Normalized GNSS Interference Pattern Technique

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It is well known that water level and snow height can be monitored with the ground reflectometry GNSS-R approach [1, 2]. In this approach the antenna situated on a mast, receives a direct GNSS signal coming from the satellite and a nadir signal reflected by the observed surface. Assuming that the antenna position is known we can compute the position of the surface of reflection. For water level monitoring and snow determination, this approach provides precise localization and dating of the measures that allows to process spatio-temporal comparison of water level and snow cover, respectively. These parameters are very important for flood monitoring, avalanche prevention, as well as for hydroelectic companies. Furthermore the approach is noninvasive and can be easily implemented on a portable instrument and embedded in a vehicle with a mast. The Interference Pattern Technique considers the behavior of the SNR of the received GNSS signal as a function of the satellite elevation [1]. The received signal is indeed the integration by the antenna of the direct and nadir reflected GNSS signals. Due to their different phase variations, the SNR oscillates at a rate proportional to the height between the antenna and the surface of specular reflection.

Unfortunately the measurement is typically very long because it needs to process the SNR for high satellite elevation variations. We indeed need to observe a sufficient number of SNR oscillations to estimate the frequency and derive the surface height. In order to reduce the estimation time to a fraction of one period of the SNR variation, we propose to normalize the measures. The normalization consists in varying the antenna height of a value dh in order to read the minimum and maximum value of SNR for a given satellite elevation, and then in processing with these values the SNR measured for different satellite elevations. We show in this paper that the normalization allows to compute the cosine of the phase delay between the direct and reflected signals and to estimate the signal frequency on a fraction of a period. We also derive the minimum antenna variation range dh as a function of the satellite elevation. We deduce from this function the minimum time of observation as a function of the satellite elevation rate. We derive the exact evolution of the SNR as a function of the signals parameters (Doppler frequency, code delay, CN_0) of the visible satellites [3]. The proposed method is assessed on real and synthetic signals.

References

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