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Using Correlation Equations for Localization

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LONG TERM GOALS

Utilize time domain information in auto- and cross-correlation functions to locate sources in multipath environments. It is assumed that the bandwidths of the sources are sufficient to resolve some multipath at the receiver(s). The technique may be especially useful in cases where it is difficult to generate a reliable model for the propagation of sound.

OBJECTIVES

Utilize the time-domain information in auto- and cross-correlation functions to locate sources in experimental situations. To keep costs down, data have been collected from a terrestrial experiment with known locations of sources and receivers. The new algorithm yields estimates for the relative travel times and amplitudes of multipath (Spiesberger, 1996; 1998). The difference in the arrival times of the first arrivals (which are straight paths) is used to locate sources using hyperbolic location techniques.

APPROACH

Data were collected from 1 to 10 sources having wide bandwidths on 15 widely-separated receivers. Data from the receivers were recorded on a digital tape recorder. The locations of the receivers and many sources were estimated using optical surveys. The locations of the sources are estimated using the new algorithm which combines the time-domain information in auto- and cross-correlation functions. Simulations will be used to estimate the efficacy of a new fourth moment function, that is used with the correlation functions, to estimate the relative travel times and amplitudes of multipath.

WORK COMPLETED

Recordings have been collected from up to 10 sources at 15 microphones. Software has been written to test the efficacy of the fourth moment function. To date, the algorithms have been used to successfully estimate the locations of some sources on land.

RESULTS

An algorithm for estimating the travel times and amplitudes of multipath was implemented. It offers a means for estimating the travel times and amplitudes of multipath when the signal-to-noise ratios at the receivers are low or negative, and when the number of multipaths are unknown. What is required is that some of the signal-related lags in the auto- and cross-correlation functions have moderate signal-to-noise ratios. The signal-to-noise ratios can be positive in the correlation functions and negative at

the receivers when the time-bandwidth product of the signal is significantly greater than unity. The work is still underway, and is expected to be completed soon.

IMPACT/APPLICATIONS

Accurate estimates of the relative travel times and amplitudes of multipath may be useful for locating signals in surveillance situations.

TRANSITIONS

No specific transitions have been identified at this time.

RELATED PROJECTS

Projects that involve locating signals are; Environmentally Enhanced Array Processing [B7] (Newell Booth, SSC-SD), Depth Discrimination With Horizontal Arrays [B9] (Evan Westwood, ARL/UT), Adaptive Array Processing In Shallow Water [B11] (Arthur Baggeroer, MIT), and Environmentally-Based Wideband Matched-Field Beamforming [B6] (Dale Barbour, SSC-SD).

REFERENCES

Spiesberger, J.L., Identifying Crosscorrelation Peaks Due to Multipaths With Application to Optimal Passive Localization Of Transient Signals and to Mographic Mapping of the Environment, J. Acoust. Soc. Am., 100, 910-917, (1996).

PUBLICATIONS

Spiesberger, J.L., Linking Auto- and Cross-Correlation Functions with Correlation Equations: Application to Estimating the Relative Travel Times and Amplitudes of Multipath, J. Acoust. Soc. Am., 104(1), 300-312,(1998).

PATENTS

None