AUTOMATIC IDENTIFICATION OF THE WAVE RUNUP LINE FROM CAMERA IMAGES

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ABSTRACT

We propose a novel methodology for an automated coastline runup detection from high-resolution remote camera images. As part of a multi-source integrated flood risk assessment platform, this methodology will further improve the characterization of the beach hydrodynamics and define automated procedures for the surveillance of coastal overtopping and overwash.

Keywords: camera, coastline, high-resolution, runup detection, MOSAIC.pt.

1. INTRODUCTION

The Portuguese coast is subject to extreme events that create high flooding risks (Fortunato *et al*., 2019; Freire *et al*., 2020). Understanding these hazardous events is necessary to improve planning and emergency responses to reduce flood damage. Project MOSAIC.pt will improve the response capability to coastal flooding events by implementing flood prediction engines using data from multiple sources.

The current MOSAIC.pt platform (Rocha *et al*., 2021) combines a range of hydro- and morphodynamic models with real-time monitoring data network to simulate the propagation of the wave energy up to the shore. Consists in a workflow of numerical models and procedures to predict basin-scale offshore wave generation up to wave propagation at the beach scale. A method for continuous coastal surveillance is introduced here, that complements the deployment of sensors, field campaigns data and periodical satellite images, which all support model predictions. Herein, we focus on high-resolution remote stationary cameras (used for leisure, security and safety applications) and discuss their use for the application of the automatic procedures directly to the camera feed or stream, which is translated into static frames, in order to detect the instantaneous position of the breaker line, the instantaneous wet-dry line and the runup line . The runup line is defined here as the landward limit of the wet-dry interface for a time interval of a few minutes.

The methodology consists in processing images from a stationary camera in real-time (Amiko BW40M400, with 1920x1080 resolution, set at 15m above mean sea level), applied and validated for a case study at the S. Pedro de Moel beach, on the central Portuguese coast. By correctly detecting water limits in any type of conditions, including low-light or stormy days, we will be able to both enrich the MOSAIC.pt platform and provide a powerful tool to the water authorities.

2. DETECTION OF THE RUNUP LINE

The methodology uses an algorithm to process the remote camera images. This algorithm is composed of Python 3 scripts that use OpenCV, a module for video and image processing; and NumPy, a mathematical module.

The procedure is composed of the following steps: 1) image segmentation for sand detection and water pixels masking; 2) image binarization, *i.e*., apartness of the sand from water pixels; and 3) maximum binary image for a customizable period of T seconds (by default, 3 seconds) and determine runup.

The averaging procedure filters out the variability associated with wind waves, making the data readily comparable to phase-averaged wave models. Images are processed before rectification to minimize errors. First, wet and dry sand are detected for all images, by i) applying a Bilateral Filter, ii) converting to HSV (Hue-Saturation-Value) colorspace, iii) normalize the image brightness, iv) applying a thresholding using inRange operator to filter the sand zones, v) applying an erosion morphological filter, and vi) apply image masking to filter unneeded information of the image for our detection. Then, we apply binarization, where we assign 0 as sand (black) and 1 as water (white) (Figure 1). Finally, in order to know if a pixel gets wet during a certain period T, we fetch the binary images for that period and create an maximum binary image, by applying the formula $Mxi = max(Pxt: t0+iT < t < t0+(i+1)T)$, where *x* is pixel, *t* is time, and *i* is binary image, and determine the runup line by checking these maximum images for pixels.

Figure 1: Left: original image; center: sand detection in HSV and masking; right: image binarization.

3. CONCLUSIONS

A new methodology for camera static images processing is proposed herein, aiming at supporting early warning systems for inundation and overtopping in coastal areas. Planned work consists in applying calibration to the original images, and application of image rectification software to the final images.

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