Final report for:
Unmanned Aerial Vehicles for early-detection and mapping of introduced plant species (Grant C53001)

2017

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Project title: **Unmanned Aerial Vehicles for early-detection and mapping of introduced plant species**
Report Submitted: **February 6, 2017**
Grant Number: **C53001**
Award Amount: **$35,000**

Grant Expenditures:

$30,000	Purchase of $40,000 hyperspectral sensor, the Headwall Hyper NanoSpec with accompanying software (in combination with funds from other grants)
$3,489	Purchase of calibration tarps for radiometric calibration of hyperspectral data
$33,489	**Total**

Summary Findings:

- UAVs are an increasingly effective and viable tool for invasive plant surveys and monitoring, especially in areas with dense vegetation and other characteristics that impede foot-travel. They should be widely adopted for invasive plant monitoring and detection in Hawaii (please attached Perroy et al. 2017 paper).
- The new Federal Aviation Administration regulations (Part 107) make it much easier and straightforward to engage in sanctioned UAV operations, though important restrictions (visual line-of-sight, operations near airports) must still be considered.
- Multicopter UAV platforms, despite their shorter flight times, are generally more practical than fixed-wing platforms for working in challenging tropical environments (Figure 1).
- The complexity, cost, and massive data files associated with hyperspectral data collection, makes it impractical for normal operations, although hyperspectral results can help guide the selection of lower-cost multispectral sensors that are target-specific (figure 2).
- Ground and helicopter surveys are still needed, though UAS surveys can supplement these efforts and reduce overall costs in certain environments. It is getting easier to envision a fully autonomous surveying (and potentially herbicide application) future via UAS platforms.
- Human analysis for the identification of individual plant targets of concern within the collected imagery is a major bottleneck, and automating these tasks via machine learning algorithms that can quickly scan through hundreds of acquired images should be an area of top priority (Figure 3).

Figure 1. Example imagery of Miconia calvescens, taken at 200 ft agl using a point-and-shoot RGB camera from a multicopter UAV platform (top), and from 400 ft agl with a NIR fixed-wing UAV platform

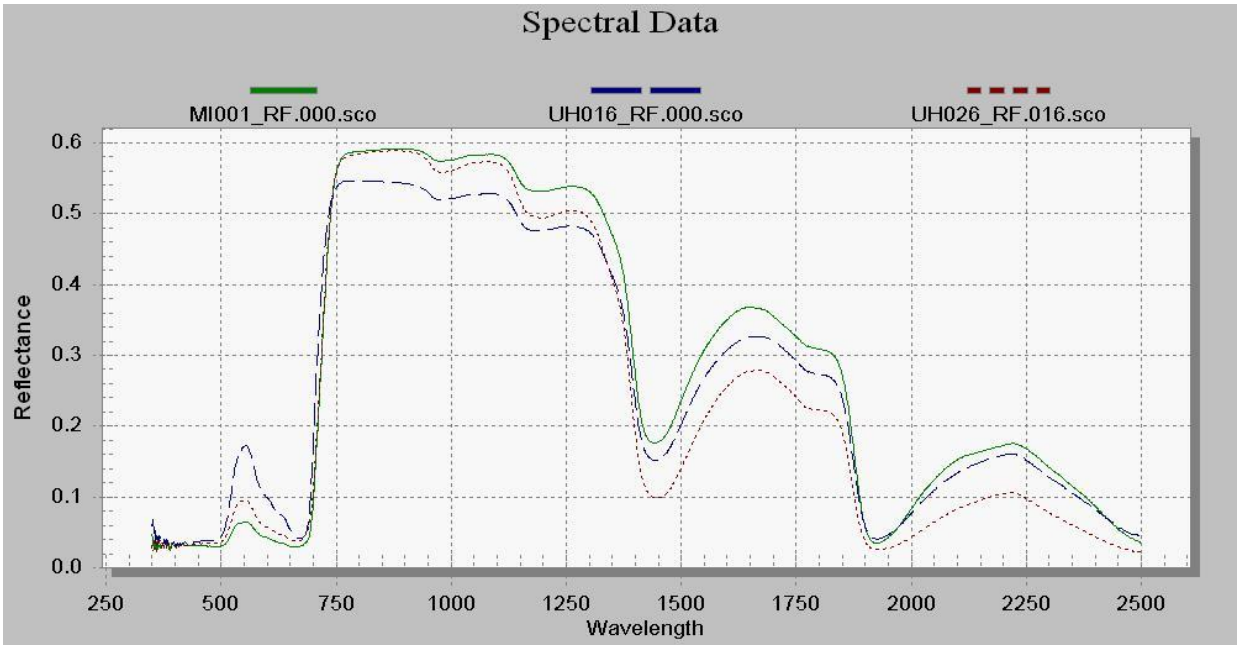

Figure 2. Example collected spectral signatures of three different invasive plants from forest outside of Pahoa, Hawaii: Miconia, Albizia, and Strawberry Guava, using an ASD spectroradiometer leaf-clip. UAV hyperspectral sensor is sensitive between 400-1000 nm.

