MASTER OF SCIENCE
IN
ENGINEERING ACOUSTICS

TRANSIENT LOCALIZATION IN SHALLOW WATER ENVIRONMENTS

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In this work, the robustness of a simple, Bartlett-type processor based on matching broadband signal autocorrelation functions is investigated. Measures of robustness to be examined include the size of the localization footprint on the ambiguity surface and the peak-to-sidelobe levels in the presence of environmental mismatch and noise. A full-wave PE model is used to produce broadband replicas. Both model-generated synthetic signals, which provide baseline results, and measured pulses in a shallow water environment are analyzed.

This work suggests that environmental mismatch has a more significant effect on the localization performance than noise. It also suggests that, as long as the noise level is not higher than the signal level, the localization performance will not be significantly affected. This is to be expected, since for white noise the majority of the influence on the autocorrelation function occurs at zero lag which has been removed in the localization algorithms. It is also shown that the autocorrelation matching in the time-domain is generally more useful for smaller bandwidths at low frequencies, which has been observed in previous work, whereas the autocorrelation matching in the frequency-domain is better suited for larger bandwidths and higher frequencies.

DoD KEY TECHNOLOGY AREA: Modeling and Simulation

KEYWORDS: Autocorrelation Matching, Transient Localization, Shallow Water

DISCRETE-MODE SOURCE DEVELOPMENT AND TESTING FOR NEW SEISMO-ACOUSTIC SONAR

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A seismo-acoustic sonar concept that uses guided interface waves (Rayleigh or Scholte) is being developed to detect buried ordnance in the sea floor and beach sediments. This thesis describes the initial research conducted into the design, construction, and field testing of possible seismic sources that excite preferentially the interface waves desired for use in such a system. The theory of elasticity shows that seismic interface waves have elliptical particle velocity orbits in the vertical plane along the path of propagation. It was therefore decided that to selectively excite the desired interface waves, a harmonic source employed at the interface must induce elliptical particle motion in this plane. Several exploratory sources

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were developed to produce this type of excitation. Field tests of the discrete-mode sources developed were conducted to evaluate this hypothesis, but due to the non-optimum nature of the experimental sources, perfect discrete source excitation was not obtained. However, it was found that the medium itself acted as a selective filter for the interface waves after a few tens of meters of propagation. The experimental results obtained here suggest that the basic concept of discrete-mode excitation looks promising.

DoD KEY TECHNOLOGY AREA: Other (Mine Warfare, Mine Countermeasures)

KEYWORDS: Seismo-Acoustic Sonar, Seismic Surface Waves, Rayleigh Waves, Scholte Waves, Buried Ordance Detection, Mine Detection

COMPUTER PROGRAMS SUPPORTING INSTRUCTION IN ACOUSTICS

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Acoustics is a field of study not easily understood and laboratory experiments which might shed light on problems in acoustics are complex and expensive to accomplish. Computers have become a valuable tool in many fields of study in order to examine complex problems which would be difficult and expensive, if not impossible to study using traditional methods. This thesis is an extension of work previously completed by Thomas Green to support instruction utilizing the text, Fundamentals of Acoustics, Third Edition, John Wiley & Sons, Inc., by Coppens, Frey, Kinsler, and Sanders. The fourth edition of *Fundamentals of Acoustics* is currently in revision and the computer programs explained in this thesis will be used to support it. All programs utilize MATLAB™, a widely accepted programing language for accomplishing numerical analysis of engineering problems. The benefit of these programs will be very dependant on students using them in conjunction with the text.

DoD KEY TECHNOLOGY AREA: Computing and Software

KEYWORDS: Acoustics, MATLAB

GEOACOUSTIC INVERSION USING DIRECT METHODS ON AMBIENT NOISE AND EXPLOSIVE ACOUSTIC DATA IN A SHALLOW WATER WAVEGUIDE

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The fundamental goal of this thesis is to determine the geoacoustic parameters of a shallow water seabed using direct analysis methods on ambient noise and broadband explosive acoustic data. All data considered are from the Mid-Atlantic Bight shelf break experiment that was conducted from 19 July to 9 August 1996. Simple, theoretical treatments of acoustic propagation in a shallow-water waveguide are applied to specific, measurable quantities in the data which can be inverted directly to produce estimates of bottom compressional sound speed, density, and attenuation. Shear influences are neglected throughout. Specifically, vertical coherence of the ambient noise is used to determine the sound speed contrast at the water/bottom interface, mode travel times extracted from spectrograms of explosive data are used to estimate bottom density based on the concept of an ideal waveguide effective depth, and mode attenuation as a function of range extracted from similar spectrograms are employed to estimate attenuation. These direct inversion methods are less accurate than

sophisticated matched field processing techniques or direct core measurements, but they do provide a relatively simple means of obtaining reasonable estimates of ocean bottom parameters from minimal information.

DoD KEY TECHNOLOGY AREA: (Other) Environmental Characterization

KEYWORDS: Geoacoustics Inversion