BuddyCam

Comprehensive Design Review

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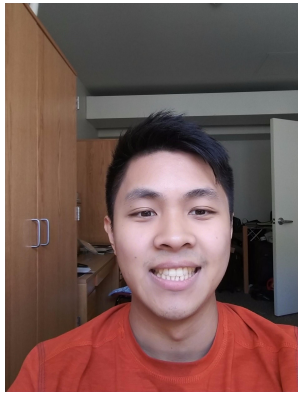
Meet the Team



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CSE

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The Problem

There is growing concern in regard to the relationships between law enforcement officers and the public

- Shooting of unarmed civilians
- Excessive use of force
- Protests across the country
- Lack of reliable information
- Violence imposed on officers and public servants

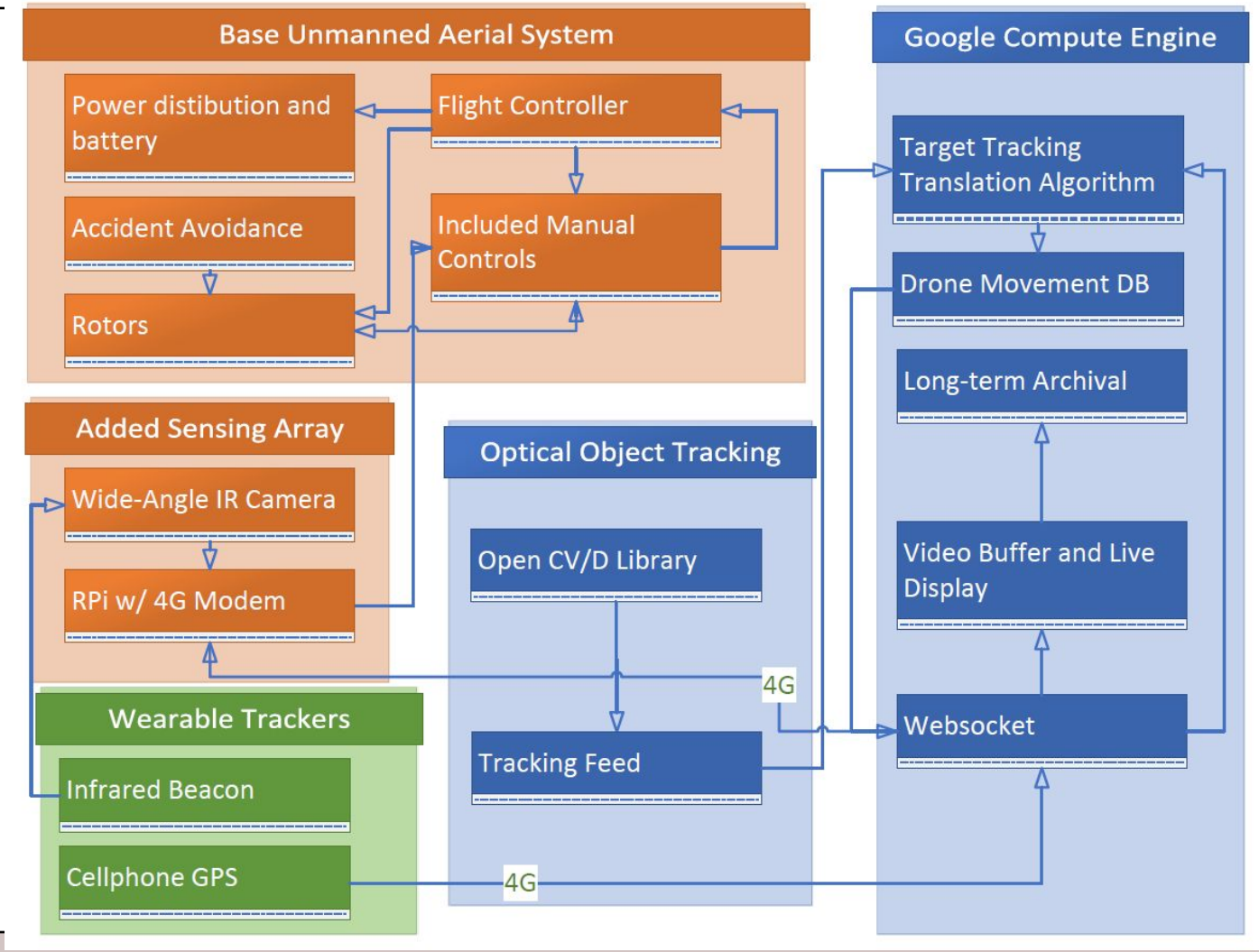
Our Solution

BuddyCam

Deployable Unmanned Aerial System (UAS) capable of autonomously identifying, tracking, and recording officers

