

UWB Forward Scattering Radar for Maritime Targets Detection

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Project Overview

This project is dedicated to the development of a buoy mounted network of forward scattering radars (FSR), utilising an ultra-wideband (UWB) signal for the detection of maritime targets. Due to the marine environment, it is foreseen that the main research aspect will be characterisation of clutter from the dynamic sea surface under different sea conditions and system topologies.

Traditional FSR – Surface Clutter Issues

Traditional narrow band (NB) FSR systems lack range resolution, posing significant difficulties in high clutter situations such as the marine environment (Fig 1).

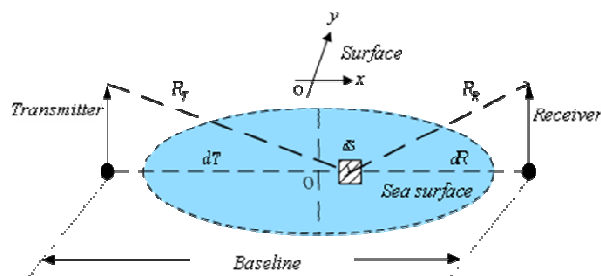


Fig 1. FS sea surface clutter from elemental area dS

Thus the main problem is to detect a small target against sea clutter when:

- Sea clutter radar cross section (RCS) in the FS direction can be up to $\sim 10\text{dBm}^2$ per m^2 .
- Clutter spectrum width is proportion to wind speed.

Therefore, NB FSR clutter problems are:

- Sea clutter originates from a large illuminated surface area defined by the transmitting and receiving antenna patterns (Fig 2).
- Clutters originating from areas close to the antenna are especially dangerous/powerful.

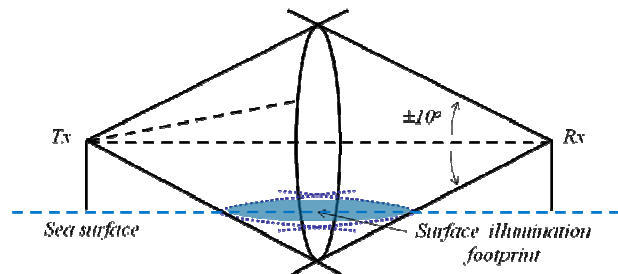


Fig 2. NB FSR surface illumination footprint

Proposed Clutter Solutions

- Reduce the area from which we receive clutter reflections.
- Remove clutters arriving from the danger areas surrounding the antenna.
- Narrow the sea clutter spectrum.

This can be achieved by the use of an UWB ranging signal.

UWB FSR

The general UWB FSR system is shown in Fig 3.

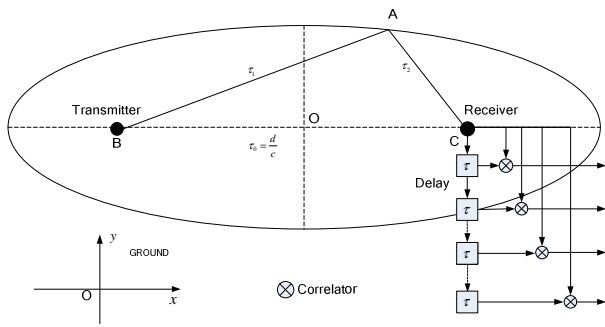


Fig 3. Block diagram for UWB FSR

The short pulse signal introduces range resolution to the system, in the form of a 3D “resolution shell”. The shell intersection with the sea surface is shown in Fig 4.

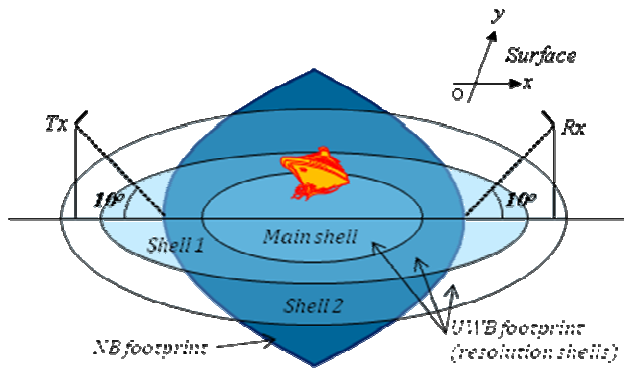


Fig 4. Comparison of NB and UWB surface footprints.

