MASTER OF SCIENCE
IN
ENGINEERING ACOUSTICS

TRANSIENT LOCALIZATION IN SHALLOW WATER ENVIRONMENTS WITH A VERTICAL LINE ARRAY

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Several algorithms based on autocorrelation matching of multiple hydrophone elements in a vertical line array have been developed to localize a broadband transient signal. An earlier developed frequency-domain autocorrelation matching (FACM) algorithm was based on autocorrelation matching of only a single hydrophone. The success and robustness of this algorithm in the presence of environmental mismatch was the motivation to adapt it to include the additional information of multiple hydrophones. The new algorithms developed were based on joint autocorrelation matching, specifically depth- and frequency-domain autocorrelation matching (ZFACM), wavenumber- and frequency-domain autocorrelation matching (KzFACM), and an incoherent summation of the FACM results of all the elements in a vertical line array (IFACM). These algorithms were tested in simple, shallow water environments with and without mismatch in the specification of acoustic parameters (e.g., bathymetry and sound speed). The results suggest that the use of the additional information from multiple elements does improve both the accuracy and robustness of the localizations. Furthermore, the IFACM and the KzFACM algorithms produced similar results that appeared to perform slightly better than the ZFACM algorithm in the presence of mismatch. However, the relative performance of the algorithms appeared to be sensitive to the environment and placement of the source and receivers in the waveguide.

DoD KEY TECHNOLOGY AREAS: Sensors, Signal Processing

KEYWORDS: Joint Autocorrelation Matching, Depth- and Frequency-Domain Autocorrelation Matching, Wavenumber- and Frequency-Domain Autocorrelation Matching

EVALUATION OF IMPROVEMENTS TO AN UNDERWATER ACOUSTIC PROPAGATION MODEL BASED ON THE PARABOLIC EQUATION

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This thesis examines two implementations of the parabolic equation approximation to the acoustic wave equation aimed at removing three errors inherent to the wide-angle parabolic equation (WAPE) model. First, the selection of the range-step size used by the split-step Fourier algorithm affects the convergence of the solution. Second, in certain ocean environments WAPE incorrectly computes the down-range transmission loss. Finally, WAPE does not reproduce the standard normal mode basis set as defined by normal mode theory. A double-precision implementation of the WAPE (DP-WAPE) is developed to evaluate the dependence of solution convergence on the numerical precision of the model. Finally, an implementation that is insensitive to the choice of the reference sound speed (COIPE) is evaluated for its ability to reduce or remove the latter two of these three errors. The stability of the WAPE solution was found to be unaffected by the DP-WAPE implementation. The range-step dependence is inherent to the split-step algorithm. The COIPE corrects the transmission loss anomaly and satisfactorily reproduces the standard normal mode basis set.

DoD KEY TECHNOLOGY AREAS: Modeling and Simulation, Other (Underwater Acoustics)

KEYWORDS: Underwater Acoustic Propagation, Parabolic Equation Approximation, Modal Decomposition