РЕДАКТИРОВАНИЕ СЕЙСМИЧЕСКИХ ВОЛНОВЫХ ПОЛЕЙ И КОРРЕКЦИЯ ЗАПИСЕЙ ВСП С ПРИМЕНЕНИЕМ НЕЙРОННЫХ СЕТЕЙ И МИНИМИЗАЦИИ ЭНТРОПИИ ДВУМЕРНЫХ СПЕКТРОВ

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Seismic wave-fields editing and correction using neural networks and entropy minimization of 2D spectrum

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Summary

Editing of spike and harmonic noises superimposed to seismic record is discussed. Proposed method is based on the neural networks recognition. The static shifts in VSP records are corrected by combined entropy minimization of two halves of two-dimensional spectrum. The methods provide for automatic implementation.

Аннотация

Рассматривается метод редактирования аддитивных и гармонических помех в сейсмических трассах. Метод основан на анализе признаков, характеризующих помеху, и принятии решения на основе предшествующего опыта. После принятия решения о наличии помехи производится коррекция участка трассы, содержащего помеху. Также предложен метод оценки статических сдвигов в волновых полях ВСП. Метод базируется на минимизации энтропии двумерных спектров.

Introduction

Presence of noise and static shifts in VSP seismic wave-fields essentially reduces quality of processing results. Application of algorithms of noise editing with the use of neural networks for their localization allows to strengthen suppression of peak impulses and local harmonic noises with minimal distortion of useful information. The method applied for correction of static shifts is combined entropy minimization of two-dimensional spectra. The resulted technology gives rise to automatic edit procedures.

Seismic wave-fields editing using neural networks

The method for peak impulses and nonlinear distortions editing in seismic records is based on localization of distortion, its estimation in the of high frequency band and subtraction from record.

After a high-frequency filtration useful signal is suppressed almost completely, and filtered record represents convolution of noise impulses with the filter. Iterative subtraction is applied for an estimation of times and amplitudes of noise.

In the absence of neighboring impulses accuracy of definition of noise is very high. However for closely located impulses results are much worse, up to deterioration of the initial data. This problem is solved by preliminary recognition of noise samples, which sharply raises unambiguity of results. Recognition of noise samples is carried out with the use of neural networks by algorithm with training.

While recognizing the noise, each sample of seismic record is characterized by some set of parameters on which classification is made. When the noise samples are determined, their amplitude is preliminary estimated with the help of an interpolation technique. These parameters of a noise samples used in procedure of iterative specification and subtraction.

After preliminary training on the set images the algorithm works not demanding any additional parameters.

On fig. 1 the example of editing of strong nonlinear distortions is shown.

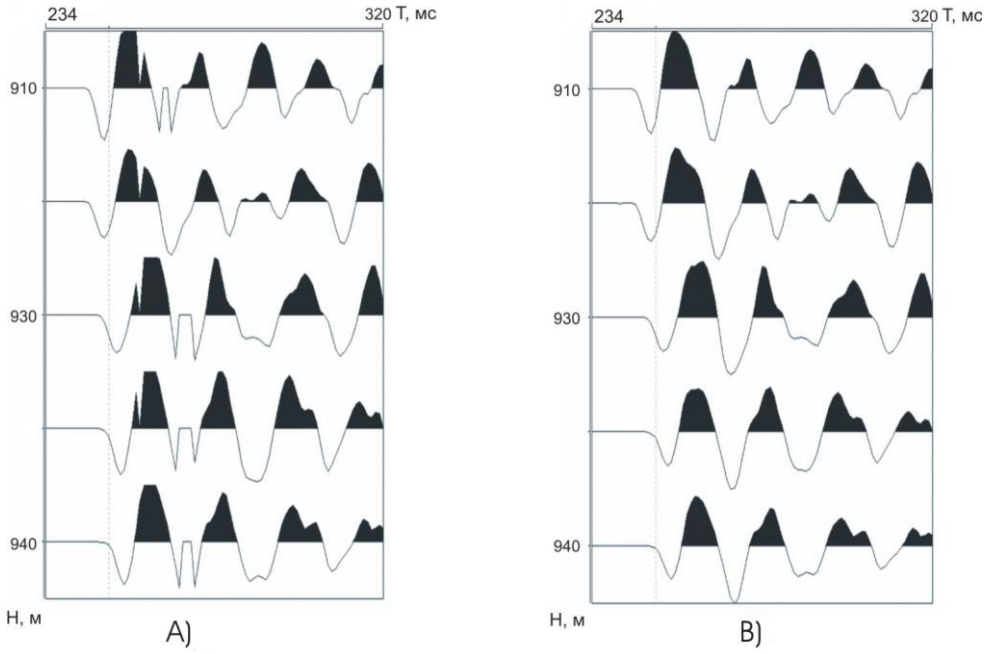

Fig.1. Editing of nonlinear distortions in the initial records: A) a fragment of initial VSP field, B) a fragment of edited VSP field.

