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The application of cBathy algorithm: the case study of Torre Canne and Riccione, Italy

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1. Introduction

The coastal erosion is a critical issue, increasing in the last decades, which severely affects beach environment, since sediment supply is not enough to compensate lost sediment volumes by wave action. Natural as well as anthropic pressures enhance such an imbalance, mainly due to climate changes, raising urbanization and exploitation of coastal zones. In Apulia region (South Italy), almost the 70% of sandy beaches is characterized by incipient erosion phenomena. Several defenses and mitigation strategies have been undertaken, but in some cases they proved to be inappropriate in the long-term. A similar condition characterizes the Emilia Romagna region (North Italy), where 65% of the beaches suffers erosion, although high percentage (around 50%) of defence structures along the coastline.
The coastal monitoring represents a priority for developing an efficient management and planning strategy of coastal zones, since it allows collecting data for the study of both hydrodynamic processes and morphological evolution. Among the coastal monitoring techniques, video system application is being quickly developing in the last years, due to its reliability, accuracy and versatility that has been tested all over the world (e.g., Davidson et al., 2007). Moreover, it allows collecting long-term data with relatively low costs.
Many algorithms have been developed for detecting shoreline position from images as well as nearshore hydrodynamics main characteristics, in a satisfactory accurate level (e.g., Valentini et al., 2017; Archetti & Romagnoli, 2011). Specifically, particular efforts are addressed to detect the bathymetry, which is probably the most critical variable for understanding and modelling the dynamic of the nearshore.
In such a context, the main aim of the study is to evaluate the performance of the cBathy algorithm (Holman et al., 2013) for estimating nearshore bathymetry at the site of Torre Canne (South Italy) and Riccione (North Italy).
The video station of Torre Canne (Figure 1, left panel) belongs to the Apulian meteo-oceanographic monitoring network, active since 2006 and managed by the local regional Apulian Basin Authority. Specifically, at Torre Canne two network cameras were installed in 2015 on a fixed pole on the parapet of a hotel. The recently installed video-monitoring system in Riccione (Figure 1, right panel) consists of a Raspberry-Pi integrated with a camera capturing images that have been firstly processed for coastal monitoring issues. In this monitored area, prototypes of innovative multifunctional structures for coastal defense and mussels harvesting were installed to verify their stability and estimate their contributions to coastal protection.

2. Methods

cBathy is an algorithm for bathymetry estimation from video imagery that is simply based on the relationship between the wave celerity ($c = \sigma/k$) and the depth (d), mathematically described by the

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well-known dispersion relationship (Holman et al., 2013):

$$\sigma^2 = gk \tanh(kd) \quad (1)$$

where σ is the radial frequency, k the radial wave number, g the acceleration due to gravity and d the water depth. From each camera installed the stream has been set for collecting video records, 15 min long with an acquisition frequency of 5 Hz. Preliminarily, each video is processed in order to extract the frames at the acquisition frequency by python scripting and then geo-rectifed. Indeed, cBathy works by approximating depth from products of temporal spectral analysis and spatial cross-spectral analysis over an array of collected time stack (Figure 2) of pixel intensities (e.g., Wengrove et al., 2013). The time stack is a gridded array of pixels, which represents the input data for the cBathy analysis, collected at predefined coordinates related to wave characteristics of interest over the analysis domain (e.g., Holman et al., 2013). The comparison with measurements obtained during field surveys will be shown in order to evaluate the performances of the cBathy algorithm in both sites, characterized by different morphological characteristics and wave climate.

Figure 1 – Video monitoring station at Torre Canne (left panel) and study site at Riccione (right panel).

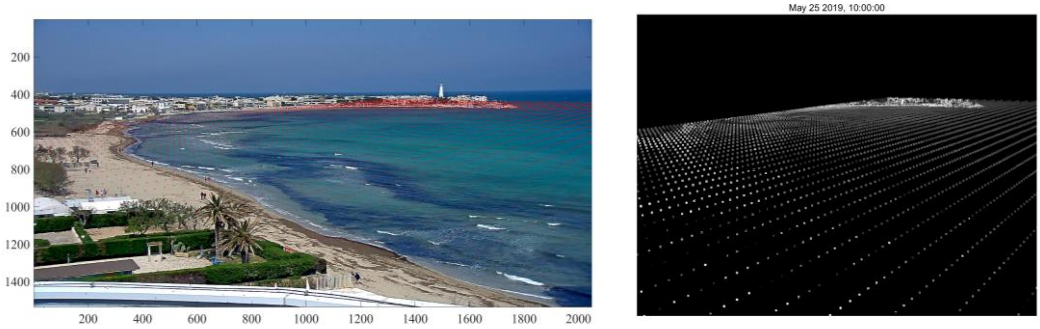

Figure 2 - Example of typical pixel array used for cBathy analysis (left panel) and an oblique stack derived from the video station at Torre Canne (right panel).

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