Sonar mapping and sampling of underwater archaeological excavations

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Motivation and Introduction

When mapping and creating 3D models and taking samples from underwater archaeological excavations, a prior assessment of the terrain is essential. Thus, by knowing the documentation area in advance, any difficulties that may arise can be taken care of [Block 2018]. Also, before the UUV is put into the water, it can be determined how and how many cameras have to be placed and at which angles.

In the system presented, a cable connection to the water surface is also used. This can be varied in length. If the maximum depth and the depth difference of the images are known before the dive, the cable length used for the dive can be determined in advance.

Since cameras are used for recording the water bottom structure, the diving depth to the mission is also of decisive importance here. So the one to three cameras can be attached to the system. Depending on how the bottom structure looks, these may also need to be adjusted in your angle to be able to create a good full 3D model.

Also, when diving deeper, care must be taken to provide enough light for the cameras. So it may happen that an extra diving lamp has to be installed to provide enough light for the recordings.

If now diving lamps cameras and cables for the appropriate depth were adapted can be planned by the previous reconnaissance the mission.

This is only possible with the cameras in place because now the area of coverage of the system is known. Now the overlap of the individual images can be determined and the paths to be followed can be calculated accordingly.

It can also be clarified in advance how a sample can be taken at the respective sites. Possible strategies and possibilities can be determined before the first real dive.

Theory and related work

The importance of mission planning and camera alignment has been known for some time and is done in other areas such as flying documentation areas with quadcopters [Ali 2020].

And sampling is an important consideration in the archaeological context. Unfortunately, there is an increased difficulty in taking these samples underwater. Specially trained divers may have to be used.

Therefore, it is easier to take samples with an autonomous underwater drone. An already developed system is used, which consists of an underwater drone with a buoy above water (see Fig. 1).

Fig. 1. current system with the bouy above water connected via a yellow cable with the submarine underwater

Reconnaissance of the documentation area

As shown in the previous paragraph, it is of high importance to know the area to be documented in advance. For an approximate extension of the structure of the water body, the water body can be marked out in advance in the dry dock. But this only counts for the surface of the water body. The structure at the bottom of the water body cannot be determined here. To determine the depth, the most useful determination is a sonar. A small sonar called Deeper can be used here. It determines individual measuring points in the depth and has a built-in GPS so that the measuring points are directly georeferenced.

Using these points a depth map can be created via QGIS and Grass, so that areas between the individual measurement points can also be discussed. Within the project, a depth map of the reservoir in Oberwartha was created (see Fig.2).

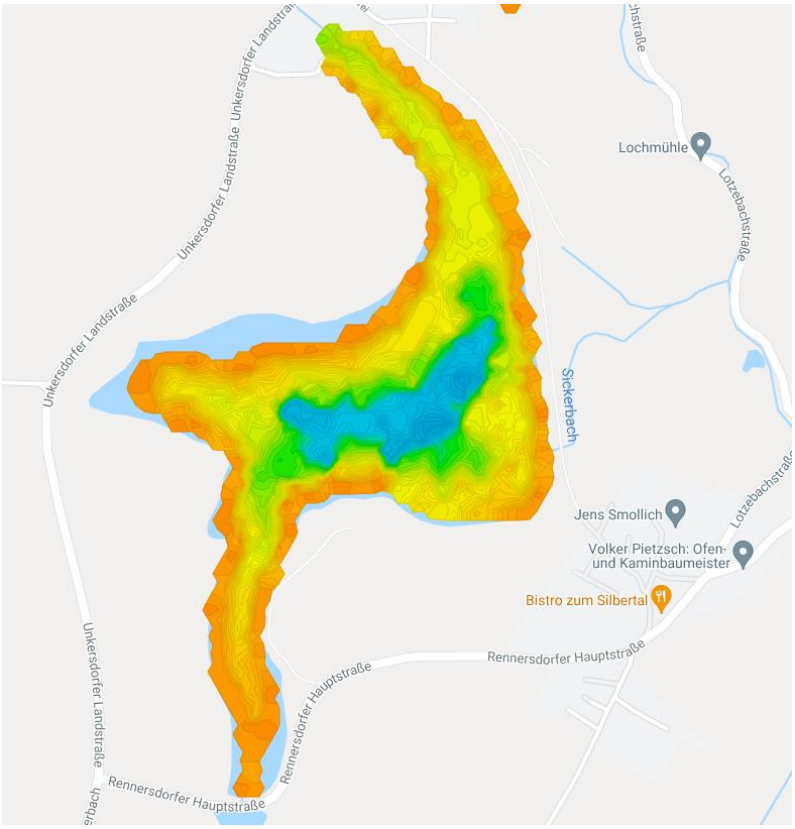

Fig. 2. Dark orange up to 1m, yellow up to 10m, green up to 20m and blue up to 20m. The deepest point of the lake was 29.132m

Likewise, it is important to know at what depths documentation is to take place in order to make provisions for both hardware and software.

Therefore, pre-mapping is crucial. Since for the creation of the videogrametric 3D model, the distance to the bottom should always be quite equal. Therefore, a 2nd sonar was attached directly to the submarine to make it easier for the boat to keep the distance to the bottom (see Fig. 3).

Fig. 3. On the left is the gripper arm with which sampling is currently possible. On the right is the sonar on the submarine, with which the distance to the bottom can be determined at any time.

By knowing the distance to the ground, several systems could be developed to take samples. One of these is shown in Fig. 3. Here, a grab arm was attached directly to the underside of the boat.

With it, individual stones could be recovered directly from the lake bottom without the need to evolve a diver. This system can be used directly in archaeology as well as in aquatic ecology so that any samples can be taken quickly and easily [Bommhardt-Richter 2020].

future work

In the future, different sample removal strategies will be compared to see which is the best for which scenario. Thereby a small portfolio will be created in which one can choose the appropriate sampling for the respective mission.

References

Ali, U. L. V. İ. (2020) „Importance of unmanned aerial vehicles (UAVs) in the documentation of cultural heritage“. Turkish Journal of Engineering, 4(3), pp. 104-112

Block M., Gehmlich B., Bommhardt-Richter M., Bochmann H. (2018) „Archaeological underwater documentations with Manio", Abstract, Poster presentation, Congress Visual Heritage, 23rd Conference on Cultural Heritage and New Technologies (CHNT 23) in Vienna/Austria

Block M., Gehmlich B., Bommhardt-Richter M., Görsch N., Bochmann H., Haferland A., Gunnarsson K., Löw C., Dworsky C. (2018) „Using Aerial Documentation for Underwater Georeferencing at UNESCO Pile Dwellings "See am Mondsee" in Austria“, Abstract, Oral presentation, Congress Visual Heritage, 23th Conference on Cultural Heritage and New Technologies (CHNT 23) in Vienna/Austria

Bommhardt-Richter M., Bochmann H., Block M. (2020) „Cousteau-II: A semi-autonomous underwater recording system for long-term recording“, Abstract in 25th Conference on Cultural Heritage and New Technologies (CHNT 25) in Vienna/Austria