Underwater Acoustic Communication

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This project focuses on underwater acoustic channel estimation, a key challenge in communication systems due to signal distortion caused by noise, reverberation, and multipath propagation. Using the Eclypse Z7 board, a Zmod DAC, an underwater speaker, and a hydrophone, we transmitted and recorded audio signals at different depths and distances in a controlled aquatic environment to create a labeled dataset. Then, in MATLAB, we process these signals by resampling and aligning them using sliding window techniques combined with frequency-domain analysis. We extract FFT-based features (e.g., zero or dominant frequency components) and compute the Mean Squared Error (MSE) between transmitted and received signals to identify the best matching segments. To estimate how the channel modifies the signal, we implement and train adaptive filters using the Least Mean Squares (LMS) algorithm, monitoring convergence and analyzing performance across different preprocessing and normalization strategies. These findings provide valuable insights for future applications such as underwater navigation, object detection, autonomous underwater vehicles (AUVs), and more robust and reliable acoustic communication systems.