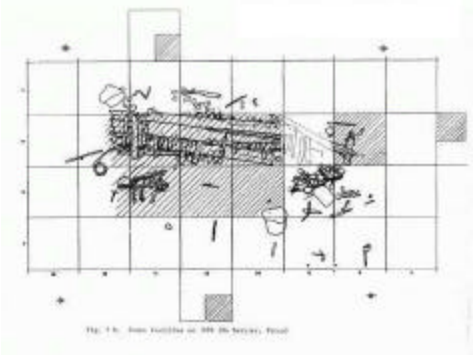
Acoustic Positioning for Mapping of Underwater Archaeological Sites

Abstract

Mapping of subsea archaeological sites is critical in determining what has actually been found, and to allow the investigators to return repeatedly to the same location. The process for creating subsea maps is currently cumbersome, time consuming, and inaccurate. New technology, developed by SonicWorks, Inc., of Portsmouth, Rhode Island (USA), enables the underwater archaeological team to quickly and accurately map any sized area of the sea floor, tag and record the position of particular areas of interest,, and produce a three dimensional visualization of the site.

Current Technology

Mapping of underwater archaeological sites today involves a variety of technologies, the most basic being the use of a rope or PVC piping grid, overlaid on the area to be mapped; measurements are then made manually, notes taken, then painstakingly transcribed to a hand- or computer-drawn map of the area. This "technology" is, of course, subject to errors of measurement and movement of the physical grid. Similar in practice to the mapping of terrestrial sites, this method is much more difficult when attempted in an underwater environment due to the limitations of mobility and visibility inherent in the ocean. It severely limits the ability of divers to move around within the area; the grid itself limiting mobility. It also has the drawback of not providing a means of letting the diver return to the same location previously investigated without an intimate knowledge of the dive site and the experience of the diver in that particular site.



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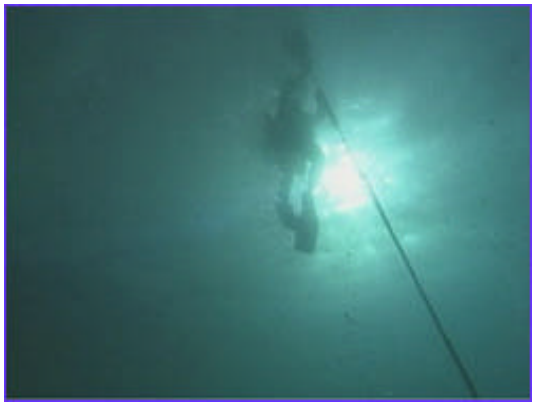
Newer methods of mapping have recently been employed that use more modern and more accurate technologies. One such system, described by Colin Clement in a paper for the NOVA Online Website, used a combination of Electronic Distance Measurement, GPS, and vertical tethers between items of interest on the bottom and floating reflectors on the surface to develop a database of marked locations, allowing a computer generated map to be produced. This method is really no more precise than the physical grid technique (an accuracy of from four to 12 inches), and is extremely labor intensive, requiring the use of at least two divers in the water and personnel in a boat as well as on shore; it also requires the measurements to be taken under very calm conditions so that the lines, buoys, boats, reflectors, etc. don't move while measurements are taken.

Diver attaching lead line.

Diver stretching measuring tape.



Diver holding mapping line steady at surface.

