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Remote Aerial Mapping Spectrometer

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ELECTRICAL & COMPUTER ENGINEERING

Remote Aerial Mapping Spectrometer

CAPSTONE DESIGN EXPO 2017

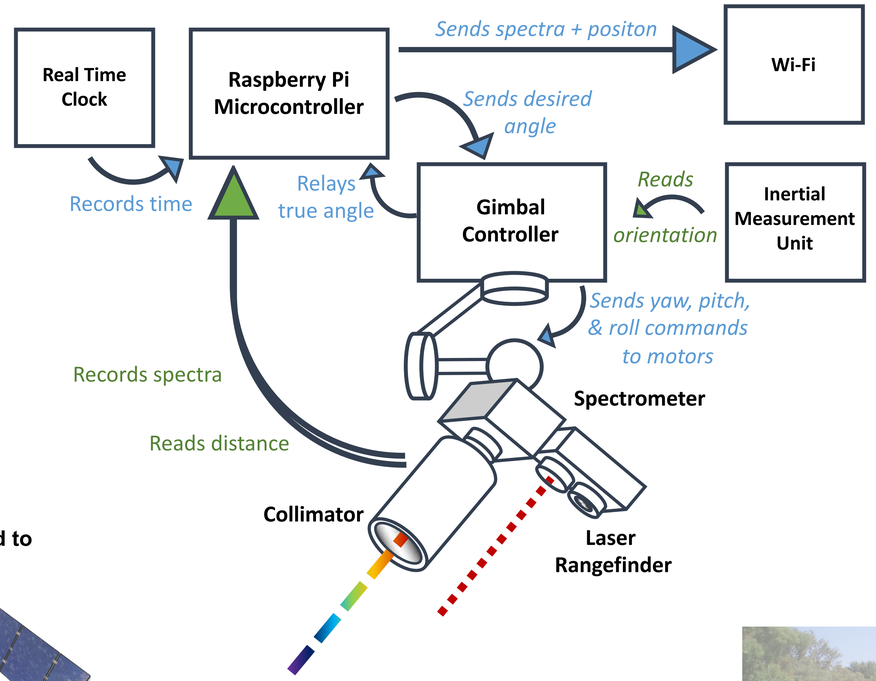
ECE-410 — **Team RAMS members:** Kenny Parker, José Ramirez, Chris Lillard, Quan Ma
Faculty advisor: Dr. Afroditi Filippas — **Sponsor:** NASA Langley Research Center — **Sponsor advisor:** Dr. Stephen Horan

A way to study our world—

We were inspired by NASA's efforts to detect harmful algal blooms (HABs). These persistent toxic aquatic events threaten the Chesapeake Bay and can be distinguished by specific photosynthetic pigments.

The Remote Aerial Mapping Spectrometer (RAMS) plots nearby surfaces' characteristic reflectance. This spectral map can be used for environment research like locating HABs, precision crop management, and monitoring invasive species.

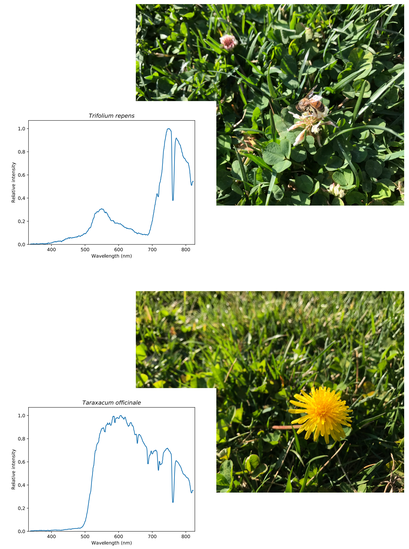
Algal bloom on the York River, credit W. Vogelbein of Virginia Institute of Marine Science



Functionality through numerous components

Our system aims its spectrometer, collimating lens, and laser rangefinder using a three-axis gimbal.

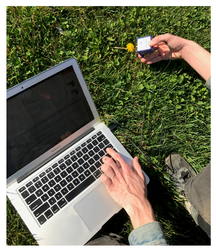
- RAMS is based on a Raspberry Pi 3 microcontroller to command orientation, gather sensor readings, and transmit data.
- The spectrometer, an Ocean Optics STS-VIS, gathers 1024 intensity samples from 350nm to 800nm of visible light.
- The collimating lens by Accuglass has a long focal length to sample spectral data from a small point: a 10 inch spot at 100 feet.
- The laser rangefinder, a Garmin LIDAR-Lite v3, rapidly scans surrounding surfaces.
- The brushless gimbal controller by Basecam directs the motors to desired angles and relays orientation from inertial measurement units.



Current spectral mapping methods:

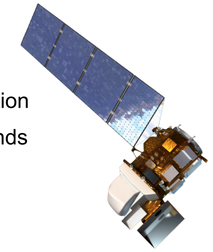
Handheld field spectroscopy

- Slow
- Tedious
- Non-mobile



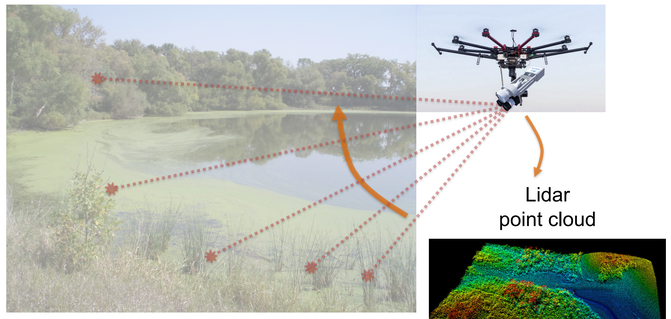
Spectral imagers mounted to aircraft and satellites

- Costly
- Low spatial resolution
- Fewer spectral bands



Dual technology sensor package

Spectroscopy reveals the chemical identities of vegetation, rock, soil, and water. The collimator gathers spectral data from a precise point. Simultaneously, a laser rangefinder distances the sample. RAMS calculates the material's position.



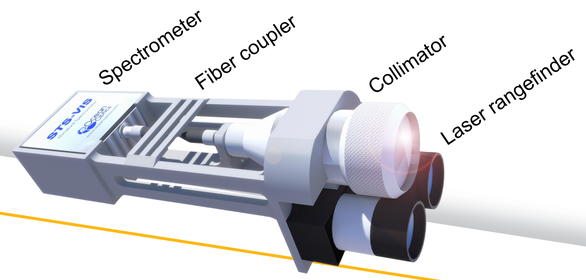
Virtualized environment display

RAMS transmits its 3D-positioned spectral data to the ground station for processing and analysis. The samples are presented as a point cloud to visualize the data's origin.

Each position point has an associated spectrometer measurement. Spectral data is smoothed and normalized for processing and classification via an artificial neural network. Position and spectral analysis are graphically presented together to provide the best interface for researchers.

The RAMS solution: an unmanned aerial system

- Faster, less expensive, more mobile and precise
- Small size, weight, and power (SWaP)
- Adaptable to various aerial vehicles
- Automatically calculates positional information



Novel design—custom production

We invented RAMS. Construction required us to design and 3D-print the sensor package and hand-etch a circuit board to integrate RAMS' many sensors and its hand-built power supply.

Unparalleled support

This project was made possible by the guidance of Dr. Filippas and Dr. Horan and through the recognition of the Sternheimer Award committee. Special thanks to the faculty of NASA Langley and to Dr. Özgür.

Mark A. Sternheimer Senior Design Award

VCU School of Engineering