AUV--based Concurrent Target Detection and Classification

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Concurrent target detection and classification is important for reducing the false alarm rate of the mine hunting sonar system. To this purpose multiple receiver vehicles may be employed to receive the active sonar signal of a single off--shore platform source. Such a system of unmanned vehicles can exploit the temporal and spatial signatures of the buried targets and reconstruct their peculiar characteristics. The target detection task is executed by using adaptive techniques with the help of a tracking algorithm, which decreases the occurrence of false alarms. Once a possible target is tracked by the system, the classification algorithm identifies the nature of the object.

New adaptive shape classification techniques, which are based on multistatic measurements of the target spatial signature, are proposed. The spatial response of the target is measured over various bistatic angles to estimate a planar cut of the 3--D scattered field of the target. The reconstruction accuracy, signal to noise ratio requirements, and processing requirements are compared with the state--of--the--art monostatic imaging techniques. Estimation performance is extensively assessed by calculating the probability of correct classification and the mean square error of the estimators for different signal to noise ratio scenarios, target characteristic dimensions and reverberation correlation.

Temporal signature--based classification techniques are also proposed. Due to the nature of the target, it is expected that there will be at least one elastic response following the specular return from the object. Higher--order spectral analysis techniques are investigated and employed to estimate the elastic response and classify man--made objects against natural objects. Thus, the classification problem is modeled as a binary detection problem, where the affirmative hypothesis describes the presence of the elastic signal energy following the specular response, and the alternative hypothesis corresponds to the null signal. The noisy environment and the highly correlated nature of the reverberation impose some limitations on the performance, which can be evaluated in different ambient and system configuration scenarios.

The performance of the proposed adaptive processing techniques are assessed through simulation and experimental data from past experiments.