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Assessment of Vertical Accuracy of Differential GPS: A Case Study in Rohtak District, Haryana

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Abstract

In this study the level transfer is compared by two methods, one is DGPS and other is spirit level. Two points were surveyed which were 5.95km apart and the aerial distance is 4.14 km . In this method the level of one point is assumed and level is transferred to the other point by spirit level. In the second exercise the two points were surveyed by DGPS and the level of the other point was compared by the level by spirit level. Point1 (28°54'56.34"N, 76°31'18.99"E) and Point2 (28°54'11.93"N, 76°31'58.48"E) in Rohtak City, Haryana were observed by DGPS and level was transferred by spirit level. In the result deviation of height falls in acceptable range. The comparison was done in two datums, in WGS84 as well as ITRF 2005. It is found that the DGPS method is an efficient method to transfer level in very less time as compare to spirit level.

Keywords: *DGPS, Spirit level, Rohtak.*

Introduction

GPS (Global Positioning System) is a basic for measuring the location on earth which is based on satellite and it is fundamental for measuring locations and shapes of archaeological sites and structures (*e.g.*, Fenwick 2004; Miyahara 2006). For attaining high accuracy the differential mode of the GPS technique is used and known as DGPS (Differential GPS). Usually GPS has only limited accuracy which is usually 5 to 10 meters where as DGPS has high accuracy (Sub-meter). In this study the accuracy of DGPS is examined by comparing the results with results of spirit leveling. The manufacturer's stated position accuracy after post-processing correction is less than a meter (Thales Navigation 2004).

Many studies have proved the horizontal accuracy of the DGPS, in this study the vertical accuracy is examined. At starting point the level is fixed and the level is transferred to the second point by Auto Level. On the other hand both points were surveyed by DGPS instrument. Although the level accuracy is tested in topographic area having low slope and with one type of device, the field site is located at Rohtak city in Haryana. The device used in the DGPS observation is dual frequency. In many studies the accuracy of DGPS level is also measured. 80% of the Earth's land mass between 60°N and 56°S mapped during an 11-day Space Shuttle mission (Charles G. B., 2005). SRTM data has been validated using spatial transformation of SRTM height (Koch A., 2002) methodology or the approach which compute SRTM height after applying EGM96 geoid model correction and its comparison with DGPS measurement.

Method

Dual frequency DGPS devices were used for observation. Built-in antenna was used and the sky view was clear at the time of observation. The aerial distance between the two points was 4.14km; the observation was taken for 1 hour. The observation data was collected in internal memory and then transferred to the processing device. Trimble Business Center (post processing software) is used in the study, giving corrected coordinates of the measured points in the UTM projection (Zone 43N). The recorded GPS signals in the devices are collated after measurement to carry out differential correction, so the method is called post-processing correction. The manufacturer's stated position accuracy after post-processing correction is less than a meter (Thales Navigation 2004). DGPS measurements were carried out at two sites, Point1 (28°54'56.34"N, 76°31'18.99"E) and Point2 (28°54'11.93"N, 76°31'58.48"E) in Rohtak City, Haryana.

The two sites have similar conditions of latitude, climate and vegetation, and the reception status of GPS signals was almost the same for the two sites, with open sky (almost no shielding by topographic reliefs, trees and/or buildings), fair weather, dry air condition and daytime air temperature of ca. 30–40°C.

Three DGPS devices were used for the measurements, one of which was set as the base station and the other two as mobile stations. The base station was set at a fixed location at each site in each case.

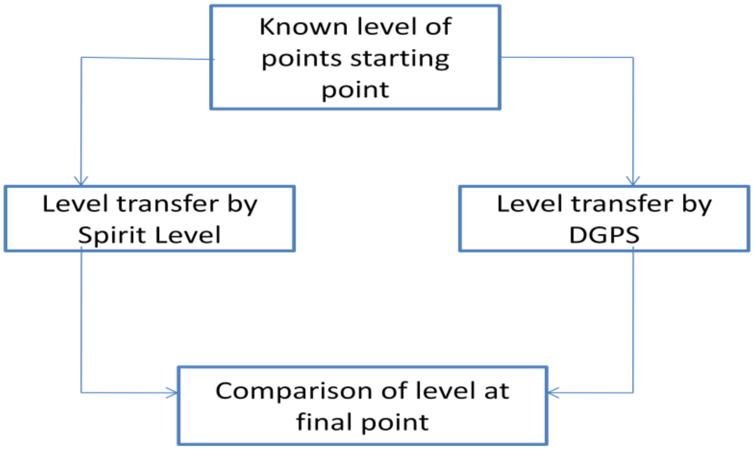

Figure 1: Methodology Flow Chart

Dual frequency receivers were used for the DGPS observation and the DGPS observation was done in Static mode and Trimble Business Center post processing software was used for the data processing. The cutoff angle was taken as 15^0. The level transfer through auto level had 4 km span.

