Unmanned Aerial Vehicle Imaging System Creation For Water Quality Analysis

Victoria Scholl

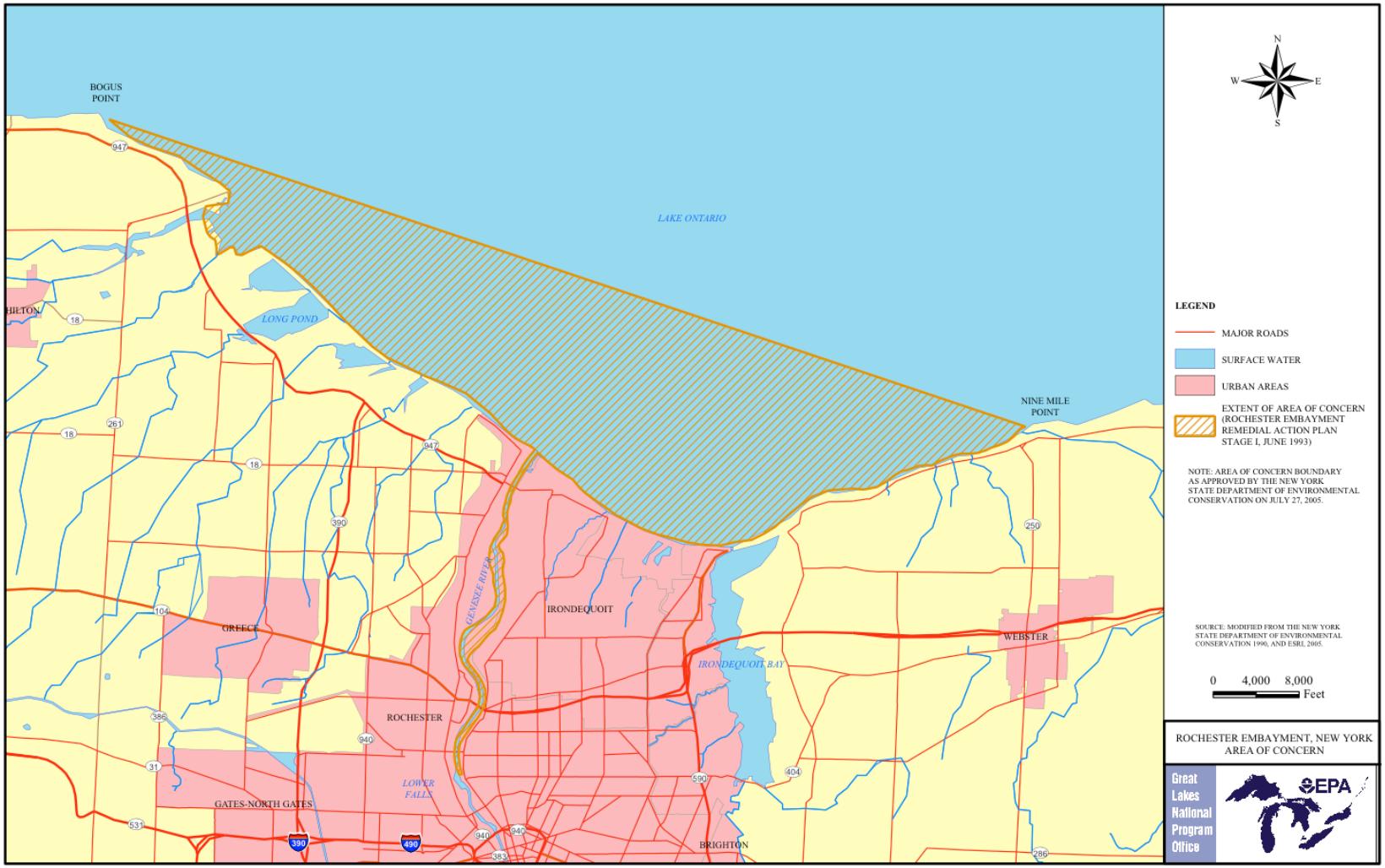
Advisor: Aaron Gerace

Committee: David Long, Carl Salvaggio

Outline

1. The Purpose
2. The Dream
3. The Team
4. The Progress
5. The Future

The Purpose


BOGUS POINT
LAKE ONTARIO
LONG POND
NINE MILE POINT
GREECE
IRONDEQUOIT
GENESEE RIVER
IRONDEQUOIT BAY
WEBSTER
ROCHESTER
LOWER FALLS
GATES-NORTH GATES
BRIGHTON
N
W
E
S
LEGEND
MAJOR ROADS
SURFACE WATER
URBAN AREAS
EXTENT OF AREA OF CONCERN (ROCHESTER EMBAYMENT REMEDIAL ACTION PLAN STAGE I, JUNE 1993)
NOTE: AREA OF CONCERN BOUNDARY AS APPROVED BY THE NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION ON JULY 27, 2005.
SOURCE: MODIFIED FROM THE NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION 1990, AND ESRI, 2005.
0 4,000 8,000
Feet
ROCHESTER EMBAYMENT, NEW YORK
AREA OF CONCERN
Great Lakes National Program Office
EPA

The Purpose

- NASA Jet Propulsion Lab Airborne Visible InfraRed Imaging Spectrometer
  - + spectral resolution (224 bands, 400-2500nm)
  - - temporal resolution (once in 1999)

