Real-Time 3D Sonar Visualization Benefits

by Angus McFadzean

Coastal development for new infrastructure, such as breakwaters, presents a challenging construction endeavour, typically involving sonar coastal surveys before and after construction, together with monitoring and analysis of the construction during development. Conventionally the pre- and post-construction sonar surveys employ multibeam sonars, while the monitoring and analysis employs various techniques such as using divers and other positioning and attitude sensors.

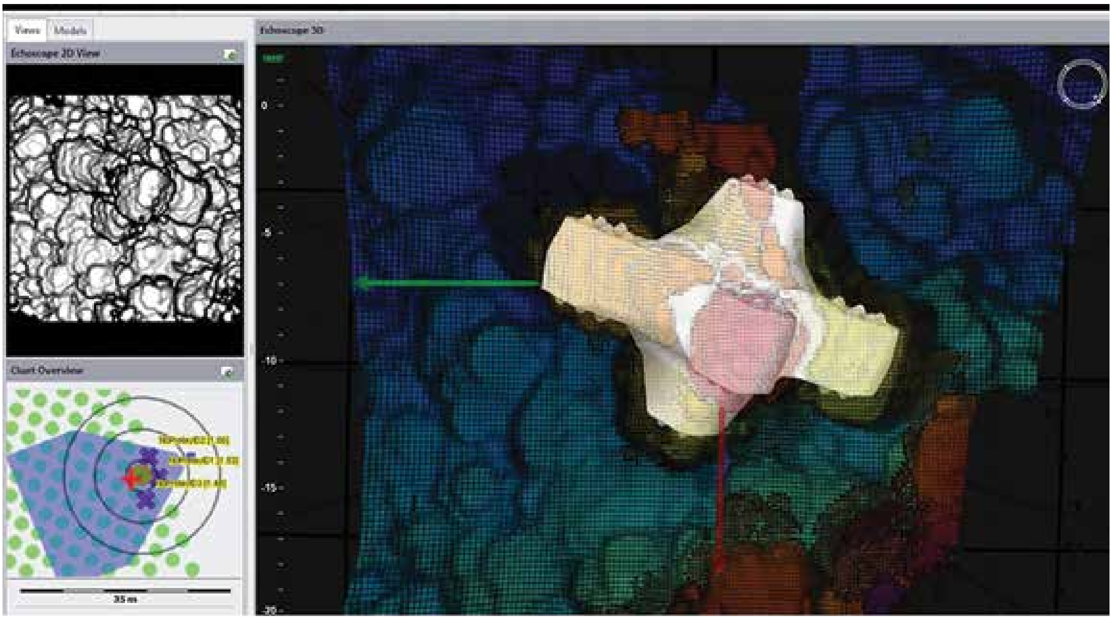
Modern breakwater construction exploits a single layer of shaped, interlocking, large concrete blocks that create a strong defence against severe sea conditions. Typical projects will require thousands of blocks which must be precisely placed to achieve the appropriate block density and interconnectedness to ensure that the blocks will never be displaced. This requires some form of monitoring and analysis during construction. Underwater video cameras are not an option since construction and prevailing weather stir up silt, making visibility very poor, if not impossible. The necessity of using different sensors for different parts of the process also makes the development more complex and costly, while the construction phase introduces safety concerns where divers and large concrete blocks are operating in close vicinity.

The issues with these conventional sensors and techniques can be overcome by employing a real-time 3D sonar. Real-time 3D sonars produce thousands of sonar beams for every ping. The beams are spread over a 2D area centred around the sonar's viewing direction. Combining each beam's detected range thereby creates a complete 3D image on each and every ping – hence the term real-time. For example, the Coda Octopus patented Echoscope® produces more than 16,000 beams over a typical 50° wide by 50° high field of view (other fields of view are available). With ping rates as high as 20 Hz, even moving objects can therefore be clearly visualized with real-time 3D sonars.

Real-time 3D sonars thereby enable the pre- and post-construction surveys and the construction monitoring/analysis all to be achieved with the same sonar, providing significant return on investment for the user. For the pre- and post-construction surveys, the 3D sonar will give very accurate results since the sonar launches beams at many more angles and has much greater beam density and overlap than a traditional multibeam. In particular, for the post-construction survey, this results in less shadowed areas within the complex geometry of the numerous interlocking blocks.

For the monitoring and analysis phase, the real-time 3D sonar can visualize the blocks, in low or zero-visibility, thereby allowing faster and more accurate block placement. In addition, the visibility afforded by using real-time 3D sonars avoids or minimizes the need for diver intervention, considerably enhancing construction safety. Use of real-time 3D sonars has been shown to speed up block placement by 5,000% over traditional techniques. Field users have reported moving from laying four blocks to 200 blocks per day, partly due to this technology allowing 24 hours operations.

During the construction phase, real-time 3D sonars can simply be used for visualization – attached to either crawler cranes or excavators



CMS software showing real-time 3D sonar data, tracked block, and already laid blocks.

– as best suited for the site. However, with the addition of appropriate GPS and motion sensors, fully geo-referenced 3D data are available from the sonar. With appropriate software, such as the Coda Octopus Construction Monitoring System (CMS), this can be used to aid block placements by presenting target-like information to the crane operator for each unique block position, aiding placement and further speeding up operations.

The availability of geo-referenced real-time sonar data allows additional benefits to be achieved. With sophisticated software, such as CMS, it is possible to track the orientation of the block from the sonar data. This allows the visualization software to show a graphical 3D model representation of the block instead of, or in addition to, the sonar data, aiding the crane operator's understanding of the viewed scene and enhancing situational awareness. However, it also allows the exact position and orientation of each block to be recorded at the instant the block is laid. This allows a complete 3D model of all laid blocks to be constructed for further analysis or reporting. Additionally, tracking can be used to update positions of any blocks that move subsequent to their initial placement. It is not uncommon that when placing one block it can knock and move an already placed neighbouring block. Tracking software can be used to "lock" onto any moved blocks to re-establish its new position and orientation and thereby update the database of laid blocks.

Real-time 3D sonars have therefore been shown to increase performance, improve safety for breakwater construction, provide evidence for audit purposes, and overall deliver better quality control of such constructions. However, they also give efficiency benefits with dual use in the pre- and post-construction, together with the visualization, tracking and analysis during the construction phase. With the many advantages gained from using real-time 3D sonars, their use for this type of project is now widely employed.

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