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Compression Perception and its Application in Earthquake Exploration

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Abstract

In underground engineering, due to the complexity of various geological conditions and the increasing difficulty of measurement and other factors, the amount of exploration data increases, which requires people to conduct reasonable treatment and analysis, to ensure that the accuracy of the whole system to achieve the required accuracy and integrity.The basic principles of seismic reflection wave and the application of compression sensing in underground media are studied, and its application in seismic exploration is analyzed to provide reference for relevant personnel.

Keywords

Compressive Perception; Seismic Exploration; Application.

1. Foreword

In seismic exploration, the compression sensing technology can be well solved.1) Through the compressed sensing theory, the frequency spectrum space of seismic signals can be distributed further away, thus improving the accuracy of the information. 2) Using the theory of compressed sensing, it can also make accurate judgments on the amplitude, phase, frequency band and other parameters of the seismic wave. 3) According to the actual collection conditions, it can simulate the real post-earthquake effect, and it can also provide a reference for the subsequent work.Therefore, adopting this method is not only a simple simplification process and an important research direction.

2. Compression Perception Theory and Foundation

(1) Sampling theorem for compressed sensing

As we know, in real engineering measurement, there are a lot of parameters can not be obtained directly from a single point (such as geological conditions, equipment performance, etc.), these are uncertain (such as structure or observation error, etc.) and in the actual exploration often need to collect a large number of raw data, so we must regard them as the quantity of unknown properties to estimate. In order to accurately describe and analyze the physical state and internal structure characteristics of the tested system, we have to process the weights of the geometric model of the measured object first, and then use mathematical methods to establish the compression perception, so as to get the compression perception consistent with the real situation. When the measured object is not a simple plane or space of the nonsmooth body, its compressed perception is realized by sampling theorem when the tested medium is heterogeneous, its compressed perception should be non-Gaussian and when the detected medium is trunk, the compressed perception should also be based on the nonlinear statistical law[1].

(2) The mathematical expression of compressed perception

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1) A mathematical description of compressed perception.In the interpretation of seismic records, we can know that the earthquake is a natural phenomenon, rather than the subjective understanding, so the spread of the earthquake is slow, and in the earthquake site, due to the change of external conditions and the influence of human factors, make the underground situation becomes complicated, and with the passage of time and the change of weather and other problems, will lead to the reflectivity of the wall, so that the wall temperature also increased, will eventually cause underground rupture and collapse.Therefore, in order to solve these problems, it is necessary to use a measurement device for observation, and through this method, we can make a good and accurate judgment of the real condition of the formation[2]. 2) The mathematical expression of compressed perception.When the position of the measured point is buried, because its own shape, size, ups and downs or some other uncertain factors will make its error, but for the actual exploration work, to ensure the accuracy of the data can not ignore the accuracy of sampling and the resolution of the measurement, if the higher the resolution of the measurement is, the more accurate the results.

3. The Construction of Compressed Perception

(1) Sparsity of compressed perception

For seismic records, we usually consider as a non-stationary stochastic process and actually seismic occurrence always has a certain regularity, which is called non-minimal sparsity. In the actual exploration, due to the complexity of the underground medium and the complex observation environment, the focal source cannot accurately identify the required information. When the collected data amount is large, due to the uncertain underground spatial location, when the underground data amount is small, the wrong selection of some parameters will be caused, which affects the final measurement result.So to solve these problems, the concept of compressed perception is proposed[3]. 1) Increase the number of measuring points in the seismic measuring area to, and reduce the sampling frequency. 2) Through research, it can be known that the relationship between the sparse coefficient of compressed sensing and the density of samples is linear or approximate in a function.

(2) The decomposition of compressed perception

In order to deal with the seismic records, it is necessary to compress and decompose the seismic data, and in the actual exploration process, we often encounter some problems that are difficult to solve in general methods. 1) It is difficult to understand all the data well during the analysis. 2) Do not well distinguish between what needs to be compressed during the study. 3) When a large amount of original information is extracted, there are usually a lot of error factors, which are unavoidable. If most of the noise generated by the interference signal can be removed, then these errors can be effectively eliminated, thus improving the efficiency and accuracy of the work.Therefore, how to put the useful information contained in this part of the interference signal is an important topic.In order to make the results of seismic exploration more accurate and reliable, appropriate methods should be used to estimate and control them. The first thing to do to use compressed sensing technology is to obtain the spatial domain of seismic records, and then construct the smallest linear local matrix according to the existing sparse representation, and finally use the compressed sensing theory to calculate the solution dimension vector of seismic profiles.

