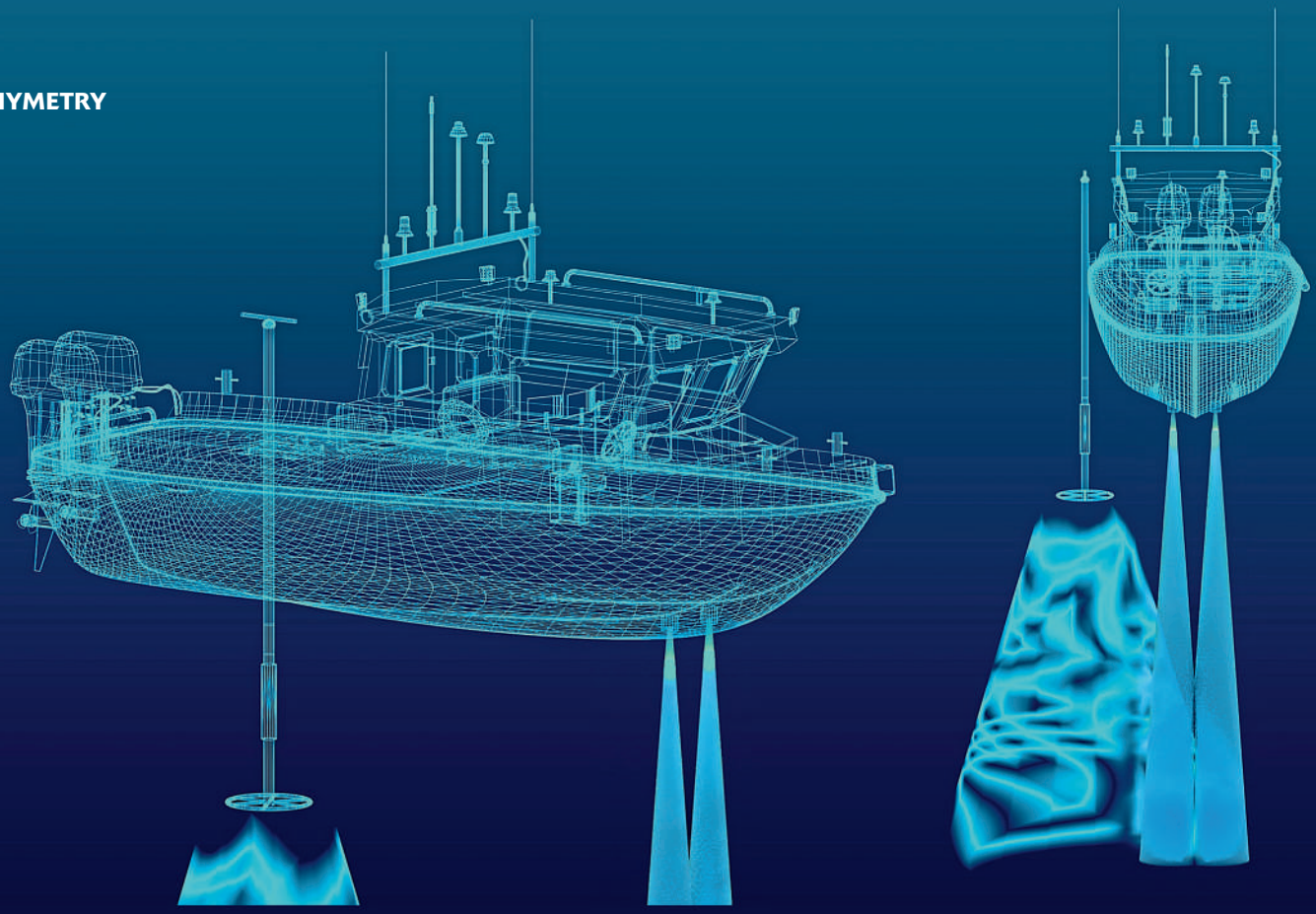


BUILDING AI FOR BATHYMETRY

WHILE MAINSTREAM SYSTEMS SUCH AS CHATGPT MAY STEAL THE HEADLINES, DANNY WEBSDALE BELIEVES THAT THE HIGHLY TECHNICAL PROCESSES OF MEASURING AND MAPPING THE SEAFLOOR ARE BETTER SERVED BY PURPOSE-BUILT, SINGLE-TASK ARTIFICIAL INTELLIGENCES

The news that 25% of the ocean floor has now been mapped was one of the milestones announced by the Nippon Foundation-GEBCO Seabed 2030 Project during this year's International Hydrographic Organization (IHO) Assembly in Monaco. Even so, we still know more about the surface of the moon than our own oceans, and acquiring enough bathymetric data to build a 100% map of them by 2030 demands that marine survey workflows be faster and more efficient.

