Property Management via Aerial Drone Imaging, Image Processing, and Change Detection

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Background

Our goal was to create a device that can capture aerial campus images and use a pipeline of image processing techniques to process and classify images in regard to changing campus conditions.

- College campus/apartment complex inspection is often inefficient
- A drone can be used to detect anomalies and notify landowners of areas of concern
- Cost-effective way to survey an area over time

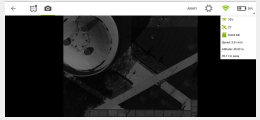
Link to our code:
https://github.com/alexanderfache6/dronezz

(a) the Dronezz team

(b) Parrot Anafi drone

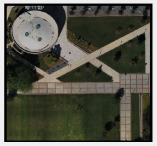
Data Collection and Preprocessing

(a) Pix4D mission overview

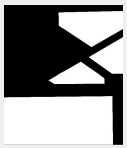


(b) Pix4D camera view

(a, b) data collection with Parrot Anafi drone using Pix4Dcapture → (c) construct global image mosaic using Pix4Dmapper → (d) grass, sidewalk, building, and gravel region selection (only once)

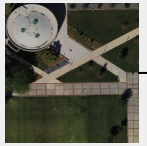


(c) original global image



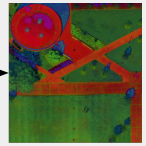
(d) grass and building region selection

(e) image alignment wrt reference mission through key point detection and homography matrix → (f) histogram normalization wrt reference mission for lighting adjustment → (g) color space conversion to HSV



(e) aligned image

(f) histogram normalized image

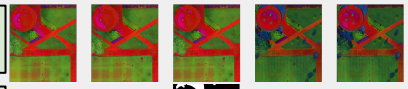


(g) HSV image

Anomaly Detection

- Method 1 - shadow removal and image differencing

HSV histogram images



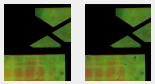
shadow removal, HSV = (69, 20, 1) to (129, 102, 34)

image differencing, band reject thresholding = (75, 175)

morphological features erosion r=1, iter=2, dilation r=7, iter=1

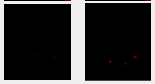
- Method 2 - find deviations through applying Bandpass Filter

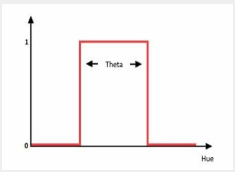
Input HSV images



Band pass filters out any deviations from grass region

Perform image differencing and use morphological features



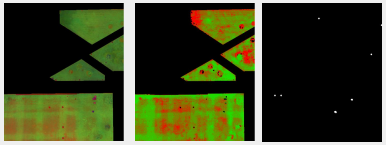


(a) Bandpass Filter with hue replacing frequency

- Method 3 - find anomalies through poorest scoring grass

Input HSV images and convert to heatmap

Mask out pixels belonging to lowest scores as anomalies and perform morphological features



(b) HSV image (c) heatmap image (d) anomaly mask

Grass Health Heatmap

- In order to visualize the grass health, we opted to use a heatmap visualizer.

- Algorithm:
- Parse/score grass pixels into buckets that represent values from 0-10.
- The closer a pixel is to a predefined value of ideal grass, the higher the score it receives.
- As the pixels deviate from ideal grass, they receive lower scores signifying grass with poorer health.
- Pixels that score a zero value are classified as anomalies.

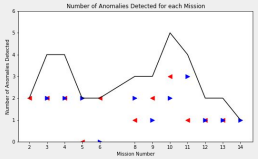
Roof Excess Water Detection

- Utilized HSV finder and OpenCV image processing techniques to detect areas of excess water on the roof of the Hive.

Final Results and Analysis

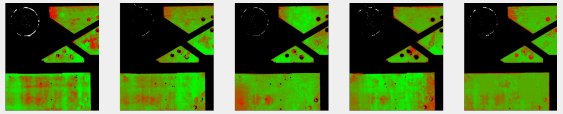
(a) a 2+ out of 3 majority voting scheme determined final anomaly masks

(b) missions with superimposed bounding boxes, red are previous change and blue are next change

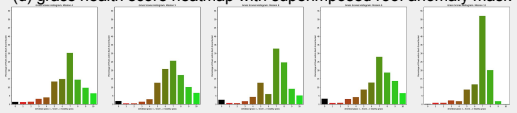


(c) number of detected anomalies

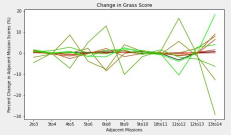
Voting Scheme Iterations:
- logical AND voting scheme eliminated anomalies
- logical OR included noise
- majority voting scheme provided a robust means of detecting anomalies



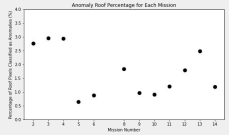
(d) grass health score heatmap with superimposed roof anomaly mask



(e) grass health score histograms show relative percent of each grass score



(f) percent change in grass health scores



(g) percent of roof anomalies

Through short term anomaly detection and long term changes in grass health scores, we were able to successfully detect all of our artificial anomalies. With a successful implementation of anomaly detection, anomaly prediction and notification would follow.