For the located in time harmonic noise editing (Fig. 2), methods of recognition are also applied. The seismic record is divided into equal time intervals, and their spectra are analyzed. During training the principle of classification is formed. After localization of noise, the spectral image of the noise interval is formed using information from the adjacent intervals. Then the filter is constructed reducing the noise frequencies. The technique operates locally, not affecting the useful signal. After preliminary training this algorithm can search and eliminate the noise without any extra tuning.

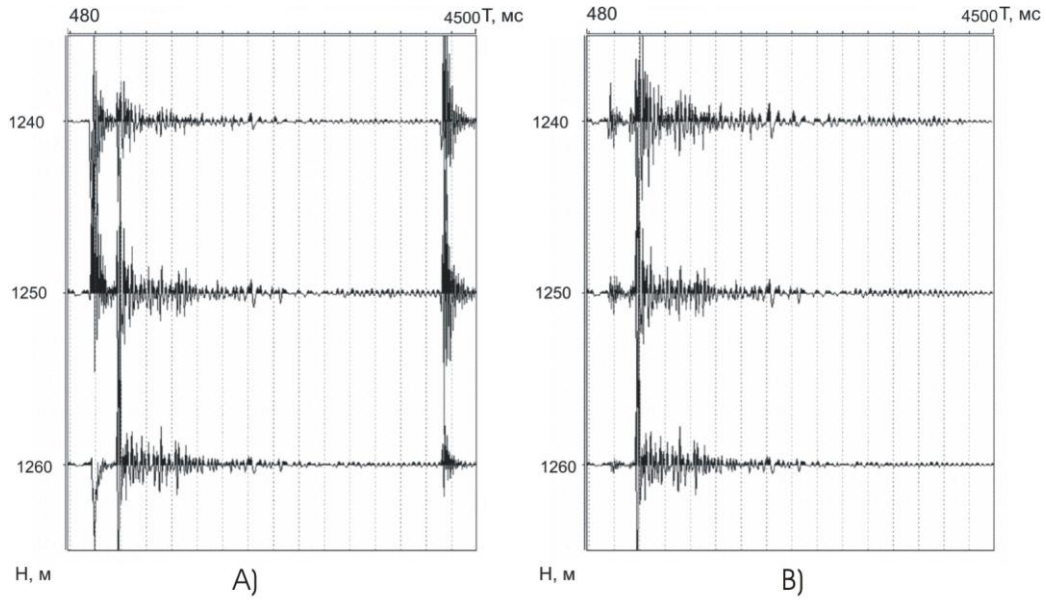

Fig. 2 Editing of local harmonious noise in initial records of VSP field:
A) initial records, B) records after editing.

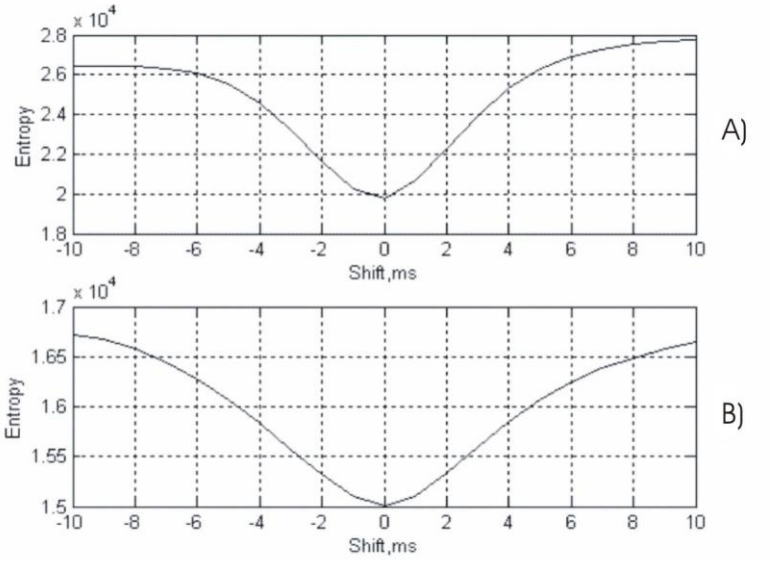

Fig. 3 scanning of entropy of two-dimensional spectrum of VSP field with varying shifts separately taken record: A) in an area downing waves, B) in an upgoing waves. The minimum of both functions specifies the true position of the record in the field.