Study Area:

The study area is located in the central part of Haryana state falling Longitude between 760 12’ to 760 54’ and Latitude 280 40’ to 290 06’.

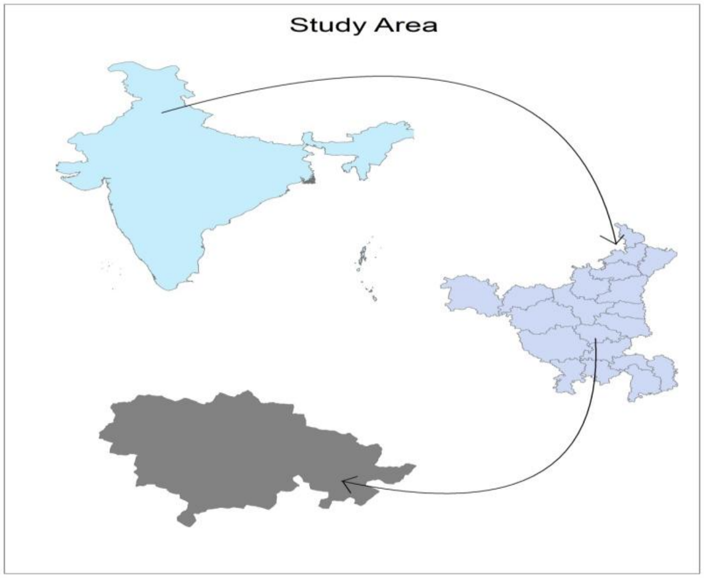

Figure 2: Study Area

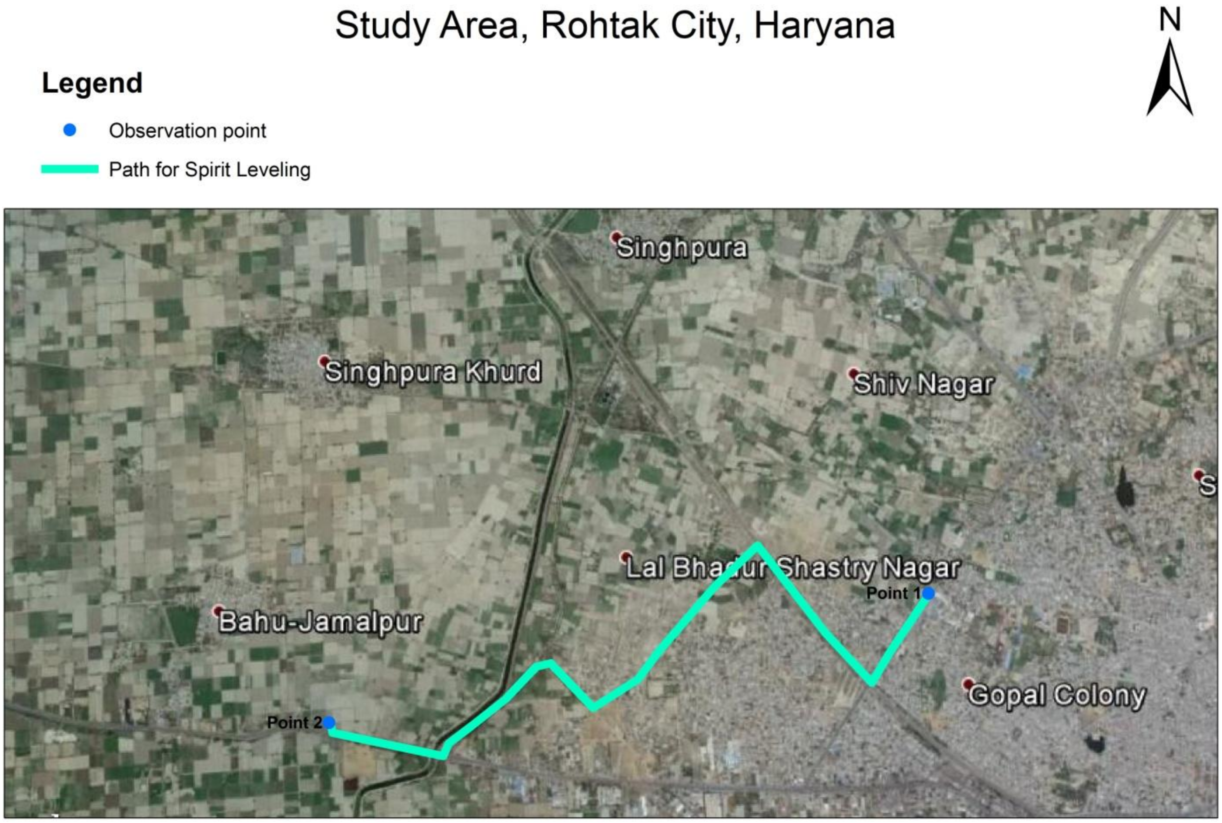

Figure 3: Spirit Leveling Path in Study Area

Results

Table1: The Level Transfer by DGPS and Auto Level of the Rohtak Exercise

Case	Level at Point 1 (meters)	Level at Point 2 (meters)	
Co-ordinate system-UTM	219.154m (fix)	219.009m (computed by DGPS)	Level at point 2 is 218.889 calculated by autolevel
Datum-ITRF 2005 Zone 43N	219.034m (computed by DGPS)	218.889m (fix)	Level at point 1 is 219.154 calculated by autolevel
Co-ordinate system-UTM	219.154m (fix)	219.007m (computed by DGPS)	Level at point 2 is 218.889 calculated by autolevel
Datum-WGS1984 Zone 43N	219.036m (computed by DGPS)	218.889m (fix)	

In the level transfer exercise, different combinations were applied with different geoids. In one case initial point is fixed and level is computed at final point and in other case level is fixed at final point and computed at first point. The result is shown in table 1, which shows there is small deviation in level computed by two different methods.

In first case the level at point 1 is fixed which is 219.154 meter and level at point 2 is computed. The computed level by DGPS post processed data is 219.009 meters where as the level is 218.889 by auto level. there is deviation of 0.12 meters and in next case level at point 2 is fixed, which is 218.889 at point 2 and the level at point 1 is calculated by DGPS processed data. The calculated level is 219.034 meters where as the level by spirit leveling is 219.154 meters. The deviation is same as first case, which is 0.12 meters. The coordinate system is UTM and datum is ITRF2005.

The same result is found in the other case where coordinate system is UTM and datum is WGS1984.

