Schlumberger Dhahran Carbonate Research

Geophysics Group

Suggested Projects for the EE662 Adaptive Filtering and Applications Course
Term-062

Project 1: Adaptive Beamforming for Coherent Noise Attenuation

Abstract:

Coherent noise such as ground-roll can affect the quality of acquired seismic data sets. This is due to the fact that the surface waves generating ground-roll reach the seismic sensors at the same time as the waves containing information about deeper subsurface geology. A common tool to remove this is noise is the use of frequency-wavenumber (F-K) filters. However, this F-K filtering is not properly applied when noise shows aliasing with the signal. Hence, the use of other advance techniques like adaptive beamforming may be important to improve the signal-to-noise (SNR) ratio.

Methodology:

Study the characteristic of ground-roll in the seismic literature. Apply on the given real data set the necessary pre-processing, e.g. band pass filtering of each trace. Then design an F-K filter and apply it to the data. Based on this work and along with the course, design an adaptive beamformer and apply it to the data. Finally, run several comparisons between the applied techniques.

Data set:

The provided data set is a 48 traces shot gather from South Africa with sampling time of 2 ms and spatial sampling interval of 100 meters. It contains some ground-roll noise. This noise can be recognized by its low frequency and high amplitude easily observed near sort offset traces (center of gather).

Suggested references:

- A. Ozbek. Adaptive beamforming with generalized linear constrains. Geophysics, Extended Abstracts, 2000
- A. Ozbek. Multichannel adaptive interface canceling. Geophysics Extended Abstracts, 2000
- B. Buttkus, *Spectral Analysis and Filter Theory in Applied Geophysics*. Springer, 2000
- P. Kearey, M. Brooks, and I. Hill, *An Introduction to Geophysical Exploration,* Blackwell Science, 3rd edition, 2002.
- Oz. Yilmaz, editor, *Seismic Data Analysis: Processing, Inversion, and Interpretation of Seismic Data,* Society of Exploration Geophysicists, 2nd edition, 2001
- A. F. Linville and R. A. Meek, A procedure for optimally removing localized coherent noise, Geophysics, 60(1):191 – 203, Jan.-Feb. 1995
- http://www.glossary.oilfield.slb.com/

Project 2: Adaptive Predictive Deconvolution for Improvement of Temporal Seismic Resolution

Abstract:

Improvement of temporal seismic resolution is one of the most important processing steps in seismic exploration. This temporal resolution can be affected by previous filtering applied to the data such as frequency filtering. One way to improve the resolution is by applying predictive deconvolution. Adaptive deconvolution techniques might be a good alternative.

Methodology:

Given a set of real data, apply the conventional predictive deconvolution method. Evaluate the results. Then along with the course, derive an adaptive method to perform such deconvolution. Finally, compare and evaluate the results using correlation analysis.

Data set:

The provided data set is a 48 traces shot gather from South Africa with sampling time of 4 ms and sampling interval of 25 meters.

Suggested references:

- B. Buttkus, *Spectral Analysis and Filter Theory in Applied Geophysics*. Springer, 2000
- P. Kearey, M. Brooks, and I. Hill, *An Introduction to Geophysical Exploration*, Blackwell Science, 3rd edition, 2002.
- Oz. Yilmaz, editor, *Seismic Data Analysis: Processing, Inversion, and Interpretation of Seismic Data,* Society of Exploration Geophysicists, 2nd edition, 2001
- http://www.glossary.oilfield.slb.com/

Project 3: Multiple Attenuation Using Adaptive Linear Prediction Error Filters

Abstract:

Linear predication is one of the most useful applications of least-square filtering. It has been employed in a number of areas including geophysical exploration. The objective of this project is to design and apply linear predication error filters using adaptive techniques to attenuate predictable components from seismic signals such as multiple reflections. The presence of multiple reflections makes the interpretation of the desired primary signals difficult and, therefore, their attenuation is an important aim of seismic data processing.

