NOISE REDUCTION AND CALIBRATION FOR MEASUREMENT OF UNDERWATER ACOUSTIC WAVES

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Abstract- In this study, noise reduction and calibration for measurement of underwater acoustic waves are given. Due to the rapid decay of electromagnetic waves in water, the acoustic wave plays a very important role in underwater communication and detection. In underwater environments, the measured acoustic signals always contain random fluctuations, interferences, multiple reflections, and system responses of environments. Therefore, the calibration for measured acoustic signals is required and important. This study contains three stages. In the first stage, we utilize the average (median) filter to reduce the random uncertainty, i.e., random noise, of the measured acoustic signals. In the second stage, the SVD (singular value decomposition) based noise reduction technique is applied to underwater acoustic measurement. We diagonalize a Hankel-form matrix constructed from the original measurement of underwater acoustic waves. In such a way, we can properly decompose the observed vector space into two orthogonal subspaces, which are noise and signal sub-spaces. Then the noise reduction is obtained by altering the singular values of the observation matrix, thereby suppressing the noise-related subspace and reconstructing clean signals from the signal subspace only. In the third step, the noise-reduced signals are further calibrated by using a reference object whose scattered field is already known (can be analytically or numerically computed). Interferences and multiple reflections are viewed as the frequency responses of environments. The resulting signals through the above procedures will be suitable for underwater acoustic communication and detection.

Index Terms- Underwater acoustic waves, Acoustic communication, Acoustic detection, Noise reduction