Abstract
We present a multimodal representation for mapping old underwater shipwrecks, in which bathymetric and optical data are joined together in a single 3D model. We use 3D smoothing and decimation techniques in order to alleviate possible aberrations on the original data and generate a lightweight faithful representation respectively. The generated model can be visualized in common 3D CAD tools for further exploration and manipulation.

Keywords – bathymetry, mosaicking, smoothing, decimation.

I. INTRODUCTION
The wide variety of sensors carried by oceanographic vehicles provides the possibility of representing the ocean floor in many different ways. Two of the most used representations are bathymetry and optical mapping. While bathymetries usually map large areas (with resolutions typically in terms of several meters), and provide an overview of the surveyed site, the optical mapping is often used for in-detail exploration (resolution of mm), and covering smaller areas. However, underwater robots carrying down-looking cameras and side-scan sonars and flying at low altitude offer the opportunity of mapping the same zone using both techniques. In this case, bathymetric and optical data can be merged together in order to provide further information than separately. For this reason, this paper aims to create a generic 3D model joining both information sources. The surveyed area presented in this article corresponds to a French shipwreck named La Lune. This 38m long vessel sunk over the coast of Toulon in the XVIIth century, but its remains are still well preserved, causing this area to be of great interest for archaeologists.

II. BATHYMETRY PROCESSING
Bathymetry manipulation usually consists in considering the depth readings as pixel values, and noise smoothing is normally carried out using image processing techniques. Since we want to create a generic virtual model, we will explore the possibility of using renowned 3D manipulation techniques instead. The bathymetry is represented in a regular grid, with depth readings on each cell. In order to change into a surface 3D model, the cells in the regular grid forming the bathymetric map are triangulated by transforming each of them into two triangles. Depending on the accuracy of the bathymetry, the resulting model can be quite noisy. In order to alleviate this problem, a Laplacian smoothing method was used. The Laplacian process moves a vertex to the mean position described by its neighbors on the mesh and itself. This procedure is applied n times until the desired smoothing is achieved (n=2 was enough for the current dataset). Obviously, the naive triangulation approach followed generates a large quantity of triangles, despite the underlying geometry in the bathymetry may actually be represented faithfully using fewer triangles. Basically, planar (or almost planar) areas of the model should be represented with a smaller number of triangles than areas showing high curvature changes, which are more informative. For this reason, we decided to apply the quadric error metrics decimation procedure [1]. The method of quadric error metrics offers a good tradeoff between geometric accuracy and computational cost. In this method, the error at a vertex is described using a 4x4 matrix Q that represents the sum of squared distances from a vertex to the planes defined by the neighboring triangles as vTQv. At each iteration, the edge with smaller error (being the sum of the error of its endpoints) is removed using an edge collapse operation. In order to update the error metric of the vertex resulting after edge collapse, the quadrics $Q$ of the original vertices are directly summed. This simple updating operation makes the method achieve a fair computational cost. Fig. 1 (a-c) shows the results of the different steps described so far. One can observe that even in this case, where the decimated version contains just the 25% of the original number of triangles, the shape is correctly preserved.

REFERENCES

M6 MERGING BATHYMETRIC AND OPTICAL CUES FOR IN-DETAIL INSPECTION OF AN UNDERWATER SHIPWRECK

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Fig. 1. Close-ups corresponding to the same part of the map (two nearby cannons): (a) shows the original bathymetry, (b) the smoothed version, and (c) the decimated version. Finally, (d) shows the triangulation of (c) with the mosaic as texture.

Fig. 2. The original bathymetry is illustrated in (a), while (b) shows the processed model with the mosaic as texture.