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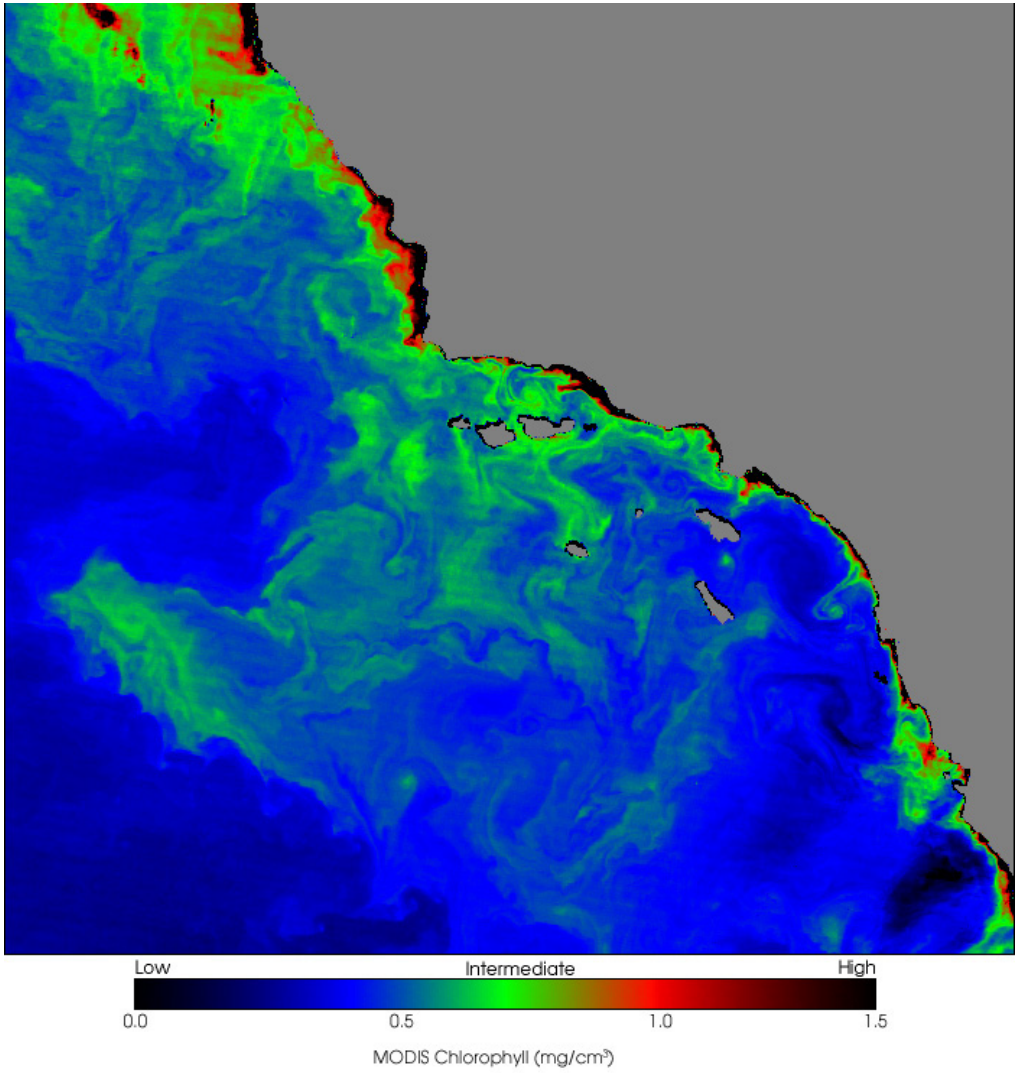
  - - spectral/spatial resolution (30m pixels)
  - - limited by presence of atmosphere & clouds
- Multispectral UAV Imaging System
  - + temporal resolution (whenever we want)
  - - spectral (any filters we want) /spatial resolution (1 inch pixels)
  - + minimal atmosphere at low altitudes

The Dream



- Fully functioning system and capture workflow
- Develop calibration protocol
- Image transfer, conversion, stitching
- Near real-time, in-water constituent mapping

The Team

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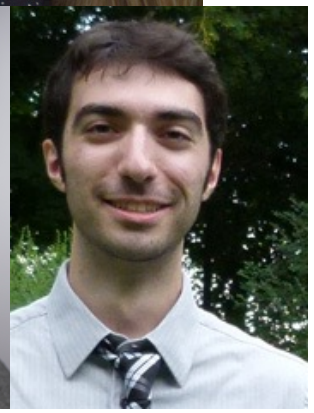

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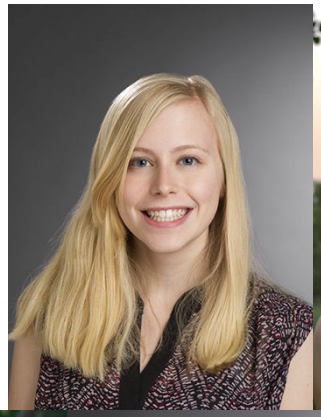


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- Drone ownership & operation
  - Zeke Hurd and Mickey
  - PJ (Papa Jeff Ring)


The Team

Jeffrey Ring

SEE RANK

Actor | Camera Department | Transportation Department

View Resume | Official Photos »

Jeffrey Ring was born as Jeffrey Alan Ring. He is known for his work on 3.14... (2014), Troop Beverly Hills (1989) and Hide in Plain Sight (1980). He has been married to Judith Ring since December 18, 1965. See full bio »

Born: Jeffrey Alan Ring

The Progress

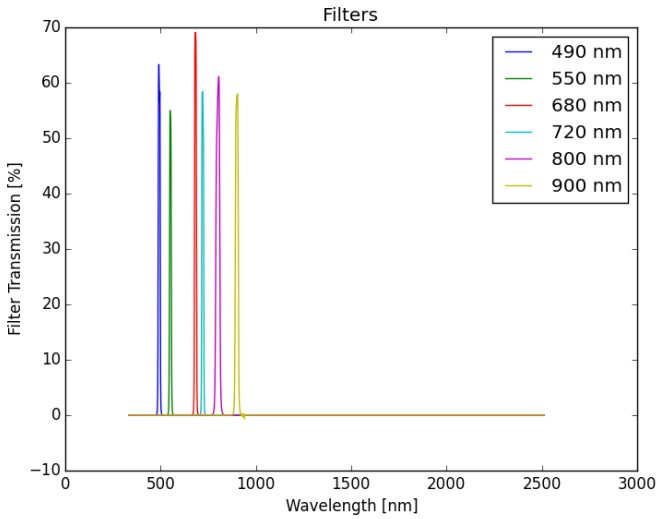
Over the summer:

