Automated Identification of Underwater Sandbanks in Time-Series SAR images

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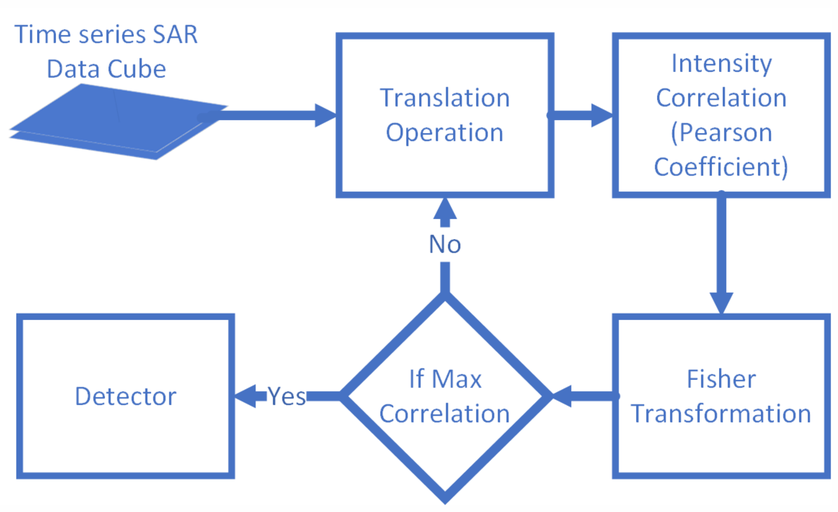
Introduction

Synthetic Aperture Radar (SAR) is a mature remote sensing technology which can form high-resolution images of the earth's surface in all weather conditions. The textural detail apparent in Earth Observation SAR imagery of the ocean surface is a manifestation of a range of physical phenomena including local weather effects, underlying prevailing ocean swells, ocean currents as well as **localised changes in the sea-bed topography.**

Aims

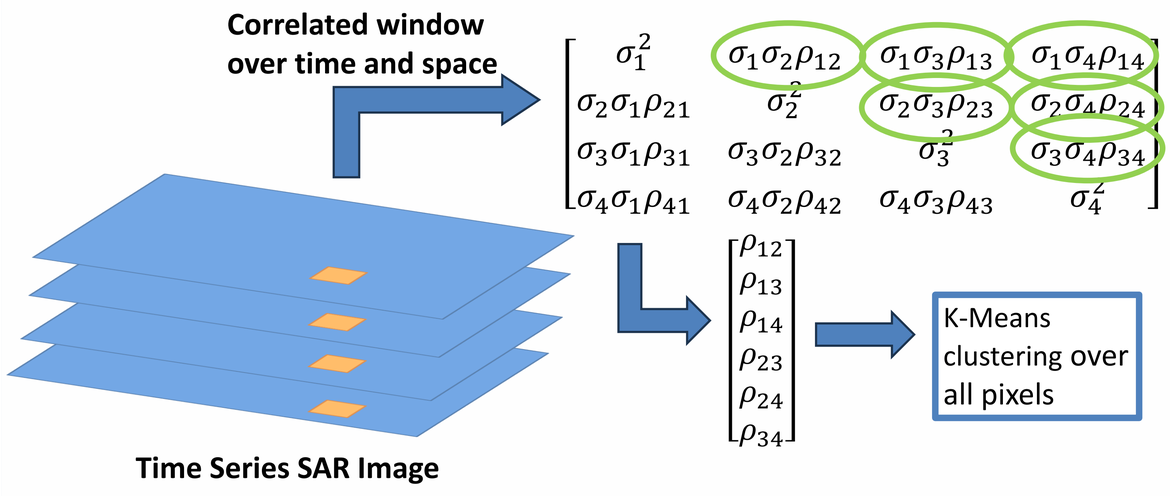
Utilise time series SAR images for the characterisation of underwater dynamic processes in ocean scenes

Method



Persistent ocean signature identification method using two SAR images

Methods for incorporating more than two images in the identification process were also investigated. A K-Means clustering algorithm was applied on the pixel "feature vector" of length 6, taken from the upper triangle of the temporal correlation matrix (green circles below). The temporal correlation matrix was generated from 4 SAR images captured at different times. This method is referred to as the "K-means Identification method" and is outlined in the diagram below.