UWB FSR’s advantage over its NB counterpart is that the surface clutter area and spectrum width can effectively be reduced by considering only signal received from a specific resolution shell.

Clutter Power Spectral Density (PSD)

Figs 5(a) and 5(b) show clutter power spectral density for UWB and NB cases respectively. The spectral width is narrowed in the UWB case, removing these high power low spectral components increases signal to clutter ratio (SCR). Fig 6 shows the SCR improvement attainable in this case for various target speeds and baseline lengths – calculations made for sea state 1.

Project Objectives

Only preliminary work has been carried out thus far, the key objectives for the project are:

- Investigation of system topology.
- Development of model for EM propagation above the sea surface.

- UWB RCS calculations.
- Development of radar equations.
- Clutter analysis for different sea conditions.
- Estimates of signal to clutter ratios for different scenarios – culmination of all above points.

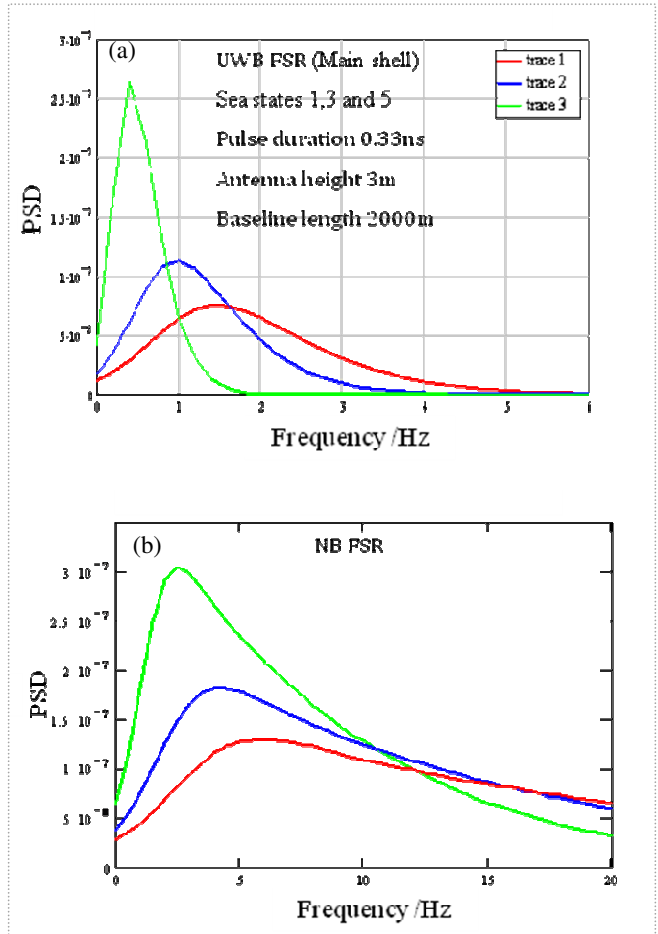


Fig 5. (a)UWB and (b) NB clutter PSD

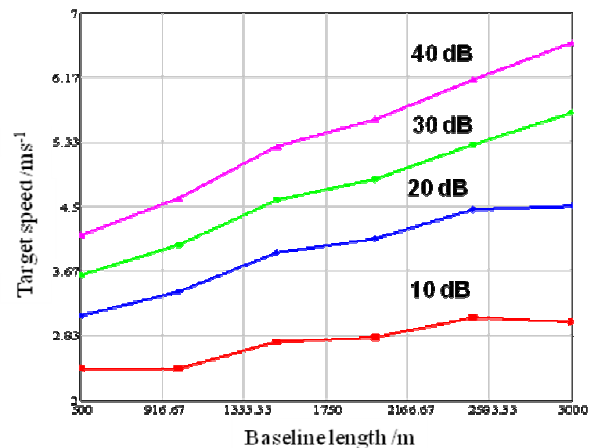


Fig 6. UWB SCR improvement for different target speeds