- Wrote funding proposal. CIS MicroGrant awarded ($5000)
- Band selection analysis started over the summer
- Camera acquired, complications with initial testing

The Progress

Tetracam Micro Multi-Camera Array Snap ($20,000)

- 6 compact, synchronized digital cameras
- 16GB memory card per camera
- 1.3 megapixel CMOS sensors (1280x1024), 10-bit DC
- Each bandpass filter ($1,300)
- 1 master (set exposure time and geo-referencing), 5 slaves (set relative to master)
- PixelWrench2 software for image transfer and processing requires Windows 8
- Focal Length: 9.6mm
- Global shutter



The Progress

Documenting how to use the Tetracam:

- Gain, exposure time, format, capture mode

The Tetracam Checklist

I. **Turn on and Capture**

1. Connect camera to monitor
2. Plug in power cord to monitor
3. Plug in power cord to camera
4. Watch monitor screen. In diagnostic mode, should see all READY and OK statuses. Status light should turn green. Live Preview should start, with date/time/gps/image info displayed along the lower portion of the screen
5. Set capture settings
    a. Press ↵ to enter Menu
    b. Use ↑ ↓ to toggle through selections, press ↵ to select, press [camera] to return to live preview
6. Press [camera] button to start capture
7. To turn off, unplug power cord to camera (from wall/outlet)

II. Transferring Images to Computer

1. Turn on camera and monitor (Section I, Steps 1-4)
2. Plug in small end of USB cord to camera body. Plug in other end of USB to port on PC. 6 new devices/drives should appear on computer (each of the SD cards)
3. Open PixelWrench2 software
    a. If this is the first time you're using the software after installing it on a PC,
        i. Navigate to the program folder (C:/ProgramFiles/Tratracam/PixelWrench2/)
        ii. Right click on the 3 .exe files → Properties → Compatibility → Check the "Run this program as administrator" box.

The Progress

Calibration

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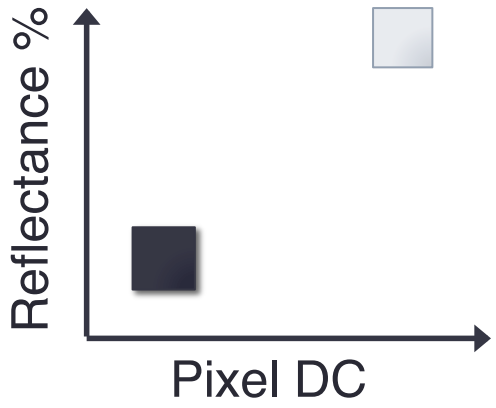
- ELM (Empirical Line Method)
- Interpolate between dark and light targets of **known reflectance**



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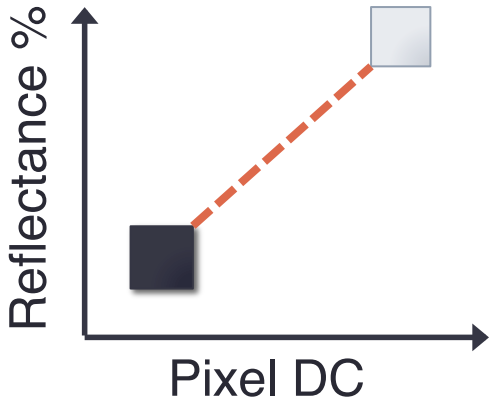

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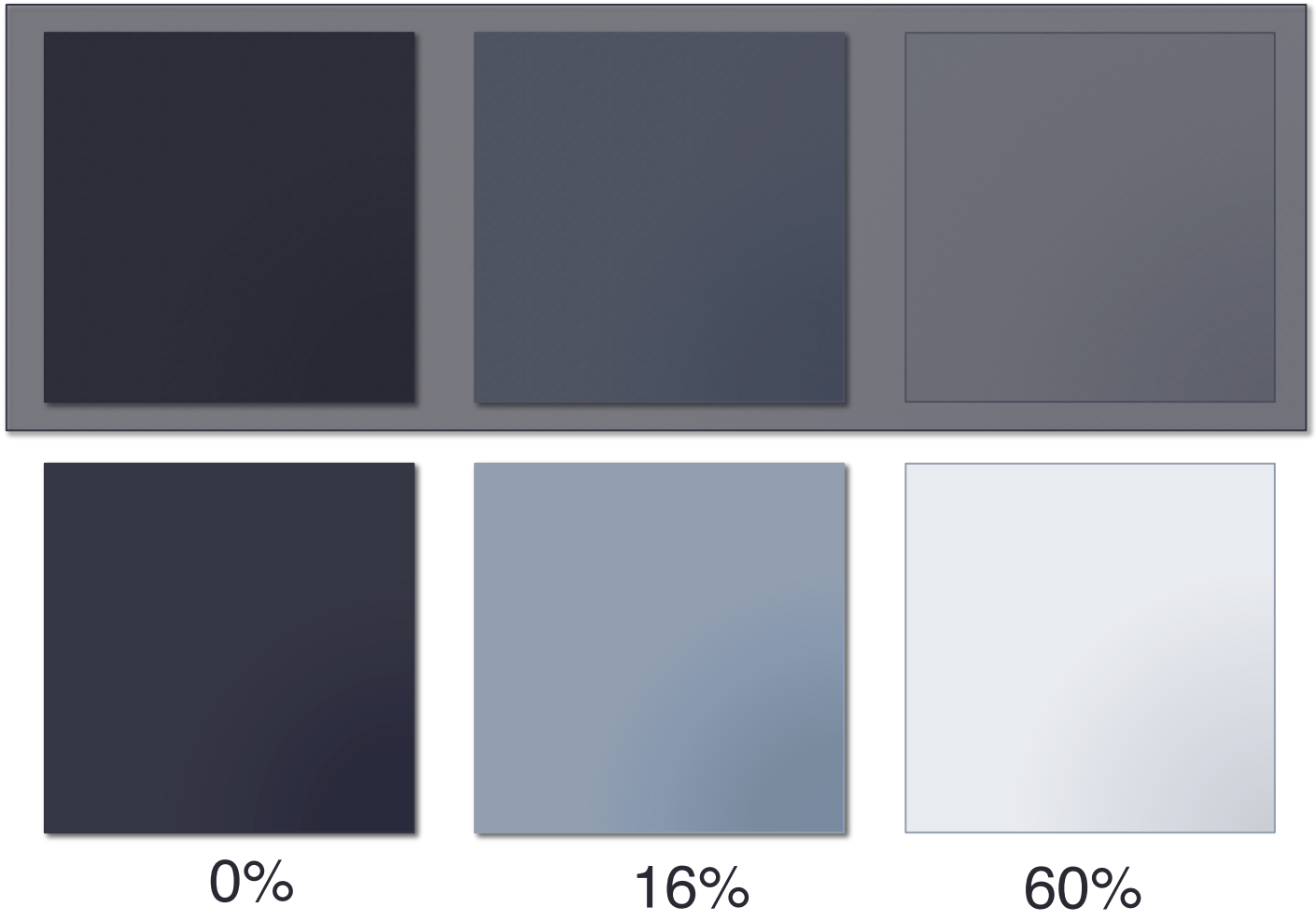

