489391	0.905937238	-0.669036538	0.51161806
	Longitude	Trimble	Sokkia	Sokkia	Sokkia
		0.972459028	0.849571639	0.811222357	0.46235312
	Ellipsoidal Height	Sokkia	Sokkia	Sokkia	Trimble
		0.371407377	0.799294815	0.809466914	0.391202336
3 PM-4 PM	Latitude	Ashtech	Trimble	Ashtech	Ashtech
		0.674008839	0.965420781	0.686508885	0.98287792
	Longitude	Sokkia	Sokkia	Trimble	Trimble
		0.959970841	-0.829240867	0.428337507	0.940161492
	Ellipsoidal Height	Sokkia	Ashtech	Sokkia	Trimble
		0.974075585	0.625525821	0.509111192	0.894012066

Table 2: Highest reliability coefficients of GPS receivers

On completion of this study, the first thing observed from the table 2 is that the GPS data obtained from the various GPS receiver is not consistent and it changes from time to time during the day and also for different logging intervals.Inspite the three receivers i.e. ProMark 120, R-3 and GRX-2 all being Single Frequency receivers does not show the consistent reliability. Considering all (i.e. time interval and logging interval) the highest reliability achieved for latitude by Ashtech ProMark 120 (0.98287792) from 3pm-4pm for 10 second logging interval(Figure 3), for longitude by Trimble R-3 (0.972459028) from 1pm-2pm for 1 second interval(Figure 4)and for ellipsoidal height by Sokkia GRX-2 (0.974075585) from3pm-4pm for 1 second interval(Figure 5).And from the figure 3 it can be seen that the latitude values goes on decreasing for getting highest reliability but at the same time the longitude values goes on increasing in order to get highest reliability and the ellipsoidal height values goes on decreasing till to get the best reliability.



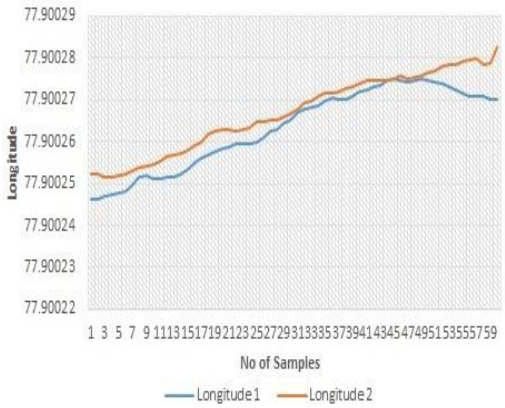


Figure 3: Variation of Latitude
Figure 4: Variation of Longitude

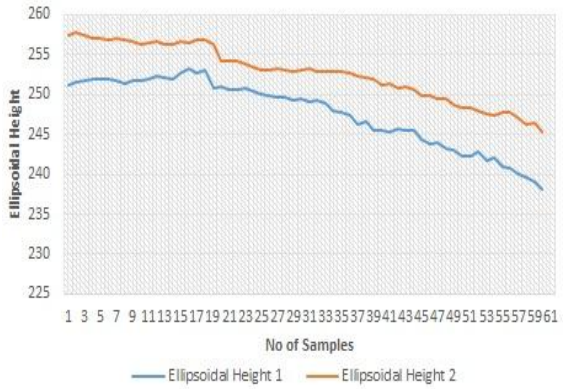


Figure 5: Variation for Ellipsoidal Height

IV. CONCLUSION

In this study, 3 Single Frequency GPS receivers has been compared and their reliability for different time intervals and with different logging rates is determined. It is seen that the reliabilities between latitude, longitude and ellipsoidal height which are very important to get the user position is independent from one another. So it it difficult to say which GPS receiver is best among them for the project undertaken when latitude, longitude and ellipsoidal height is considered simultaneously.

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