Performance Assessment of Supported GNSS service through a Standalone Smartphone Device in an Urban Environment

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Abstract

Vivo 1606 model is used for the study of standalone use of smartphone as a positioning device with FM supported location (Assisted- GNSS) for GPS, GLONASS, BeiDou. The observations were collected at every 5-minute interval for the analysis. The sessions were divided into three shifts morning, afternoon, and evening to check the accuracy in real time static mode. Mobile topographer app was used for capturing WGS-84 geographic coordinates having horizontal and vertical position with time in an urban environment to analyze which time of a day is good and till what time one can take GPS reading to get the minimum errors using smartphone. It is found that the positional dilution of precision (PDOP) stabilizes in about 35 minutes and minimizes at a value 0.2. The observations beyond have minor changes, so the position at 35 minutes has been used as reference for evaluation of statistical parameters. The real time observations of horizontal, vertical, and positional accuracy seem to increase with time as the PDOP, HDOP, VDOP values decrease i.e. improves with time. It has been observed that, RMSE of PDOP is 0.0485 and HDOP is 0.029 during afternoon is higher as compared to morning and evening values. The study suggest that the preference of survey shall be in the order: morning, evening and afternoon, which may further depend on the season at time. The survey during noon in summers can give much higher values of PDOP and thus the survey can be carried out during morning and evening times preferably.

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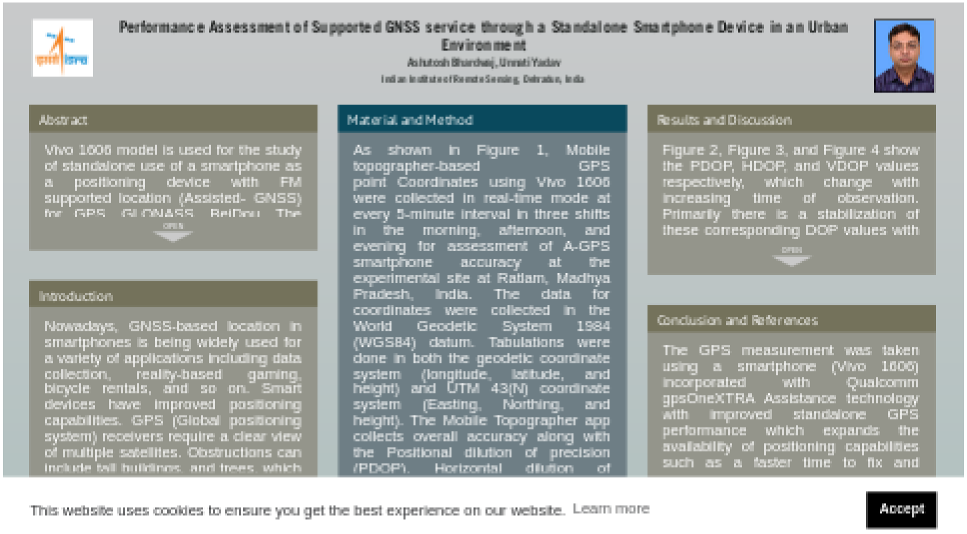

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ABSTRACT

Vivo 1606 model is used for the study of standalone use of a smartphone as a positioning device with FM supported location (Assisted- GNSS) for GPS, GLONASS, BeiDou. The observations were collected at every 5-minute interval for the analysis. The sessions were divided into three shifts i.e. morning, afternoon, and evening to check the accuracy in real-time static mode. Mobile topographer app was used for capturing WGS-84 geographic coordinates having a horizontal and vertical position with time in an urban environment to analyze which time of a day is good and till what time one can take GPS observation readings to get the minimum errors using a smartphone. It is found that the positional dilution of precision (PDOP) stabilizes in about 35 minutes and minimizes at a value of about 0.2. The observations beyond 35 minutes have minor changes, so the position at 35 minutes has been used as a reference for the evaluation of statistical parameters. The real-time observations of horizontal, vertical, and positional accuracy seem to increase with time as the PDOP, HDOP, VDOP values decrease i.e. improve with time. It has been observed that the RMSE of PDOP is 0.0485 and HDOP is 0.029 during the afternoon is higher as compared to morning and evening values. The study suggests that the preference of survey shall be in the order: morning, evening, and afternoon, which may further depend on the season at the time. The survey during noon in summers can give much higher values of PDOP and thus the survey can be carried out during morning and evening times preferably.

INTRODUCTION

Nowadays, GNSS-based location in smartphones is being widely used for a variety of applications including data collection, reality-based gaming, bicycle rentals, and so on. Smart devices have improved positioning capabilities. GPS (Global positioning system) receivers require a clear view of multiple satellites. Obstructions can include tall buildings, and trees, which means the places i.e. settlements (or urban regions) where most of us reside can have some trouble getting the intended quality data for positioning at times. Here, the Assisted-GPS can help in improving the standalone GPS performance. Various errors in GPS (Global positioning system) / GNSS (Global Navigation Satellite System) that influence the accuracy include Ionospheric error, Multipath effect, Receiver's noise, cycle slip, poor satellite geometry such conditions can degrade the GPS performance. Ionospheric delays are typically minimal in the middle of the night and early in the morning, however, they are five times greater in the late afternoon than at night. The ionospheric delay is also affected by location, time of day, and even observation orientation. The attenuation will continue to rise as long as the GPS signal remains in the environment.