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Calibration Target Paint Reflectance

- Light, Land: 60%
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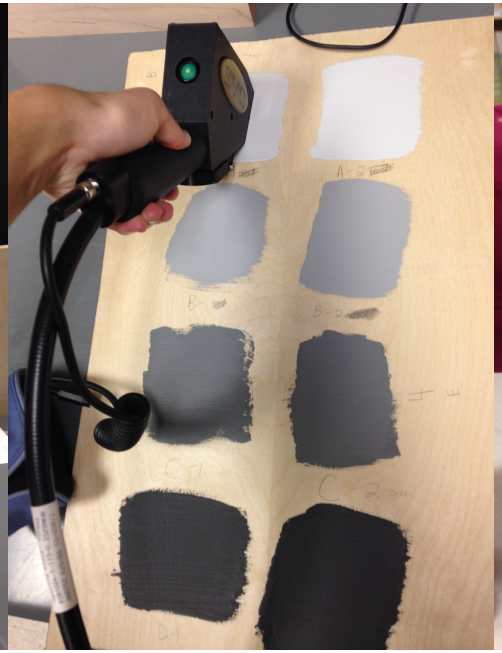

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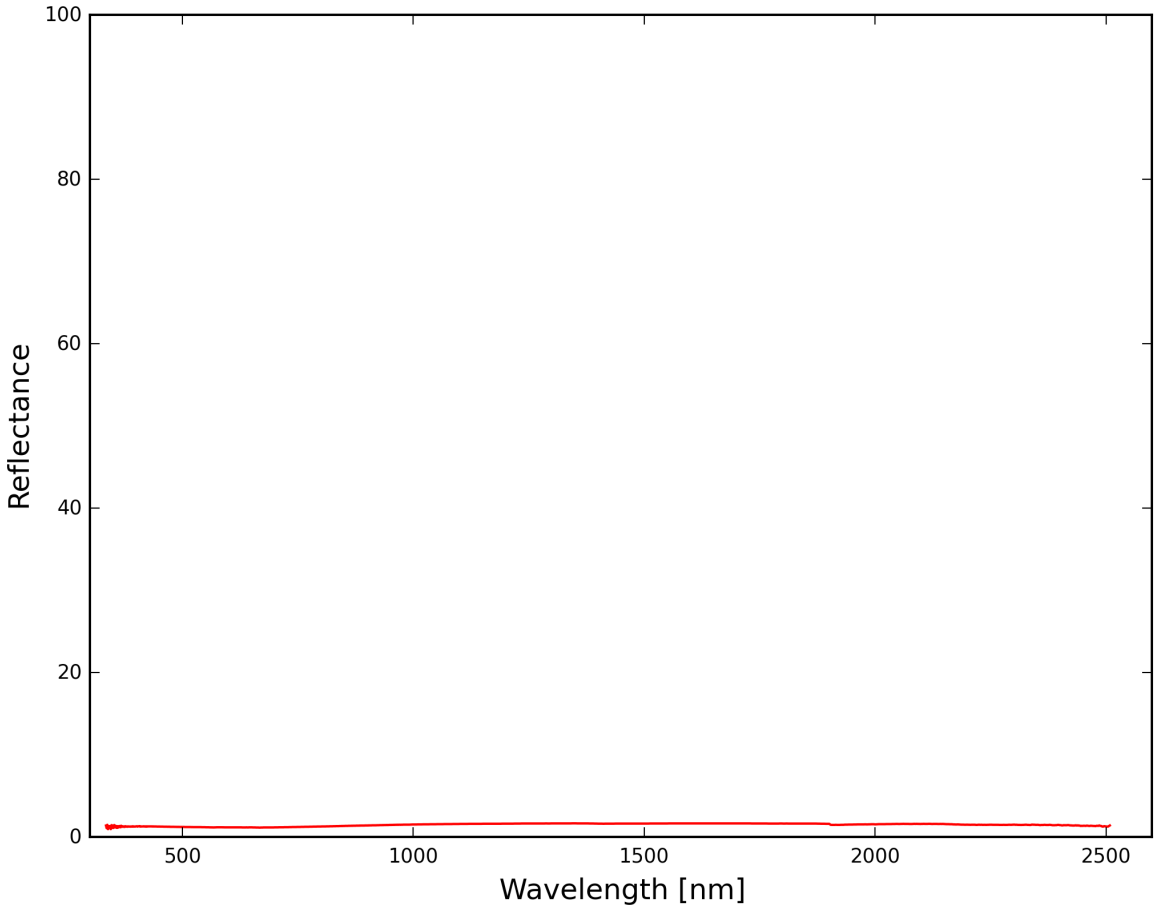

