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Application of Optimal Filtering to Take into Account the Influence of Baric and Temperature Fluctuations of the Seismic Instrument and the Environment

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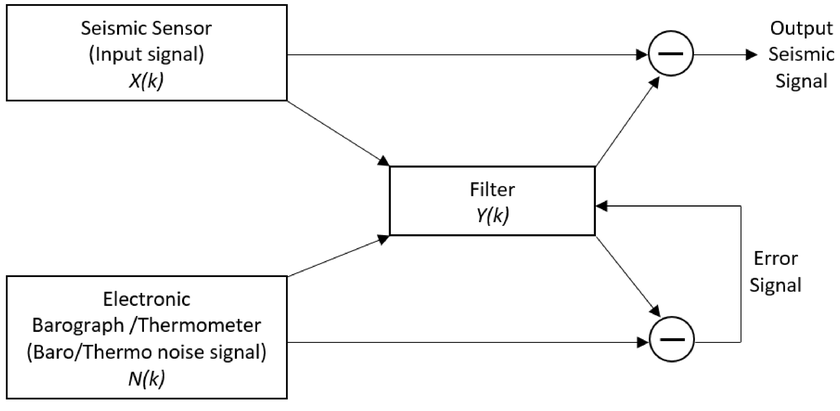
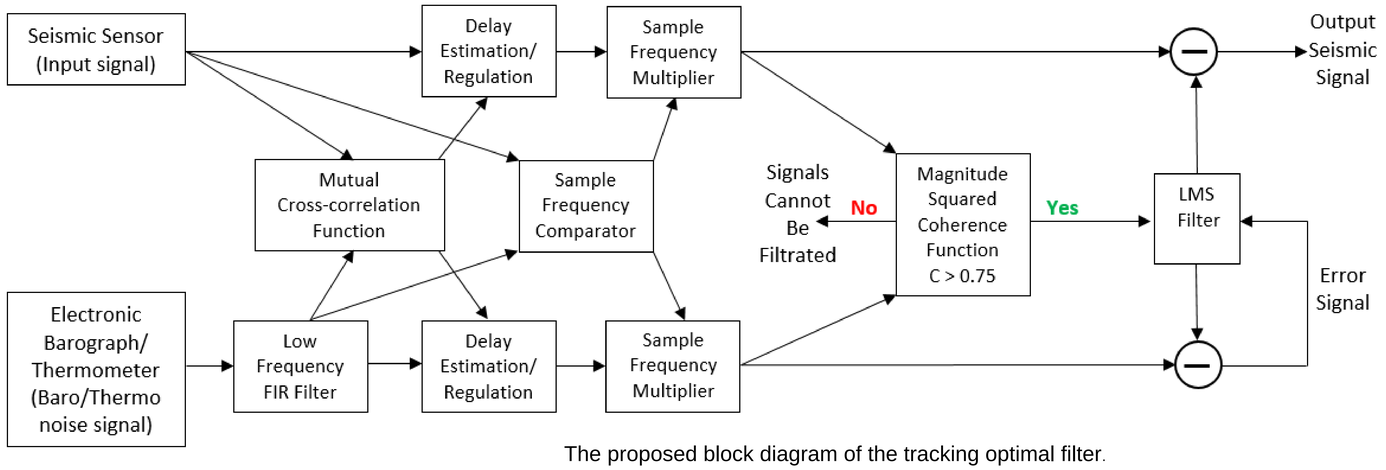
T3.1-P6

This poster is devoted to the use of the optimal filtering technique for the correction of seismic signal records, where there may also be some noise associated with both fluctuations in atmospheric pressure and temperature. It is not possible to record seismic true information about the movement of the soil by modern seismic instruments due to the considerable sensitivity of these instruments to fluctuations of atmospheric pressure and temperature both of the surrounding space and within the instruments themselves. Consideration of changing the internal temperature of seismic instruments is a very difficult task too, since uneven heating of the internal volume caused by local heat sources, which may be electronic components, for example, operational amplifiers, resistors and inductances that are part of electronics any modern device, must be taken into account. The effect of this kind of noise of non-seismic origin on the instruments increases with the expansion of its frequency response for longer periods. In the course of research, we have demonstrated that the use of optimal filters for the correction of long-period channels records of seismic instruments can significantly improve the signal-to-noise ratio, which will allow the detection of seismic signals masked by similar types of noise.



Typical structural scheme of the optimal filter.



The proposed block diagram of the tracking optimal filter.

To solve a wide range of urgent scientific and applied tasks in seismology the necessity often appears in the information on true and general motion of the earth at seismic events. It includes not only knowledge of the values of the Earth surface motion along three axes at the recording site, but also the values of tilt or rotations of the surface at the site.

