A New Approach for Bathymetric Video-Inversion: Field Study

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1. Introduction and Methods

Scientists and managers of the coastal zone need to know the coastal bathymetry to understand the behaviour of the beaches and be able to predict their evolution. Intensive monitoring programs through campaigns of direct measurements of the bathymetry are excessively expensive, so that in the last decades alternative methodologies have been developed. Many of them are based on video monitoring stations, and among the different existing algorithms, cBathy (Holman et al., 2013) is the algorithm that achieves the best results.

In a first step, cBathy gets the dominant frequencies and their corresponding wave numbers from the Cross Spectral Matrices (CSMs) of a given set of frequency bands. An estimation of the local water depth is then obtained from the dispersion equation. In the second step, the estimated bathymetries obtained for each video are smoothed through a Kalman filter to obtain the final hourly estimates. This algorithm, which has been used in a number of studies (e.g., Bergsma et al., 2016; Rutten et al., 2017) to obtain 2-D bathymetries, presents however some limitations and/or known problems that have been reported in the literature (Rutten et al., 2017).

The work being presented here is an alternative to the first step of cBathy. It consists of performing a Principal Component Analysis (PCA) to the matrix made of pixel intensities from a series of snaps. The result of the PCA is the decomposition of the video into a set of modes associated with the components of the wave field. The spatial part (the Empirical Orthogonal Function, EOF), is associated with the spatial phase of the wave from which a wave number can be derived. The amplitude of the mode (Principal Component, PC) is associated with the frequency of the wave component. To facilitate the decomposition of the videos in modes of travelling waves, a Hilbert transformation in time of the matrix of intensities has been carried out.

The objective of this work is to apply the PCA of video images to obtain beach bathymetries. To this end, videos from different camera/field sites have been used and the bathymetry derived from videos has been compared with direct measurements. It has been studied the influence on the results of: the image lighting, the camera position, wave characteristics and study area size.

2. Results

The proposed methodology is applied to video images obtained at Castelldefels and Barcelona beaches (Spain), in the NW Mediterranean (coo.icm.csic.es). These beaches, open and embayed respectively, are exposed to relatively small dominant periods, in the order of 6s. The video snaps are first projected into a horizontal plane (plan-views) prior to apply the PCA. Further, it is analysed how the subdivision of the spatio-temporal domain influences the quality of the retrieved bathymetry.

For illustrative purposes, Figure 1 shows the bathymetry estimated for Castelldefels beach using the proposed algorithm.

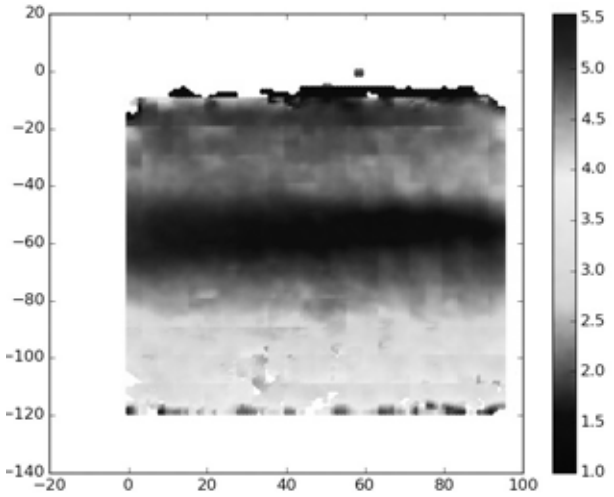

Figure 1. Bathymetry obtained from Castelldefels station. The shoreline is above. It is observed a bar at ≈ -50 in the vertical axis. All the units are meters.

3. Conclusions

The implementation of a simple and promising methodology for bathymetry inversion from video images is presented, and the results are satisfactorily compared to field data.

Acknowledgments

This research was partly funded by the Spanish Government projects CTM2015-66225-C2-1-P, and CTM2015-66225-C2-2-P (MINECO/FEDER).

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