MATERIAL AND METHOD

As shown in Figure 1, Mobile topographer-based GPS point Coordinates using Vivo 1606 were collected in real-time mode at every 5-minute interval in three shifts in the morning, afternoon, and evening for assessment of A-GPS smartphone accuracy at the experimental site at Ratlam, Madhya Pradesh, India. The data for coordinates were collected in the World Geodetic System 1984 (WGS84) datum. Tabulations were done in both the geodetic coordinate system (longitude, latitude, and height) and UTM 43(N) coordinate system (Easting, Northing, and height). The Mobile Topographer app collects overall accuracy along with the Positional dilution of precision (PDOP), Horizontal dilution of precision (HDOP), and Vertical dilution of precision (VDOP) values. The GPS point observations were assessed and data were observed to be stabilized at 35-minutes at about 0.2, thus the PDOP value (0.2) from the observation sample is used as a reference for statistical analysis. According to the reference, statistical computation is performed by computing Mean, standard deviation (SD), root means square error (RMSE), and the results were compared for the three shifts.

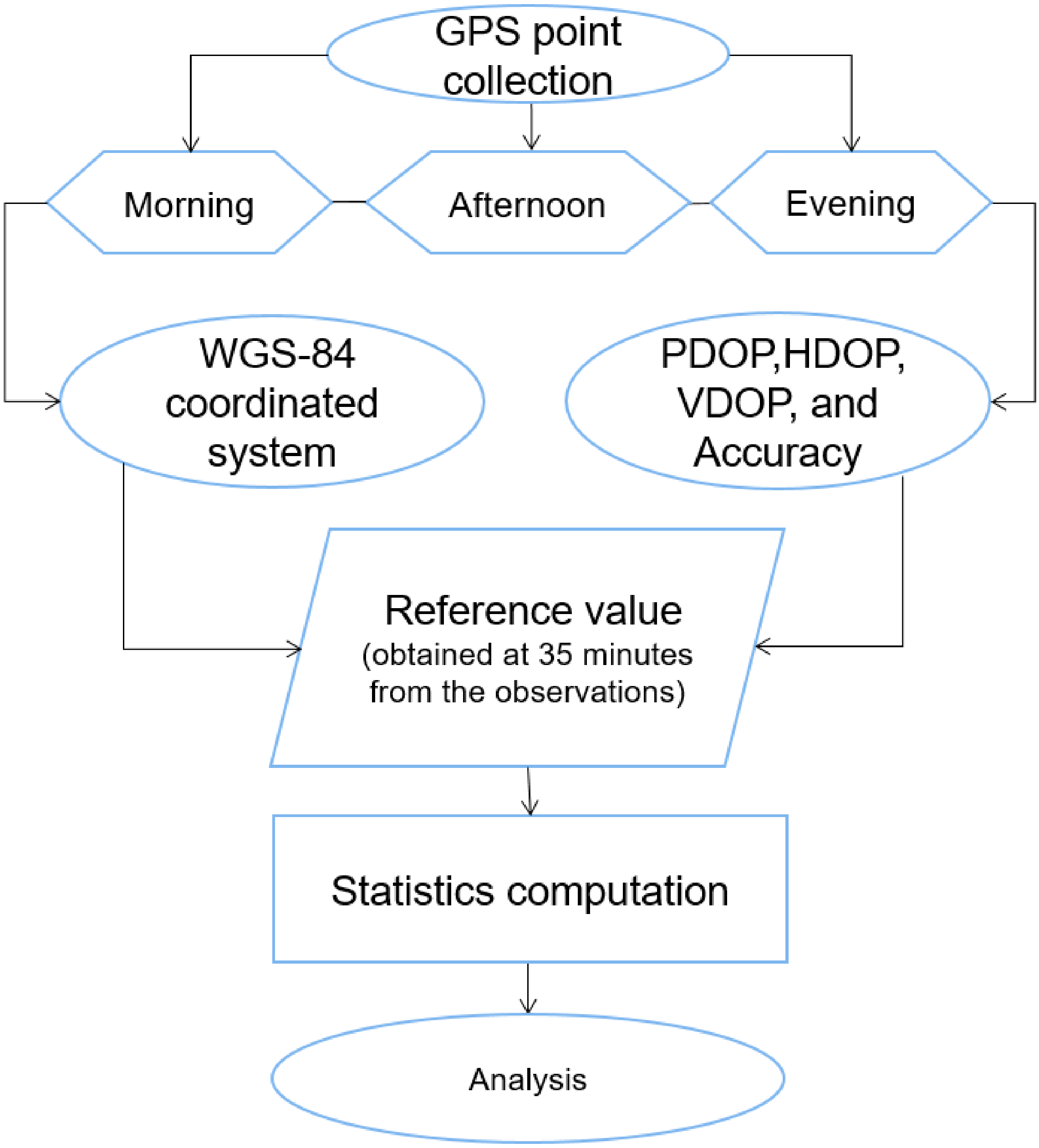

Figure 1:Flowchart of the adopted methodology

RESULTS AND DISCUSSION

Figure 2, Figure 3, and Figure 4 show the PDOP, HDOP, and VDOP values respectively, which change with increasing time of observation. Primarily there is a stabilization of these corresponding DOP values with an improved decreased value. The lowest RMSE in DOP values are noted during the morning observations wherein the PDOP, HDOP, and VDOP are better than their corresponding values in the afternoon and evening. The relatively degraded positioning performance in the afternoon can be attributed to the higher ionospheric errors due to higher ionospheric activities in the afternoon. The RMSE of 0.31m for positional accuracy is found best for the morning observations.