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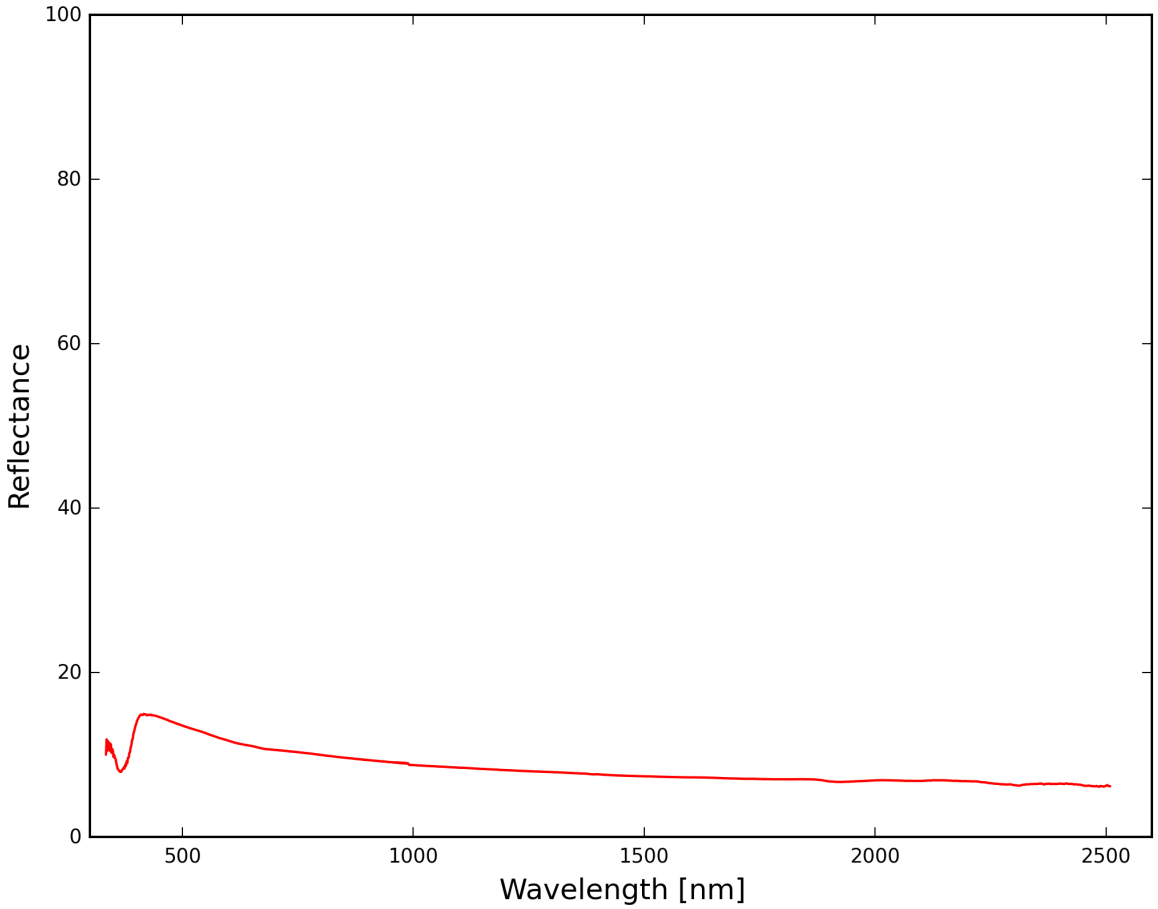

