Detecting coastal change in unmanned aerial vehicle Multi-View Stereopsis (UAV-MVS) point clouds

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Abstract:
Landscape change is a process that can occur over millennia or within moments and these changes can be minuscule or vast. To quantify and monitor change a scientist needs to choose the tool that best suits the scale of change (Anderson and Gaston, 2013). High spatial and temporal resolution datasets are important for coastal erosion monitoring and modelling. The focus of much of the research into coastal change and the impacts of sea level rise has been on exposed ocean beaches. The changes that are occurring along sheltered coastlines are also important and the gradual changes may be event driven or the erosion may be an indicator of more subtle long term trends. Erosion along these sheltered coastlines is not driven by ocean swell. Wind waves that coincide with peak tides are the primary driver for erosion of the shores (Prahalad, 2014). Housing and infrastructure are common along these waterways and monitoring the changes and the effectiveness of erosion mitigation efforts is a key application of sub-decimetre coastal change detection. The traditional methods for monitoring coastal change are either based on coarse-scale monitoring using satellite data, aerial imagery and LiDAR, or fine-scale monitoring using profiling or expensive terrestrial laser scanning (TLS). These fine-scale studies are undertaken at key indicator sites that can then provide insight into the changes occurring along a larger section of coast. The emergence of unmanned aerial vehicles (UAVs or drones) as tools for remote sensing and terrain mapping has the potential to revolutionise landscape change monitoring. UAVs can fly on-demand and at low altitude so that the datasets produced can meet spatial and temporal resolution requirements. UAV photogrammetry using Multi-View Stereopsis (MVS) is known as UAV-MVS and it uses high-resolution image sets to reconstruct the terrain and generate 3D point clouds with very high point density. It is possible to map a section of natural coastal cliff to better than 6 mm (1σ) accuracy at a point density of 1-6 points per cm^2 from 25 m above ground level using precise GCPs ($\sigma \leq 2$ mm) and 10-12 mm (1σ) accuracy using DGPS precision GCPs ($\sigma = 22$ mm) (Harwin *et al.*, 2015). The technique is a cost-effective alternative to other small change monitoring techniques. The point clouds can be compared and the differences detected can be visualised and analysed to gain insight into coastal erosion and accretion at very high resolution. The detail they provide also allows for accurate shoreline proxies to be extracted. This study illustrates cloud to cloud differencing, profile comparison and shoreline proxies to assess the effectiveness of UAV-MVS for monitoring centimetre-level coastal change detection. The resulting absolute difference point clouds show the magnitude of change. Sparse sections of the cloud resulting from occlusion can result in false change. Profile comparison allows change direction to be determined and manual measurement of changes

to be made. The comparison of two shoreline proxies, scarp edge and vegetation edge, indicates that, at the scale provided by UAV-MVS, vegetation edge is a poor proxy for shoreline and scarp edge can be more accurately determined.

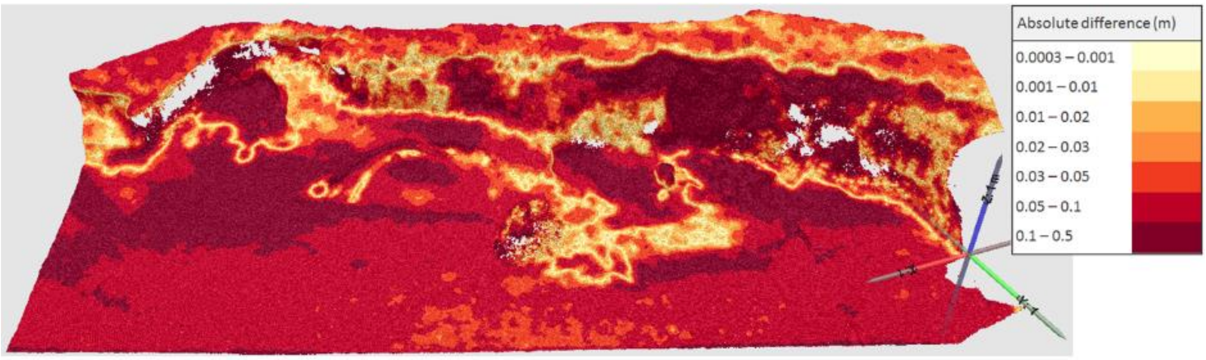

Figure 1. Absolute difference in UAV-MVS point clouds (of a 10 m section of coast) for 2010 versus 2013.

References:

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