RADAR SENSING OF THE ENVIRONMENT FOR FUTURE AUTONOMOUS MARINE PLATFORMS

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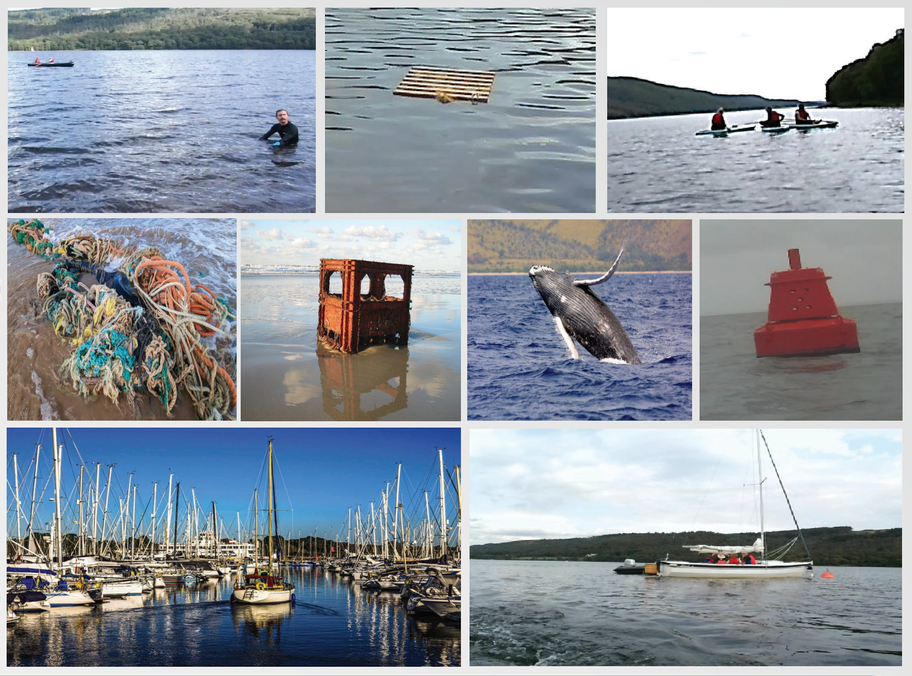
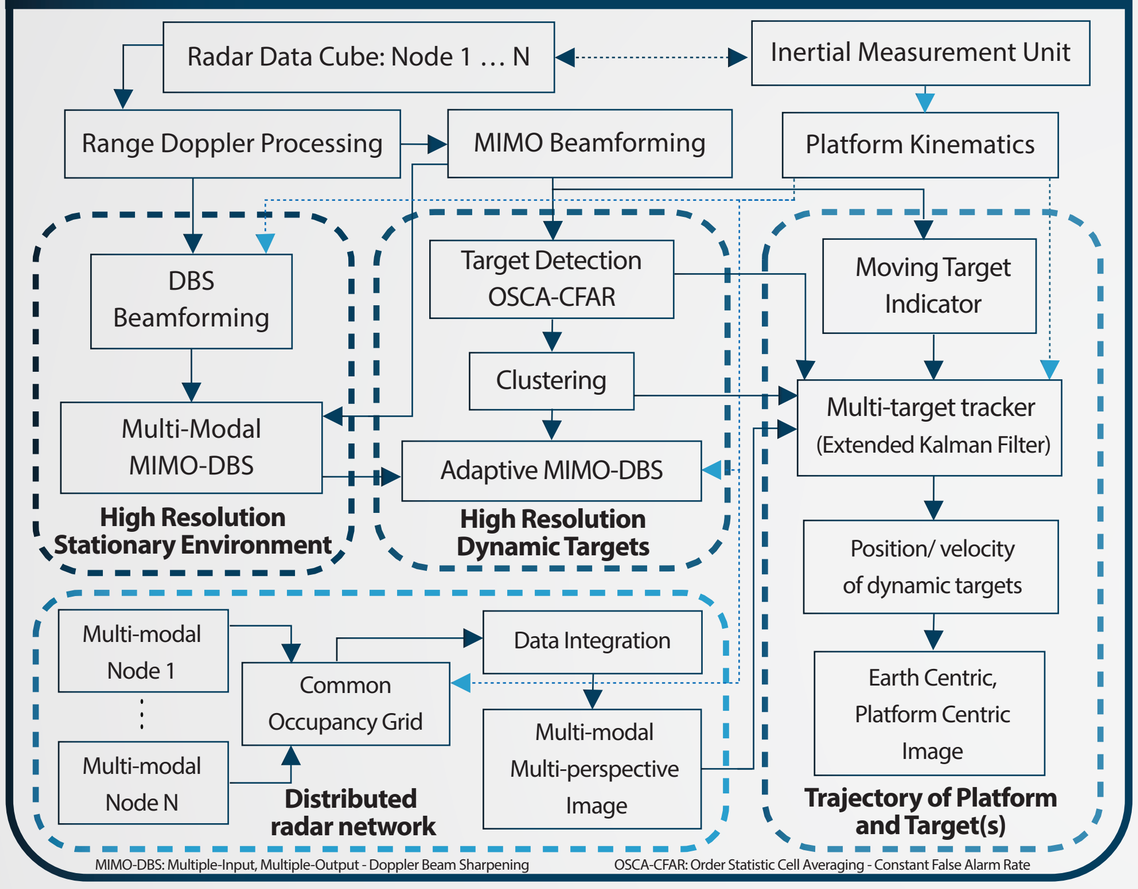
MOTIVATION