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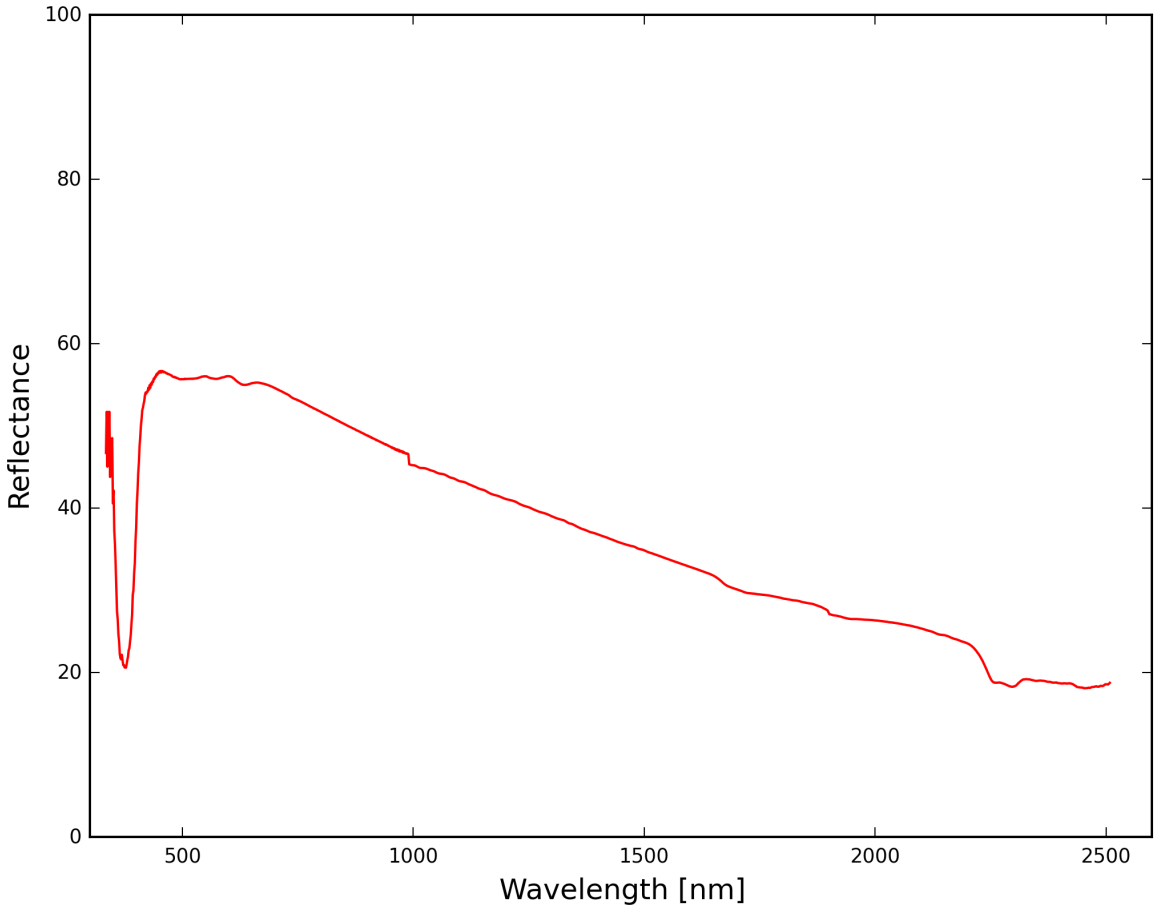
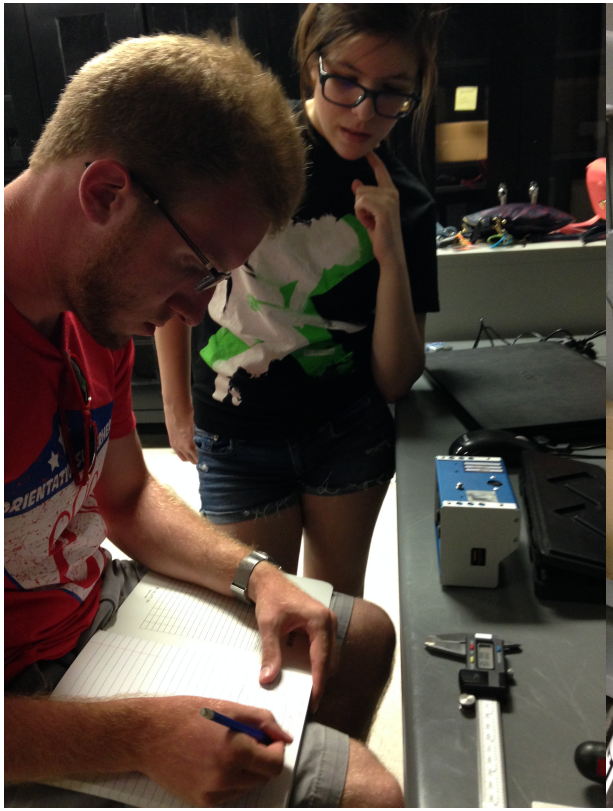
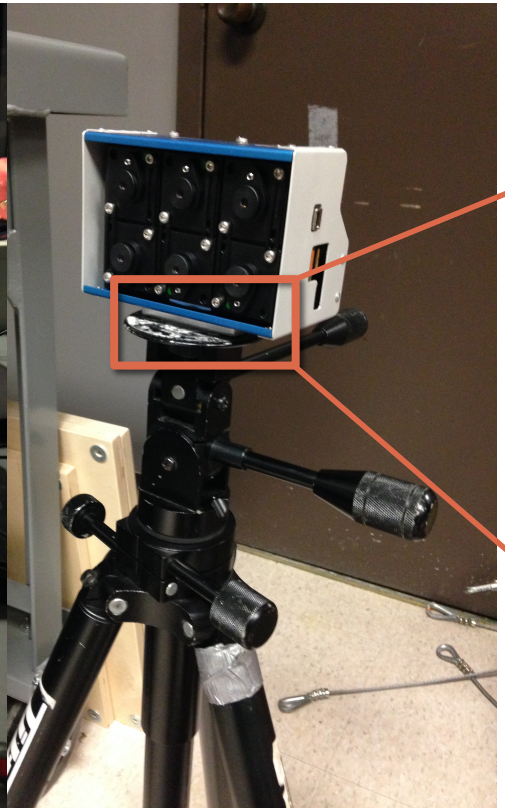