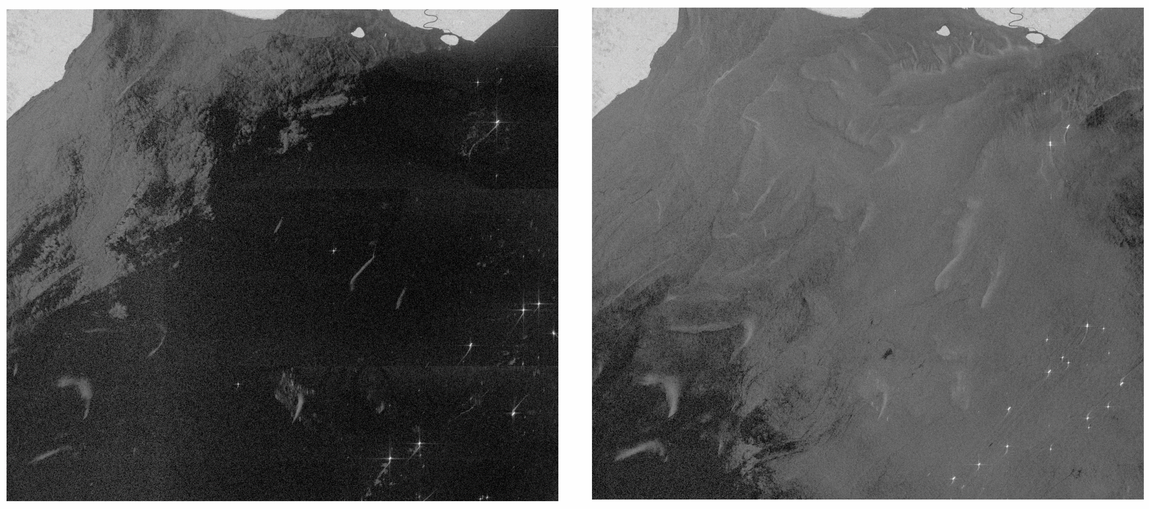


K-Means Sandbank Identification Method

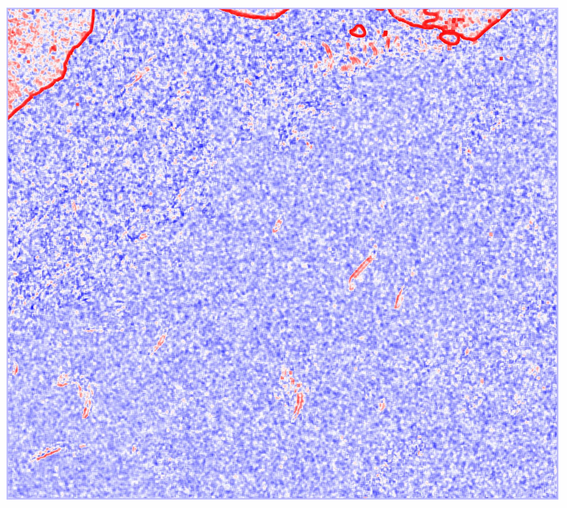
Discussion

- Automated underwater identification of sandbanks has been demonstrated.
- Demonstrated feasibility of using more than two images in the identification process, but further work is required
- Limitations include no ground truth for validating results, however by classifying these signatures as either persistent or transient, this additional information can be used as an input to other methods improving overall characterisation performance

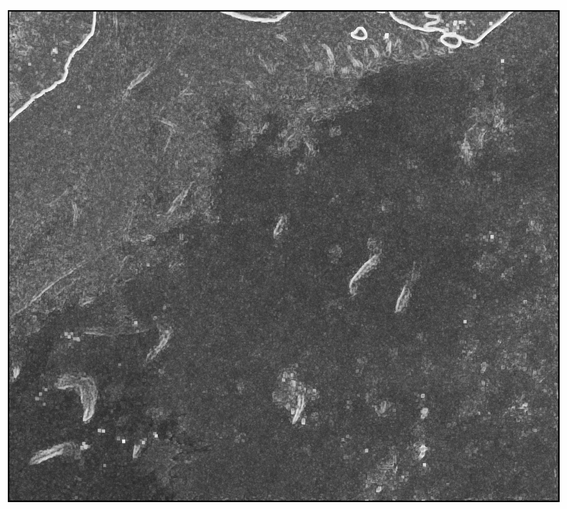
Results



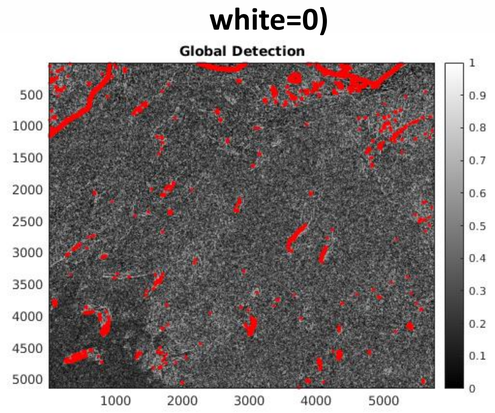
Two Sentinel 1 SAR images captured approximately 1 month apart of the Strait of Malacca



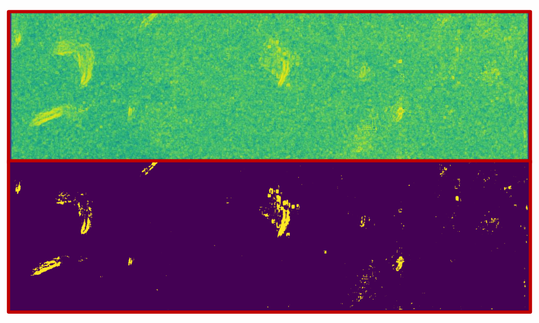
Intensity correlation (red=1 blue=-1 and white=0)



Max of Intensity correlation after translation operation



Global detector applied to Max Intensity correlation after translation operation



Top: Max Intensity correlation image
Bottom: K-means clustering method associated with sandbanks (combined detection from 4 SAR images)

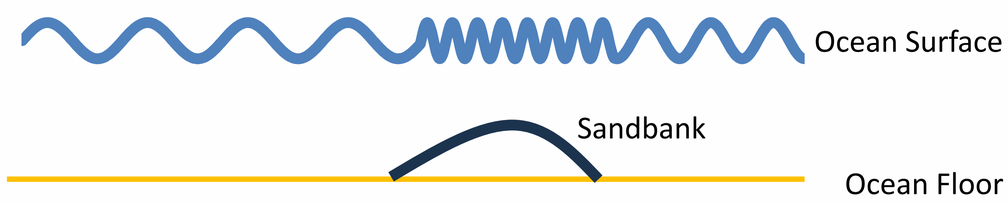


Diagram showing convergence effect enabling imaging of underwater objects

Predicted Impact

By demonstrating that time-series SAR images can be used to identify persistent signatures, similar techniques can be applied to other ocean signatures.

- Enables classification of other ocean signatures by type, such as persistent or transient
- Ship detection can be improved via mitigating false alarms due to these anomalous ocean signatures
- Improved maritime awareness for shipping, environmental monitoring etc.

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