

Document	712220210423
Classification	Unclassified
Status	FINAL
Reference	BathymetryNexus_TN0001
Customer	University of Liverpool
Project	Bathymetry Nexus
Date	2021-04-23
Issue	1.0
Issued by	Dr Cai Bird

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Synoptic 4D coastal monitoring system Technical note

Synoptic radar system overview

The main aim of the Synoptic 4D system is to provide coastal managers, engineers and scientists with a cost effective technology that enables the observation of a wide variety of physical parameters and collect data useful to those working in the dynamic coastal environment.



Figure 1: Synoptic 4D system installed at Crosby as part of the NW regional monitoring programme

Novel data collection and analysis techniques are used to process radar, meteorological and camera data together to produce data over several kilometres; observing changing bathymetry, wave climate, surface currents and weather in a semi-autonomous manner. This allows long time series of data to be collected and analysed, revealing patterns of coastal change and behaviour that are incredibly difficult to reveal with single snapshot surveys.

The system is typically employed by coastal managers who desire the ability to rapidly characterise a large area and collect data to inform models and justify design decisions – however in the case of this project, we pass the raw radar image data to the project Data Nexus for further analysis and integration.

This brief note describes the technical capabilities of the system and highlights its role in the project.

Radar system

The 2.2 m X-band marine radar operates at 9.4 GHz and is extremely well suited to observation of the marine environment. The electromagnetic waves emitted by the antenna have a wavelength of ~3-10 cm, this causes the system to pick up ripples of a similar size on the sea surface very clearly. The system also uses a custom vertically polarised antenna that is more suited to picking up wave crests, than vessels allowing us to better measure wave behaviour and sea surface dynamics. The 15m lighting also hosts a met sensor, AIS (Automatic identification system) verifying ships and 4G antenna for transmitting data back to HQ.



Figure 2: example radar image

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Data products produced

While this system is providing raw data for further analysis in the Data Nexus, it is capable of estimating depths, currents and wave statistics.

The raw radar imagery is produced by the antenna projecting electromagnetic energy at each angle as it rotates, some of that energy is reflected from hard targets in the environment such as ships, seawalls and windfarms, and some from the sea surface itself. The reflected signal is then encoded into a pixel intensity and the data projected onto a Cartesian grid giving a picture that mimics a birds-eye view of the environment.

The system has an instrumented range of 6 km, however the projected radar energy decays rapidly beyond this range resulting in less signal returned to the radar, therefore best results are between 0.05 and 4 km. The raw data used in this project will attempt to apply completely new techniques to the entire dataset and extend the utility of raw data across the whole radar range.