The Progress

Hardware prep

- Tetracam tripod mount

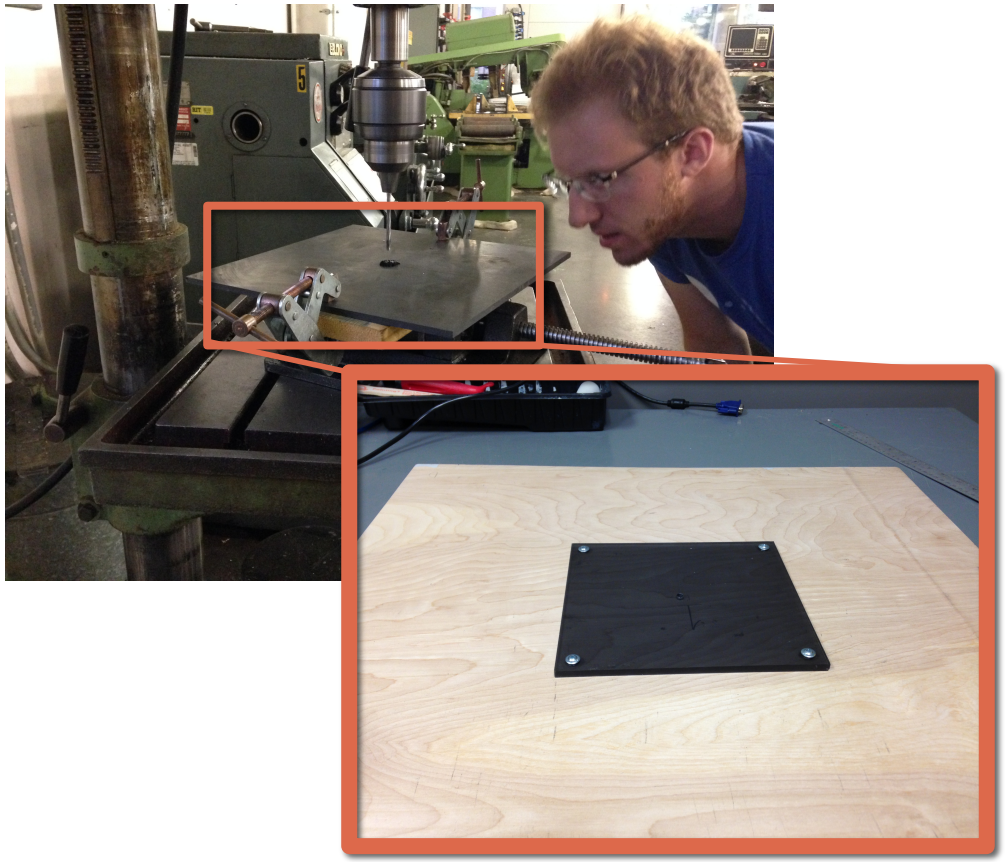




The Progress

Hardware prep

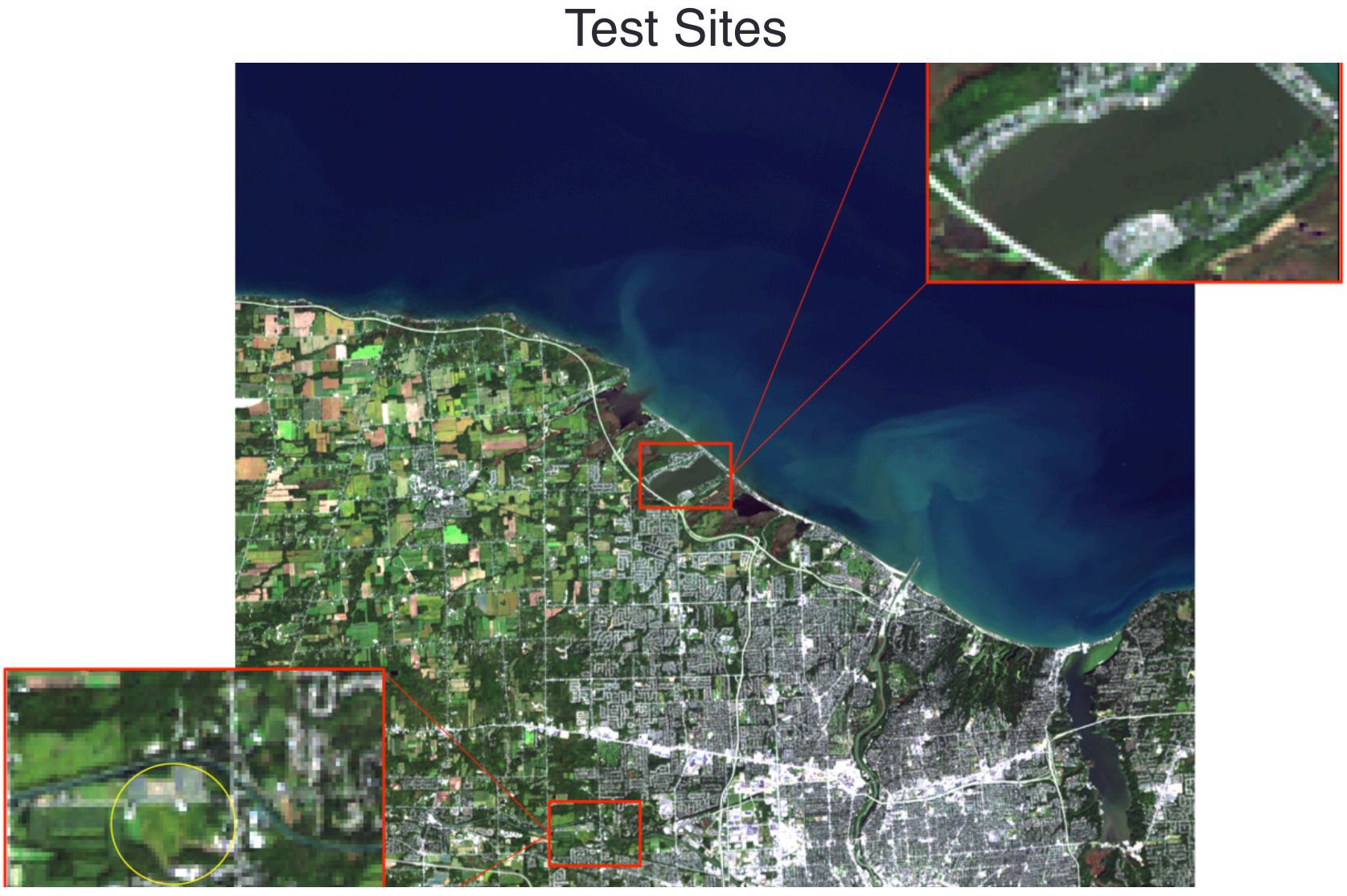
- 6 wooden calibration targets, painted, with tripod mounts
- Exposure target



The Progress

- Protocol for setting exposure
  - Need to manually set exposure time (microseconds)
  - Auto-exposure means imagery is not scientifically meaningful

