Sparse Seismic Signal Recovery By Wavelet Transforms

Sunjay and M. Banerjee

Geophysics, BHU, Varanasi-221005,India

Sunjay.sunjay@gmail.com,manasgp@yahoo.co.in

ABSTRACT

The ability to efficiently and sparsely represent seismic data is becoming an increasingly important problem in geophysics. Transforms such as wavelets, curvelets, contourlets, surfacelets, and shearlets, etc. are used for the problem of recovering seismic wavefields from incomplete measurements. Geophysical Seismic Signal Processing (GSSP) is of paramount importance for imaging underground geological structures and is being used all over the world to search for petroleum deposits and to probe the deeper portions of the earth. Processing is faster and simpler in a sparse representation where few coefficients reveal the information we are looking for. Such representations can be constructed by decomposing signals over elementary waveforms chosen in a family called a dictionary.Sparse representations in redundant dictionaries can improve pattern recognition, compression, and noise reduction, but also the resolution of new inverse problems. This includes super-resolution, source separation, and compressive sensing. Edges often define regular geometric curves. Wavelets detect the location of edges but their square support cannot take advantage of their potential geometric regularity. Many seismic exploration techniques rely on the collection of massive data volumes that are mined for information during processing. The "curse of dimensionality" is the main roadblock, and is exemplified by Nyquist's sampling criterion, which disproportionately strains current acquisition and processing systems as the size and desired resolution of our survey areas continues to increase. We offer an alternative sampling strategy that leverages recent insights from compressive sensing towards seismic acquisition and processing for data that are traditionally considered to be undersampled. The main outcome of this approach is a new technology where acquisition and processing related costs are no longer determined by overly stringent sampling criteria. Compressive sensing is a novel nonlinear sampling paradigm, effective for acquiring signals that have a sparse representation in some transform domain. We review basic facts about this new sampling paradigm that revolutionized various areas of signal processing, and illustrate how it can be successfully exploited in various problems in seismic exploration to effectively fight the curse of dimensionality. Modern-day seismic-data processing, imaging, and inversion rely increasingly on computationally and data-intensive techniques to meet society's continued demand for hydrocarbons. This approach is problematic because it leads to exponentially increasing costs as the size of the area of interest increases.Principal component analysis and Independent component analysis is very important for geophysical signal analysis and dimension reduction.