Preliminary Results

Target Acquired

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Recap of Requirements and Deliverables

Need statement: The ASE Design Team and Austin Fire Department need a software able to recognize targets of interest, discern between critical/non-critical targets, and deliver accurate GPS coordinates within a generated map.

- **Guaranteed Deliverables**
  - Image recognition software able to recognize and classify TOI’s
  - Targets of Interests’ GPS location & classification (CAT/CRT)
  - Generated map of area of interest
- **Stretch Goals**
  - An interactive map with that is paired with the respective GPS coordinates

(Nic)

Progress Update

Completed/In-progress Tasks:

- Collect training images for prototype image recognition algorithm (Completed)
- Create a working prototype for our algorithm tested on training & live video (Completed) (In Refinement)
- Create an algorithm for Map Generation (Completed) (In Refinement)
- Collect training images for our final model, taken from the mission altitude and in a field of similar features (Completed)
- Create algorithm to transfer between pixel location to Lat/Lon coordinates (Completed) (In Refinement)

(Rohan)

Review of Test Flights

Since our last presentation, we've had multiple "flyouts"

- Drone Flight (April 1st) → Shaky video of targets (alt. 200ft)
- First Flyout (April 7th) → Video of targets from plane (alt. 320ft)
- Second Flyout (April 13th) → Collect more training footage (alt. 320ft)
- Third Flyout (April 18th) → Tested feature recog and GPS calc (alt 320ft)

What's ahead for us:

- Fourth (Final Test) Flyout (April 26th) (alt. 200ft - 250ft)
- Final Flyout/Competition (April 27th or 29th)

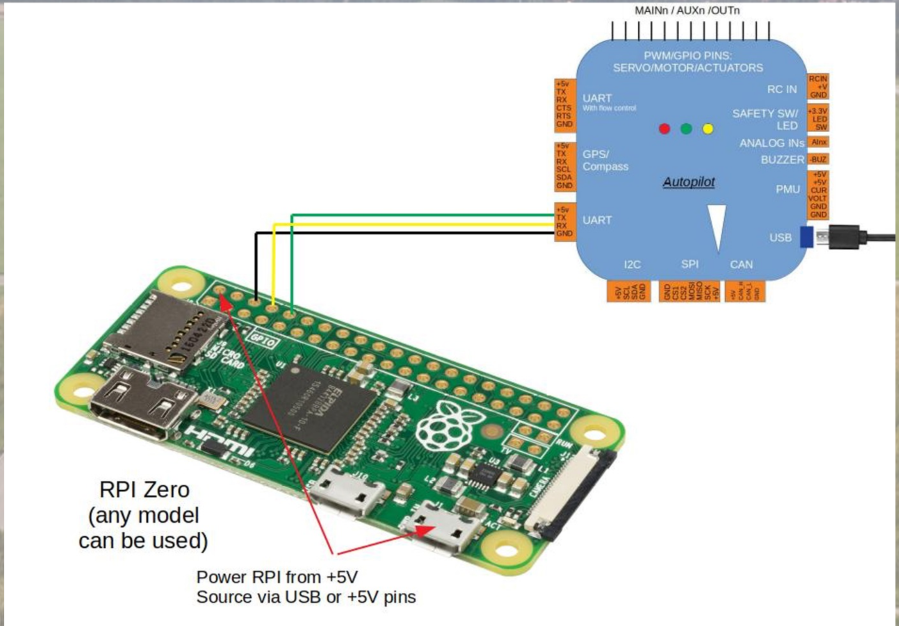
(Ryan)

Design Updates

Raspberry Pi and Pixhawk Integration

- Can successfully pull any number of parameters in live time from the plane such as GPS, altitude, Yaw/pitch/roll, flight stage

- Necessary for calculating position of targets



(Nicholas)

Change in Approach to ATR Algorithm

ATR Model

Pull frame from live video
Pull Lat/Lon from GPS

RGB Thresholding to get reasonable contours around tarp

Apply SIFT and FLANN if suitable

Make decision on smiley/frowny or tarp

Mark center of target
Convert pixel location to Lat/Lon

(Preston)