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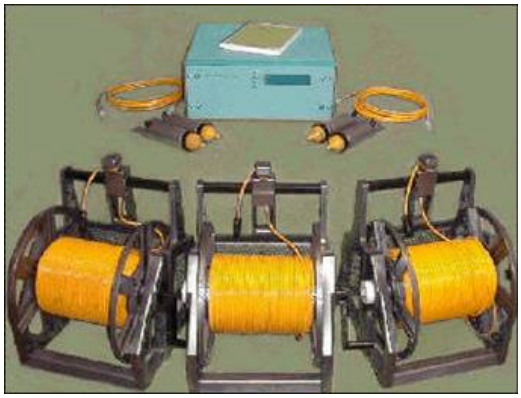
More recently, acoustic position systems have been employed to map sites in conjunction with divers and Robotic Underwater Vehicles (ROVs) or Autonomous Underwater Vehicles (AUVs). While certainly easier to employ than the methods described above, these systems suffer from two basic and severe limitations: calibration time and accuracy. The acoustic position systems available to date typically require days to calibrate properly, and even then are capable of resolutions of no better than one-half meter (many much worse). While this may be acceptable for large area sea floor mapping, it is useless for small scale mapping of shipwrecks or submerged ruins of structures formerly on dry land. This method also suffers from the limitations of needing to be close to shore and in shallow waters.

The SonicWorks™ APNS™ Solution

The SonicWorks™ APNS™ is a new, short to long baseline, acoustic positioning system which, utilizing a combination of frequency hopping, digital signal processing, and power control technologies, attains a position resolution of ±1 cm, and produces repeatable, accurate measurements of any sized area of the sea floor. The Windows™ based system consists of a control computer, at least four cabled or wireless transceivers placed on the seabed around the area to be mapped (depending on the size of the area), a hand-held cursor for a diver to mark locations with, and/or an ROV module to track an underwater vehicle. Deployable from a small boat, the system is capable of operation in waters up to 1000 feet or more in depth, with no need to be close to shore.



Operation of the APNS™ is simple and straightforward. The transceivers are deployed around the area to be mapped, and connected to the controller. A calibration routine is run, which takes three minutes or less to complete; this process establishes a "net", or coordinate system of the area. A diver, using the hand held cursor, can then mark any number of locations, which are recorded into a database and include three-dimensional position information for each location. Objects on the sea bed can be traced with the Diver Cursor to provide a precise record of the object's location, size, dimensions, etc. Annotation software in the controller allows an operator to include information about each location such as description, photograph, or video taken simultaneously, which is saved in the same database. A virtual-reality component is then able to process the database information, rendering a 3D representation of the area

mapped. Other information, such as computer generated drawings, can be overlaid on this image, allowing a sophisticated representation of the site.

Coordinates and annotations of any location can be retrieved at any time from the system, allowing the diver to return to a precise location as necessary, regardless of the visibility in the water. Because the system is self-calibrating, placement of the transceivers is not critical, and not subject to errors caused by currents.

The APNS™ utilizes, as described above, at least four transceivers to establish a "net", within which is contained the area to be mapped or cataloged. In typical application, the transceivers are placed roughly 75 to a 100 meters apart, resulting in a net covering an area larger than an acre. Additional transceivers can be added, allowing larger areas to be covered, or allowing known obstructions or geologic formations to be compensated for. Each controller accommodates up to twelve transceivers, plus multiple ROV modules and Diver Cursors; in addition, multiple controllers can be networked to provide coverage of very large areas.

The APNS™ is deployable on any existing ROV to provide accurate, repeatable positioning data. Motion compensation capability and continuous auto-calibration provide for long-term precision in practically any sea state, allowing for work to proceed over an extended period without any downtime for re-alignment or recalibration of the equipment.

All together, the features and capabilities of the SonicWorks™ APNS™ provide the user with an extremely cost-effective, highly accurate solution to the problem of mapping underwater archeological sites in any location, depth, or sea state.

SonicWorks, Inc., founded in 1996, has long been involved in the design and construction of position systems, ROVs, and related systems for a variety of applications. The APNS™ is the fourth-generation iteration of technologies developed by SonicWorks designed for "off the shelf" configuration and deployment in any situation. SonicWorks, Inc. works with the user on application-specific requirements such as integration with existing ROVs, data processing and interpretation, and integration with database CAD/GIS systems.

Further information may be obtained by contacting SonicWorks, Inc., 1 Maritime Drive, Portsmouth, RI 02871. Our phone number is (401) 682-2073; our email address is sales@sonicworks.com.

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