NEAR VIDEO-QUALITY IMAGES FROM ACOUSTIC SYSTEMS

Object Identification in Turbid Water

Working underwater requires visual feedback to prevent work slowing or even coming to a halt. Acoustic systems make images in turbid water, but not always with the required detail provided by optical systems. This article reviews technology that provides near-optical-quality acoustic images, allowing work to continue in zero-visibility water.

Problem Overview
A significant amount of underwater work takes place in seas, rivers and coastal areas where visibility is minimal and optical systems generate blank screens. Conventional sonar provides images under these conditions, but the detail generally does not come close to the optical detail needed for identification, inspection and manipulation of objects. In turbid water, divers are required to descend onto located structures or objects and use their hands to identify them by tactile examination. Divers also are required to work Ã¢â‚¬Ëœby BrailleÃ¢â‚¬â„¢ in turbid environments when operators of submersibles cannot get the required visual feedback.

Acoustic Lens
A new breed of sonar uses acoustic lenses that use sound to form near-video-quality imagery. Like light waves, sound waves refract and can be focused with an acoustic lens system as light is focused through an optical lens. The result is an acoustic image containing great detail. The acoustic camera bridges the gap between medical ultrasound, which images the fingers of a foetus at a range of 10cm, and conventional sonar that images a shipwreck at 300 metres. The acoustic camera focuses like an optical camera by moving one of the lens elements. Acoustic cameras operate using a combination of high frequencies, acoustic lenses and very narrow beams, to increase image detail. The operating frequencies range up to 3MHz. High-frequency sound is more quickly absorbed in water than is low-frequency sound, and thus the range of these high-frequency acoustic cameras is limited to ~40 metres when operating at 1.1MHz and ~15 metres when operating at 1.8MHz.

The only commercially available acoustic camera is DIDSON (Dual-Frequency Identification Sonar). The standard system focuses from as close as 1 metre out to its maximum range of 40 metres. This acoustic camera has a 29-degree field of view and needs either to be fixed on a mount that pans, or the operator needs to pan by turning the ROV to cover a larger field of view. Due to the systemÃ¢â‚¬â„¢s limited range and field of view, some users call it an Ã¢â‚¬Ëœacoustic flashlightÃ¢â‚¬â„¢. The DIDSON is a good identification tool, but not a good search tool. In searching a large area, a start needs to be made using side-scan sonar to locate several targets of interest. An acoustic camera may then be used for positive identification. Having an acoustic camera in oneÃ¢â‚¬â„¢s arsenal can make a significant difference, as noted in the following examples.

Search Effort
Tyco Telecommunications (US) Inc assisted the Baltimore City Fire Department in locating three victims of the tragic water-taxi accident in March 2004 (Submarine Telecoms Forum, 14th May 2004). During the first twenty-four hours of the recovery operation an ROV was manoeuvred along the 20-metre-deep harbour bottom and conventional sonar used to detect objects of approximate size and shape of the victims. Divers had to investigate targets that could not be ruled out with the sonar. With hundreds of potential targets on the bottom of the harbour, a miracle was required to find the victims.

The head submersible engineer at Tyco, Phil Walker, had heard of the acoustic camera and requested one for the search effort. The next day they had the system integrated on the ROV. With near-video-quality images, debris was eliminated and the potential targets moved through much faster, with resulting positive identification of each of the three missing victims. The acoustic camera focused on a victim, the ROV was positioned about a metre away on the seabed with its umbilical serving as a down-line for Fire Department divers. This technique reduced dive time to a minimum and greatly assisted the divers, who were working in extremely cold and dark waters.

Potential Use
King County, Washington State, Department of Transportation is testing an acoustic camera for two purposes. The D.O.T. needs to build a bridge across a river and wants to use techniques that minimise disturbing nearby aquatic life. It plans to employ the acoustic camera to monitor fish behaviour during pile-driving operations so that differing construction methods may be correlated with resultant fish behaviour. The D.O.T. is also investigating using the camera for inspection work after completed stages of the job.

Sample Images
The following examples show a variety of acoustic images taken in varied applications. All are Ã¢â‚¬ËœstillsÃ¢â‚¬â„¢ (single-frame

snapshots) of a Ã¢â‚¬Ëœfilm Ã¢â‚¬â„¢ recorded at the site. A film is useful for monitoring movement of objects within the field of view, or for getting an undistorted full image as the sonar platform moves.

Concluding Remarks

Acoustic cameras provide sufficient detail to identify objects in turbid water, and obviate the need to send down a diver when optical systems prove ineffective. The initial users were in harbour-security and in fisheries management. An emergent application for the system is within the oil & gas industry, where it is used for inspection, feedback on work in turbid water, and generation of images for clients to allow them to sign off work correctly carried out under low-visibility conditions.

https://www.hydro-international.com/content/article/object-identification-in-turbid-water