Growing market for small agile vessels & need for enhanced situational awareness	• Reliable all-weather, day/night detection and classification of small objects. • Detection and tracking of large waves.
Challenges in the maritime environment	• Unpredictable weather and sea conditions. • Multiple moving objects (ships, boats, kayakers, marine wildlife).
Millimeter-wave & sub-THz radar system (76-340 GHz) as the key solution	• High-resolution imaging and fine Doppler information. • Compact sensors with advanced 'cognitive' signal processing.
Advantages over traditional marine radar	• **Video-like radar imaging** – enables advanced image processing. • **Enhanced cross-range resolution** – improves small object detection. • **3D radar imaging** – enhances object differentiation and scene awareness.



Situational awareness for small marine crafts is of vital importance for improved marine safety, path planning, and obstacle avoidance.

METHODOLOGY



MEASUREMENTS

77 GHz automotive MIMO radars → 79, 150, 300 GHz prototype radars → Inertial measurement units → ZED stereo cameras → LiDAR

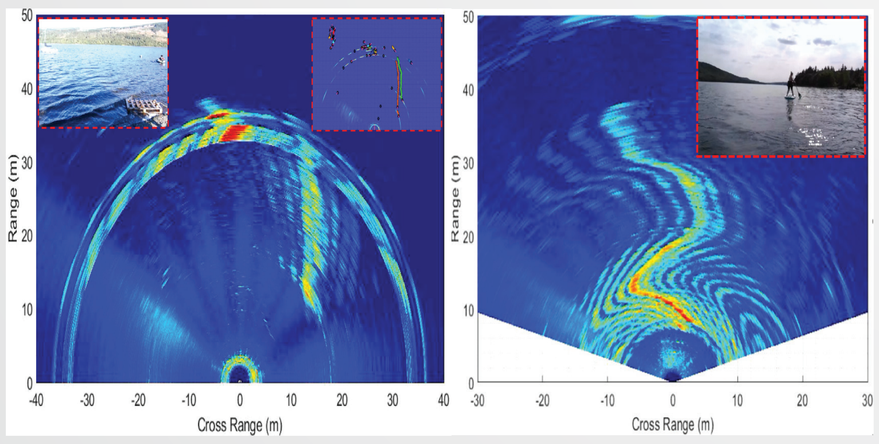
Backscatter data of sea surface
Different sea states, wind directions, pointing directions, grazing angles to investigate propagation effects in marine boundary layer.

