Design, Build, Fly a Dual-Use Unmanned Aerial System (UAS)

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Design, Build, Fly a Dual-Use Unmanned Aerial System (UAS)
Precision Agriculture

- NDVI Map a 1000 Acre Farm
- Autonomously detect, and GPS locate stressed plants
Normalized Difference Vegetation Index (NDVI)

- Common method of stress indexing
- Discerns plant health through light reflectivity
- Healthy plants:
  - Reflect Near Infrared (NIR) and green light
  - Absorb other visible light bands
  - Value output range: -1 to 1

\[
NDVI = \frac{NIR - Visible}{NIR + Visible}
\]

<table>
<thead>
<tr>
<th>Healthy plants</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dead plants</td>
<td>0</td>
</tr>
<tr>
<td>Water</td>
<td>-1</td>
</tr>
</tbody>
</table>
Search and Rescue

- Flying 2 km into a search area, perform a scan of a 2km by 2km area, and then return to launch site as an autonomous system.
- Live video downlink to ground station.
- Autonomously detect and GPS locate people on the ground.
### SAR Organization Wish List

- GPS Coordinate System
- Color Video
- Real-Time Sensors
- Endurance of 60-90 minutes
- High Visibility
- Robust
- Automated Image Analysis and Mission Planning
Preliminary Design
Design

Vehicle Sketch Pad Design

Imported into SolidWorks

Original Design

Final Design
Payload Assembly

- Design assembly in order to place the center of gravity
- Optimize space and airflow
Fuselage Construction
Wing Construction

- Fiberglass covered foam wing
- Carbon tube for structure and attachment
Fuselage Construction
Modifications

- Cameras record light in three bands: Red, Green, and Blue
- Remove NIR filter glass ➔ sense NIR light
- Add blue film ➔ filters out Red light

- NDVI calculations use NIR as the RED light Band

\[
ENDVI = \frac{(NIR + Green) - (2 \times Blue)}{(NIR + Green) + (2 \times Blue)}
\]

- Enhanced Normalized Vegetation Index (ENDVI): both the NIR and green light bands are used as reflective channels, blue is the absorption channel
Camera Testing

Canon IR Test

PiCam IR Test
Sensor Suite & Secondary Systems

- Raspberry Pi
- Raspberry Pi Camera
- Canon SX260
- 4000mAh Battery
Visualizing the Algorithm

- Input Image
- Mean Shift Segmentation
- Color Channels
- Edge Information
- Contours/Final Image
Airframe Testing

Dolly and Taxi Testing

Wing Loading Test
Technology
In
Ground
Rescue and
Environmental
Stress
Sensing

TIGRESS
Flight Plan

Itinerary

- 2x Manual
- 1x Stabilize
- 4x Fly-by-Wire A/B
- 1x Fully Autonomous
- 4x Mission
Day 2
Conclusion

• Completed design, build, system integration, and initial flight tests
• Further work: verify autopilot performance
Questions