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Guest Editorial

Applied acoustics special issue on: 'The detection of buried marine targets'

Since the end of the Cold War the emphasis has changed in the study of underwater acoustics. This has in part been driven by a military imperative, whereby the main challenge is no longer the detection of large nuclear submarines in deep quiet waters. Today the emphasis is on protecting merchant, military and aid vessels, military and civilian personnel, and the environment, in the shallow coastal waters, ports and harbours which have characterised Naval deployments by Western powers in recent years.

The acoustics of such environments is complicated by the proximity of the air/sea interface, the seabed, and the mixing processes which occur at both (entraining bubbles, raising clouds of suspended sediment etc.). These can strongly scatter and attenuate sound fields. With the changing environment and targets of interest (from large nuclear submarines to small mines, for example), the balance between use of passive and active sonar has shifted, and there has been a move to higher frequencies, to obtain better spatial and range resolution, including in the use of sonar for imaging.

It is easy to understand how the enhanced acoustic complexity of these shallow-water environments can be seen as problematic, causing clutter, reverberation, multipaths, and noise. However with the growth of the new field of 'acoustical oceanography', these 'problems' have been viewed from another perspective, as opportunities to diagnose features of the environment. In climate studies alone, for example, with appropriate models the multipath effect can be used to estimate the water temperature, and the noise from breaking waves provides information useful to studies of the flux of 'greenhouse' gases between atmosphere and ocean.

Nevertheless for the problem of target detection, the acoustical complications of shallow water for the most part still represent challenges, rather than opportunities. In parallel with the above developments, the use of increased bandwidth and enhanced modelling of the environment and propagation, have generated a wealth of developments in the commercial sector.

This Special Issue outlines a range of studies on the use of acoustics to detect targets buried in the seabed. It begins with a paper by Wen-Miin Tian which describes the detection of the commercial pipelines around Taiwan using high frequency sonar imaging, in conjunction with sonar which penetrates the seabed to form 2D images (a technique known as sub-bottom profiling).

The paper by Plets et al. describes how careful alignment of a series of such 2D sub-bottom profiles can be used to generate a pseudo-3D image of the seabed. They employ chirp acoustic sources described in a later paper in the volume (Gutowski et al.) to produce pseudo-3D images of the *Grace Dieu*, showing how shipwrecks buried in mud can be non-invasively examined whilst leaving them undisturbed *in situ* for future generations of marine archaeologists using techniques yet to be developed.

This is followed by a description by Gutowski et al. of how a rigid frame containing chirp sources and hydrophones can be used to generate true 3D images of the seabed, and how it was used to locate a Coffer Dam. This object had been buried in marine sediment in the late 1960s during earlier construction work in the Port of Southampton, and had to be located prior to further construction work at the Port.

The theme then changes for the subsequent two papers (Tesei et al.; Leighton and Evans), which outline how predictive models of the scattering functions of specific targets can be used to enhance the detection of a range of difficult targets either partially or completely buried in marine sediment. Such studies represent steps towards matching the renowned capability of dolphins to detect fish and other objects buried in the seabed.

However as we expose the marine environment to ever increasing levels of man-made (anthropogenic) sound, produced either as a by-product of our activities or generated deliberately as a probe to explore the environment, that exposure may constitute a nuisance or hazard. Unlike the above-air counterparts, in the marine environment there are rarely members of the public to raise awareness of,

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and act as monitors for, noise nuisance. Therefore it is important that those who generate underwater sound are proactive in assessing the potential of their radiation to cause nuisance or hazard (since even nuisance can have fatal consequences if it leads to behavioural changes in a delicate ecosystem). Placement of standards or guidelines will not serve to protect the environment if they are not accompanied by a rigorous and accurate approach to assessing the impact of anthropogenic noise underwater, and to measuring noise levels. The issue ends with a paper by Finfer et al. which illustrates why easy solutions to characterising anthropogenic noise levels under water might not be as readily to hand as one might expect.

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