2D AND 3D MAPPING OF A LITTORAL ZONE WITH UAS AND SfM PHOTOGRAMMETRY

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Accurate and inexpensive mapping of the littoral zone along the coast has implications in land management, cadastral systems, and erosion and habitat monitoring. The potential for conducting littoral surveys with small-scale unmanned aircraft systems (UAS) could provide for a cost-effective method to obtain accurate elevation and boundary data in areas difficult to access. Furthermore, traditional GPS surveys utilized for monitoring purposes at times are cost-prohibitive and UAS-derived spatial data may provide a means to survey areas where available budget cannot provide for intensive base and rover surveys. This study examines the accuracy of topographic and bathymetric elevation derived from UAS-based Structure from Motion (SfM) photogrammetry and bathymetric inversion for 2D and 3D mapping of the littoral zone. The study site is called University Beach, an engineered and restored beach, located on Ward Island in Corpus Christi Bay, TX. Ward Island is home to the main campus of Texas A&M University-Corpus Christi (TAMUCC). The UAS utilized in the research is a Sensefly eBee which navigates using an onboard autopilot coupled with GPS, inertial sensors, magnetometer, and wind speed/pressure sensor. The UAS can be programmed with a planned flight path for designing data acquisition at a specific side-lap and end-lap percentage and ground sample distance. The system is equipped with a Canon IXUS 16 megapixel consumer-grade RGB (3-band) handheld camera.

Several key components were analyzed in order to assess the accuracy and usefulness of elevation derived from the UAS/SfM approach. First, accuracy of the 3D point cloud produced by the SfM densification process over the sub-aerial beach is analyzed by comparing residuals between differentially corrected cross-shore RTK GPS transects and the UAS-derived point cloud data. Secondly, a contour representing the MHHW shoreline for Corpus Christi Bay (0.49 m) is interpolated using the UAS-derived DEM and the contour horizontal position and morphologic integrity is compared to in-situ RTK GPS observations using the currently accepted method for conducting legal littoral boundary surveys in the state of Texas. Finally, bathymetric measurements extracted from the UAS-derived point cloud are compared to a bathymetric inversion approach that uses the attenuation in the three spectral bands of the UAS camera to derive an estimate of water depth.

The analyzed imagery dataset was flown at an altitude of approximately 90.5 m above mean sea level resulting in a mosaicked ground sample distance (GSD) of 2.9 cm. The high density point cloud was filtered to produce a point cloud with an average point spacing of 19 cm to remove noise. Average horizontal RMS error from observed targets (RTK GPS) and the UAS-derived value was 2.2 cm. Average vertical error on the sub-aerial beach relative to the RTK GPS cross-shore transects was estimated to have a RMS of 16.4 cm. In the submerged beach, vertical uncertainty of SFM-derived bathymetry increased with an RMS of 28.7 cm in water depths less than one meter(non-refraction compensated). Comparison to bathymetric inversion is ongoing as initial results have indicated substantial error due to image to image irradiance differences; normalization and high frequency filtering should improve results. Finally, the point cloud data was interpolated into a high-resolution DEM to model the sub-aerial beach and derive a shoreline contour. Average distance separation along the transects between the UAS-derived MHHW contour and GPS-derived MHHW contour was calculated to be approximately 0.28 m. Preliminary results indicate the potential for obtaining survey-grade quality data for sub-aerial mapping of the littoral zone using small-scale UAS equipped with non-metric, high resolution imaging cameras.