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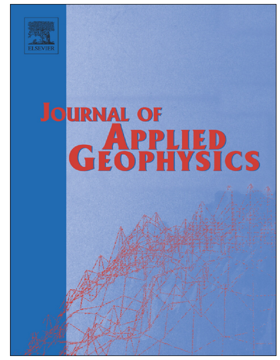

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GPU acceleration for 2D time-domain elastic full waveform inversion

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Abstract

Full waveform inversion (FWI) is a computational challenging procedure due to the high cost related to modelling, especially for elastic case. The graphics processing unit (GPU) has become a popular technology to speed up the computation for inversion. We implemented GPU-based 2D elastic FWI (EFWI) in time domain on single GPU card. Boundary saving strategy is exploited to reconstruct the forward wavefields, and thus avoids the large storage in RAM or disk which may degrade computation efficiency due to the data transfer to GPU memory. Main modules of inversion are performed on GPU and the usage of shard memory in block improve the computation speed of inversion. Moreover, the L-BFGS optimization method used in the inversion increases the convergence of misfit function. A multiscale inversion strategy is performed in the workflow to obtain accurately inverted result. The numerical test verifies the effectiveness of our method.

Key words: FWI, boundary saving strategy, GPU

1. Introduction

In the 1980s, Lailly (1983) and Tarantola (1984) proposed time-domain full waveform inversion (FWI). They show that the gradient of the misfit function can be built by crosscorrelating the incident wavefield emitted from the source and the back propagated residual wavefields, which makes FWI method realized. FWI has the potential to reconstruct high-resolution subsurface models as the full information content in the seismograms can be considered in the optimization. Due to the many drawbacks in FWI, such as, nonuniqueness of inversion, nonlinearity, and the great computational cost, especially for elastic case, FWI is not recognized as a robust seismic imaging technique. Over the past years, many researchers explored different strategies to solve the problems. Hierarchical multiscale strategies are developed in time domain by Bunks et al. (1995) to mitigate the nonlinearity by progressively increasing high-frequency content because low frequencies are less sensitive to cycle-skipping artifacts (Virieux and Operto, 2009). Pratt et al.(1990, 1991) presented the frequency-domain FWI which provides a more natural framework for multiscale approach. Other approaches in terms of objective function reduce the nonlinearity such as individual inversion of phase and amplitude (Shin et al., 2006), inversion based on Huber norm and L1 norm (Brossier et al., 2009), crosscorrelatted objective function (Leeuwen et al., 2008), enveloped objective function (Luo et al., 2013; Wu et al., 2014; Chi et al., 2014).

FWI demands intensive computation and great memory cost, especially for elastic case and 3D problem. The misfit gradient is formed by crosscorrelating forward and reverse time propagating wavefields, which requires at least two modellings each shot. When the number of shots and iteration are large and the multiscale strategies are applied, the computation cost will

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