Shahrood University of Technology

JOURNAL OF RESEARCH ON APPLIED GEOPHYSICS

(JRAG)

2016, VOL 2, NO 1

(DOI): 10.22044/JRAG.2016.652

Iranian Geophysical Society - 1975

Residual static correction using denoising in f-x domain

Seyed Hossein Seyed Aghamiry[1*] and Ali Gholami[2]

1- Ph.D. Student, Institute of Geophysics, University of Tehran, Tehran, Iran
2- Associate Professor, Institute of Geophysics, University of Tehran, Tehran, Iran

Received: 5 March 2016; Accepted: 1 May 2016

Corresponding author: h.aghamiry@ut.ac.ir

Keywords

Static Correction
Residual Statics Correction
Denoising
Krylov Subspace
Regularizing Iteration Methods

Extended Abstract

Summary

Estimation of residual statics in complex areas is one of the main challenging problems in seismic data processing. It has been shown that residual statics show itself as random noise in the frequency domain, and hence, can be treated as a denoising problem. Here, we develop an f-x domain denoising algorithm to attenuate the residual statics in seismic data. A subset of low frequencies are selected and denoised individually via a Tikhonov's type filter. The denoised section is cross-correlated trace-by-trace with the noisy one, and then, the maximum shifts are picked and applied to reduce the statics. This procedure is repeated until convergence is accomplished. Numerical tests show good performance of the proposed algorithm to compensate static effects on synthetic and field seismic data.

Introduction

Static corrections are applied to compensate seismic data for the complex interaction between the incident wavefield and the near surface irregularities. Several methods have been developed in the literature for this purpose including traveltime inversion based methods and stack-power maximization methods. Recently, a new method has been proposed for residual static correction based on non-linear sparsity maximization. Here, we treat the problem by noise reduction tools in the f-x domain.

Methodology and Approaches

Statics shift traces in time domain, so it changes the phase in frequency domain. A scaled version of statics vector adds to each frequency in the f-x domain, so the real and imaginary parts of each frequency in the f-x domain can be considered as noisy versions of the corresponding parts in the clean signal. The problem is formulated as b=x+n where b is a noisy mono-frequency signal, x is the clean signal, and n is some random noise.
Therefore, we consider the following cost function:

$$\arg_x \min \|b - x\|_2^2 + \lambda \|Dx\|_2^2$$

Where λ is the regularization parameter and D is the regularization operator. If we solve this problem using direct methods, it can be time consuming. In this paper, we use a Krylov subspace method for solving it. Krylov subspace methods are often ideally suited for this task: their iterative nature is a natural way to handle large-scale problems, and the underlying Krylov subspace provides a convenient mechanism to regularize the problem by projecting it onto a low dimensional "signal subspace" adapted to the particular problem. In this paper, we use PRRGMRS, a Krylov subspace method. We select some low frequencies of the f-x domain and denoise them and take an inverse f-x transform. Then, we calculate statics using time shifts via cross-correlation. This procedure is repeated until convergence is accomplished.

Results and Conclusions

We have proposed a new method for residual static correction based on denoising tools in the f-x domain. It has been shown that residual static shifts show itself as random fluctuations (like the effect of random noise) on data spectrum in the frequency domain. Therefore, these effects can be compensated by proper denoising tools in the f-x domain. An efficient algorithm has been proposed to achieve this goal. Applications of this algorithm on synthetic and real data confirmed high performance of the presented algorithm.