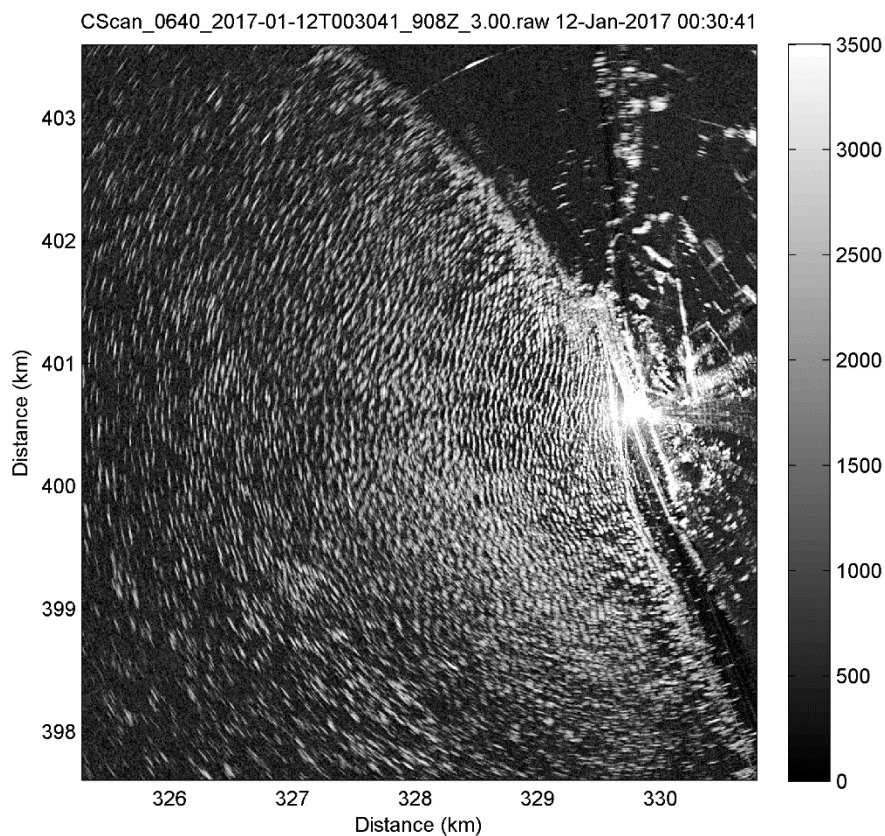


Figure 3: radar imagery example showing land to the East and waves to the West from the system deployed at Crosby

Further to this raw imagery, the system also produces the data products illustrated in the below diagram. These products are being produced for use by the Northwest Regional Monitoring Programme led by Sefton Council, and Peel ports who have co-funded the radar deployments in this project.

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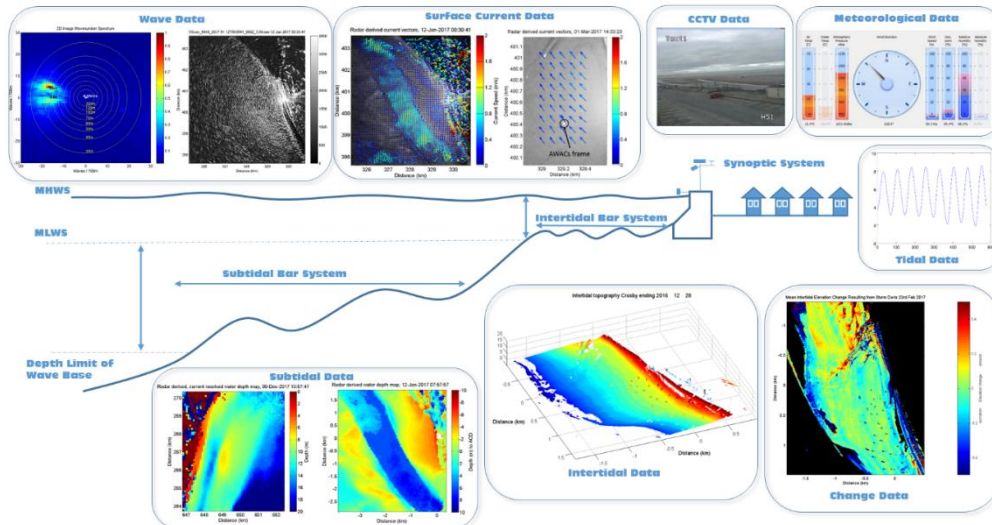


Figure 4: selection of data products produced by the radar: wave data, surface current data, bathymetric maps, cctv, tide, weather and change detection

Installation process

The process to install a system is reasonably simple, assuming local authorities and coastal managers are key stakeholders and engaged in approving the sites. Planning permission is a requirement for these installations and is currently underway for the North Wirral radar installation. A 3x3 m trench is excavated and a concrete foundation poured, with power provision from a local line. Following this the equipment is installed onto a 12 m bespoke steel column, which is then lifted and bolted to the foundations. The base of the column contains the processing and data recording computer and associated network infrastructure to deliver data back to our processing centre.



Figure 5: installation process

The system can then be operated remotely with periodic (8 monthly) maintenance checks. Data is pipelined to the Data Nexus via Marlan HQ in Liverpool. The associated project document BathymetryNexusPR0001 explains how these data are used in more detail.