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Displacement monitoring by GPS-RTK applying FIR filters

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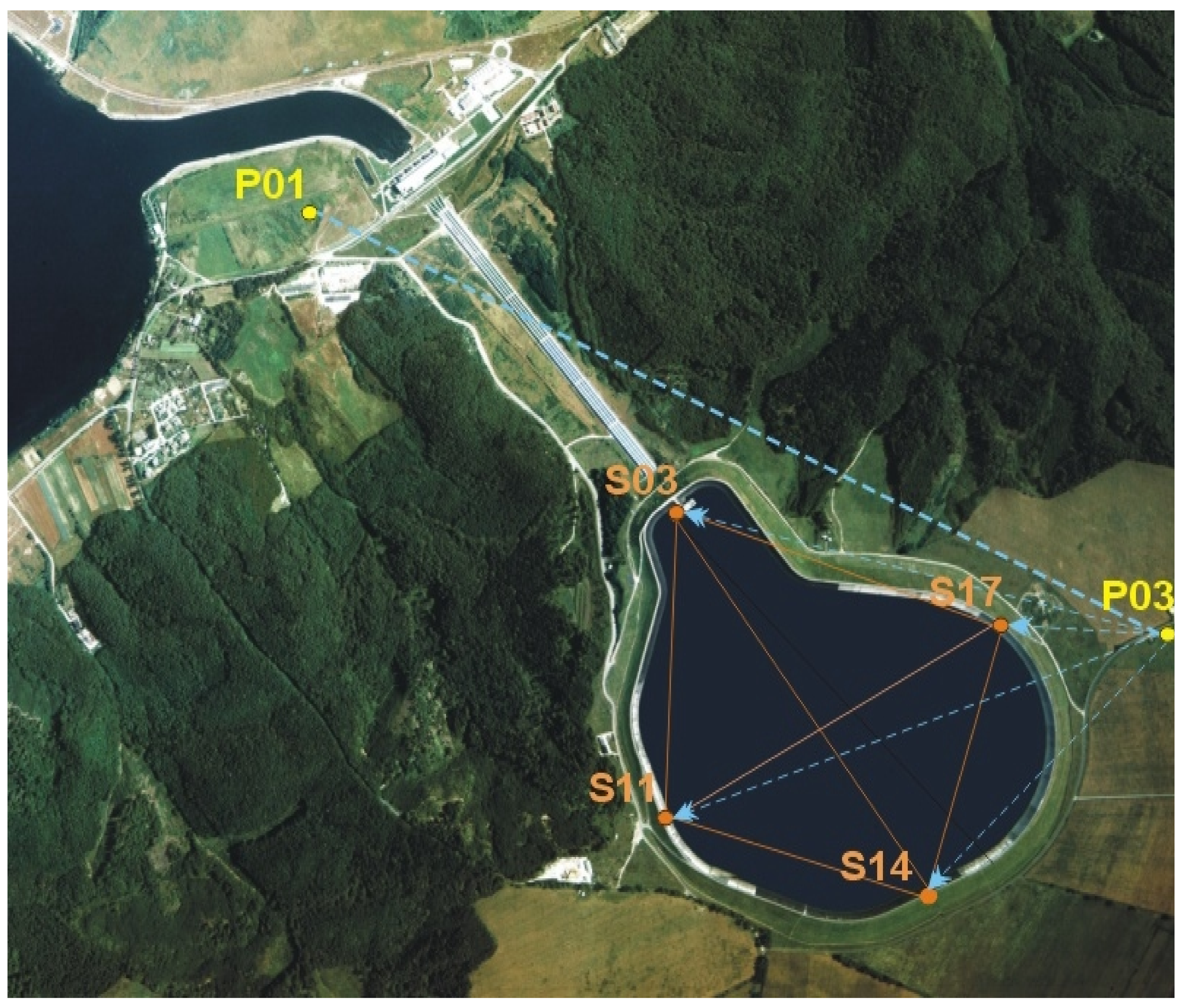

Fig. 1 Map of the network

ABSTRACT

Displacement determination of control points fixed at the engineering constructions is a important component of their safe exploitation. Kinematic satellite GPS-RTK measurements used for such a goal enable us continuous determination of the movements relating the reference systems. Measured coordinates of control points should be processed to reduce the noise. The poster presents applying the FIR *(Finite Impulse Response)* filters for the noise reduction.