- Quadcopter equipped with fixed camera
  - Aerial video capture of officer
  - Raspberry Pi3 for image processing and communication
  - IR beacon tracking provides additional opinion
  - GPS tracking
- GPS Components
  - Android app sending geolocation data
  - Google Compute Engine collecting GPS data

Block Diagram



Specifications

- Fully autonomous after lift-off
- Track and keep subject in frame
  - maximum of 1.6 s out of frame
- Maintain minimum height of 10 ft after initial lift-off
- Maintain line of sight of subject within a radial distance of 15 ft
- Operate and record for at least 10 minutes

Specifications -- Analysis and Justification

"Maintain minimum height of 10 ft / distance of 15ft"

- Initial tests with the drone show that altitude settings are extremely precise, += approximately 1 inch, and thus this measurement can be set to a value seen fit by the user

"Maximum of 1.6s out of frame"

- Based on a median throughput limit of 22.3 Mbps on 4G networks (IEEE Research Publication)

"Operate and record for 10 minutes"

- Based on the specifications and size of battery included with the drone we are using. This can be easily upgraded as seen fit, budget allowing, by law enforcement agency

MDR Recommendations Addressed

Concern: *Reliability and impact of a fault in location data.*

Solution: We are collecting location data from three different sources: IR LED tracking, HSV bound matching, and GPS location. The use of a Bayesian algorithm to weigh these inputs will improve accuracy of overall system.

MDR Recommendations Addressed

Concern: *Why can't image processing be done directly on the Pi?*

Solution: Image Processing will now be conducted directly on the Raspberry Pi 3. It is mounted to the drone.

MDR Recommendations Addressed

Concern: *How will we address maintaining a safe distance from the subject.*

Solution: We have implemented a mobile GPS solution to track the geolocation of the subject and the drone. Using these coordinates, we can maintain that distance.

Current Progress

- GPS is implemented
  - Drone is able to track GPS receiver carried by subject and make changes to its location according to movement of the receiver
- Image processing software is implemented
  - Image processing algorithm can track subject within video frame
  - Soon will perfect a method to convert this tracking into more accurate drone movement
- IR Beacon is implemented
  - Portable and running on 9V battery

