[O01] Locally Invariant Signal Processing to Discriminate Between Key Man-made and Natural Features

A popular approach for automatic minehunting with sidescan sonar is to focus on shadow regions of objects. This is thought by many as more dependable than the highlight region. In good conditions, and given prior knowledge, it can be used to accurately classify the object into broad shape classes. However, under changing conditions, and in the presence of clutter such as sand ripples, this simplified approach tends to lose its effectiveness. The highlight region of objects has also been considered for classification but so far results have proven to be too dependent on the specific sonar conditions and the approach is therefore also currently considered unreliable. The difficulty is to extract features that are invariant, or at least tolerant, to shift, scale, orientation, background, and multiple views. Due to the highly textured appearance of modern sidescan sonar imagery, recent efforts have explored the potential of using texture for classification. This has lead to some proposals for features based on fractal measures.

In this project, a novel combination of state-of-the-art feature extraction and classification methods will be brought to bear on the challenging problem of target detection and classification using sidescan sonar imagery. We propose an extension of current texture extraction and classification methods for sidescan sonar target detection by using dual-tree complex wavelet (DTCWT) based local multifractal descriptors and support vector machine (SVM) classifiers for anomaly detection. Our approach will be to extract well localised smoothness and textural descriptors, fractal signatures, and lacunarity using dual-tree complex wavelets. These features will be carefully fed into a support vector machine classifier. In this context, the performance of the DTCWT will be compared directly to other existing wavelet-based fractal extraction methods by performing classification, firstly on some standard texture datasets, and ultimately on sidescan sonar imagery. We will investigate whether lacunarity and other textural descriptors are complementary to fractal and multifractal dimension features.

Project Supervisor: Prof Nick Kingsbury

Nick Kingsbury is Professor of Signal Processing at the University of Cambridge, Department of Engineering, and head of the Signal Processing and Communications Research Group. He has worked in the areas of digital communications, audio analysis and coding, and image processing. He has developed the dual-tree complex wavelet transform and is especially interested in the application of complex wavelets and related multiscale and multiresolution methods to the analysis of images and 3-D datasets. He has been involved in many projects for the MoD, from his early career days at Marconi Space and Defence Systems to recent projects in the Data and Information Fusion DTC and UDRC programmes.

Project Summary

Project Type: Accepted Status: Open Call