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Multipath Detection with Threefrequency SNR Combination Example from Urban Environment

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<u>P. Špánik</u>, J. Hefty, Ľ. Gerhátová, J. Papčo Slovak University of Technology, Faculty of Civil Engineering, Department of Theoretical Geodesy, Slovakia email: peter.spanik@stuba.sk

Presentation overview

- Introduction of multipath detection method using three-frequency Signal-to-Noise measurements (Strode and Groves, 2016)
- Description of calibration measurement, definition of detection criterion for measurement rejection
- Multipath detection in urban environment
- Conclusion, future work plans

Three-frequency SNR multipath detection

- Method proposed by Strode and Groves in 2016
- Utilize close relation of SNR values with phase observation and thus also with phase multipath



One path delay = different relative phases

Reflected signal is always delayed



Path delay for single reflection is constant while relative phases on different carriers change:

$$\psi_{1} = \frac{\Delta d}{\lambda_{1}} \sim SNR_{1}$$
$$\psi_{2} = \frac{\Delta d}{\lambda_{2}} \sim SNR_{2}$$
$$\psi_{5} = \frac{\Delta d}{\lambda_{5}} \sim SNR_{5}$$

Multipath detection statistics S_a^s

1. As proposed in original article of Strode and Groves



2. Simplified formula for only two frequencies (older GPS satellites, GLONASS satellites)

Calibration measurement

- Have to be performed in low multipath environment, (environment without significant reflectors)
- Estimation of regression parameters for SNR differences at two carriers which will serve as reference



Trimble R8 Model 3 multi-GNSS receiver supporting three-frequency GPS and Galileo signal acquisition.

Sampling interval: 1s Duration: 8 hours

Calibration measurement results

GPS Block II-F (in time of observation 8 satellites visible)



Calibration measurement results

Galileo satellites (in time of observation 8 satellites available)



Calibration measurement results (two frequencies)



Calibration measurement – detection statistics



Criterion based on 3-sigma rule is proposed by authors of the method. Many observation under 40 degrees would be consider as multipath.

We proposed criterion based on weighted 3-sigma, where weight depends exponentially on the value of satellite elevation angle. Parameter of weighting function is chosen empirically. Only 0.1% of observation is greater than 3weigth-sigma.

Multipath detection in urban environment

Selected area at SUT principal residence. Closest wall was 5 m from receiver. Height about ground was about 4.2 m. Surrounding buildings should cause severe multipath.

Sampling interval: 1s Duration: 16 hours





Detected multipath – first results (three freq.)

GPS

GALILEO



Detected multipath – first results (two freq.)

GPS

GLONASS



Future plans

- Compute position using original measurements and edited RINEX file with infected satellites excluded. Use simplified method for multipath detection on GLONASS satellites.
- Make calibration in different conditions, more similar to condition in urban areas (concrete or asphalt surface will be considered).
- During calibration put antenna approximately at the same height as it is during ordinary RTK surveys 2 m (to get the same oscillation pattern of SNR values during calibration and real measurements).

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References

Strode, P. R. R – Groves, P. D.: GNSS multipath detection using three-frequency signal-to-noise measurements, GPS Solutions 2016, Vol. 20, Issue 3, pp. 399 – 412.