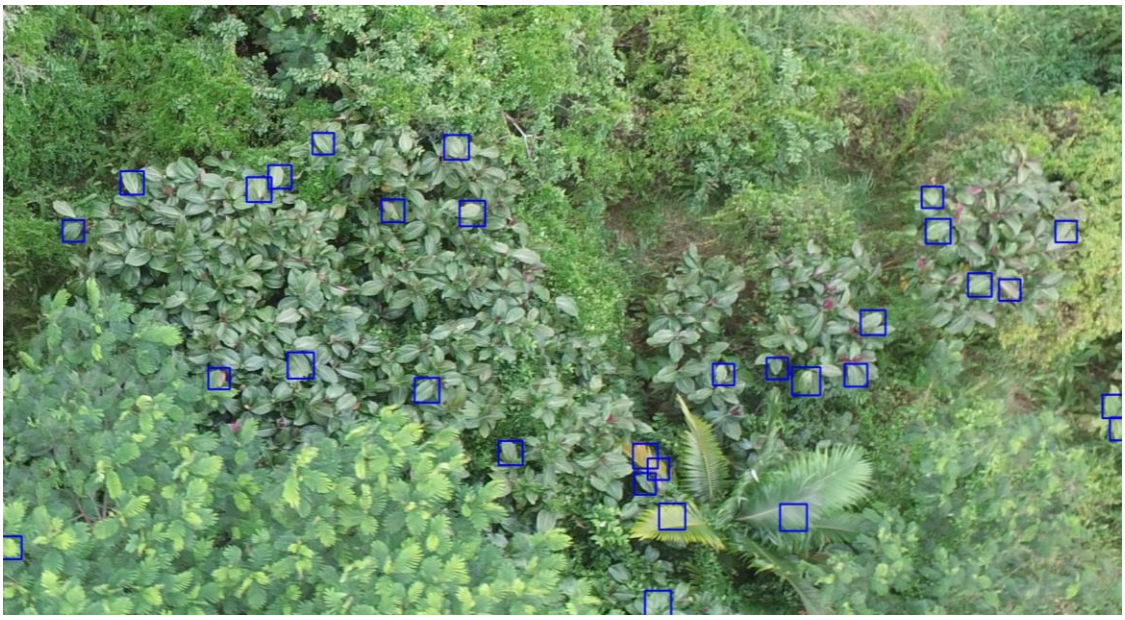

Figure 3. Example of results from automated Miconia detection algorithm being developed by UH Hilo SDAV lab to increase the speed at which imagery can be processed to detect invasive species. Algorithm developed in OpenCV by C. Saragosa.

Products:

Peer-reviewed paper

- Perroy, R. L., Sullivan, T., & Stephenson, N. (2017). Assessing the impacts of canopy openness and flight parameters on detecting a sub-canopy tropical invasive plant using a small unmanned aerial system. ISPRS Journal of Photogrammetry and Remote Sensing, 125, 174-183.

Conference Presentations

- Perroy, R. (2016) Some Selected Environmental Applications of UAS on the Big Island, 2nd University of Hawaii System Workshop on UAS, May 18, Honolulu, HI. Invited
- Domingsil*, J., and Perroy, R. (2015), Using unmanned aerial vehicles and object-based image analysis to detect Miconia calvescens on Hawai'i Island, Poster session, Hawaii Space Grant Symposium, November 21, Honolulu, HI.

Datasets

- 40+ successful UAS flights and derived spatial datasets over hundreds of acres covering a variety of Hawaiian invasive species
- Initial development of an 'invasive species spectral library' (Figure 2)

Ongoing projects:

- Automated computer vision algorithms for the detection of Miconia from UAS imagery
- Comparison of the efficacy of using hyperspectral imagery vs. visible imagery for the detection of invasive vegetation plant species