Coherent Based Feature Extraction for Detection and Classification of Underwater Objects from Sonar Imagery

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PRESENTATION PREFERENCE: Oral Presentation

Detection and classification of underwater objects in sonar imagery is a complicated problem due to the various factors such as variations in operating and environmental conditions, presence of spatially varying clutter, variations in target shapes, compositions and orientation. Moreover, bottom features such as coral reefs, sand formations, and the attenuation of the sonar signal in the water column can totally obscure a mine-like object. In this paper a new coherent-based feature extraction method for high-resolution sonar imagery is developed using canonical correlation analysis. Canonical coordinate decomposition allows us to quantify the changes between the returns from the bottom and any target activities in sonar images and at the same time extract useful features without the need to perform separate detection and anomaly feature extraction. These features can be used for simultaneous detection and classification of mine-like and non-mine-like objects. Moreover, in situations where any visual analysis or verification by human operators is required, the detected/classified objects can be reconstructed from the coherent features. Test results of the proposed methods on a dataset of underwater side-scan sonar images provided by the Naval Surface Warfare Center in Panama City, FL will be presented. This database contains synthesized targets in real images varying in degree of difficulty and bottom clutter. Results illustrating the effectiveness of the canonical correlation analysis as a coherent change detection tool will be presented in terms of probability of detection, false alarm and correct classification rates for various density of clutter.

KEYWORDS: Canonical correlation analysis, sonar imagery, target detection and classification, feature extraction, coherence detection

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