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DETECTING VERTICAL DISPLACEMENTS IN REAL-TIME BY LOW-COST GNSS RECEIVERS

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Currently real-time PPP (Precise Point Positioning) and low-cost GNSS (Global Navigation Satellite System) receivers can be considered as up-and-coming tools for early warning systems and structural health monitoring. Vertical displacements determination is traditionally surveyed with precise levelling, but it can be also achieved by GNSS measurement by different techniques, e.g. RTK (Real Time Kinematic), fast-static or static. In the research implementation of low-cost GNSS and geodetic receivers for real-time and static GNSS levelling, respectively are considered. At first, the data of static GNSS levelling was processed in four software/programs (GNSS-WARP, CSRS-PPP, Leica GeoOffice and POZGEO). The differences reached up to 58 mm, but mostly they were below the uncertainty level of a dozen mm. This part of the research indicated that it is not recommended to detect low amplitude vertical displacements using real-time GNSS levelling. However, in order to detect simulated vertical displacements ranging from 2 to 55 mm, there were proposed ten strategies for time-series analysis. The strategies included time differentiation (by one or five epochs), differentiation between two receivers, and Butterworth filtering. Moreover, there were compared impact of coordinate constraining in the Kalman filtering and the cut-off angle. The most similar solution for prediction Up component was achieved for 10° angle and 0.01 m constraining. Furthermore, the best solution resulted from single-station processing and time-differencing with the interval of five epochs (30 seconds), followed by the high-pass Butterworth filtering. The effectiveness at the three-sigma level showed the detection six out of eight displacements above 20 mm. The results of the experiment are promising for future research, especially including low-cost equipment and real-time computations.