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GNSS-SNR-derived water surface heights based on Newton Interval Analysis

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The power of Global navigation satellite system (GNSS) signals is commonly recorded as signal-to-noise ratio (SNR) by GNSS receivers. SNR mainly depends on the direct signal but also on the reflected signal. Hence the analysis of SNR data allows the computation of heights of the reflecting surfaces by means of interference pattern technique (IPT).

In classical IPT the distance between the antenna and the reflector is derived from the multipath pattern using a Lomb-Scargle Periodogram (LSP) analysis which is calculated separately for every satellite involved. The final reflector height is later estimated combining all those results

A more sophisticated approach uses a consistent computation of the reflector height from all observations of all satellites in a single estimation step. This is achieved by replacing LSP analysis by an appropriate common least squares adjustment for all satellites. The sum of squares of residuals from such an adjustment depends on the reflector height and is used as an objective function. The reflector height is than derived in a global optimization process based on interval analysis. This approach additionally reduces the computational efforts compared to LSP.

For a constant or only slowly changing reflector height, the height could be treated at least as a quasi-static non-time-depending function for a particular time window. In this one-dimensional case the global optimization can be carried out based on the Interval Newton Method. The method is demonstrated using a data set obtain from a measurement on the Weser river, Germany.