A Low-cost Unmanned Aerial System (UAS) for Mangrove Mapping and Monitoring

Un Drone à Bas Cout pour Cartographier et Surveiller les Mangroves

Un Dron de Bajo Costo para Cartografiar y Monitorear Manglares

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EXTENDED ABSTRACT

Introduction

Mangroves provide a variety of ecosystem services to coastal communities and are increasingly threatened throughout the Gulf and Caribbean. Mangroves protect coastal areas from ocean waves, including those produced by storms. They also help prevent erosion by stabilizing sediments with their complex root systems and maintain water quality and clarity by filtering pollutants and trapping sediments. In addition, they serve as valuable habitat for many critical species, particularly as nursery areas, providing food supplies and refuge from predators.

Small Unmanned Aerial Systems (sUAS) provide several unique advantages over manned aircraft survey for monitoring and mapping mangrove habitats. These advantages included higher spatial resolution and more frequent temporal resolution. In addition, acquisition cost, pilot training cost as well as maintenance and storage costs all contribute to a much lower cost for data collection.

Methods

We demonstrate a new monitoring tool using a relatively inexpensive sUAS used to create very high resolution (<5cm) othophoto mosaics and digital surface models (DSMs) of various mangrove forests around the Caribbean. Our sUAS used in this project consisted of a modified 3DR Solo. The 3DR Solo is a consumer platform that can be purchased at many retail outlets ranging in price from $250-$1,000. One advantage of this platform is the ability to modify both the hardware and software that controls the vehicle. Our modifications were to adopt an additional camera payload and trigger that camera using a relay connected to the onboard computer. Loaded onto this onboard computer was an updated script loaded that aided in triggering the camera at the proper intervals to achieve the proper overlap in the images. This additional camera that we attached to the platform was a low-cost, modified, commercial camera system capable of acquiring co-registered multispectral data (Blue, Green, Red, NIR) for each mangrove site. There were two different camera systems used. At the beginning, we used modified GoPro cameras and later we used a modified Sony Qx1. In each case the modification allowed the collection of data into the near infrared portion of the spectrum.

Well established remote sensing research has repeatedly demonstrated that several indices that utilize near-infrared (NIR) and red reflectance correlate well with many vegetation metrics (e.g. biomass). The most commonly referenced index being the Normalized Difference Vegetation Index (NDVI):

$$NDVI = NIR – Red / NIR + Red$$

Our study sites included many of the larger mangrove stands in St. Lucia, as well as a number on the Genadines, particularly Union and Carriacou Islands.

Results

Analysis was performed to quantify and model various biophysical measurements related to the mangroves (NDVI, height, biomass, structure, etc). The results demonstrate that the sUAS platform and camera system is a viable tool for resource managers to map and monitor mangrove environments at very fine scales (Figure 1).

KEYWORDS: UAS, drones, conservation, mapping

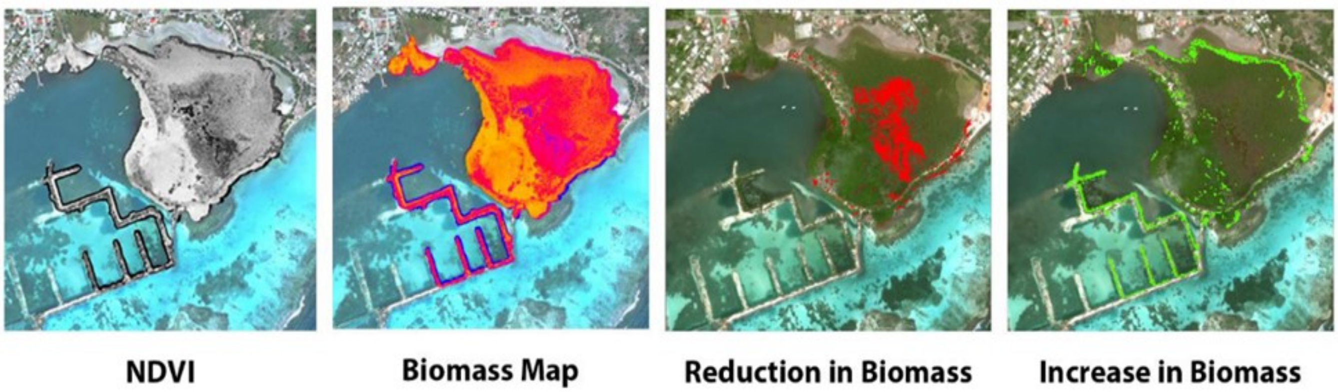

Figure 1. sUAS imagery is used to create an NDVI map shown in the first image. This NDVI map is correlated to biomass field measurements and the resulting relationship is used to make a map of biomass depicted in the second image. Finally, biomass maps created at different time periods are differenced to examine change as shown in the last two images. In these figures the background imagery is from Google Earth. The sUAS data was compared with earlier high resolution satellite data to produce the differences shown in biomass.