Drone-Assisted Field Mapping
Team

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Background

Performance of agricultural crops can be affected by many factors:

- Poor irrigation
- Seasonal changes

Early detection of poor performing or stressed crops allows time for corrective action to take place.
Current Solution

Hire a trained pilot to aerially survey land with camera.

- Expensive
- Infrequent
Goal

To prevent significant financial losses from poor performing crops through the use of an early detection system

Design, build, and test a system that is capable of detecting potential crop stressors by use of small unmanned aircraft systems (sUAS).

• Cost effective
• Can be used frequently by farmer
Customer Requirements

• **Must Do**
  • Flight time between 5 and 15 minutes (quantitative)
  • Fly at least 50 feet above ground (quantitative)
  • Fly along designated waypoints (quantitative)
  • Be cost effective for Farmers (quantitative)
  • Lift vision system payload (quantitative)
  • Identify crop health problems in field (qualitative)

• **Should Do**
  • Use off the shelf components when available (qualitative)

• **Would be Nice**
  • Operate autonomously after learning to fly along waypoints (qualitative)
  • Stream video and telemetry data to a computer (qualitative)
## Engineering Specifications/Targets

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Engineering Specification</th>
<th>Metric</th>
<th>Method/Device</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Flight Time</td>
<td>Time</td>
<td>Minutes</td>
<td>Stop Watch</td>
</tr>
<tr>
<td>2 Altitude</td>
<td>Height</td>
<td>Feet</td>
<td>Weighted String</td>
</tr>
<tr>
<td>3 Waypoint Accuracy</td>
<td>Distance</td>
<td>Feet</td>
<td>GPS</td>
</tr>
<tr>
<td>4 Thrust Force</td>
<td>lbf</td>
<td>Pounds</td>
<td>Scale</td>
</tr>
<tr>
<td>5 Cost Effective</td>
<td>Cost</td>
<td>USD</td>
<td>Calculator</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Engineering Specification</th>
<th>Target</th>
<th>Condition(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Flight Time</td>
<td>Time</td>
<td>10 minutes</td>
<td>Full payload, Fair weather</td>
</tr>
<tr>
<td>2 Altitude</td>
<td>Height</td>
<td>At least 50 feet</td>
<td>Full payload, Fair weather</td>
</tr>
<tr>
<td>3 Waypoint Accuracy</td>
<td>Distance</td>
<td>Within 10ft of waypoint</td>
<td>Fair weather</td>
</tr>
<tr>
<td>4 Thrust Force</td>
<td>lbf</td>
<td>Verify Payload</td>
<td>Full payload</td>
</tr>
<tr>
<td>5 Cost</td>
<td>Cost</td>
<td>&lt; $2,500.00</td>
<td></td>
</tr>
</tbody>
</table>
Design Solution
Fabrication

Focused on using off the shelf components when available.

Camera Mount
• Chose to use the Go Pro camera mounting system
  • Easy to mount
  • Versatile
  • Interchangeable
  • Secure

Camera Triggering
• Camera is electronically triggered through custom firmware on the camera and code written for the flight controller.
  • Triggering electronically is more reliable than a mechanical trigger.
  • Camera can be triggered based on discrete GPS waypoints or set to trigger after a predefined distance traveled.
Testing

Flight Time Test

• Flew drone with fully charged batteries until a low battery warning which automatically landed the drone.
• Measured flight time with a stopwatch over 4 different trials and took an average of the flight time.
• The average flight time was 11 minutes 6 seconds.
Testing

Altitude Test

- Tied a 50ft length of string to the bottom of the drone with a weight attached to reduce slack.
- Flew drone until the weight was off the ground.
- The drone was easily capable of maintaining an altitude of 50ft.
- Test pictures were taken at the maximum altitude allowed by the FAA of 400ft with no issue.
Testing

Waypoint Accuracy

• The drone was preprogrammed with an autonomous mission to fly to designated waypoints.
• After the flight data was downloaded from the flight controller to verify the position of the drone at the specified waypoints.
• The drone was able to get within a range 3.8ft to 8ft of the designated waypoints.
Testing

Thrust Force

• The drone was put on a digital scale at full payload.
• The propeller directions were reversed to so the thrust force was applied to the scale.
• Measurements were taken from the scale at incrementally increasing throttle positions.
• This test plan verified our theoretical thrust force equation used to determine the payload capacity.
# Final Budget

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>3DR RTF Quadcopter Unmanned Aerial Vehicle</td>
<td>$599.00</td>
</tr>
<tr>
<td>Hardware Replacement Kit</td>
<td>$114.99</td>
</tr>
<tr>
<td>Spektrum DX7s Radio Control Kit</td>
<td>$299.99</td>
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<tr>
<td>Go Pro Hero 3 Black Edition</td>
<td>$399.99</td>
</tr>
<tr>
<td>Extra Batteries</td>
<td>$102.99</td>
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<tr>
<td>Triple axis Magnetometer (HMC5883L)</td>
<td>$17.99</td>
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<tr>
<td>DF13 4 Position Connector 15cm (Connect Compass to Device)</td>
<td>$2.00</td>
</tr>
<tr>
<td>Canon Modified Point and Shoot Camera (4 Band Image Sensing)</td>
<td>$399.99</td>
</tr>
<tr>
<td><strong>Camera Mount</strong></td>
<td><strong>$12.99</strong></td>
</tr>
<tr>
<td><strong>Replacement Frame</strong></td>
<td><strong>$40.00</strong></td>
</tr>
<tr>
<td><strong>Replacement Propellers</strong></td>
<td><strong>$39.02</strong></td>
</tr>
<tr>
<td><strong>Drone and Imaging Total:</strong></td>
<td><strong>$2,028.95</strong></td>
</tr>
</tbody>
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Reflection

• Our final design solution met and exceeded the customer requirements and specifications.
• Our design is affordable, easy-to-use and has a fast turn around for processing data.
• Every part used for this project is available to purchase, no custom parts were used.
Questions?