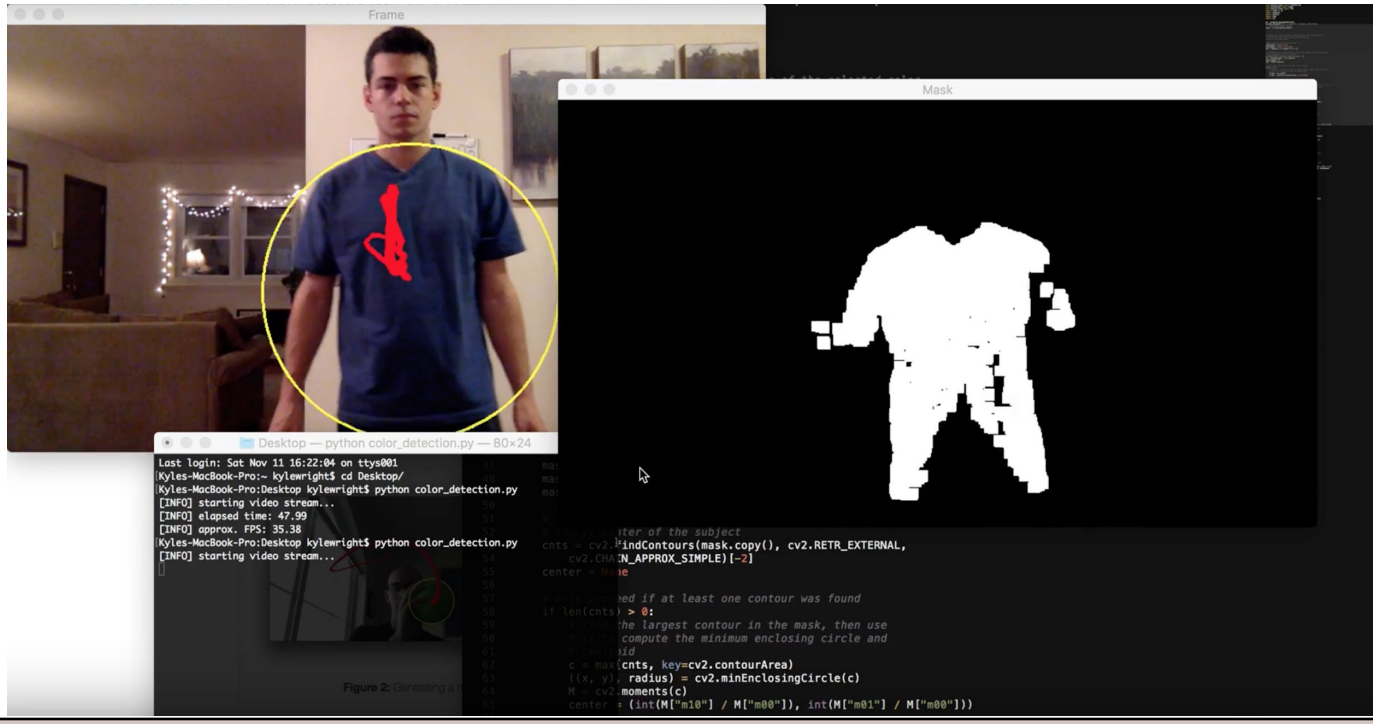
Image Processing

1. Frame is segmented using image thresholding: This creates a mask segmenting the correct shade of blue in the frame

    a. Each pixel value in image is recalculated according to a mask matrix
    b. Color blue in HSV color-space is segmented

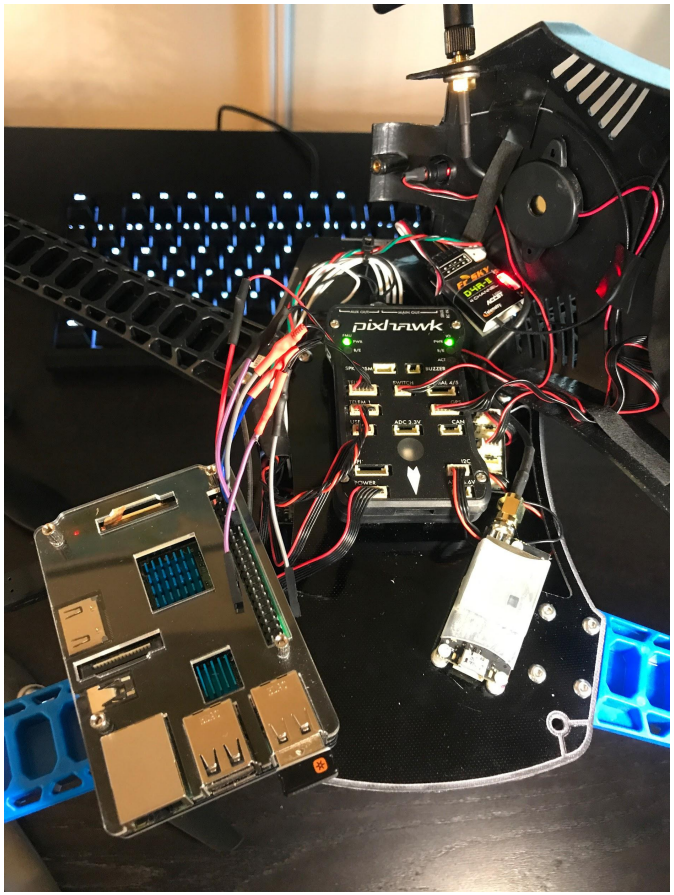
2. Distance between center of subject and center of frame is calculated