Camera Calibration Approach

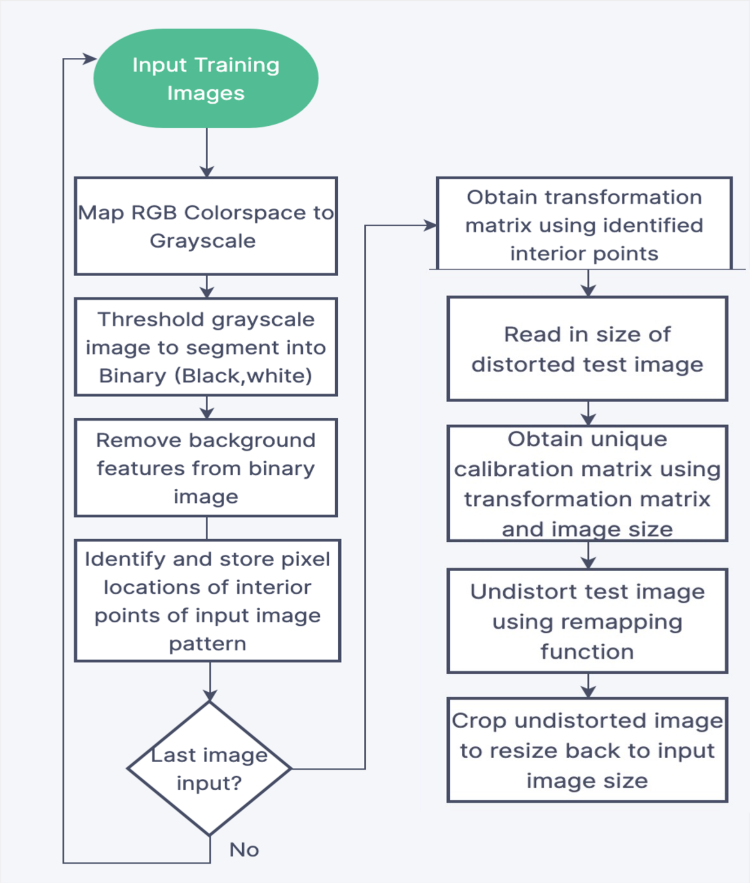
- **Background**: All camera lens have intrinsic properties such as focal lengths, and optic centers that must be approximated through calibrating captured images at a fixed resolution

- **Objective**: The purpose of calibrating the camera was to obtain a “Camera Calibration Matrix” (transformation matrix) that could be used to remove tangential and radial distortion from all captured images

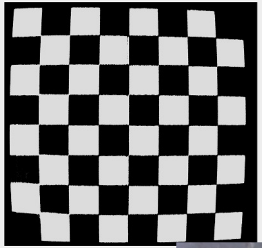
- **Goals**: A transformation matrix will enable the team to more accurately identify the images and calculate the GPS coordinates

(Justin)

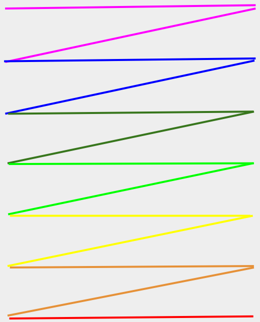
Flowchart for Camera Calibration Algorithm



Original image



Black & White



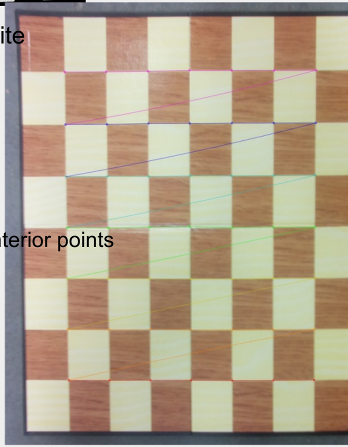
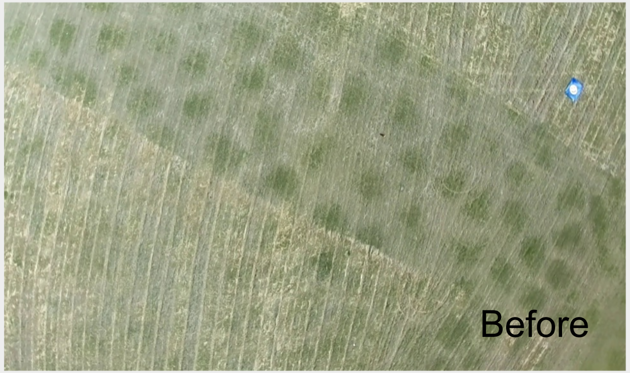


