Coda Octopus
Sound Underwater Intelligence

Validation of Echoscope® Data for IHO S-44 Quality Surveys

Executive Summary

A study was carried out to assess the capabilities of the Echoscope real time 3D sonar as a bathymetric survey tool with respect to the data quality specifications as set out in International Hydrographic Organisation's (IHO) S-44 standard. Creating a benchmark was achieved by conducting a high quality multibeam scan, and then computing the estimated error bounds of where the true seabed surface actually lay, within established realms of probability. The Echoscope data was then compared with these benchmark levels to establish whether enough data met the varying orders of tolerance described by the IHO S-44 specification, and thereby qualify as having met the order of the standard. The study found that under the conditions of typical Echoscope deployments, it is possible to achieve IHO Special Order quality surveys in real-time, with no post-processing of the point clouds subject to using the Echoscope and its capabilities properly.

The study also found that general precision of the Echoscope® data, once post-processed, is comparable to that of multibeam surveys, in real-world applications with global environmental, navigation and calibration uncertainties prevalent throughout.

Methodology

A high-end widely adopted 400kHz multibeam echosounder was used, together with a Coda Octopus F180® INS with RTK corrections, real-time speed of sound probe and tidal correction data to collect the reference data. The multibeam had a patch test performed before collecting survey data to determine offset corrections. This data was processed in Hypack using the CUBE algorithm with appropriate TPU Editor parameters to a CUBE grid of 25cm resolution. Alternative feature hypothesis were edited to select correct levels to cap the uncertainty at 0.25cm. The 95% confidence levels around the best estimate surface were then used to derive upper and lower bound best-estimate surfaces.

The S-44 specification requires data to be within the TVU limits with a probability of 95%. Therefore, if 95% of any Echoscope data is within the TVU limit from a reference surface, then it meets the specification. If this check is performed on both the upper and lower bounds of the best-estimate surface, and passes both, then it meets the specification that TVU limit refers to. The Echoscope® data was collected for both 375kHz, 50°x24° swath, -82.5° tilt (Setup A) and 700kHz, 20°x20° swath, -82.5° tilt (Setup B). Within CodaOctopus Underwater Survey Explorer (USE) software, patch tests, speed of sound and tidal corrections were also performed on this data, similar to the multibeam data. The data was then exported as both raw XYZ values (full pointcloud data) and binned XYZ values using the binnedXYBinnedZ algorithm available in USE.

Data Analysis

The Echoscope point cloud data was analysed to find the closest XY cell of the reference surface for each of the test points. The difference in the Z values was then computed for each Echoscope point with respect to the chosen reference surface.

These 'delta-Z's were then used to identify all points which showed a difference less than the S-44 TVU limits and their percentages calculated. Any pass rate lower than 95% meant the Echoscope data failed that particular specification.

Echoscope test data (full XYZ point clouds)	Upper Bound Ref. Surface			Lower bound ref. surface		
	Special	**Order 1**	**Order 2**	**Special**	**Order 1**	**Order 2**
Setup A	99.86	100.00	100.00	99.99	100.00	100.00
Setup B	99.99	100.00	100.00	100.00	100.00	100.00

Echoscope test data (binned xyz point clouds)	Upper bound ref. surface			Lower bound ref. surface		
	Special	**Order 1**	**Order 2**	**Special**	**Order 1**	**Order 2**
Setup A	99.99	100.00	100.00	100.00	100.00	100.00
Setup B	100.00	100.00	100.00	100.00	100.00	100.00

These tables show that both setups comfortably meet the Special Order criteria for TVU.

Conclusions

The Echoscope has been shown to be capable of comfortably achieving bathymetric survey data that meets the various orders of IHO S-44 standard under what can be regarded as typical survey conditions. In terms of meeting the highest of these orders (Special Order), simple post processing steps (available with the Echoscope software) will greatly increase the likelihood that data meets this standard. Unprocessed, real-time raw data will likely also produce Special Order quality data but the Echoscope.

Although the Echoscope is often primarily used for real-time visualization work – since it produces real-time 3D images – its bottom detection algorithms do not assume a single height per XY position. The sonar therefore is not designed exclusively as a multibeam device, but nonetheless can be used as a bathymetric tool. This report has demonstrated that the Echoscope can be used to perform standard mapping to IHO specification, in a similar manner to a conventional multibeam sonar.