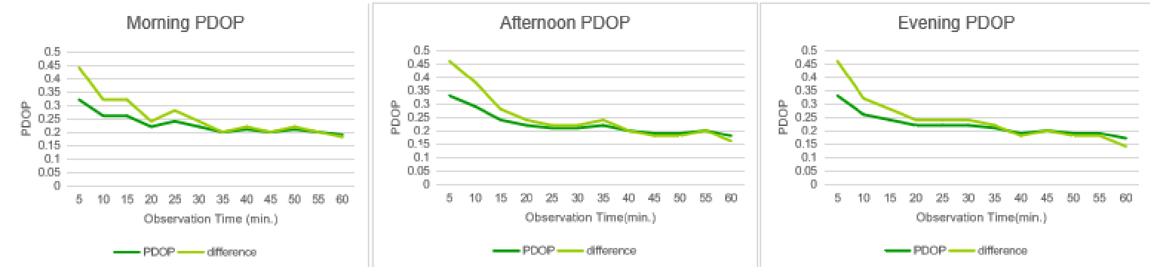

Figure 2: PDOP for Morning, afternoon, and evening observations

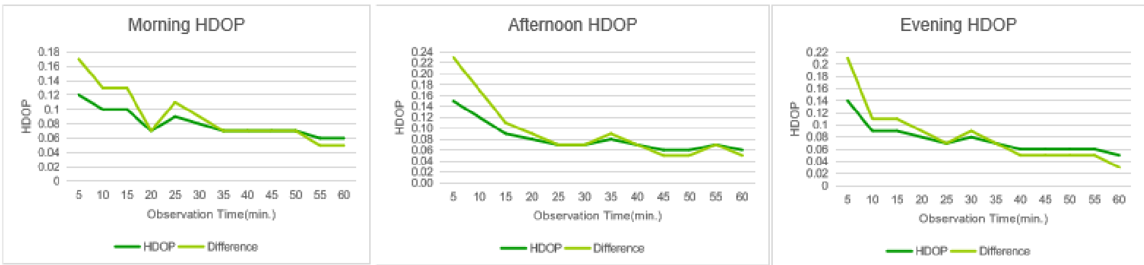

Figure 3: HDOP for Morning, afternoon, and evening observations

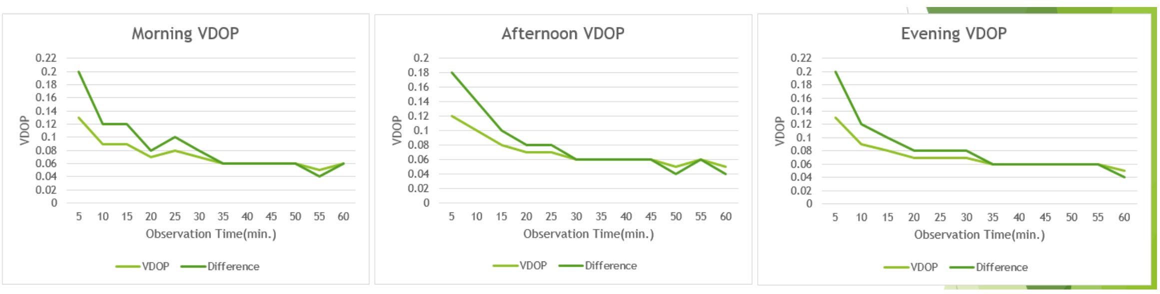

Figure 4: VDOP for Morning, afternoon, and evening observations

CONCLUSION AND REFERENCES

The GPS measurement was taken using a smartphone (Vivo 1606) incorporated with Qualcomm gpsOneXTRA Assistance technology with improved standalone GPS performance which expands the availability of positioning capabilities such as a faster time to fix and operations in challenging environments. The positional dilution of precision, horizontal dilution of precision, and vertical dilution of precision are statistically computed and analyzed. As the results, it shows that PDOP values are stabilizing at time observation of 35 minutes in the morning so, the values at 35-minutes from the observation samples are taken as reference. The PDOP and HDOP values are higher in the afternoon resulting in lower positional accuracy. It is found in the study that, A-GPS smartphones are useful for real-time observations. The overall accuracy is higher in the morning time shift with an RMSE of 0.31m using the Mobile Topographer application.

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DISCLOSURES

The authors have no conflicts of interest to declare that are relevant to the content of this article.

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