Image with interior points recognized

(Rohan)

Results

Camera Calibration Results



- Algorithm results in a transformation matrix for camera at fixed resolution that will be used to undistort AOI images to improve target detection and map stitching accuracies

- Camera Calibration (Transformation) Matrix:

$$\begin{bmatrix} f_x & 0 & c_x \\ 0 & f_y & c_y \\ 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 3910.01 & 0 & 2021.48 \\ 0 & 3896.32 & 1417.29 \\ 0 & 0 & 1 \end{bmatrix}$$

- Current Limitations: Aspect ratio of some test images are incidentally modified during the undistortion process

(Justin)

Target Recognition & GPS Results

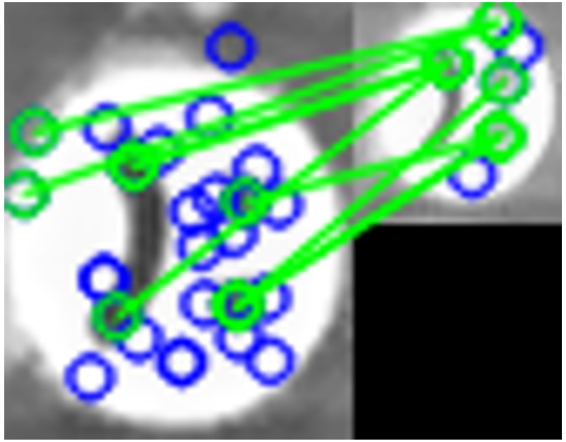
- After the past flight test, **our ATR algorithm eventually recognized all targets**
- First Iteration of GPS location calculation on flight test #4 put targets somewhere in the Atlantic Ocean

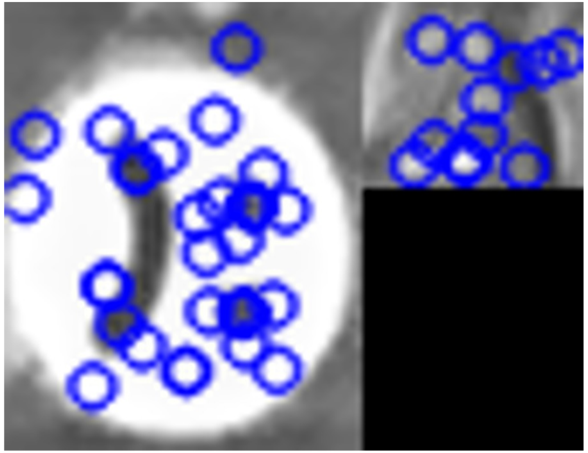
Test	Frames Taken	Positive Ground	Correct Identification	False Positives
Video from flight test #2	123	103	10	8
Live Video Capture from flight test #4	*20,000+	*19,000+	*75-100	*< 25

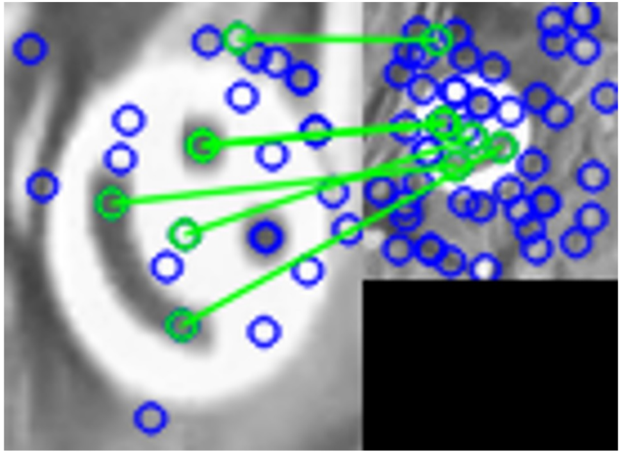
***Rough Estimates**

(Nicholas,Preston)