The Progress



The Progress

Spreading Wings S900 drone

- Max flight time: 22 minutes

The Progress

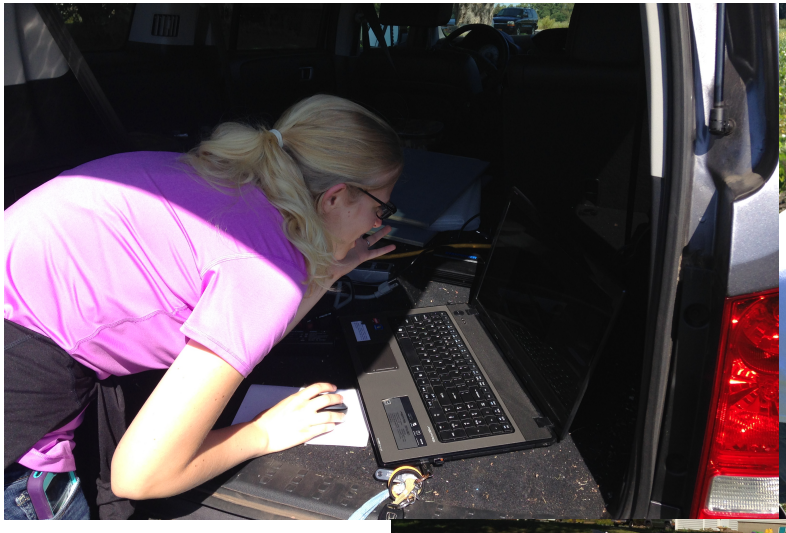
Test Flight and Initial Aerial Capture

The Progress

Setting up Calibration Targets

The Progress

Setting Exposure



The Progress

Flight over Maier's Farm Soybean Field


EMERGENCY
STOPPING
ONLY

The Progress

Imaging Long Pond

The Progress

Same-day Landsat collection, water samples taken

The Progress

- Challenges in the field
  - Windows Updates
  - Efficient exposure method determined for vegetation
  - Inefficient exposure method determined for water
  - Manual flight renders imagery useless
  - No GPS information

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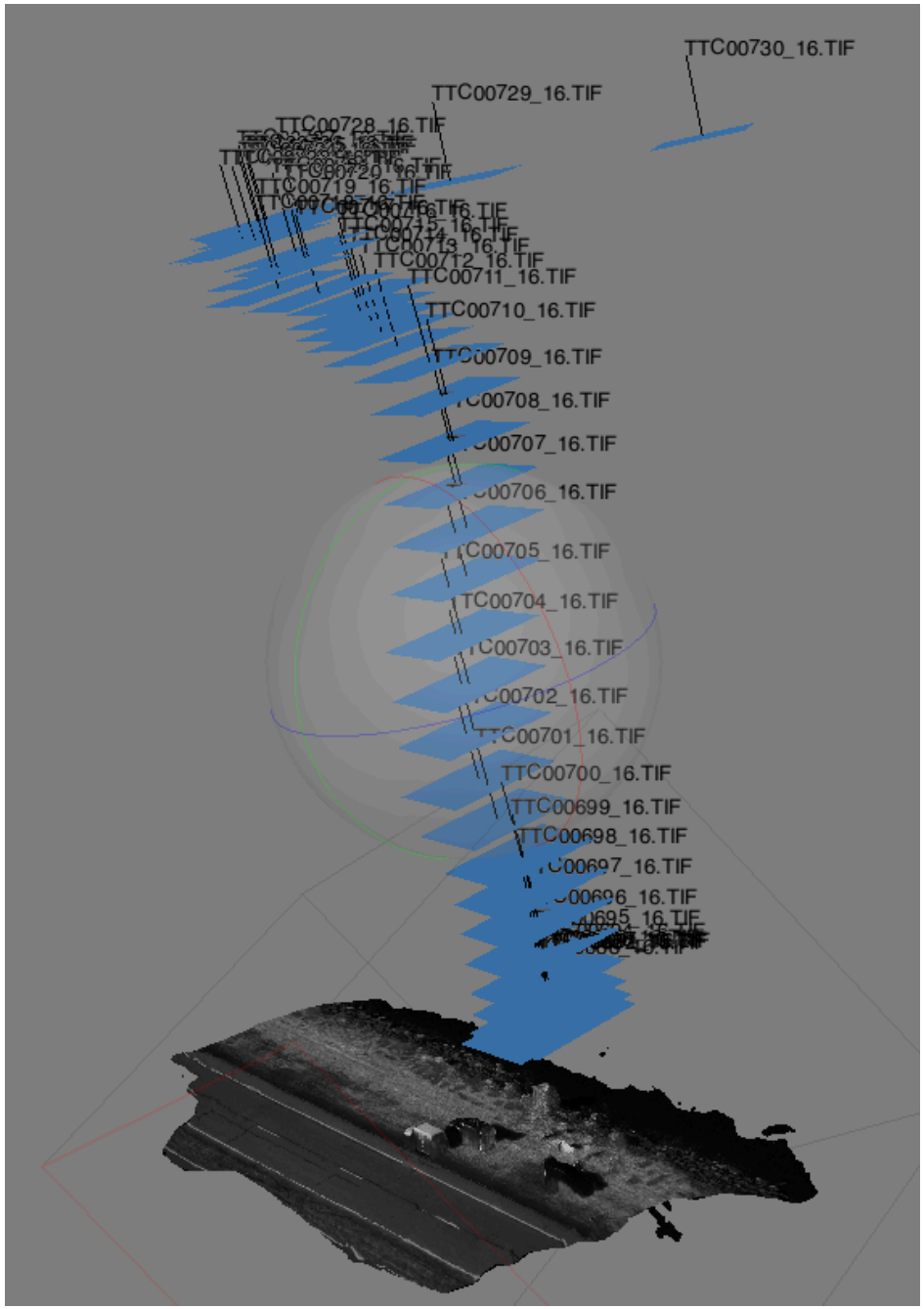

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- Water quality analysis
  - Mosaic over water
  - Multispectral analysis

The Future

Anticipated to be involved in the following:

- ~~Writing grant proposal for funding~~
- Modeling to determine spectral bands most pertinent to water quality analysis
- ~~Acquisition and integration of hardware components~~
- Learning to operate UAS & program flight collection paths
- ~~Ground truth data collection~~
- ELM Calibration to account for atmospheric effects
- Collaboration with other academic institutions for measurements
- Stitching together collected imagery
- Programming algorithms to extract water quality information from imagery
- Producing RGB and in-water constituent map for scene

KEY
~~Completed~~
In progress
Not yet attempted
Likely not going to be involved

Questions / Comments?