Applications of Remote Sensing in the Archaeology of the Mediterranean Basin

Summary

Remote Sensing is an extraordinary tool for studying the underwater archaeology of the Mediterranean Basin. In a field such as ancient history there is a lot of hypothesis and supposition, and this technology, as it is utilized more and more, helps historians and archaeologists ‘bridge the gap’ between the ancient world and the present. So far, it has been used in many ways, including exploration of sites deep underwater that are not reachable by the human hand. Most of these sites are shipwrecks that were lost at sea and sank. In another context, remote sensing tools can be used for to identify sites that are easily accessible. A recent example of this is the use of remote sensors to find boats that have been used in Egyptian burial rituals. Remote sensors have also been used to detect and map ancient harbors, a large majority of which is now submerged. Following discovery, sites of significance can be monitored with sensors, especially if they are in shallow water. This is particularly significant to the sites of the ancient world as they are older and are more endangered than newer sites.

Shipwrecks in deep water are discovered using sub bottom profilers, side scan sonar, and occasionally magnetometers. Should archaeologists wish to survey a site in part or in full, it can be done using ROVs and AUVs with cameras, sonar technology and in certain instances, chemical sensors. From these sensors a large amount of data can be collected and interpreted. From this data, archaeologists can create a variety of informative maps, such as bathymetry maps. Bathymetry maps can speak to the nature of the ship itself, including nuances in the construction that may not be noticeable in photographs. In more recent studies, bathymetry maps have been combined with photomosaics for 3D reconstruction. The complexity of these maps in particular can help archaeologists organize the ship and its spatial components. It is important to understand the ship spatially as a thorough understanding of this could inform the nature of the ship’s journey, the origins of the crew and cargo, as well as trade routes and political interaction of ancient civilizations.

The application of remote sensing to the study of submerged sites has made giant strides in the study of ancient harbors. Photomosaics created using high-resolution cameras are being used in conjunction with manually made maps to ensure that a complete representation of the site is done for later study. In the future, the creation of photomosaics may be able to replace manual measurement entirely, which will have a significant impact on the errors made during survey. In an underwater environment this is particularly significant because weather and visibility conditions can have a hazardous effect on making maps of an underwater site.

Despite the usefulness of remote sensors in underwater archaeology, there are certain limitations to the current technology available. The underwater environment still causes a large margin of error, especially when it applies to photomosaics. Depending on the site conditions, some photomosaics that have been created for different sites are useful for spatial reconstruction but are not able to be used for actual measurements during post processing. Developers of different software have created computer-processing programs that can help correct this. SLAM, or simultaneous localization and mapping, is being used in real time to adjust each picture according to the velocity or angle. In the future hopefully this will become an even more seamless process.
While remote sensing technology as it applies to archaeology has a long way to go, it is being used presently in remarkable capacities and is changing the way that archaeology is done underwater. In the future, I believe that remote sensing will be used in all underwater archaeology research; the capabilities it has demonstrated so far have revolutionized the field in only a few short years. The creation of more technically specific ROVs and AUVs may allow for full excavation of deep-water sites, and further fine-tuning of both the sensor and post-processing programs will help those in shallow water map sites and analyze constructions further. The study of the ancient world, the future of which lies underwater, cannot be accomplished without this invaluable piece of technology.

Annotated Bibliography


In 1999, an archaeological survey was conducted on two eighth century Phoenician shipwrecks that sank of the coast of what is now southern Israel. At the time these wrecks were the earliest known deep-water shipwrecks. As these wrecks are currently at a depth of 400m underwater, the survey and data collection in this case was done using exclusively remote sensing techniques. These techniques were especially important in keeping track of the ROV Jason while it was below the surface. This was done using two EXACT transponders that were dispatched into the water and communicated with their counterpart on the ROV itself. In order to obtain the most information from these wrecks, they were mapped in several different ways using high resolution cameras for a photomosaic and side scan sonar which produced a fine-scale bathymetric map of both wrecks. This research represents an early effort of remote sensing technology in underwater archaeology and while it was a successful effort, it is less sophisticated than the technology that is being used today. For example, the bathymetric map that was produced was detailed and accurate enough so that the researchers could take quantitative measurements from it. This was not possible with the photomosaic because there were too many errors and there was not a sophisticated enough computer program that could digitally correct the errors. These two shipwrecks, while not fully excavated, did lend enormous insight into the establishment of Phoenician colonies and trading routes, and contributed significantly to the underwater archaeological record.


