

4D Modelling of Low Visibility Underwater Archaeological Excavations Using Multi-Source Photogrammetry in the Bulgarian Black Sea

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Abstract : This paper introduces the applicability of underwater photogrammetric survey within challenging conditions as the main tool to enhance and enrich the process of documenting archaeological excavation through the creation of 4D models. Photogrammetry was being attempted on underwater archaeological sites at least as early as the 1970s and today the production of traditional 3D models is becoming a common practice within the discipline. Photogrammetry underwater is more often implemented to record exposed underwater archaeological remains and less so as a dynamic interpretative tool. Therefore, it tends to be applied in bright environments and when underwater visibility is $> 1\text{m}$, reducing its implementation on most submerged archaeological sites in more turbid conditions. Recent years have seen significant development of better digital photographic sensors and the improvement of optical technology, ideal for darker environments. Such developments, in tandem with powerful processing computing systems, have allowed underwater photogrammetry to be used by this research as a standard recording and interpretative tool. Using multi-source photogrammetry (5, GoPro5 Hero Black cameras) this paper presents the accumulation of daily (4D) underwater surveys carried out in the Early Bronze Age (3,300 BC) to Late Ottoman (17th Century AD) archaeological site of Ropotamo in the Bulgarian Black Sea under challenging conditions ($< 0.5\text{m}$ visibility). It proves that underwater photogrammetry can and should be used as one of the main recording methods even in low light and poor underwater conditions as a way to better understand the complexity of the underwater archaeological record.

Keywords : 4D modelling, Black Sea Maritime Archaeology Project, multi-source photogrammetry, low visibility underwater survey

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