3. Necessary logic is derived to maintain the center of the subject in the center of the frame



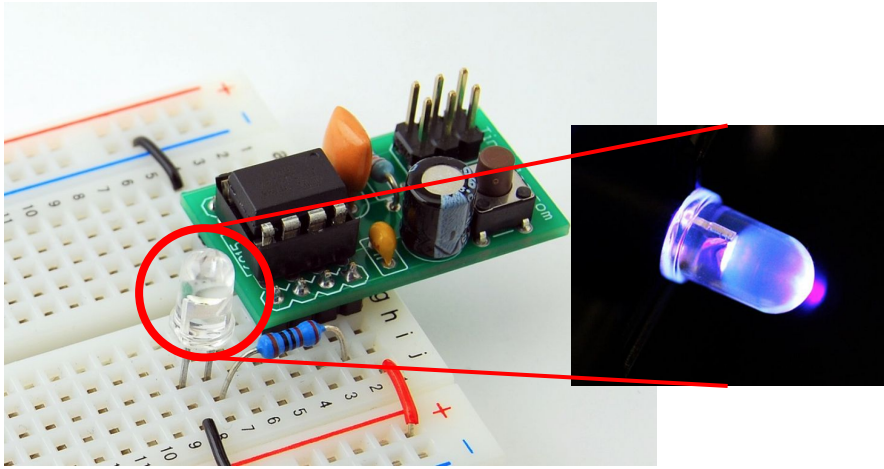
Raspberry Pi 3

- Serves to process communication between flight controller and remote server
- Internet connected via local access point
- Relay instructions to flight controller



IR LED Beacon Technology

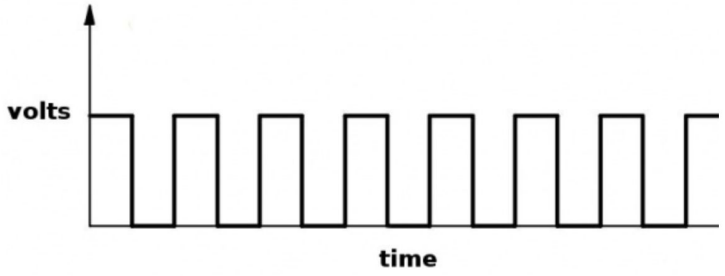
- Used hand in hand with image processing
- IR LED will be sending Pulse Modulated Signals



Courtesy of: TinkerLog

Pros:

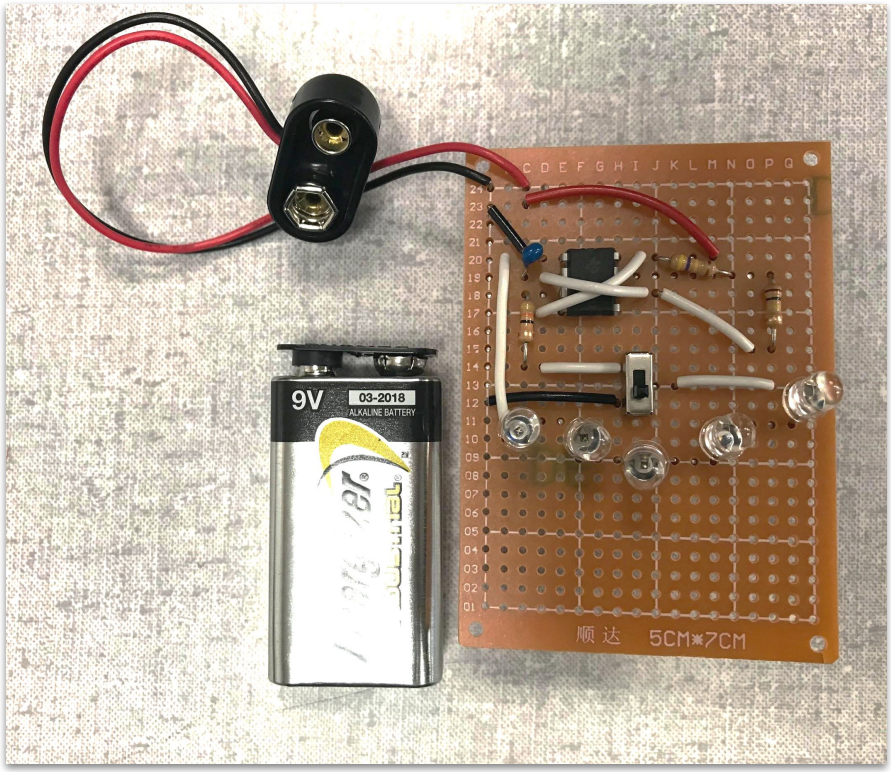
- Can be detected in the dark
- Signal is Unique