The total stretch is 5.95km of spirit level and the aerial distance between two points is 4.14km.

Conclusion

This study examined the vertical accuracy of post-processing DGPS in comparison of spirit level. The results in the study shows the accuracy of DGPS technology can be efficiently used in level transfer as the result shows sub-meter vertical accuracy after post processing of the data.

DGPS is an efficient way to level transfer as spirit level is accurate but it is time consuming and the time of transfer the level is highly dependent on the distance between the points where by using DGPS the level is transferred in very less time.

In this study, the area is chosen have low undulation, in further study the high undulated area will be taken. The accuracy can be increased by increasing the observation time as in observation time of one hour is taken in this study. The results were compared in different Datum models like WGS84 and ITRF 2005.

It should be noted that some troubles in device operation occurred during the survey: for instance, the liquid crystal displays of two of the devices were malfunctioned and the display barely worked. The most serious trouble was corruption of data written to the SD memory card in the device, and this frequently caused loss of some of the DGPS log data. Furthermore, failures in finalizing the GPS log data occurred when the battery died or at accidental shut-down of the device. These troubles may have occurred due partly to the strong sunlight and heat at the sites, although such troubles also occurred later in other areas (such as in Japan) without strong sunlight. The device itself may have some vulnerability in the display and memory systems, and their cause should further be investigated by the provider of the device. We users, however, should also be careful to avoid accidents in devices we use in the tough environments of field survey.

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