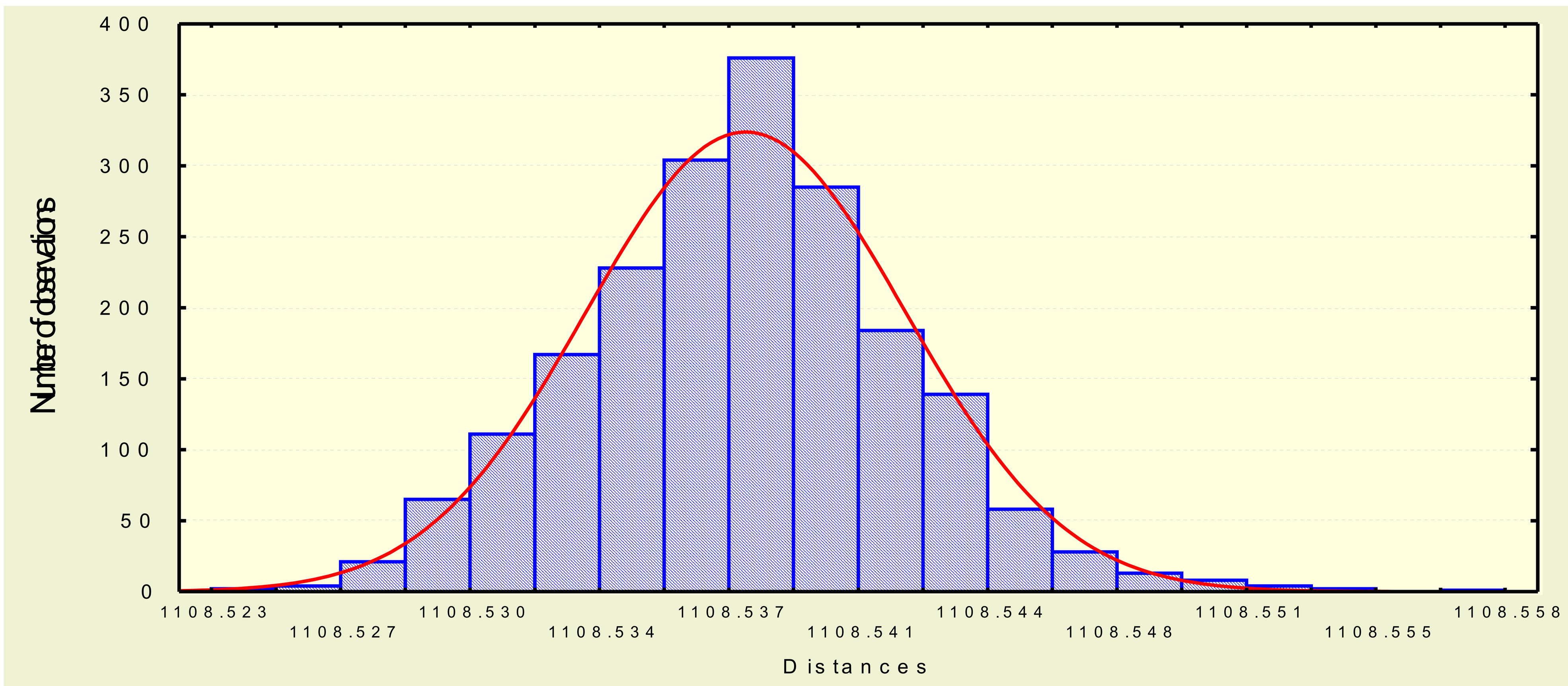

Fig. 3 Bar chart of the kinematic result for vector S11-S17 (2002)