In other news, the impact of man-made climate change is no longer a problem for the future. It's happening now, so the development of green energy solutions is more critical than ever. Considering that bathymetric data is essential for planning, building, and operating offshore wind farms, this is another major driver for optimising marine survey processes.

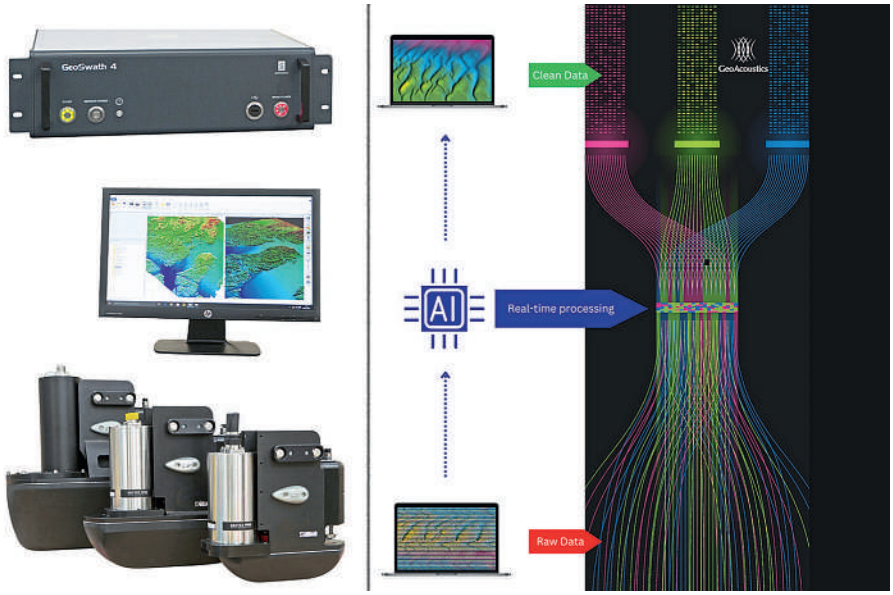
It's in this context, that GeoAcoustics Ltd, a manufacturer of bathymetric sonars for surveying the seafloor, embarked on its mission to enable surveyors to work more efficiently with marine data at sea, and during post processing on dry land. The initial vision to apply AI techniques to expedite the post-processing of data acquired by the company's GeoSwath 4 (GS4) bathymetric sonar was soon expanded to include the delivery of a real-time, quality-controlled live stream of the seafloor direct to the survey vessel.

Knowledge Transfer

With partial funding from Innovate UK, GeoAcoustics Ltd turned to specialists at the University of East Anglia to help develop and integrate the AI system. Following an initial six-month research project, an official Knowledge Transfer Partnership (KTP) project kicked off in April 2021 with its initial focus on finding the right type of AI technology to apply to the GeoSwath software. It soon became clear that only a purpose-built solution could deal with the complexities of the bathymetric data produced by the GeoSwath 4 sonar.

The customised development approach would also give the team improved scope to produce a software solution that would operate without needing to upgrade existing on-board hardware, or depend on the use of Cloud-based computing power which, when considering the high latency issues and cost of satellite connectivity at sea, would be unable to meet the real-time performance capabilities the team demanded.

This meant that the AI had to be self-contained within the GeoSwath 4 control unit, together with its ability to process data in milliseconds across highly diverse seabed environments and water depths. As the system was intended as a software-only update, the team also had to develop for all versions of GeoSwath 4 units in the field, allowing both current and future users to utilise and benefit from its use.



Pictured left: Key elements of the GeoSwath 4 (GS4) system include the deck unit (top), GS4 software display (centre), and transducers in 125kHz, 250 kHz and 500 kHz configurations (lower). The system is also available with a module for USVs, as a ruggedised portable deck unit, and as a Portable Hydrographic System (PHS). Pictured right: The GS4 software (v1.0.25) introduced a unique hands-free AI data processing system for live streaming of the seafloor and improved quality control

To frame the scale of the challenge, the GeoSwath 4 sonar at maximum range produces up to 22,000 data points (returns) per ping – the hydroacoustic signal produced by the transducer head to measure the water depth between it and the seafloor – with the number of data returns and pings per second (maximum of 30 pps) depending on the water depth and therefore range, and the frequency of the sonar.