Frowny vs. Tarp vs Smiley







Map Generation Preliminary Results

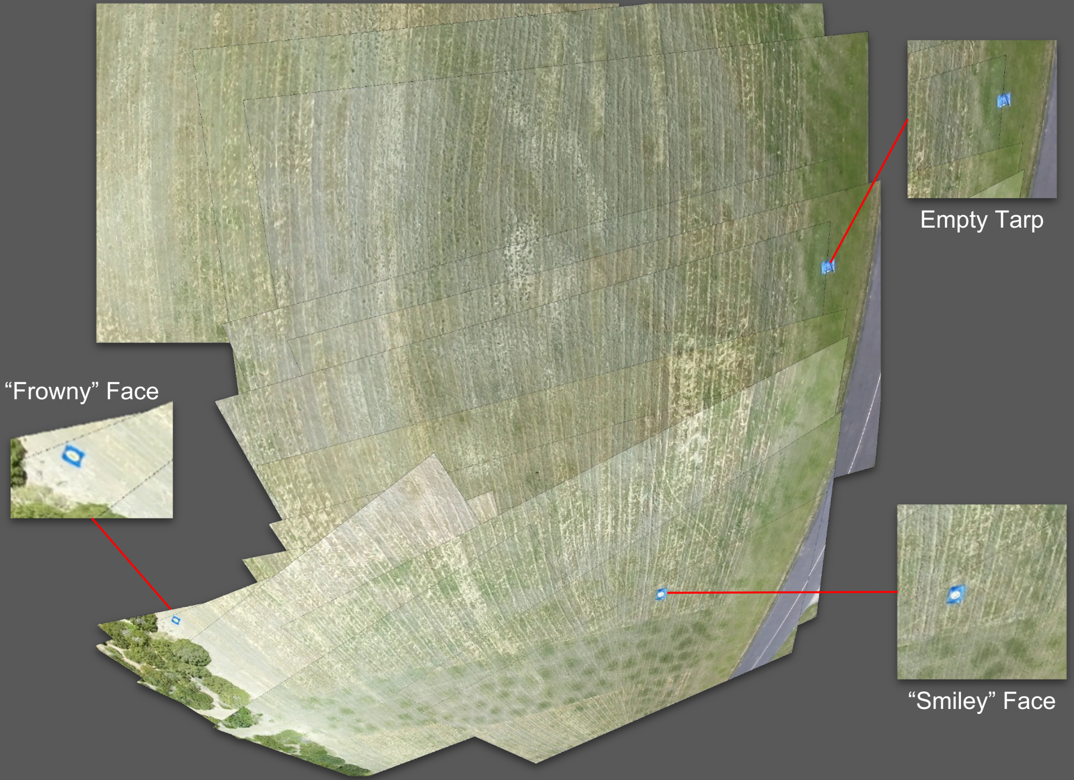


Figure 1: Example output of the Stitching Algorithm using 17 frames taken from a test video during our second flyout

What changes have been made to our approach to map generation since our last presentation?

- Still using Aerial Image Stitching
- Now using an approach that utilizes the same SIFT keypoint detection and FLANN feature matching algorithms that our ATR algorithm uses

Requirements Check?

- Judged "qualitatively for quality"...
- What can we qualitatively say about our current results?

(Ryan)

Map Generation Preliminary Results (cont.)

What are the expected results of our Map Generation algorithm?

- Using a set of test images found online we get the image shown on the right.
- This set of images:
  - Are undistorted
  - Have high overlap between photos (70% - 80%+)
  - Are taken from a camera/drone that is completely vertical
- The resulting stitched image is pretty desirable.
- This tells us that we need a better way to feed in “good” images into our algorithm for a better final result.

What can we do to receive better images?