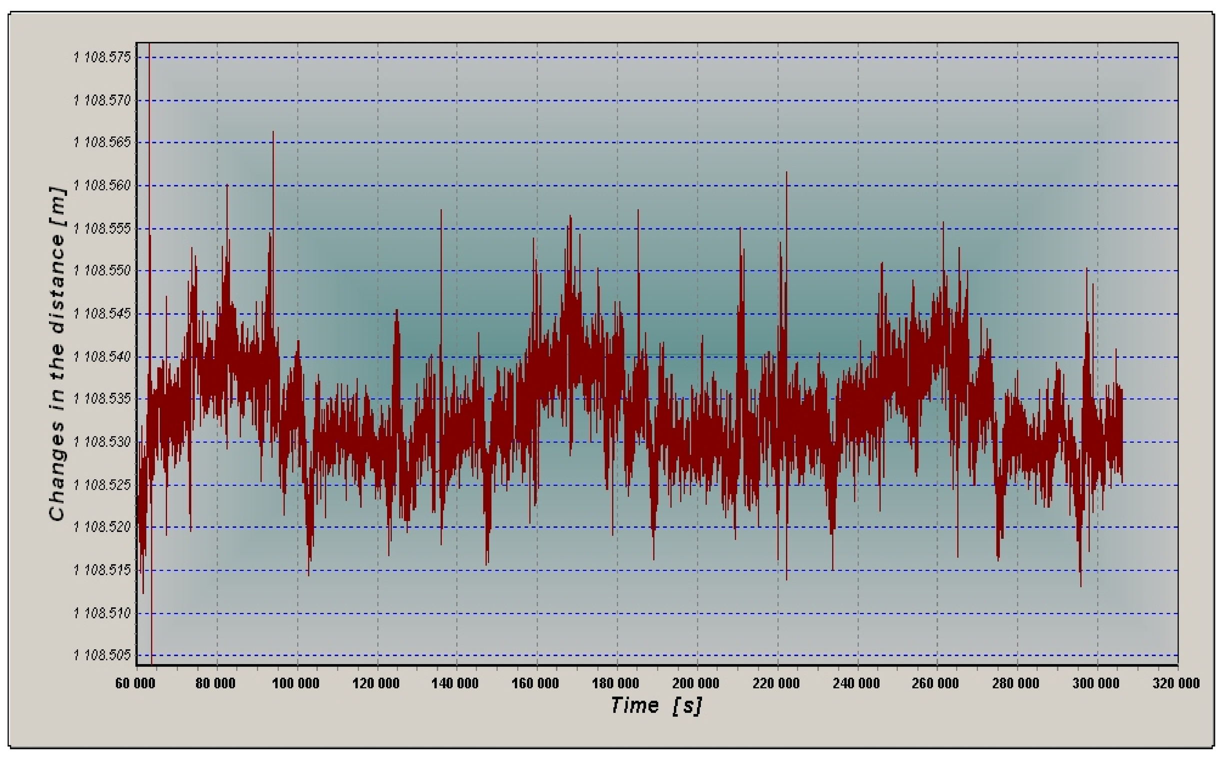

Fig. 2 Changes in the distance of the vector S11-S17 over time

Modern surveying techniques, particularly the satellite kinematic observations, make possible the permanent monitoring of the control points fixed in engineering objects. Registration of the coordinates of the GPS antenna with a high frequency (even 10 Hz) creates tracking possibility of fast moving objects with an accuracy on the level of ±20 mm. The authors' experiments - as well as others – indicate that even a slight movements (of a few millimeters) may be detected on condition that the motion is slow enough and proper filter-algorithm is applied while data processing. Numerical experiments are based on the measuring results gathered during observation campaigns on the top of water reservoir of pumped-storage power station in Zarnowiec. The measurements were programmed in such a manner to register the object deformation resulted from the periodical power-station activity. The water level in the reservoir is changing of ±15m in a diurnal cycle. This produces oscillatory movements of the points situated at the top of the reservoir. The reservoir expands after empting and contracts after filling up(fig. 2). The movements reach 10 mm and are radial-directed regarding the center of the reservoir. Statistical analysis of the measuring data (fig.3) (mainly absolute values of the vectors) resultes in histogram (bar chart) of the probability density function as well as auto-correlation and inter-correlation functions charts of raw data (fig.4, fig.5). The histogram says that the results contain only the random noise without any usable result. But further two charts indicate that the data besides the random noise contain the signal as well. In order to get information concerning the harmonic components contained in observed absolute value of the vectors, discrete Fourier transform was applied. Transforming the observed time-series into frequency-series demonstrates that movement frequencies of the points situated at the top of the upper water reservoir are tightly correlated with a frequency of filling up and empting of the reservoir. The proper filtering of the random noise is essential for the sake of variable frequency the power-station is working with. For such a goal a finite impulse response filter has been applied. The characteristic feature of such a filters is that only input data sampling is used to determine output signal(fig. 6). Designing of the filter has been accomplished in two successive stages: the first was to define the transmission-function, the second – to execute the inverse DFT in order to get an impulse response of FIR filter.