In typical usage with simultaneous port and starboard pinging the AI must be able to process over 83,000 returns every second of a survey across the full GeoSwath product pipeline, in order to produce quality-controlled data that can also form the basis of a live stream of the seafloor aboard the survey vessel.

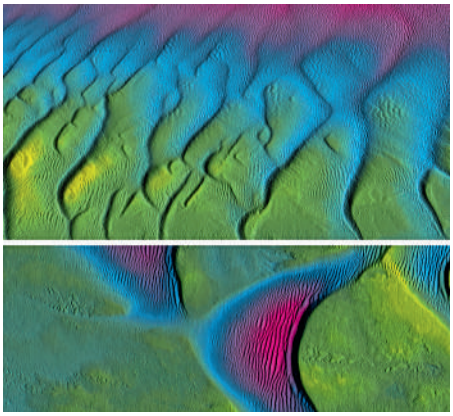
Real-time data

The live stream provides a sonar-dependent quality-controlled track view that marine surveyors can use to better follow the progress of their survey and make informed decisions about the next survey lines based on the data presented. The advantage is in their newfound ability to ensure that the survey will likely produce a complete and validated data set as any anomalies or missed areas can be addressed straight away. Formal validation requires additional sensor information not available in real-time and must be performed post-survey.

Without knowing the quality or coverage completeness of the data acquired, a second survey may need to be commissioned, which essentially doubles the cost of the data collected, and can add weeks to the project while tying up valuable resources at the marine survey company and causing delays in the construction or dredging projects for which the data is needed. Considering the number of moving parts in an offshore wind farm development project or any other marine construction, the extra costs and knock-on delays can be problematic for all stakeholders.

The AI system helps to speed up the entire bathymetric data acquisition workflow and avoid these issues as it is designed to look for exactly what a human would look for in the raw data – which is essentially any returns that do not make up part of the seabed or environment. These data points, often referred to as 'outliers', are unwanted noise usually recorded in the water column prior to seabed detection (i.e., before reaching the seabed depth).

The system had to be designed to recognise both the location and nature of the noise and seabed, so that the live stream and saved data is as clean as possible. This in turn means that the system needs context in which to process each ping, which is one of the reasons that the AI solution had to be developed from scratch. Insight on the technical processes came from the GeoAcoustic team, while the university team focused on the AI itself and the challenge of integrating it within the GeoSwath 4 software.



Examples from AI trials conducted in the North Sea off Lowestoft by specialists from the University of East Anglia and GeoAcoustics. Top: a section of a 780m X 380m grid of the Stanford Channel acquired with GS4 showing sand waves between 0.08m and 4m in height. Lower: Sample from a calibration area 190m x 550m east of Holm Sand (50cm resolution)

Autonomous intelligence

GeoSwath 4's new AI data-processing capabilities have been field tested in diverse environments and applications globally over the last 18 months, with results confirming new levels of performance and onboard data quality that would be challenging to achieve in real-time using standard bathymetric echosounder technology. Further, users are reporting significant time savings during post processing, which helps them to deliver data faster and make more use of their internal resources. The quality of the data can be seen easily in the images produced of a survey of the sandbank off Lowestoft in the UK, which took place in December 2022.

It's clear that the new AI solution for GeoSwath 4 won't be single-handedly responsible for enabling the Seabed 2030 project to reach its goals, or for unlocking the huge amounts of bathymetric data that the growth in offshore wind demands. However, it is certainly an innovation that helps to streamline the acquisition of ocean data, making the entire workflow much faster and more cost-effective.

These benefits can be compounded when applying the AI-enabled GeoSwath 4 to autonomous survey platforms. While Unmanned Surface Vessels and Autonomous Underwater Vehicles don't require the same visualisation as a human operator, piping the real-time data into the AI controller delivers new levels of situational awareness. Essentially, when receiving AI-processed data from GeoSwath 4, an AI-powered survey platform can make the same decisions as that of a human operator following the live stream.

Autonomous platforms are already capable of outperforming crewed vessels in the task of marine data acquisition but adding an extra layer of AI from the bathymetric sonar will unlock even more efficiency. Ultimately, this will help us to map more of the ocean floor, build solutions to tackle climate change, and just as importantly, deliver a buoyant and sustainable marine survey industry.

Danny Websdale was the Knowledge Transfer Partnership Senior Research Associate at University of East Anglia for the duration of the AI development project and is now an AI/ML Research Scientist at GeoAcoustics Ltd based in Great Yarmouth, Norfolk (www.geoacoustics.com)