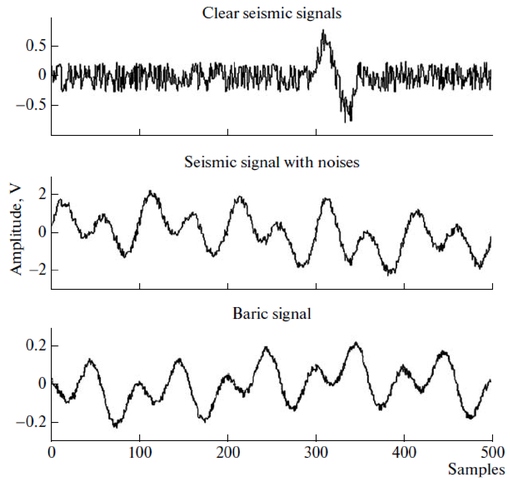
The main obstacle in the way of development of effective long period seismic instruments, including tiltmeters, consists in various sorts of noise, frequently not of seismic origin. Their influence on the instrument increases as its frequency characteristic is extended toward longer periods.

Therefore for creating any seismic instruments with high resolution it is necessary to develop effective hardware and software means and methods of noise protection. But it is necessary to note that such noise protection represents a significantly complex technical and algorithmic task to solve which as a whole the previously developed methods of protection of short period seismic sensors are ineffective.

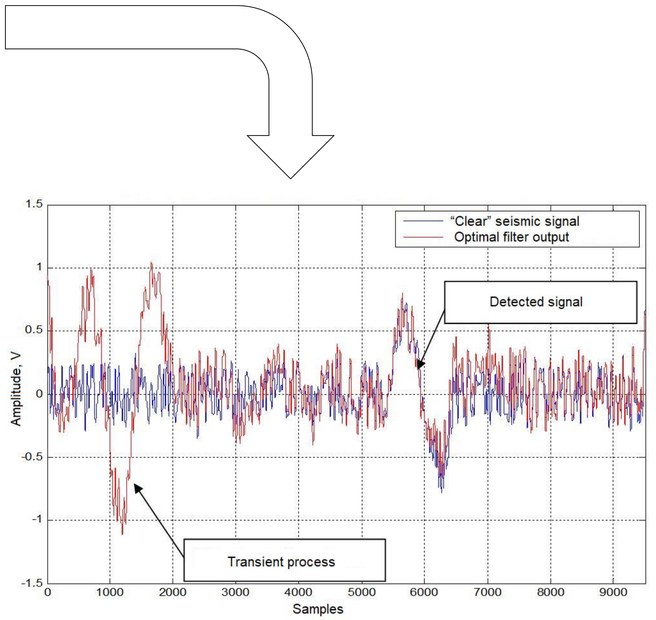
Using digital optimal filtering technique we can be considered as one of the most advanced methods of control of long period seismic noises in the seismic records of any seismic devices. Optimal filters are one of the most progressive modern types of filters permitting to solve many complex practical tasks of filtration and allocation of useful signals due to rapid development of the computer science at present.

The main difference of optimal adaptive filtration methods from classical digital filters is represented by availability thereby of feedbacks and, therefore, transfer function varying in time depending on the set signals. So this class of digital processing methods of noisy signals based on use of one or several reference signals—noise signals which are correlated or weakly correlated with useful signal subject to allocation besides properly basic noisy seismic signal which is subject to allocation.

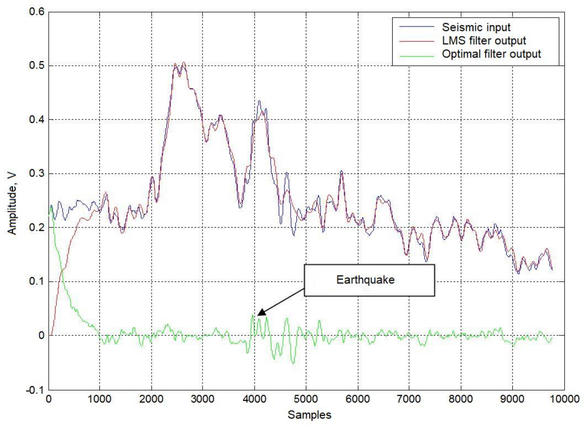
Due to the fact that it is impossible to directly visually verify the correct operation of the developed tracking optimal filter, since we do not have a “clean” test seismic signal from the seismometer output, a number of test experiments were performed showing the operability of the algorithm. Let us demonstrate one of the most illustrative examples highlighting the capabilities of the developed algorithm in the case when it is required to filter a useful seismic signal with a fundamental frequency equal to the frequency of interference (noise). It should be noted that such seismic signal is not possible to filter using conventional direct or recursive digital filters.



Test signals for checking of efficiency of the optimal algorithm filtration.



Example of synthetic input and output signals of the tracking optimal filter.



Detection of distant earthquake waves from the records of the long-period channel of the seismometer.

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