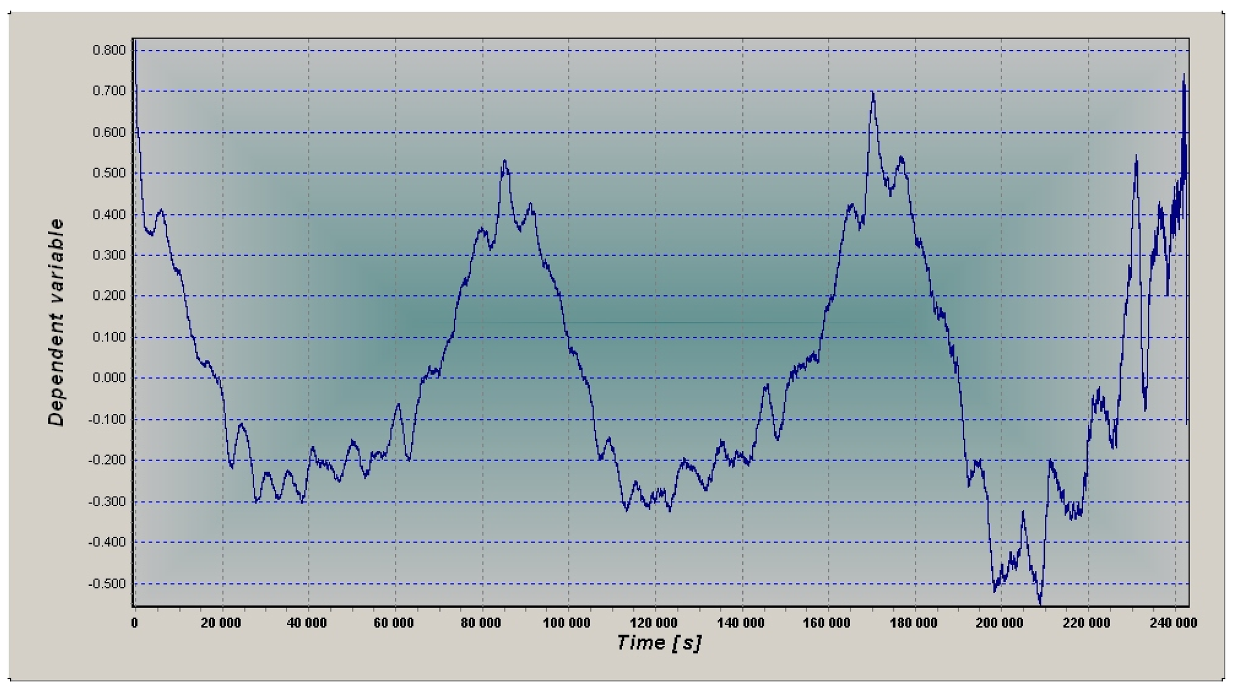

Fig. 4 Autocorrelogram for vector S11-S17

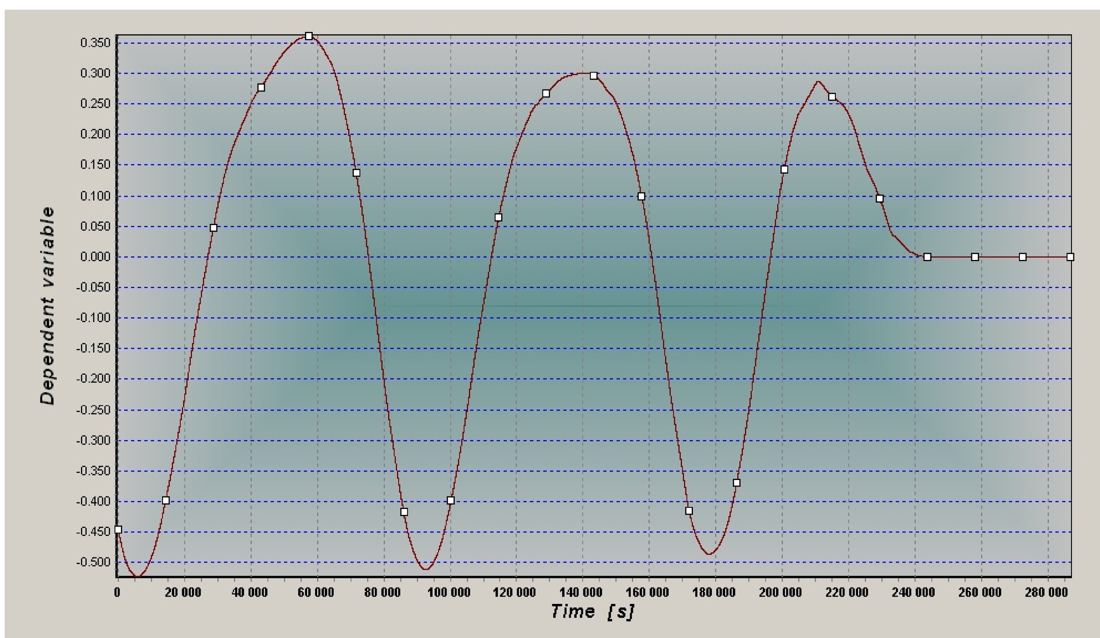

Fig. 5 Intercorrelogram for vector S11-S17

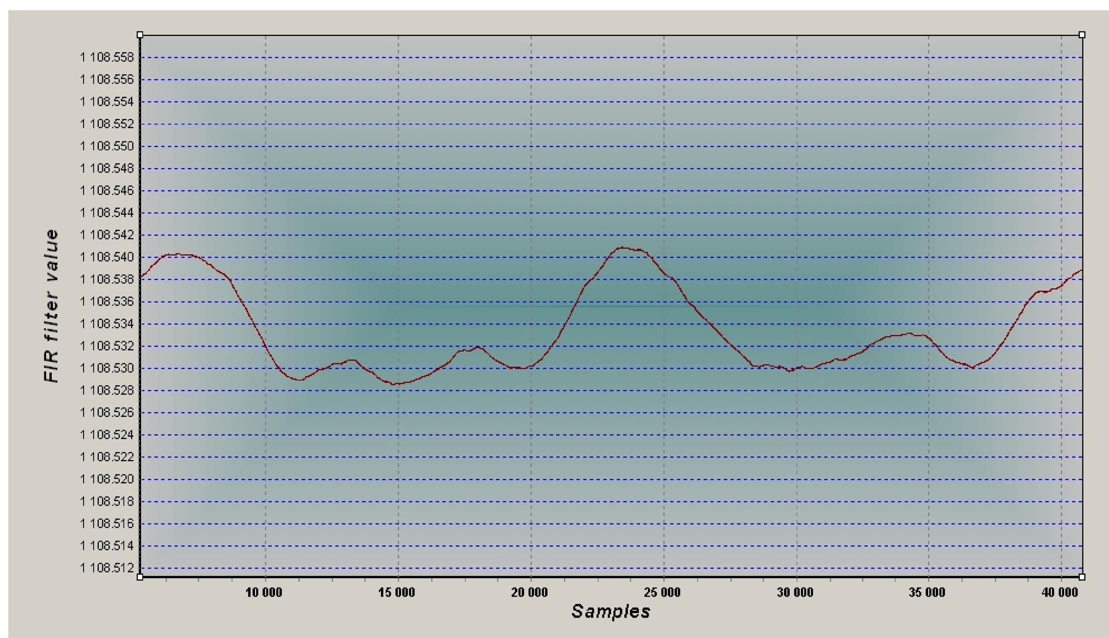

Fig. 6 FIR filter for vector S11-S17

Summary

Applying of the finite impulse response filter guarantees that the signal will be not distorted by the phase-delay of the different frequency components. Considerable filter-length (steep filter characteristic in a transition-band) resulting in possible long-delays can not be considered as filter-defect due to filtering of long-term signals. Adaptation filters are intended to be applied in the following stages of experiments.

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