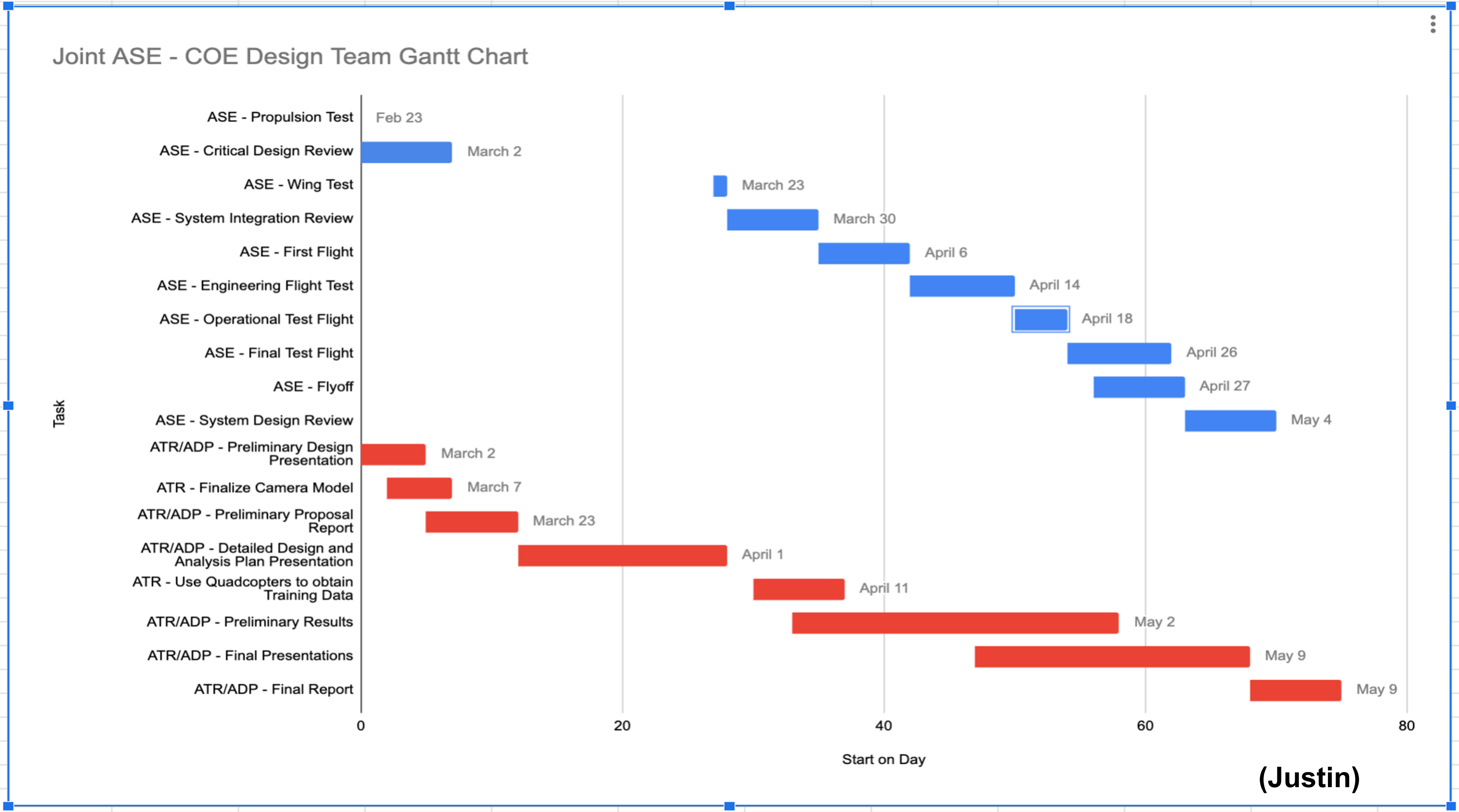
- Properly run all images through calibration algorithm to remove distortion
- Read in the roll from the Pixhawk so that we do not feed in images when the plane is turning/tilted.

Figure 2: Example output using our current stitching algorithm and an 12 images from an example DJI set found online

(Ryan)

Next Steps

- Refine map generation
- Use roll of plane as filter to save images for map generation
- Integrate camera calibration into ATR
- Refine outputs of GPS locations for Payload Drop & ASE team



Joint ASE - COE Design Team Gantt Chart
Task
ASE - Propulsion Test
Feb 23
ASE - Critical Design Review
March 2
ASE - Wing Test
March 23
ASE - System Integration Review
March 30
ASE - First Flight
April 6
ASE - Engineering Flight Test
April 14
ASE - Operational Test Flight
April 18
ASE - Final Test Flight
April 26
ASE - Flyoff
April 27
ASE - System Design Review
May 4
ATR/ADP - Preliminary Design Presentation
March 2
ATR - Finalize Camera Model
March 7
ATR/ADP - Preliminary Proposal Report
March 23
ATR/ADP - Detailed Design and Analysis Plan Presentation
April 1
ATR - Use Quadcopters to obtain Training Data
April 11
ATR/ADP - Preliminary Results
May 2
ATR/ADP - Final Presentations
May 9
ATR/ADP - Final Report
May 9
0
20
40
60
80
Start on Day
(Justin)


Q&A