Applying of Convolution Wavelet-Scattering Neural Network for Microseismic Signals Analysis

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Microseismic monitoring makes it possible to track many processes occurring in areas with natural and induced seismicity. Monitoring systems directly collect and further analyze data.The emergence and active development of machine learning methods makes it possible to apply them to the processing of microseismic data in order to simplify and speed it up. This is especially true in view of the increasing amount of data that comes from monitoring objects.

The methodology for processing and analyzing a seismic signal from the point of view of machine learning is not unique and is common for several types of signal. It includes the transformation of a signal into a time-frequency image (spectrogram) using the Fourier transform with the further use of a neural network. A neural network, as a rule, is a sequence of convolutional, recurrent and fully connected layers. Such an approach demonstrates its effectiveness in relation to a large number of seismic problems: signal separation from noise, separation of the first arrivals of S and P waves, location of the source of a seismic event and its characteristics.

In the present work, an alternative approach to solving such problems is applied. It consists in replacing convolutional layers with filters based on the wavelet transform. Thus, it becomes possible to reduce the number of trainable parameters, as well as to generalize the methodology for processing and analyzing microseismic signals by choosing the optimal sets of wavelet transforms. In favor of the choice of the wavelet transform is the fact that the transformation is performed in the frequency and time domains simultaneously, which is not the case with the Fourier transform. The advantage of the wavelet decomposition is the invariance with respect to deformations.

In the course of the work, the problem of signal extraction and the first arrival was solved. Waveforms from the Stanford University global seismic dataset were used for the analysis. In the future, it is planned to adapt the obtained results to the problem of analyzing the type of seismic signal source.