The Challenges of Shallow Water Hydrographic Surveying

Surveying Britain's 2000 miles of inland waterways is specialised work. Kate Rowlatt and John Williams show how a new compact custom system aboard a bespoke survey vessel is capturing cleaner data even under difficult conditions.

Hydrographic surveying on inland waters can often be extremely challenging as there may be many risks to both personnel and equipment or perhaps factors which compromise the survey methodology resulting in poor data quality. Risks may come from ultra-shallow regions where the survey vessel and/or equipment may touch the riverbed; fast flowing currents in and around weirs, dams and intakes or, as seen more recently, due to flooded regions where submerged debris may be deemed too hazardous to survey. Other environmental factors such as poor GNSS positioning around bridges and under tree canopies; high turbid waters, fluid mud or even bubbles in the water downstream of weirs may all have a significant impact on data quality. The solution is therefore to try and mitigate these effects by using correct survey methodologies with proven equipment.

Evolving Technology to Meet New Demands

The Canal & River Trust (C&RT) manages and cares for over two thousand miles of canal and river navigations. With a variety of users from pleasure boaters, through commercial craft to the needs of the environment and aquatic life, it is sometimes hard to meet everyone's expectations. In 2007, C&RT's predecessor, British Waterways, adopted the strategy that every kilometre of the waterway would be surveyed on a cyclical basis rather than when required.

To address this challenge, the C&RT had to come up with more efficient and reliable methods for surveying its inland waterway system. Single beam echo sounding evolved into a system using four single beam echo-sounders rigged onto contractible booms, allowing four run-lines to be surveyed in one pass linked to four individual data loggers, and with position offsets applied to each run-line of data.

In 2003, a new system called GeoScan was launched which used a Tritech Super SeaKing dual-frequency profiler linked to a vector hemisphere GPS and MDL micro tilt sensing. The profiler incorporated a mechanically rotating head with varying scan step intervals so that data could be captured to meet the required survey needs. This changed the output of data from four longitudinal run-lines to cross-sectional data captured every 6-7m along the navigation route.

In 2014, a group was established within the Trust to review dredging and survey techniques. As part of this process, a new multi-beam sonar system was deemed necessary to further improve the data collection process. Instead of single or multiple run-lines, where cross-sectional data could then be extracted, the multi-beam sonar could offer a swathe of 256 soundings with a very high repetition rate at a user-selectable frequency. This would provide very high-resolution data along both the vessel route as well as across the width of the canal covering significantly larger areas in less time than previous systems. The continuous 'picture' of the river bed would give the Trust greater confidence in the condition of the navigation channel and detail exactly where dredge activities would need to be performed. Additional changes to the presentation of data were also required so that information could be accessed via survey drawings, cross-sectional data, spreadsheets and GIS, which will all be managed internally through the Trust's hydrographic survey team.

Customised MBES

C&RT decided to procure from Swathe Services a dual-head R2SONIC SONIC 2020 multi-beam (MBES) Sonar with Integrated Inertial Navigation System (INS). This MBES system was installed on a new vessel for ultra-shallow survey operations and met all of the C&RT criteria.

The SONIC 2020 is a small compact MBES and offers a range of operating frequencies from 200 to 400 kHz; variable swathe

sector from 10 to 130 degrees; 256 beams with a NADIR beam size of 2 × 2 degrees at 400kHz; 1.25cm range resolution from 60 kHz signal bandwidth and simultaneously bathymetry, backscatter and water column data acquisition capability. When operated in the dual-head configuration up to 60Hz of simultaneous pinging can be achieved, ensuring extremely high along - and across-track resolution. The integrated INS, which is an Applanix WaveMaster OEM component, provides accurate position, heading, heave, pitch and roll data and is combined with the sonar data using the HYPACK/HYSWEEP data acquisition and post-processing software. A Valeport MiniSVS is also used to measure changes in speed of sound which may vary due to temperature and salinity or in some cases may also be due to turbidity variations. This equipment was installed on the new bespoke designed survey vessel.

The installation of the MBES was of paramount importance to ensure the widest swathe widths whilst maintaining operational efficiency and at the same time protecting the equipment from any submerged debris. To achieve this, the C&RT survey team designed a bespoke moon pool mount for the dual-head sonar and INS sensor in the centre of the vessel. The sonars' heads were mounted at 30-degree angles to ensure minimal overlap whilst maximising swathe width. The INS was mounted directly over one of the sonar heads so that accurate motion values could be observed.

Cleaner Data

This installation was both rigid and repeatable, reducing the need to re-calibrate the system for every survey, and with clean MBES data obtained during acquisition, this has reduced lengthy manual cleaning experienced with the previous profile scanning sonar. Consequently, the 'ping to chart' time has been reduced by a considerable margin allowing for much greater efficiency within the survey department.

Initial data acquisition has shown bank-to-bank capability with high across-track resolution and much greater along-track resolution highlighting features on the canal bed that have not been seen before.

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