MASTER OF SCIENCE
IN
ENGINEERING ACOUSTICS

FULL DUPLEX DIGITAL ACOUSTIC COMMUNICATIONS

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Due to issues of in-band artifacts produced by a transmitter that would otherwise influence or jam an adjacent receiver in the near field, current digital acoustic communication systems employ half-duplex algorithms. This limits the information transfer between nodes to exclusively send or receive at any given time. The use of digital full-duplex communications, allowing simultaneous send and receive protocols to be employed, could help to improve data transfer rates and error checking.

In this thesis, a direct evaluation of the effectiveness of digital full-duplex transmissions is investigated. This thesis presents the results of experiments in an enclosure including noisy environments and data analyses performed to examine and evaluate the Matched Environment Signaling Scheme (MESS) method to utilize simultaneous two-way digital communications achieved through the use of adjacent, non-overlapping frequency bands. When a digital full-duplex protocol is employed, this method provides a communication solution with increased computational complexity at the receiver ends allowing higher data rates and displaying good behavior in the presence of the noise resolving the simultaneously transmitted messages from each node without errors at lower SNRs.

KEYWORDS: Full-Duplex Communication, Matched Environment Signaling Scheme, Acoustic Signal Processing, Digital Communication

ENVIRONMENTAL INFLUENCE ON SHALLOW WATER BOTTOM REVERBERATION

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In this work, the influences of various environmental scenarios on the bottom interface and volume reverberation in shallow water were numerically analyzed. Based on similar modeling reverberation geometry defined in previous works, the numerical analyses were conducted for broadband pulse signals to generate complex reverberation structures in the time-domain. The reverberation model used is based on the well-documented Parabolic Equation (PE) approximation. The environmental scenarios are divided into three main categories. They include different sound speed profiles, different levels of bottom interface roughness and different bottom volume fluctuations. While one category is being analyzed, the other two are held constant. The various analyses include broadband two-way reverberation levels comparisons, vertical correlation analysis and power spectral analysis.

KEYWORDS: Shallow Water Reverberation, Reverberation Pressure Levels, Coherence, Peak Vertical Correlations, Power Spectral Density, Power Ratio Spectral Density, MMPE

EFFECTS OF ACOUSTIC SCATTERING ON THE PERFORMANCE OF A 688I CLASS SUBMARINE'S HULL SONAR ARRAY

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Rigid and elastic scattering theory was used to model the effects of acoustic scattering on the performance of a 688I class submarine's hull sonar array. The analytical results were compared to experimental data. The submarine's bow was reduced to the sonar sphere, and was modeled as both a rigid sphere and an elastic (steel) spherical shell. Scandrett's method of solution of the coupled acoustic and elastic equations was used to solve for the response of an elastic sphere. Basic beam forming theory was used to estimate the type of effects such scattering would have on the beam pattern of a sonar array. The results showed that the pressures seen at the elements of the hull array during the experiment were caused by scattering, but the simple model used failed to completely match the experimental results. The beam forming analysis showed both main lobe and side lobe strengths to increase.

KEYWORDS: Acoustic Scattering, Submarine Sonars