ABSTRACT

Underwater object identification and sound source localization are important in defense, underwater biological and environmental applications. Time delay estimation based localization method is a well-established technique to localize a sound source. Time delay estimation (TDE) can be categorized into time of arrival (TOA) and time difference of arrival (TDOA). TOA is implemented in an active sonar system, where a known sound signal is projected towards the target object, and the projected sound is reflected. The projected and reflected sound signals provide information regarding the target. In this work, maximum length sequence (MLS) signal is used as a projected signal to get information from the bottom of an underwater tank. Moreover, MLS signal is compared with an impulse signal for underwater acoustic modeling, and then the use of MLS signal is justified.

In TDOA, the sound generated by the sound source is acquired and the time delay between transducers is obtained. Localization of low frequency and low strength signal in a passive sonar system is a challenging task. When the source and receivers are placed in a reverberant environment, localization becomes more challenging. In this research, an AC motor – impeller setup is used as an underwater acoustic source. Generalized cross correlation (GCC) method, a well-known technique to estimate the time delay is used. The accuracy of time delay depends on the selection of prefilter in GCC. The selection of prefilters depends on the input signal type, signal to noise ratio, and the reverberation in the underwater system. Empirical mode decomposition denoising maximum likelihood (EMD ML TDE) method and Wavelet denoising maximum likelihood time delay estimation (Wde ML TDE) methods are developed to estimate the time delay between underwater noise measuring hydrophones in a reverberant environment. Both EMD ML TDE method and Wde ML TDE method are denoising based prefilters. Moreover, the sound source location is estimated from TDOA. The results prove that the EMD ML TDE method and the Wde ML TDE methods are adequate to localize a sound source in a reverberant environment for a low frequency and a low strength underwater acoustic signal.