ALTERNATIVE IMAGE STABILIZATION METHOD FOR COASTAL VIDEO MONITORING SYSTEMS

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INTRODUCTION

The use of shore-based video systems has become a very popular and accessible low-cost tool for coastal monitoring given their capability to deliver continuous and high-resolution temporal data over large enough spatial scales. However, the reliability of the final image products can be compromised by external factors, sometimes overlooked, that can alter the image geometry over time. In particular, unwanted camera movement, produced either by thermal or mechanical effects, can lead to significant geo-rectification errors if not properly corrected. Several studies (Bouvier et al., 2019; Holman and Stanley, 2007; Pearre and Puleo, 2009; Vousdoukas et al., 2011) have acknowledged the presence of camera motion and have proposed different post-processing procedures, often referred to as image stabilization methods, to compensate for camera movement. This study addresses an alternative straightforward method to stabilize an either continuous or subsampled image sequence based on state-of-the-art techniques and available routines.

METHODS

The image stabilization method required the presence and identification of different land-sub-image regions containing static recognizable features (referred to as keypoints), such as corners or salient points. Keypoints were matched against themselves after computing their two-dimensional displacement with respect to a reference frame. The vertical (tilt) and horizontal (azimuthal) pixel displacement was obtained using a cross-correlation algorithm with sub-pixel accuracy (Guizar-Sicairos et al., 2008) together with a Canny edge detection filter. Pairs of keypoints were afterwards used as control points to fit a geometric transformation in order to align the whole frame with the reference image. The stabilization method was applied to 5 years daily images collected from a three-camera permanent video system located at Anglet Beach (SW France), 70 m above mean sea level. Azimuth, tilt and roll deviations with respect to the initial frame were computed for each camera. In addition, 2.5 km of shoreline were manually digitized for the outstanding winter period of 2013/2014 using non-stabilized and stabilized rectified images to estimate the real-world horizontal positioning error due to camera movement.

RESULTS AND PERSPECTIVES

The three cameras presented motion during all the time series and showed a particular annual signal in azimuth and tilt deviation. This can potentially be attributed to the sun position and thermal expansion fluctuations. Camera movement amplitude reached approximately 10 pixels in azimuth, 30 pixels in tilt and 0.4° in roll, together with a quasi-steady counter-clockwise trend over the 5 year time series period. Moreover, camera viewing angle deviations were found to induce large rectification errors up to 400 m at a distance of 2.5 km from the camera. The mean shoreline apparent position was also affected by an approximately 10-20 m bias during the 2013/2014 winter period. The stabilization appears to improve camera geometry for fixed video monitoring systems, as illustrated in Figure 1 where all the blurriness of the long-term averaged video is removed. This method can also be applied to remove high-frequency camera movements obtained when using unmanned aerial vehicles (UAVs) for monitoring purpose. Image stabilization is a fundamental post-processing step that should always be performed in general coastal imaging applications to increase the accuracy of video-derived products, such as shoreline/sandbar position and depths estimate.

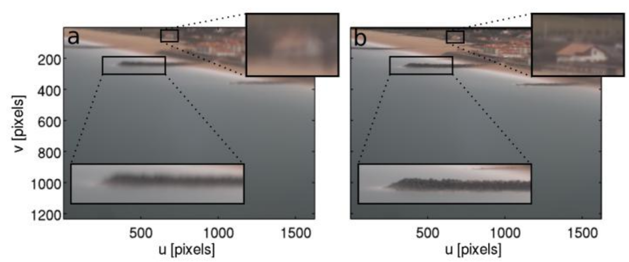

Figure 1 – Time series average (spanning Oct/01/2013 – Sep/09/2018) of all the a) unstabilized frames and b) stabilized frames.

REFERENCES

Bouvier, Balouin, Castelle, Holman (2019): Modelling camera viewing angle deviation to improve nearshore video, Coastal Engineering, vol. 147, pp. 99-106.

Guizar-Sicairos, Thurman, Fienup (2008): Efficient subpixel image registration algorithms, Optics Letters, vol. 33(2), pp. 156-158.

Holman and Stanley (2007): The history and technical capabilities of Argus, Coastal Engineering, vol. 54, pp. 477-491.

Pearre and Puleo (2009): Quantifying Seasonal Shoreline Variability at Rehoboth Beach, Delaware, Using Automated Imaging Techinques, Journal of Coastal Research, vol. 25(4), pp. 900-914.

Vousdoukas, Ferreira, Almeida, Dodet, Psaros, Andriolo, Taborda, Silva, Ruano, Ferreira (2011): Performance of intertidal topography video monitoring of a meso-tidal reflective beach in South Portugal, Ocean Dynamics, vol. 61, pp. 1521-1540.