3D COASTAL BATHYMETRY RECONSTRUCTION USING TOPSAR DATA

Maged Marghany
Department of Remote Sensing
Faculty of Geoinformation Science and Engineering
Universiti Teknologi Malaysia
81310 UTM, Skudai, Johore Bahru, Malaysia
Email: maged@utm.my,
magedupm@hotmail.com

1. INTRODUCTION

Coastal bathymetry is considered to provide key parameters for coastal engineering and coastal navigation. In this paper we address the question of reducing the effect of speckle on the accuracy of depth determination in coastal waters using TOPSAR multipolarized data without needing to include any sounding data values. This is demonstrated using integration of the Volterra kernel [2] and Fuzzy B-spline models [1]. Four hypothesis are examined: (i) the Volterra model can be used to detect ocean surface current from TOPSAR polarised data, (ii) there are significant differences between the different bands in detecting ocean currents, (iii) the continuity equation can be used to obtain the water depth, and (iv) Fuzzy B-splines can be used to invert the water depth values obtained by the continuity equation into 3-D bathymetry.

2. METHODOLOGY

In doing so, two three-dimensional surface models, the Volterra model and a fuzzy B-Spline model, which construct a global topological structure between the data points, were used to support an approximation to the real bathymetry surface. The fuzzy B-splines (FBS) are introduced allowing fuzzy numbers instead of intervals in the definition of the B-splines. Typically, in computer graphics, two objective quality definitions for fuzzy B-splines are used: triangle-based criteria and edge-based criteria. A fuzzy number is defined using interval analysis. There are two basic notions that we combine together: confidence interval and presumption level. A confidence interval is a real values interval which provides the sharpest enclosing range for current gradient values. An assumption level μ -level is an estimated truth value in the [0,1] interval on our knowledge level of the gradient current. The 0 value corresponds to minimum knowledge of gradient current, and 1 to the maximum gradient current. A fuzzy number is then prearranged in the confidence interval set, each one related to an assumption level $\mu \sqsubset$ [0,1]. Moreover, the following must hold for each pair of confidence intervals which define a number: $\mu \succ \mu' \Rightarrow h \succ h'$. Let us consider a function $f : h \rightarrow h'$, of *N* fuzzy variables $h_1, h_2, ..., h_n$. Where h_n are the global minimum and maximum values of the water depth of the function on the current gradient along the space. Furthermore, the identification of a fuzzy number is acquired to summarize the estimated water depth data in a cell and it is characterized by a suitable membership function. Furthermore, the membership support is the range of water depth data in the cell and whose vertex is the median value of water depth data.

2. RESULTS AND CONCLUSION

With 10 m spatial resolution of TOPSAR data, bias of - 0.004 and the standard error mean of 0.05 m in depth determination was obtained with L_{HH} band. It can be said that the integration between the Volterra model and the fuzzy B-splines could be an excellent tool for 3-D bathymetry determination from SAR data.

11. REFERENCES

[1] A.M Anile ,S. Deodato, and G. Privitera, "Implementing Fuzzy Arithmetic", Fuzzy Sets and Systems, 72,123-156.1995.

[2] J. Inglada, and R., Garello, "On rewriting the imaging mechanism of underwater bottom topography by synthetic aperture radar as a Volterra series expansion". *IEEE Journal of Oceanic Engineering*.27, pp:665-674. 2002.