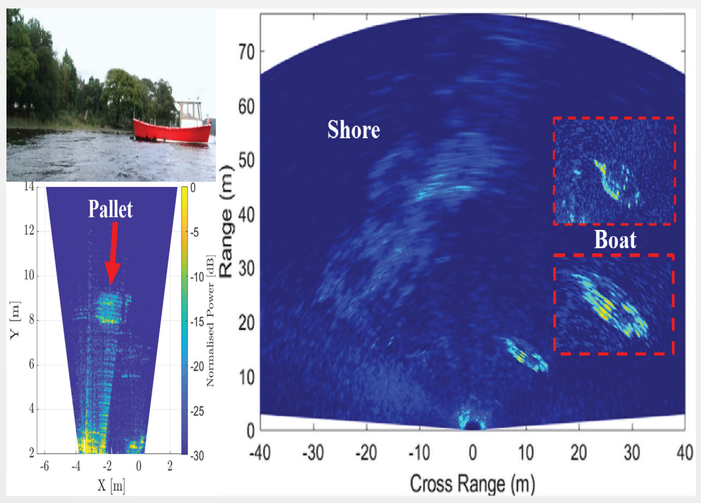
Data of floating marine targets
e.g. flotsam, jetsam, lobster pots, buoys, pallet, wimmers, to record signatures in situ.

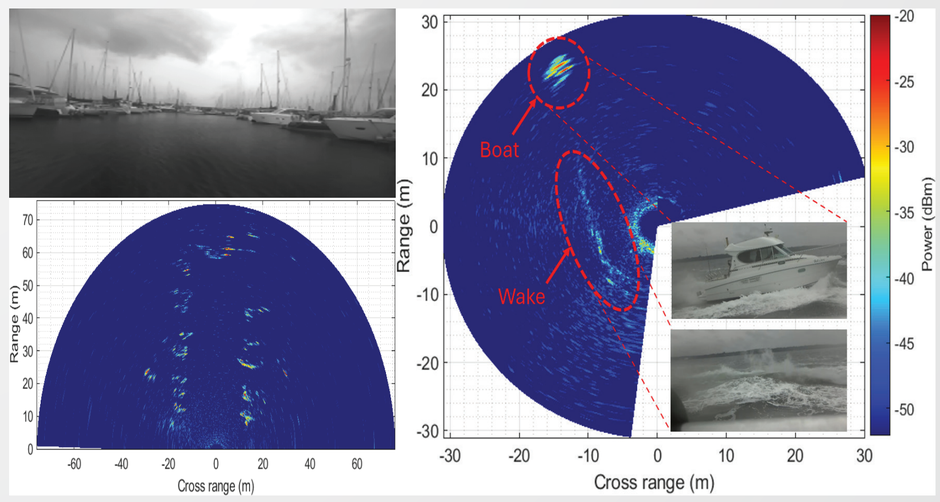
Data from marine mammals
e.g. seals, dolphins.

Distributed sensing network
for multi-modal and multi-perspective imaging.

RESULTS







Scene decomposition into stationary and dynamic regions

Digital reconstruction of a scene

Structure of marine targets for segmentation and classification

IMPACT OF THE RESEARCH

Fundamental and applied research conducted to develop adaptive multi-modal algorithm for mitigating effects of dynamic sea clutter will produce focused imagery of small targets and resolve targets as anomalies.

Multi-target detection and tracking will estimate the trajectory of platform and targets in complex dynamic maritime environment.

Radar sensing network will equip next generation of autonomous, remotely controlled and assisted small/medium marine platforms with day/night, all-weather, high fidelity situational awareness.

Anomaly detection and cognitive sensing will enable planning paths in dynamic sea, docking, and avoiding obstacles such as buoys, flotsam & jetsam, hazardous waves, swimmers, and sea mammals.

FUTURE WORKS

- **Hardware design** – smaller form factor, high pulse repetition frequency, multi-band.
- **Sensor fusion** with multi-perspective sensing from distributed sensing network.
- **Image segmentation and classification** to establish a catalogue of marine targets.
- Algorithms for **path planning** to deliver 'true' autonomy.

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