Courtesy of: TinkerLog

Our Current IR Transmitter

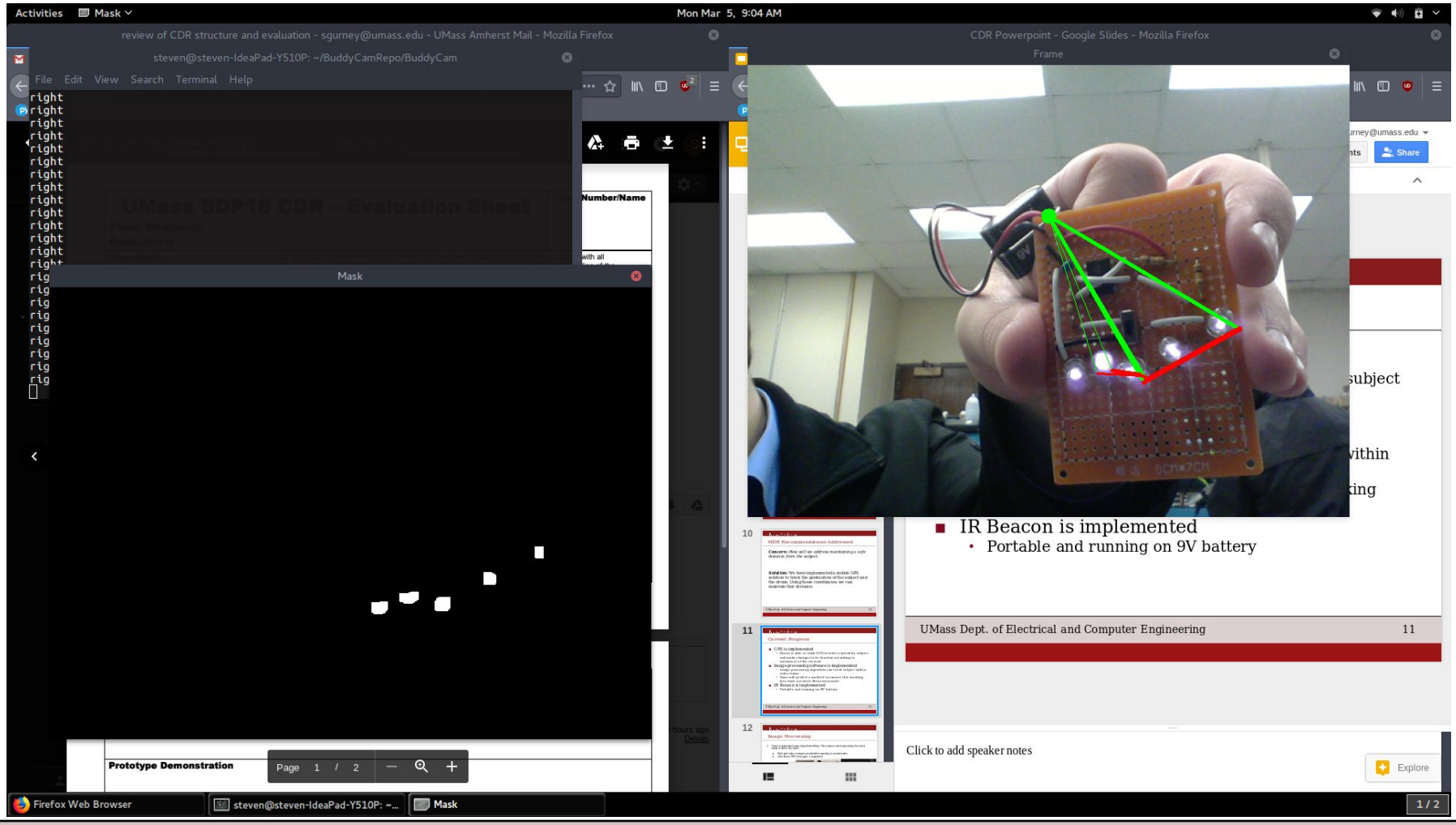
- Transmits at 1.3 Hz
- Switch for on/off
- Pulsing w/ a series of 5 LEDs
- Portable with 9V battery source



