Potential of Detecting Dynamic Motion by Analysing SNR of GPS Satellite Signal

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SUMMARY

High-accuracy GPS monitoring applications suffer from various biases and errors including multipath and obstructed satellites, which may reduce the accuracy of the estimated position and/or displacement. Several methods and techniques have been developed to limit the noise of the GPS measurements and increase their accuracy and reliability, such as filtering the GPS time series for frequencies below 0.1Hz to remove the noise due to the multipath effect. This study investigates the potential of using the signal-to-noise ratio (SNR) of the GPS records to detect motion and the corresponding frequency.

Several experiments of vertical excitations recorded by GPS receivers, have been carried out with the amplitude and frequency of the excitation varying from 8mm to 4.5cm and 0.01 to 1Hz, respectively. It was observed that the spectral analysis of the SNR of the GPS records could reveal the frequency of the motion even for excitations of small amplitude (<1cm) or low-frequency (i.e. <0.1Hz). This approach was also applied to GPS records of a pedestrian bridge monitoring project, showing that the natural frequency of the bridge (i.e. 1.64Hz) and the frequency of the semi-static motion (i.e. ~0.02Hz) could be detected from the spectral analysis of the SNR of the GPS satellite signals. The results were observed to depend on the position of the satellites.

Even though, further investigation is needed, this new approach can be beneficial in cases of unreliable or even absent GPS positioning solution (e.g. in heavy multipath environment or in a lack of many visible satellites), and to detect very low-frequency motions (i.e. <0.1Hz), which until now are filtered during the GPS time series analysis.