Smart Cameras for Coastal Monitoring

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Abstract
Coastal engineering practitioners are regularly faced with the difficulty of managing areas subject to beach erosion and inundation while having limited monitoring data of the coastal zone. In most cases, coastal data is sporadic, outdated or no longer represents the constantly changing nature of the nearshore which often hinders the long-term success of coastal management decisions. While routine monitoring of the nearshore using camera-based systems is a well-established technique, these systems have traditionally been costly to establish and generally beyond the resources available for most projects. A low-cost smart camera system is presented here to overcome these challenges by combining start of the art machine learning algorithms with established image processing techniques to quantify beach usage and track shoreline change. The innovative system is completely self-2ontained and can be easily installed on existing bef (59-8.9 (n.9 (ng)-12.6b(ge.)-1.1 (T)- (ar)-

Table 1 Features of the smart camera system

Feature	Details
Camera model	Swift Enduro 4G
Price	AUD $700
Power and data transfer	

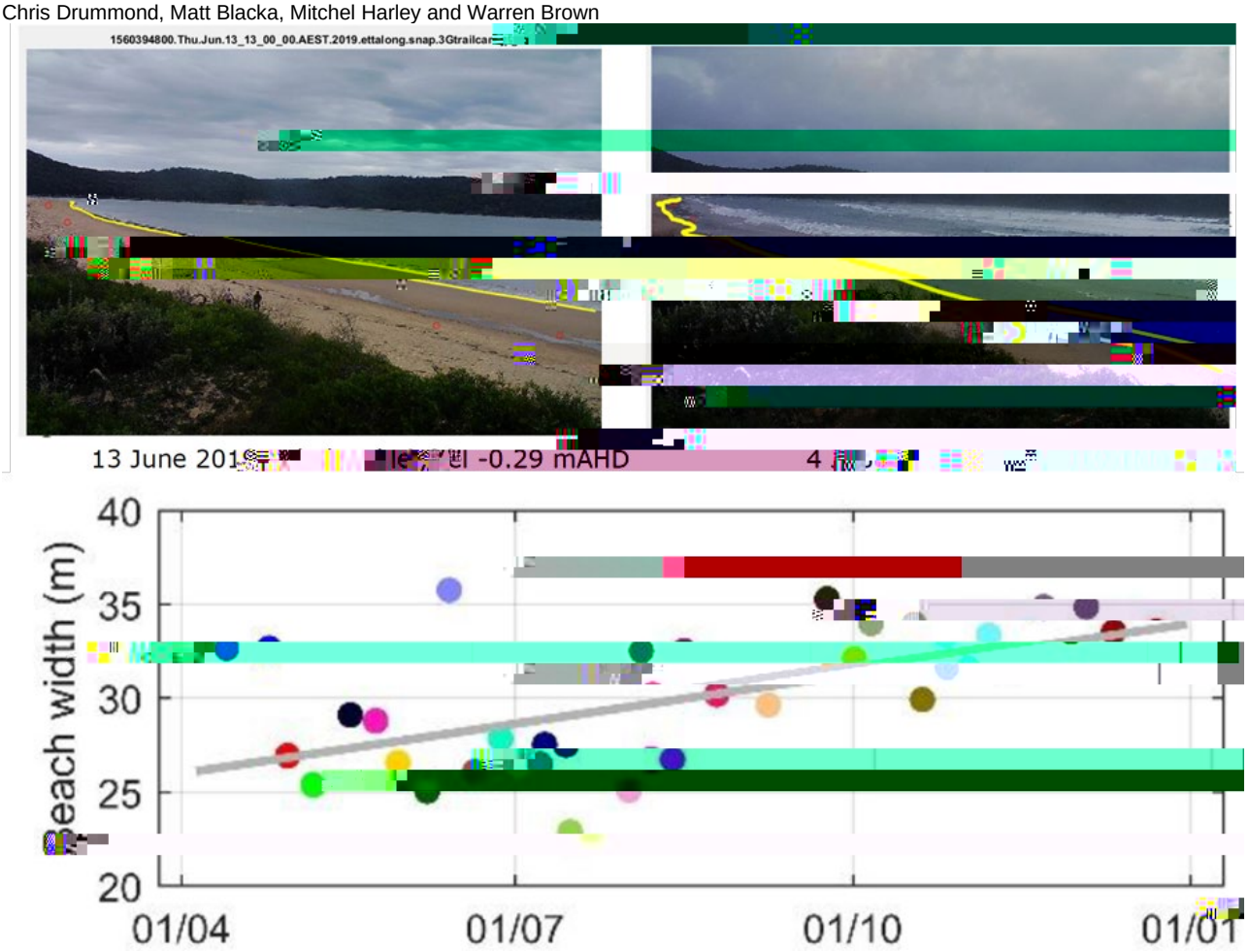

Figure 6 Results of shoreline analysis of Ocean Beach, NSW throughout 2019 during a beach nourishment exercise involving placement of 10,000m3 of beach material dredged from the adjacent navigation channel.