Next Steps:

- Design on PCB
- High Power IR LED

IR LED Beacon Technology



Utilization of 4G

- 4G LTE connection used to make local access point
- RPi 3 uses this data connection to access GPS server
- Possible to send video through this connection to cloud VM using FFmpeg for long term storage

GPS

- GPS is pulled from Android location manager
- Networked to Google Cloud server, then pushed to RPi.

Proposed CDR Deliverables

- Portable IR Beacon
- Video of Subject with IR Beacon
- Image Processing through Google Compute Engine
- Network RaspPi to 4G
- Formatting Flight Controls Based on output of Code

Proposed FDR Deliverables

- Portable IR beacon on PCB, with power supply
- Drone able to track and follow a moving subject
  - Three environmental inputs
    - GPS
    - Image Processing
    - IR Beacon tracking

FDR Deliverable: Team Roles

Saswati

IR Beacon on PCB design with battery source

Joseph

Refining app backend and integrating video storage

Kyle

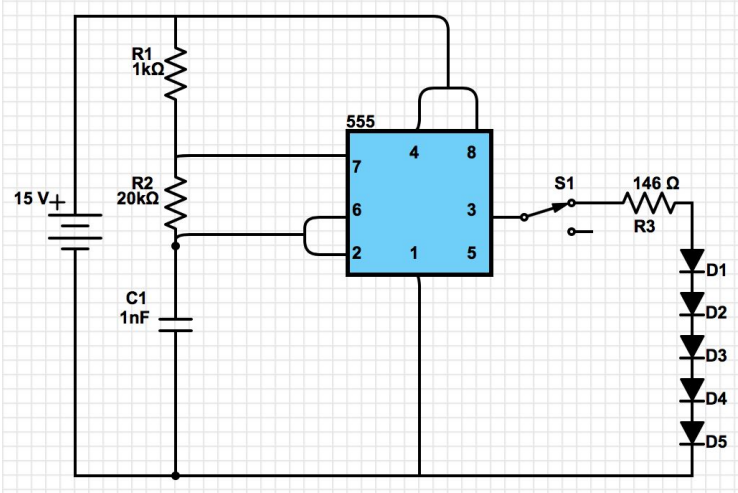
Development of conditional probability algorithm to weigh the three environmental inputs

Steven

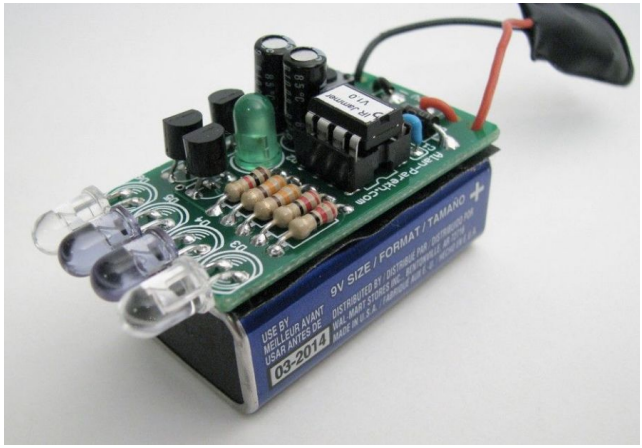
Polishing Android app, tweaks to server protocols, aid in the improvement of tracking algos. and GPS accuracy