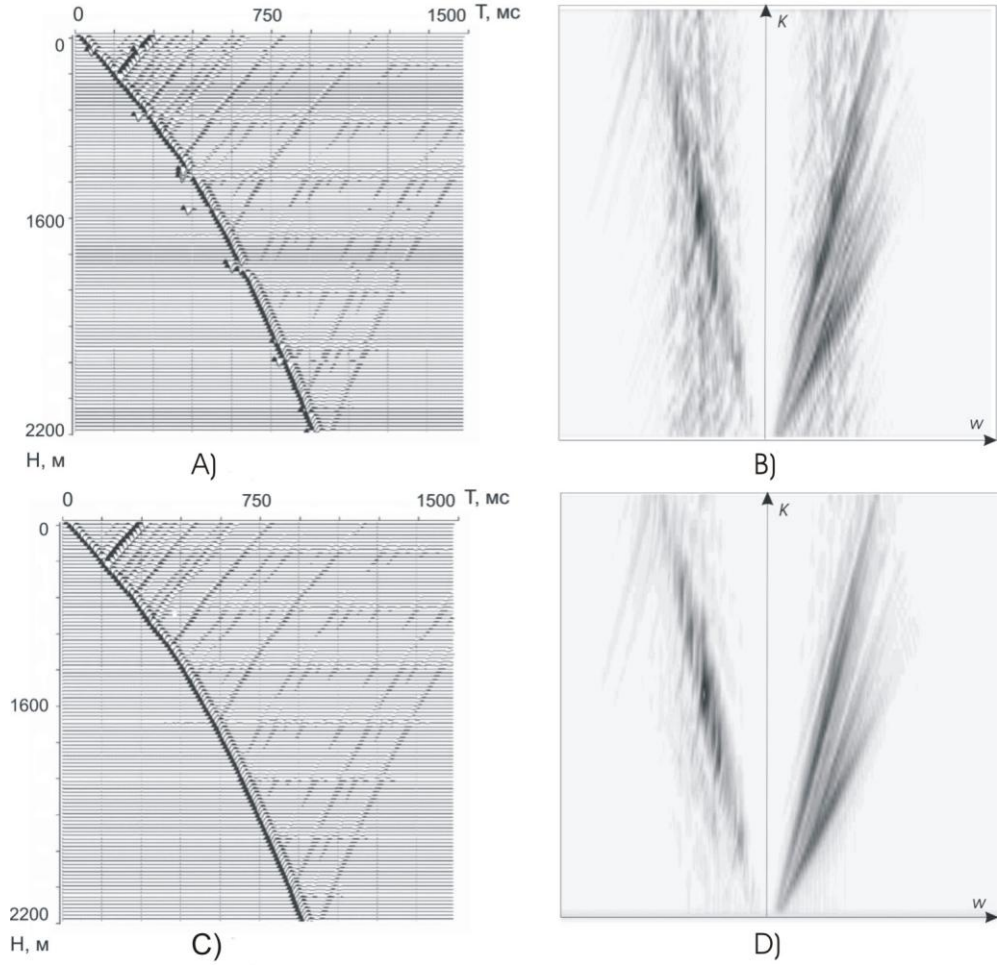

Fig. 4 Correction of static shifts by entropy minimization of two-dimensional spectra:
A) Synthetic VSP wave field with static shifts, B) a two-dimensional spectrum of synthetic VSP wave-field with shifts, C) corrected synthetic VSP wave-field, D) a two-dimensional spectrum of synthetic VSP wave-field

The method of correction the static shifts, based on entropy of two-dimensional spectra minimization is offered. The idea of a method is based on the fact that presence of casual shifts in initial wave field VSP results in increase of entropy of its two-dimensional spectrum. To correct static shifts it is proposed to minimize the entropy of the two-dimensional spectrum of the wave-field simultaneously in downgoing and upgoing waves domains. This allows to prevent straightening the phase correlation lines (Fig.3).

On fig. 4 the example of correction of static shifts is given. Highly reliable result is obtained.

Conclusion

Proposed approaches give rise to technologies providing:

- Suppression additive noise and nonlinear noise from initial seismic records with the minimal distortion of a useful signal.
- Automatic static correction of VSP wave-field in the absence of control device records.
- Removing manual operations in the raw data.

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