The Benefits and Limitations of using UAS-SfM versus Airborne Lidar to Monitor Coastal Environments

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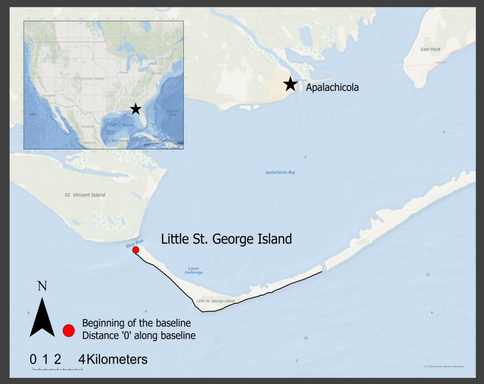
1. Introduction

Recent advancements in small unmanned aircraft systems (UAS) equipped with digital cameras have allowed for the use of UAS structure-from-motion (SfM) photogrammetry to be used as a substitute, or in conjunction with, more traditional airborne lidar techniques to survey coastal environments. UAS-SfM has been used for diverse coastal applications such as performing geomorphic feature extraction, land cover classification, and monitoring storm impacts. While UAS-SfM has its own unique set of advantages to consider for coastal applications, there are also challenges associated with its use compared to that of traditional lidar. ***This study investigates the respective advantages and limitations of using UAS-SfM by referring to personal research utilizing UAS-SfM to investigate the impacts of Hurricane Michael on Little St. George Island, a barrier island off the coast of Florida.***

2. Research Methods

Small UAS platforms have been used to collect overlapping, high-resolution imagery of Little St. George Island annually beginning in 2016.



STUDY AREA

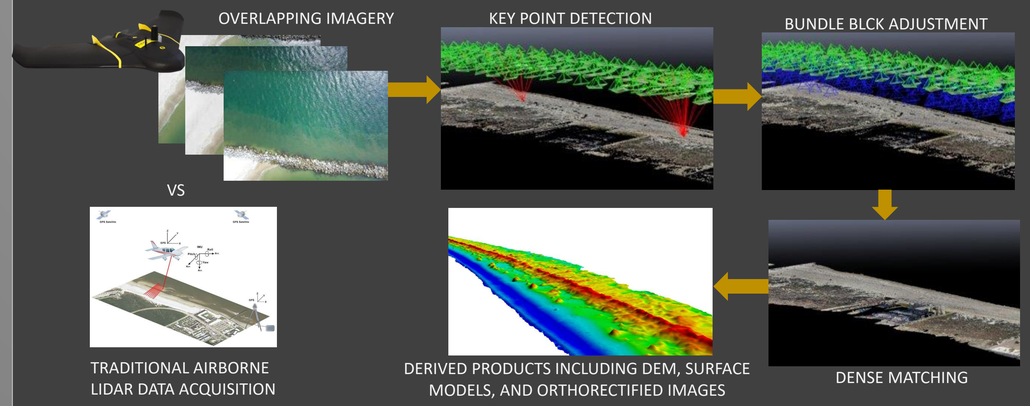
2.1. UAS Image Acquisition for SfM

- Overlapping imagery were obtained with a small UAS platform equipped with an RGB digital camera
- Established independent check points with a valid GPS to determine the vertical accuracy of derived UAS-SfM products and models
- Georeferencing was completed using post-processing kinematics (PPK) GNSS
    - Advantageous because the 15 km linear length of the beach could be mapped in a day using PPK or real-time kinematics (RTK) versus four days it originally took using a series of ground control points (GCPs) along the island

GCPs

2.2. Data Processing and Data Products

- The imagery was processed using SfM to derive high-density point clouds that were then filtered to isolate ground points and utilized to produce a digital elevation model (DEM)
    - DEM vertical accuracy was determined using the check points



- The DEM was utilized in conjunction with an airborne-lidar derived DEM to evaluate the following impacts of the storm:
    - Volumetric changes, evolution of the dune crest and toe, horizontal movement of the dune crest, dune toe, and shoreline

3. Results

3.1.Advantages of UAS-SfM

- At local scales, the use of UAS-SfM can be an affordable and flexible option to obtain data
- Generates high density, textured point clouds that can be used to produce high-resolution elevation models, surface models, and orthorectified images
    - In example, a 2018 UAS-SfM survey produced a 300 point/m^2 point cloud and was used to produce a 0.1 m DEM
- Capable of achieving high vertical accuracy over bare earth environments such as an exposed beach
    - In example, the 2018 UAS-SfM derived point cloud achieve a bare earth vertical RMSE of 0.11 m at 95% confidence compare to a publicly-available airborne lidar-derived model of the study area at 0.196 m RMSE at 95% confidence
- Capable of being utilized in conjunction with the other geospatial data for quantifying volumetric changes, and assessing the evolution of dune crest and toe

3.1.Disadvantages of UAS-SfM

- Highly dependent on weather conditions to deploy the UAS, most noticeably wind and is limited to scale of coverage due to endurance and regulation limitations
- Dynamic surface features and image texture can cause noise and data gaps due to the nature of SfM
- Limited bare earth extraction under vegetation to acquire ground points because of its single-return technique versus the multi-returns of most airborne lidar systems

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