Combined Standard Measurement Uncertainty Model to Bathymetric Data

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I. Introduction

Analysis and interpretation of bathymetric data are always directly related to data resolution. In other words, the Digital Terrain Model (DTM) resolution should be higher than the seabed morphological elements and structures to be interpreted. Bathymetric data resolution is calculated based on data uncertainty as presented by [1]. Many classical uncertainty models based on the direct georeferencing model are proposed such as [2] and [3]. These models consider the uncertainty associated with the measures performed by each system sensor, such as GNSS coordinates, altitude angles, and beam measurement. The present study proposes a new Combined Standard Measurement Uncertainty (CSMU) model that has been adapted from a model dedicated to mobile LiDAR systems [4]. This new model consider not only the uncertainty related to sensor measurements, but also the seabed morphology.

II. Combined Standard Measurement Uncertainty Model

Classical CSMU or Total Propagated Uncertainty (TPU) models [2] and [3] do not take into account the sea-bottom morphology and the range value is expressed as one single parameter. However, the range value depends on a combination of several measurements and each of them has a related uncertainty. Thus, these uncertainties should be considered in the CSMU model. The classical georeferencing model can be observed in (1).

$$\Sigma_{X_n} = \Sigma_{P_n} + \Sigma_{r_n} + \Sigma_{a_n} \tag{1}$$

Where P_n considers the GNSS receiver, a_n the IMU and lever arms and r_n the MBES, IMU and boresight angles measurements and related uncertainties.

In addition to the measurements and related uncertainties of bathymetric data acquisition, the seabed morphology induces a geometric error (pointing error - δ_{ρ_i}) that should be considered in the sounding uncertainty (Fig. 1).

Our current research project aims at improving the classical CSMU in order to integrate the uncertainty contribution of the range value and the seabed morphology. A new georeferencing model has been proposed where the covariance matrix associated with seabed morphology (Sn) has been added to equation (1). The new model is presented in (2). Detail about this new model is provided in [5].

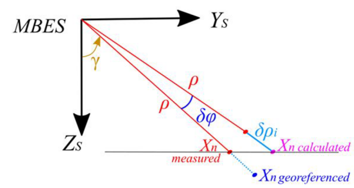

Fig. 1. Pointing error (cyan). When: X_n is the surveyed point, ρ is the distance measured between MBES and the seabed, γ is the angle between the nadir and the beam direction and $\delta\varphi$ the uncertainty in the roll angle.

$$\Sigma_{X_n} = \Sigma_{P_n} + \Sigma_{r_n} + \Sigma_{a_n} + \Sigma_{S_n} \tag{2}$$

III. Model Validation

The new CSMU model that takes into account the seabed morphology as geometric uncertainty has been validated with simulated data. The model is now being validated with real bathymetric data. Considering that the resolution of DTM is calculated based on the estimated CSMU, our improved model is being used to define the optimal resoltion in the context of dunes migration where the CHS standards should be fulfilled [1]. The results of the validation with real bathymetric data shall be presented in the CHC 2020.

References

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