EdgeTech Multi Phase Echo Sounder Technology

This document is designed to provide an overview of the background and the theory of operation of, the EdgeTech Multi Phase Echo Sounder (MPES) technology.

Background

Surveys in shallow water are typically inefficient and costly due to the design of legacy instruments. This inefficiency has led manufacturers to explore new innovations in Swath Bathymetry Systems. Historically swath bathymetry systems have been firmly placed into one of two groups: Phase Discrimination Bathymetric Sonars (PDBS), which are based solely on interferometric techniques, and Multi Beam Echo Sounders (MBES) that utilize beamforming techniques. However, over time this distinction has become more blurred. For example, today's MBES use amplitude detection in the beams closer to nadir and switch to using phase measurements in the outer beams in order to achieve soundings across a wider swath than would be possible by using just amplitude detection.

Furthermore, MBES systems are used on many survey platforms around the world because they are accurate and fairly simple to use but are limited in angle or area coverage in shallow water. PDBS systems, on the other hand, provide wide swath coverage in shallow water (depth less than 35m), but have a blind spot right under the unit, thereby eliminating the efficiency gained by this technique.

EdgeTech's unique MPES or hybrid approach, however, takes the benefits of both technologies while overcoming the limitations of each. This MPES technology is what forms the basis for all EdgeTech bathymetry products such as the pole mounted 6205 and AUV/ROV 2205 systems.

Theory

Traditional interferometric systems, or PDBS systems, use 3 non-uniformly spaced elements to infer one phase estimate of the echo samples from each side. This method is susceptible to multi path and inherently makes the data quite noisy. Conversely, EdgeTech's MPES technology uses 10 elements to derive up to 9 phase difference measurements per side. These multiple phase measurements provide several benefits when resolving for the seafloor soundings. First, the increased channel count provides additional information to derive mean and standard deviations for each sample in order to statistically filter out the dual echo (or multi-path) contaminated samples. This approach is analogous to the statistical processes used by beamforming systems to derive the result for each beam, and has similar benefits in terms of making the data much cleaner and more accurate.

Second, the high channel count in each transducer allows some beamforming (like traditional MBES systems) to take place to help focus the energy at nadir to create a denser data set in this region. EdgeTech's MPES is the very first of its kind to produce clean, wide swath coverage (out to 12x water depth) while maintaining real acoustic data at nadir with a data density that remains almost constant from nadir to the outer swath.

Finally, traditional bathymetric systems receive the side scan or backscatter data from one of their relatively short receive elements used to infer the bathymetry data. This short receiver naturally has a very wide beam, thus producing very poor resolution imagery. In response to this, EdgeTech pushed the boundaries even further with its next generation MPES transducer design, which includes dedicated full length transmit and receive channels for both high and low frequencies to enable the user to collect ultra-high resolution and accurately geo-referenced side scan imagery without interference or loss of resolution. This additional piece of information is crucial for shallow water surveys as it can mean the difference between cleaning the data such as water column noise, and retaining a real object.

System Performance

To demonstrate the overall system performance of EdgeTech's MPES technology as a function of water depth, the 95% confidence level acquired by an EdgeTech 6205 is plotted in Figure 1. The solid blue line is fitted to these values for visualization purposes and the Total Vertical Uncertainty (TVU) for International Hydrographic Organization (IHO) Special Order surveys is shown by the flat red horizontal line marked "IHO Special Order".

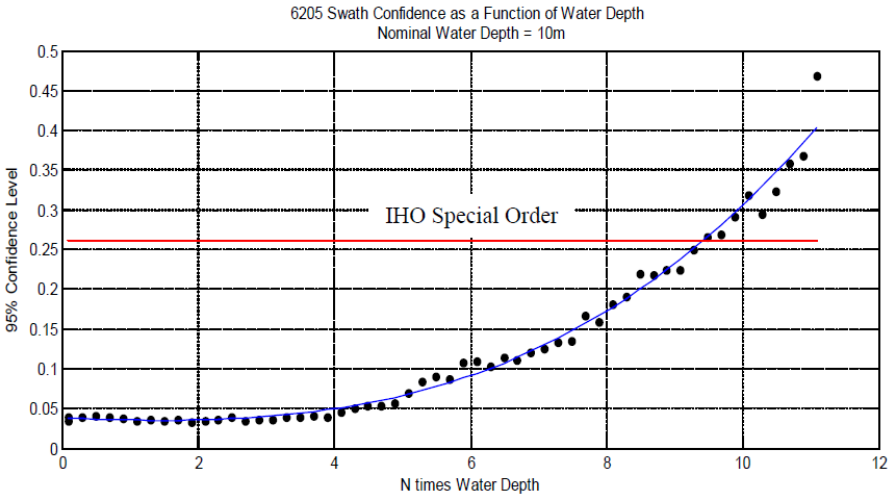

Figure 1: EdgeTech 6205 swath confidence as a function of water depth for a nominal water depth of 10m. IHO Special Order standard is indicated by the red line and equals 25.4cm for this particular water depth.

Based on the above plot it can be said that the EdgeTech 6205 produces IHO Special Order quality data out to approximately 9.5 times water depth.

Benefits

There are several benefits to using the MPES approach. These can be summarized as follows:

- High accuracy/wide swath coverage, particularly in shallow water (depth less than 35m)
  - IHO SP-44 Special Order compliance with proven results
  - Data density maintained from nadir to the outer swath
- Maintains spatial resolution across the entire swath width
  - Equidistant and equiangular "pseudo-beam" output options
- Clean data sets that require minimal post-processing
  - Surface reflection and multipath suppression
- Single deployment to collect co-registered and simultaneous dual-frequency side scan and bathymetry
  - Eliminates the need for further site visits
  - Full resolution side scan aids feature detection and data interpretation
  - Simpler and less time consuming post processing workflow

Further Reading

[1] Brisson, Lisa and Wolfe, Damon. "Performance Analysis of the EdgeTech 6205 Swath Bathymetric Sonar."
http://www.edgetech.com/wp-content/uploads/2013/09/Performance-Analysis-of-the-EdgeTech-6205-Swath-Bathymetric-Sonar.pdf

[2] Brisson, Wolfe, and Staley. "Interferometric Swath Bathymetry for Large Scale Shallow Water Hydrographic Surveys".
http://www.edgetech.com/wp-content/uploads/2014/06/EdgeTech-Paper-on-6205-presented-at-CHC2014.pdf