

XV. DETECTION AND ESTIMATION THEORY

Academic Research Staff

Prof. Arthur B. Baggeroer

Graduate Students

Steven J. Leverette
Louis S. Metzger

José M. F. Moura
Steen A. Parl

Leroy C. Pusey
Kenneth B. Theriault

RESEARCH OBJECTIVES AND SUMMARY OF RESEARCH

JSEP

1. Tracking of Narrow-Band Space/Time Signals with Adaptive Arrays

Joint Services Electronics Program (Contract DAAB07-74-C-0630)

José M. F. Moura, Louis S. Metzger, Arthur B. Baggeroer

In many applications, such as passive sonar, location of radio sources, and buoy tracking, we want to determine the position of a narrow-band signal source when there is no active ranging information. To do this we need to exploit either the wave front curvature of the signal when observed across a large stationary or synthetic array, or the Doppler shifts induced by a constrained motion of the source. Accuracy bounds for the location of a passive source, which indicate the tradeoffs among array size, source motion, observation time, and signal-to-noise levels, have been determined and will be the subject of a forthcoming thesis by J. M. F. Moura. The space/time structure of signals from a broadband moving source observed across an array are being investigated by L. S. Metzger.

2. Detection and Estimation Theory Methods

Joint Services Electronics Program (Contract DAAB07-74-C-0630)

Leroy C. Pusey, Steen A. Parl, Arthur B. Baggeroer

Generalizations of the maximum entropy method using optimal filtering concepts of spectral analysis have indicated fundamental results on the problems of extending a covariance function. These generalizations have also been found to be applicable to problems in reflection seismology and transmission lines. These results will be presented in a forthcoming thesis by L. C. Pusey. Generalization of these results to spatial processes is now being considered.

An investigation concerning the estimation of a distributed field using its dynamics and boundary conditions has been completed and a doctoral thesis has been submitted by S. A. Parl. These results have been used to formulate the problem of estimating internal waves in the ocean.

JSEP

3. Seismic Data Processing for the IDOE East Atlantic Continental Margin Program

National Science Foundation (Grant GX-36331)

Kenneth B. Theriault, Steven J. Leverette, Arthur B. Baggeroer

An investigation comparing the results of various processing methods when synthetic seismograms are used has been completed and a Master's thesis has been submitted by

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K. B. Theriault. The synthetic signals were generated using a layered earth model which included attenuation and a source signal which was recorded during the research. An analysis of processing methods derived by using scattering function methods has been completed by A. B. Baggeroer.¹ The methods have been compared when used upon data taken during the International Decade of Ocean Exploration African cruise.

References

1. A. B. Baggeroer and H. Hoskins, "Seismic Filter Design Using Scattering Function Theory and Source Monitor Signals," Woods Hole Oceanographic Institution Ref. No. 74-69, November 1974.

4. Multichannel Array for Seismic Data Acquisition

Woods Hole Oceanographic Institution Purchase Order No. 36004

Kenneth B. Theriault, Steven J. Leverette, Arthur B. Baggeroer

A six-channel array for acquiring seismic data is being constructed at Woods Hole Oceanographic Institution. Through a joint program between M. I. T. and W. H. O. I. the array and processing program will be tested in a cruise off Georges Bank in the summer

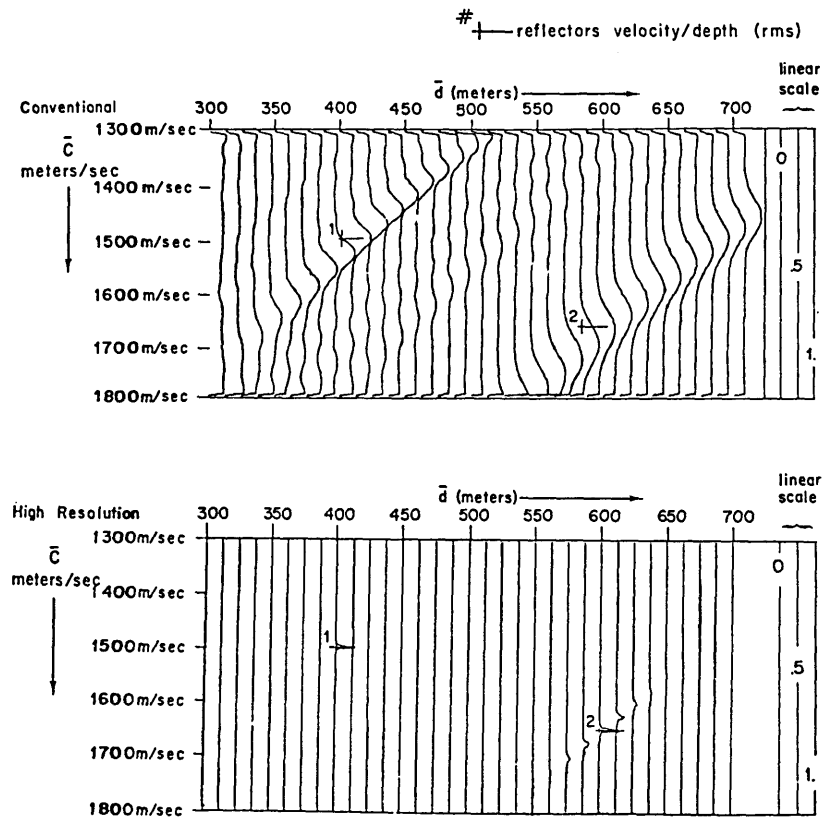


Fig. XV-1. Comparison of conventional and high-resolution velocity/depth spectra on an expanded linear scale near reflectors.

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of 1975. Novel algorithms for estimating velocity spectra based upon high-resolution methods have been developed.¹ A comparison between conventional and high-resolution procedures for estimating the velocity/depth spectra of a seismic model with reflectors at (1500 m/sec, 400 m) and (1650 m/sec, 600 m) are shown in Fig. XV-1.

References

1. A. B. Baggeroer, "High-Resolution Velocity/Depth Spectra Estimation for Seismic Profiling," Proc. IEEE International Conference on Engineering in the Ocean Environment, Halifax, Nova Scotia, August 21-23, 1974, pp. 201-211.

5. Theses Submitted

John Moffett, "The Effects of Measurement Errors on Data Adaptive Spectral Analysis Methods," Department of Electrical Engineering, M.I.T., May 10, 1974, Master of Science.

Kenneth B. Theriault, "Optimum Arrival-Time Estimation in Exploration Seismology," Department of Electrical Engineering, M.I.T., September 25, 1974, Master of Science.

Steen A. Parl, "Filtering for Distributed Parameter System Using Semigroup Theory," Department of Electrical Engineering, M.I.T., November 27, 1974, Doctor of Philosophy.