In this paper, Bingham and his team of researchers provide a brief overview on their use of an AUV to survey the Chios Shipwreck. This shipwreck is approximately 4th century BCE and is located in the northeastern Aegean Sea. Over a period of three days the AUV was able to determine a few important factors about the wreck, such as the size of the cargo and the integrity of the site itself. What is most unique about this study is that the AUV they employed used several different sensors, not only sonar, to collect data. In particular, the AUV was equipped with a chemical sensor, which was able to
register chemical data in real time alongside the sonar and camera equipment. This survey represents the first time in archaeology that sonar equipment, cameras and chemical sensors have been used simultaneously in one survey and represents a significant stride in this field. What I found most interesting about this survey was their combination of photomosaic and sonar mapping. The result of this fusion shows a texturized, interactive, 3D representation of a site, and will be useful in future excavation of deep-water shipwrecks.


This article was helpful in showing how useful remote sensing technology can be adapted to study the maritime world on land. Upon studying the excavation reports of a French team during the late nineteenth century, the researchers of this article discovered that there might have been two unexcavated boats buried as part of a tomb complex for Senwosret III (1878 – 1839 BCE). They decided to use a magnetometer and an EMI conductivity meter to find the potential boats. The researchers posited that the magnetometer would register ferrous material that may be incorporated into debris piled underneath the boat. There was also the possibility that this boat had been built with metal fasteners like several other boats from this period. This method was unsuccessful in find the boats of the French survey, however it was successful in another respect. While searching for these boats, the archaeologists used the magnetometer over several known walls and features of the tomb complex and got very positive readings from both the magnetometer and conductivity meter. This confirmed that these two meters could detect the presence of mud brick that has been fired, mud brick that has not been fired and granite. This newfound use for these meters will be extraordinarily helpful in future land excavations.


In the history of underwater archaeology, only two methods have been used for recording site: manual measurements done by a diver and the use of an ROV with different sensors attached to it. Manual measurement is time-consuming and errors can lead to problems in data analysis later on, however if done properly it can be an effective tool. Use of an ROV removes most of the error involved in manual measurement, but it is extremely expensive and therefore only available to only the most well funded of expeditions. Henderson and his colleagues have come up with a compromise, which is a 3-D diving platform that uses SLAM (Simultaneous Localization and Mapping) on their cameras, either in the field or during post processing. SLAM incorporated the orientation and velocity into the estimate of the camera positions, so that if necessary photos can be 'corrected' if an error occurs. The researchers tested it out on a submerged ancient city of Pavlopetri in Greece and it was quite successful. The researchers were not only able to create photomosaics of the site, but they were also able to make a depth map and a texture map which informed the impression of what the site was like when it was lived in. Because the site was only about 1-2 meters of water, it had optimal conditions for testing of this technology, as the divers were able to maintain a fairly consistent height.

The research presented in this article shows how remote sensing can be used in both geological applications and archaeological contexts, and how the two can be combined together. Paptheodorou and his colleagues used side-scan sonar and a sub-bottom profiler to create a paleogeographic reconstruction of Cape Sounion in Greece, which was an important ancient port. This expedition helped the archaeologists to find some submerged portions of the ancient harbor, including rock-cut walls and a ship slipway. The most important aspect of this study however is the use of remote sensing in the analysis of sea level rise in this area. When studying their results, the archaeologists found that the harbor at Cape Sounion has experienced significant sea-level rise over the past 2500 years. This is contrary to what models of sea-level rise in this area have predicted when taking into account human activity and coastal erosion. While it certainly seems odd that the sea has risen more in this spot, this has been noted at other harbors around the Mediterranean, and it has been posited that this abnormal rise is due to frequent seismic activity. This implication is not only groundbreaking in terms of the study of the ancient world, it is also extraordinarily significant in the study of Mediterranean tectonic activity during the present day.


Royal's discussion focuses on his survey of the Southeastern Turkish coast in 2004 using two multibeam echosounders mounted on two ROVs. This venture was extraordinarily successful; a total of nine new shipwrecks were discovered using this technology. Using the echosounders, while a more expensive piece of equipment, was a smart decision because unlike side scan sonar and other remote sensing tools which create 2D maps, the echosounders are able to create 3D maps. This means that the data output is more apt at eliminating geographical anomalies in the ocean floor, which allows archaeological targets to be picked up more easily. Along the same lines, this type of technology is also good at picking out low profile mounds, or, in other words, smaller sites that would not be noticed on other forms of remote sensing equipment. These nine new shipwrecks were also beneficial to the wider archaeological community, as they were from several different time periods. One was from the Roman Imperial period and has yet to be investigated. Two of the wrecks were wooden ships from the Ottoman Renaissance period, and are extremely important in the context of Ottoman naval force during that time.