(3) Compression-sensing sine-wave signal calculation

Since the propagation of seismic waves is conducted in the spatial domain with time-varying and nonlinear processes, we need to describe the signal characteristics of seismic records with finite time-varying components, and the attenuation of seismic information is caused by sparsity and inevitable problems. To solve this contradiction, this paper proposes a sine wave signal processing method, that is, the idea of compressed sensing to estimate the frequency shift of the high frequency decomposition matrix of the high frequency coefficient and the amplitude as an independent time domain can study the spectral distribution of continuous random variables of the low order modes in the signal and the amplitude of the odd resonance[4]. The frequency shift and the amplitude of the noisy signal are

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obtained by using the SIM inversion of MATLAB, and the feasibility and effectiveness of the method are proved.

4. Application and Analysis of Compression Sensing in Seismic Exploration

(1) Compression sensing measurement in seismic exploration

The seismic survey is mainly to make real-time observation of the propagation process of seismic waves, and take it as the basic means of information processing to analyze and study its data. In the actual exploration work, we generally use the following methods to obtain information about seismic waves. 1) Direct collection method. 2) Indirect sampling method. 3) The combination of Windows and forms. 4) Methods of elastic foundation, etc. In seismic survey, we usually need compression sensing technology. It is a new exploration method, which can compare the original geological situation with the results of the previous field survey, so as to get more accurate conclusions and effectively reduce the cost of human and material resources. However, because the current related application is not very perfect, so in order to truly promote this technology to the whole engineering construction, it is necessary to make full use of this advanced detection system, so that more people can know this new knowledge and new ideas and be willing to participate in it.

(2) Earthquake exploration and reconstruction based on compression perception

The statistical characteristics of seismic signals are used to analyze the collected data, and then an explanatory map of seismic records, the properties of the underground medium and the relations and laws of various parameters are obtained.The process of reconstructing seismic exploration based on this known information is realized by extracting some key details in the original data and then comparing the obtained results with the actual observations, so as to verify whether the proposed method is accurate. Based on the compressed sensing model, we can use the Matlab software to simulate the whole process of seismic exploration, and apply it to the whole stage of seismic exploration[5]. First of all, the position coordinates of the three basic points, lines and surfaces in the roadway space obtained in the field are expressed by the mathematical formula, that is, formula (2-3) is the length of the well and the thickness of the reservoir. From the above formula, the density of the well network is determined, and second, from the perspective of the integrity of the reservoir, the reservoir reflectivity can also be determined by the size of the porosity.

(3) Imaging of compression sensing in seismic exploration

Through the above analysis can know, seismic record information is huge, and in the actual exploration process, there will often be a lot of raw data need to process, these are because the data is very large, and the density is very large, so when the earthquake observation often appear many error signals, and we usually use the compression sensing technology to identify it, so that can well reduce the error, and improve the measurement accuracy. Because the existence of compression perception makes both the wavefront domain and the frequency domain of the earthquake are fully utilized, so in the seismic exploration, if it can be reasonably applied to it, it can greatly reduce the workload and reduce the cost.The compressed sensing theory is applied to the underground geological body detection, and then the reflection coefficient at each depth is calculated according to the measured wavefront domain and frequency domain, and then combined with the real formation parameters, so as to obtain the effective resolution of each profile, and compare with the original imaging to verify whether the algorithm is accurate.

(4) The impact of compression sensing on the compression of seismic exploration data

If the compression sensing is used in the seismic exploration, the seismic data can be compressed, but the processing of the seismic data is very complicated due to the nonlinear and noncontinuous characteristics of the seismic signals. 1) Calculation of the instantaneous wave spectrum of seismic waves. 2) In the seismic exploration of the size of the data and resolution selection of the according to the above analysis we know, for the original source information, the spectrum distribution is different, and the underground reflection coefficient, the height of the frequency is not the same, so,

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to get clearer results must be to the study of the stratum geological conditions have a comprehensive understanding and specific distinction[6]. Therefore, in the actual operation process, the problems need to consider the following points.First of all, to ensure that the collected data is true and reliable, and secondly, to minimize the time interval of sampling.The last is to ensure that the information obtained is not lost for human reasons. Of course, when the measured parallel density is too large or when the parallel depth is too deep, it will cause large errors or even errors.

5. Conclusion

After a comprehensive analysis, the conclusion is as follows: 1. We establish the system of nonlinear equations by using the finite element solution method, and explain the elastic wave propagation characteristics and the regularity of the sound velocity distribution of the oil bearing layer. 2.3. Theoretically speaking, when the thickness of the well wall decreases, the amplitude of the seismic waves will become large, but the existence of the well wall reduces the energy concentration of the seismic waves, so when the thickness of the formation increases to large enough, it will cause its strength to decrease.Therefore, for low-frequency cases, we generally use the aperture of a small aperture as the seismic signal collection method. However, at high frequency, the effect of the small aperture should be taken into account to reduce the resolution, but the effect of this treatment is not good.

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