3. Results

3.1 Shoreline monitoring

Results of shoreline monitoring of the nourishment exercise at Ocean Beach identified an overall accretionary trend at a rate of +1 m per month for the period between April and December 2019 (Figure 6). The widest beach width identified during the monitoring period occurred on 13th June 2019 when a low tide terrace bar welded to the shoreline, whereas the most landward waterline captured during monitoring occurred on 4th June 2019 midway through a major storm. The accuracy of camera derived shorelines were investigated through comparison with in situ field measurements collected via drone photogrammetry (Figure 7). This comparison identified shoreline positions were located within +/- 1 m horizontally from both techniques. These results demonstrate confidence in the accuracy of the camera derived shorelines which were able to provide monitoring data at a much higher temporal frequency than the drone survey deployments at a much lower cost.

Shoreline monitoring was also used to quantify the impact on Wamberal Beach caused by a severe weather event that impacted the NSW coastline between the 14 and 19 July 2020. The event, termed an East Coast Low, created large wave conditions that resulted in significant damage to beachfront properties at Wamberal Beach [3]. The storm produced a peak significant wave height of 6.9 m from a south-east direction and was the sixth most severe storm to occur over the past 62 years based on cumulative storm energy [3]. The response of Wamberal Beach to this storm event has been quantified through shoreline analysis from our smart camera system (Figure 8). This analysis identified a generally stable beach in the months leading up to the storm before rapidly narrowing by 30 metres over the course of a few days.

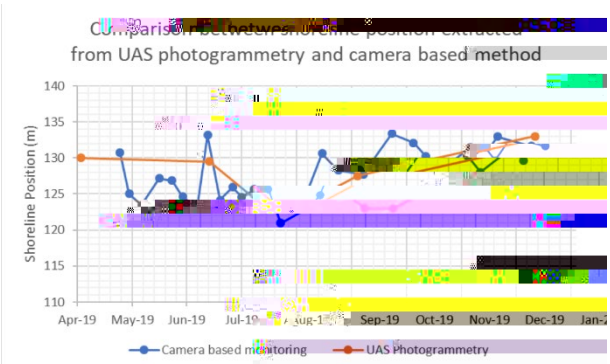

Figure 7 Comparison between camera derived shorelines and shorelines measured in situ using drone photogrammetry

Figure 10 Results of machine learning based beach visitation data over a 12 month period at Ocean Beach showing seasonal trends (top), trends in time of day (bottom left), day of the week (bottom centre), and month of year (bottom right).

While there is room for further improvements in the accuracy of the beach user detection model used in the study, the method is likely to yield more reliable data compared to manual headcounts from lifeguards which can be subjective and inconsistent. Further improvements in this model should focus on efforts to identify how users are using a beach through detection of multiple classes such as sunbaking, dog walking, swimming or surfing. Combining this analysis with the remote camera systems outlined in this paper has huge potential to improve beach safety in unpatrolled locations by pairing this analysis with rip detection techniques. This study has demonstrated the value of using low-cost smart cameras to quantify patterns in beach usage at unpatrolled beach locations. Through the simple yet innovative system, a significant amount of information is able to be unlocked to greatly assist with beach safety planning.

5. Conclusions

A smart camera system has been detailed in this paper and has been shown to provide a cost-effective solution to unlock unprecedented information about shoreline change and beach visitation data. This information is becoming increasingly critical as we attempt to understand the value of beaches to our communities and develop sustainable future management strategies to protect our beaches for future generations.

6. References

[1] Anning., D (2012). “Estimation of the economic importance of beaches in](or)-613.4 (ID hpor)17 (7 -1.16 Td[(i)-0.( ](or)(“E4 /MCID 11 BDC /-0.0L(or s)-4 (ID