Underwater objects extraction and analysis

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***Abstract*—Osculatory surfaces were initially developed to study mobile sandy bedforms dynamics. In a static framework, this technique turns out to be a powerful tool for extracting the shape of the objects present on the seafloor. Their ability to extract natural and anthropogenic features of different sizes is presented in this paper.**

Keywords—MBES; Bathymetry; Object extraction; Trend surfaces; Osculatory surfaces;

I. INTRODUCTION

Multibeam echosounder systems (MBES) are currently used to routinely map the seafloor. Their full-coverage and high resolution capabilities provide high resolution Digital Bathymetric Models (DBM) that can be investigated using geomorphometric techniques. In this framework, osculatory surfaces were firstly introduced to assist geoscientists in the routine extraction of stable sandy bedforms from repeated MBES surveys. While tracking inner trend interfaces within dynamic sediment [1], osculatory surfaces turn out to be a powerful tool for extracting objects on a static seabed. Such a technique was applied to detect, extract and analyze a wide range of natural and man-made features, from rocks on a pier jetty to a lock on the bottom of an artificial lake, including several mines and wrecks.

II. DATASETS DESCRIPTION

Tested areas with respect to their geomorphologic features of interest are described in table I. DBM were generated from bathymetric data acquired using several MBES installed aboard the Panopée, ENSTA Bretagne's hydrographic launch.

TABLE I
UNDERWATER OBJECTS

Geomorphologic features	MBES	Depth range (m)	Spatial scale of analysis (m)
Kleber wreck	1	33 - 42	90
Cobetas wreck	2	14 - 25	50
Mine	3	1.5 – 6.5	30
Lock on a lake bottom	3	0 - 35	20
Rocks on west pier /Brest Harbor	3	0 - 17	20

1 : Kongsberg EM2040C 400kHz; 2 : R2Sonic2022 700kHz ;
2 : Kongsberg EM2040C 300kHz

III. MEDOTHOLOGY ANS RESULTS

Osculatory surfaces are trend surfaces extracted from DBM that automatically segment foreground objects (rocks, mines, wrecks …) from the seafloor. The feature of interest is extracted at a given spatial scale depending on its size (Table I) and is defined as a structured aggregate found within the map of the residuals between the DBM and its osculatory surface. The wreck footprints of the Kleber and the Cobetas (Fig. 1.) are extracted by setting a 90 m and 50 m spatial scale. When applied to the deck of the Cobetas [2], the osculatory surface performs a deeper analysis of the wreck by highlighting its remaining structures. In the more complex case of the bottom of an artificial lake consisting of an incised valley, the osculatory surface makes it possible to identify artificial objects such as locks, houses, or natural objects such as the riverbed, and tree stumps. Small size and isolated objects like mines or rocks are extracted by decreasing the spatial scale to 20 m. Finally, the extraction of pinnacle rocks on the west pier of Brest harbor is performed through a generalization of our approach [1].

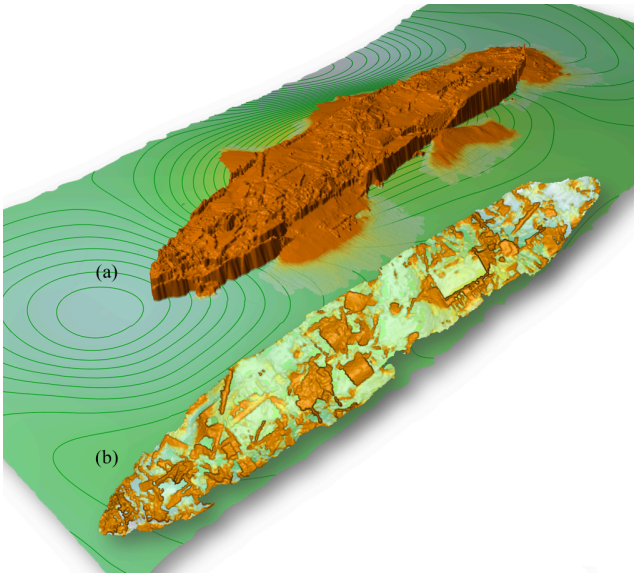

Fig. 1. Osculatory surface (a) while separating the wreck from the sea bottom (b) while extracting the remaining features lying on the deck.

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