**NON-CONVEX SEISMIC ACOUSTIC IMPEDANCE INVERSION**

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In an inverse manner, what we perform to obtain the acoustic impedance from seismic data is the application of a processing flow to produce migrated seismic sections, followed by implementing acoustic impedance inversion method. This is a tool to gain a quantitative rock-property describing an a reservoir from migrated seismic data. A critical step in impedance inversion is to remove the source signature from seismic traces to obtain reliable seismic reflectivity series, the so called deconvolution operation. The quality of employed deconvolution algorithm in recovery of the true reflection coefficients is very effective in properly obtaining the true seismic impedances. In this paper, we investigate an acoustic impedance inversion algorithm in which the deconvolution step is performed by a non-Convex programming.

The following explicit relation approximately links the acoustic impedances series, to the seismic reflection series

Zj+1 = Z1 exp (2) (1)

For <<1. To estimate reflectivity series from migrated seismic traces, a wide range of inversion based deconvolution algorithms has been introduced. Generally, the algorithms which assume a Gaussian distribution of added noise, includes minimization of the following cost function:

r = arg+λ φ (2)

The regularization term, φ (m), controls the behavior of obtained solutions. The most common term to use is *l2* and *l1*–norm of the model, which is known as Wiener and sparse deconvolution, respectively. Although, It has been shown that using the sparse deconvolution leads to sparse recovery of reflectivity series (which is more consistent to reality), it doesn’t lead to the true estimation of reflectivity amplitude.

To combat the problem, here we employ the generalized potential function

(m) = , (3)

The capability in more accurate estimation of reflector amplitude, while retaining the sparsity properties, is considered. The following example presents a typical acoustic impedance inversion by employing the proposed method.

A synthetic model is generated for a geological model with 6 horizontal layers with constant density and velocity (Table). The generated trace added with Gaussian noises (S/N=10 db) is shown (Figure 1 (a)). To simulate blurring effects of the source, we convolve a Ricker wavelet having 20 Hz central frequency with the reflectivity.

Table

Parameters of the used synthetic geologic model

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Layers | 1 | 2 | 3 | 4 | 5 | 6 |
| Velocity (m.s-1) | 900 | 950 | 1100 | 1050 | 1200 | 1100 |
| Density (kg.m-3) | 2000 | 2150 | 2250 | 2400 | 2300 | 2500 |
| Thickness (m) | 200 | 50 | 200 | 50 | 100 | 270 |



**Fig. 1.** A synthetic trace (a) and recovered reflectivity series by Wiener deconvolution (b), l1 deconvolution (c) and the proposed deconvolution (d). Red circles show the true reflectivities.

The reflectivity series obtained by Wiener deconvolution, *l1*-norm deconvolution and the proposed deconvolution are depicted (Figure 1 (b)-(d)), respectively. The corresponding acoustic impedances evaluated by equation (2) are illustrated (Figure 2). Obviously, the proposed non-Convex deconvolution outperformed two methods in estimating reflection series, and as a result the acoustic impedances are estimated more accurately, numerically and visually.



MSE= 5.1635e+003

MSE= 1.1521e+003

MSE= 0.9557e+003

**Fig. 2.** The true (blue) and estimated acoustic impedances obtained by Wiener (red),  (black) and proposed (green) deconvolutions. To show the details a small part of the figure is zoomed in the right panel.

In this paper we employed a generalized non-Convex regularization term in deconvolution step of acoustic impedance inversion. We showed that our proposed method outperformed the classical methods.

No need to reference any publication!