Methodology:

Design and apply a linear prediction error filter to this data. Then use your gained knowledge from the course to design an adaptive filtering method for the same application purpose. Compare the results of both filtered data.

Data set:

The data set given for this project is a marine shot gather from the Arctic. It is composed of 48 traces with a time sampling interval of 2 ms and a horizontal spatial sampling interval of 67 meters. Different types of multiple noise events exist.

Suggested references:

- B. Buttkus, *Spectral Analysis and Filter Theory in Applied Geophysics*. Springer, 2000
- R. Essenreiter, M Karrenbach, and S. Treitel, Multiple Reflection Attenuation in Seismic Data Using Backpropagation, IEEE TRANSACTIONS ON SIGNAL PROCESSING, VOL. 46, NO. 7, JULY 1998

- E. Robinson and S. Treitel, *Geophysical Signal Analysis*, Society of Exploration Geophysicists, 2000 (**this was published before by Prentice-Hall**)
- P. Kearey, M. Brooks, and I. Hill, *An Introduction to Geophysical Exploration, Blackwell Science*, 3rd edition, 2002.
- Oz. Yilmaz, editor, *Seismic Data Analysis: Processing, Inversion, and Interpretation of Seismic Data,* Society of Exploration Geophysicists, 2nd edition, 2001
- http://www.glossary.oilfield.slb.com/

Project 4: Adaptive Filtering of Signals obtained from Different Sensors

Abstract:

The analysis of physical phenomena might be improved if sensors measuring different properties are used. The data obtained by those sensors can be combined in different ways to enhance the knowledge about the phenomenon to be studied. In this project, data obtained from a geophone and a microphone will be combined in order to improve the signal-to-noise ratio of the geophone.

Methodology:

The student will evaluate the best alternatives to apply adaptive filter techniques in real time for this project.

Data set:

A proper data set will be provided.

Suggested references:

- Dragoset, B. and Barr, F., 1994. Ocean-bottom cable dual-sensor scaling. Society of Exploration Geophysics (SEG) meeting. Extended Abstract, 857-860.
- Dragoset, B. 1995, Geophysical applications of adaptive-noise cancellation. Society of Exploration Geophysics (SEG) meeting, Extended Abstract, SP2.7
- Dragoset, W.H., 1995. Method for attenuating coherent noise in marine seismic data. United States Patent, Number: 5448531
- Stone, L.D, 2001. A Bayesian approach to multiple target tracking. Handbook of multiple sensor data fusion. Edited by D.L. Hall and J.Llinas, NY, CRC Press, Chapter 10.

Project 5: Turning Noise into Signal (Advanced project)

Abstract:

A new trend in some scientific disciplines is the use of special cases of noise to improve the knowledge of physical phenomena. A specific case in seismic exploration is the conversion of multiple reflections (noise) into information (signal) that can be used to improve the resolution of the images depicting hydrocarbons reservoirs. The main assumption for this process is that the multiples contain repeated information from the target reflectors.

This is an advanced project that can be conducted after the previous multiple attenuation project mentioned above.

Suggested references:

- Berkhout, A.J. and Verschuur, D.J., 2006. Imaging of multiple reflections. Geophysics, 71, SI209-SI220.
- Dragoset, W.H., and Jericevic Z. 1998. Some remarks on multiple attenuation. Geophysics, 63, 772-789.
- Fan, C., Pavlis, G.L., Weglein, A.B. and Nita, B.. 2006. Removing fre-surface multiples from teleseismic transmission and constructed reflection responses using reciprocity and the inverse scattering series. Geophysics. 71, SI171-SI178.
- Snieder, R., Wapenaar, K. and Larner, K., 2006. Spurious multiples in seismic interferometry of primaries. Geophysics, 71. SI111-SI124
- Verschuur, D.J., Berkkhout,A.J. and Wapenaar, C.P.A., 1992. Adaptive surface-related multiple elimination. Geophysics, 57, 1166-1177.

Note:

For all the suggested projects, all the data sets will be given in *.mat format. Also, all the necessary MATLAB codes for displaying and processing will be provided.