Warren J. Baker Endowment for Excellence in Project-Based Learning
Robert D. Koob Endowment for Student Success

FINAL REPORT

I. Project Title
Feasibility of UAV Technology to Promote Crop Yield and Health through Normalized Difference Vegetation Index Imaging

II. Student(s), Department(s), and Major(s)

(1) Derek Myers, Charlie Ross

(2) BioResource and Agricultural Engineering Department

(3) BRAE

III. Faculty Advisor and Department
Bo Liu, BRAE

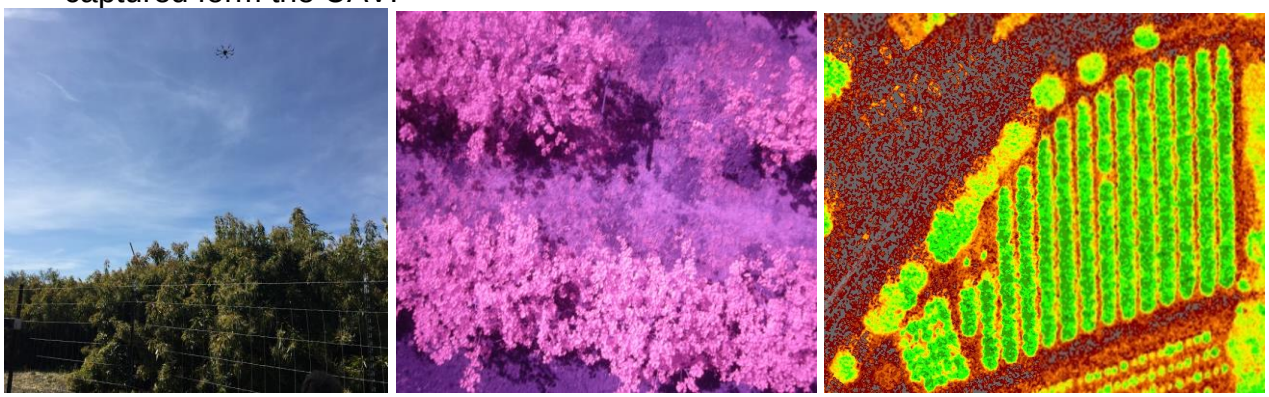
IV. Cooperating Industry, Agency, Non-Profit, or University Organization(s)
Dr. Balaji Sethuramasamyraja, CSU-Fresno

V. Executive Summary
In this project, a high payload octocopter/unmanned aerial vehicle with crop health monitoring capabilities was developed. The developed UAV could carry various sensors/devices (up to 25 lbs.) and fly over a Cal Poly farm field (about 15 mins flight time) to take color infrared images. The recorded images were later stitched together and georeferenced to create NDVI (Normalized Difference Vegetation Index) maps via ERDAS software. The results showed that the NDVI maps could be used to indict plants' photosynthetic activity/health since different plant surfaces reflect different types of light differently. The NDVI maps (Cal Poly HCS North B field) generated via this UAV platform were validated by comparing them to maps generated by TerrAvion (TerrAvion provides weekly NDVI and Thermal maps of all Cal Poly farms).

VI. Major Accomplishments
(1) Developed an octocopter with color infrared imaging capabilities. Figure 1 shows the developed UAV at Mechatronics Lab, BRAE, Cal Poly. The UAV is cable of lifting up to 25 lbs devices and flying about 15 mins.

Figure 1. Students working on the UAV

(2) Determined the practicality of using NDVI imaging on drones for crop health assessment based on accuracy and precision. Figure 2 shows some sample images captured form the UAV.



a) b) c)

Figure 2. The developed UAV imaging system. a) The flying UAV working above a Cal Poly orchard; b) one raw image (color infrared image) taken by the UAV; c) developed NDVI map (green presents high photosynthetic activities, yellow presents low photosynthetic activities and red shows presents no photosynthetic activities)

(3) Attended 2015 Annual ASABE (American Society of Agricultural and Biological Engineers) conference, and presented the work during the conference. Figure 3 shows Derek Myers (BRAE student) doing a presentation during 2015 ASABE conference in New Orleans.

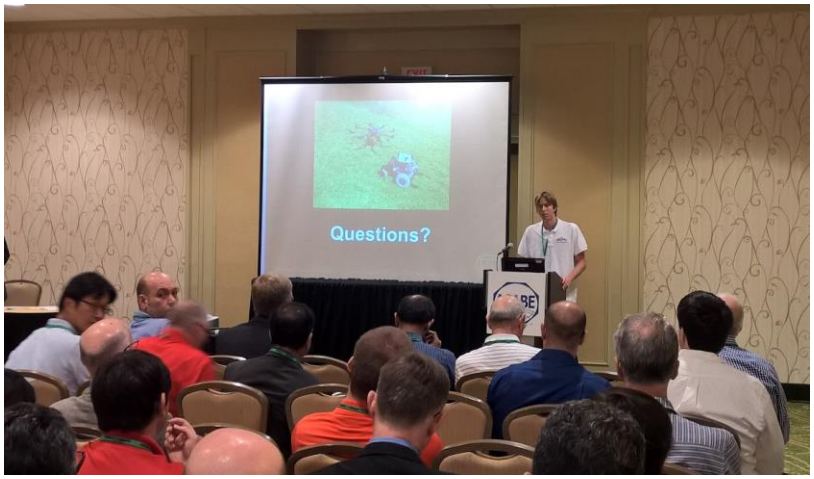


Figure 3. Derek Myers presenting the NDVI mapping project at 2015 ASABE conference

VII. Expenditure of Funds

Unit	Price/unit	Price
Cobra CM-4510/28 Multirotor Motor	$ 75.0	$ 599.9
Cobra 40A Opto Multirotor ESC	$ 39.0	$ 311.9
ZIPPY Flightmax battery	$ 103.9	$ 207.7
Futaba 14SGA 14-Channel Transmitter	$ 550.0	$ 550.0
Tarot T18 FPV Octacopter Frame	$ 600.0	$ 600.0
Tax, shipping and handling		$ 230.5
	Total	**$ 2,500**

VIII. Impacts to Student's Learning

The students participated in this project were able to integrate electronics, electricity, control systems, sensors and computer interfacing and computer interfacing and computer programming knowledge learned at Cal Poly into the developed UAV system. Students learned how to use different knowledge sets and integrated them into on complex system to solve real-world problems.

This project exposed cutting-edge technologies used in agricultural industry and research to Cal Poly students. Color infrared imaging, NDVI maps development, and wireless control of digital camera were new and advanced topics for BRAE undergraduate students. After this project, students are aware of these new technologies and methods used in agricultural productions. The results of this project will also be integrated into several on-going senior projects from CPE, BRAE, and EE departments at Cal Poly.