Planned Schedule of Activities - Saswati

- Design on PCB
  - Using Altium
  - Will hold the power supply for IR Beacon



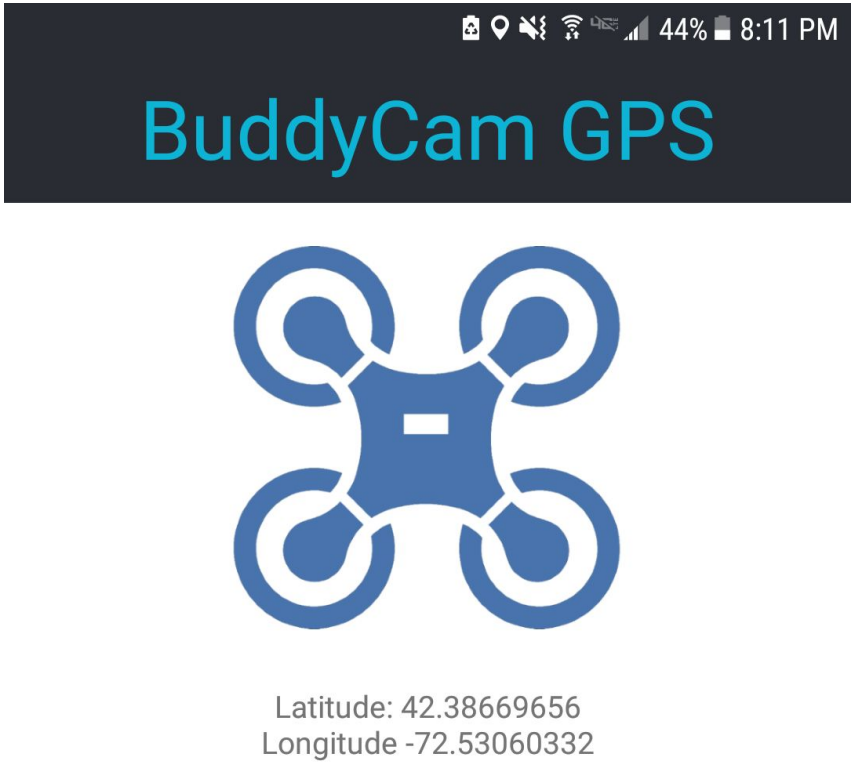
- High Power IR LED
  - Allow for detection in real time image processing



Courtesy of: Instructable.com

Planned Schedule of Activities - Joe

- Improving reliability and addressing bugs with app backend
- Integrating Video with Cloud Resources
  - live video stream
  - long term archival and storage
- Refining flight and GPS data sent from Compute Engine to RPi



Planned Schedule of Activities - Kyle

GPS
Image Proc.
IR Beacon
} Algorithm to weigh inputs

Calculate a weighted average based on the reliability of each source:

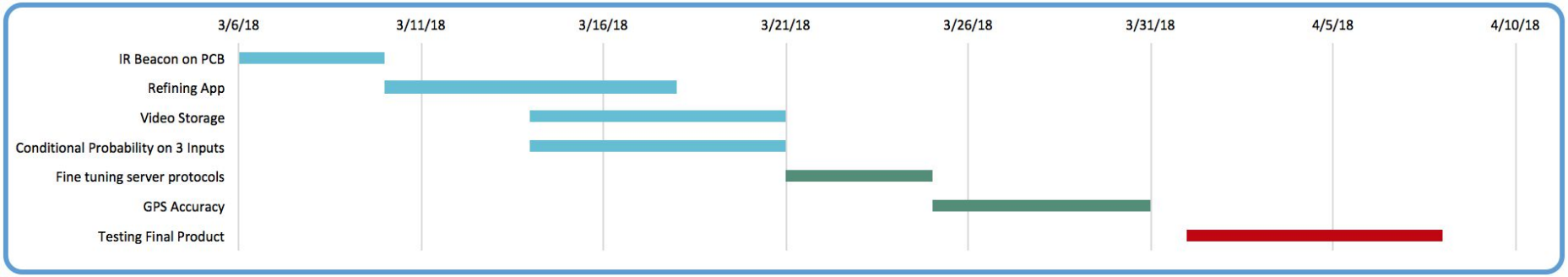
- Is the image over exposed?
- Is each GPS coordinate relatively plausible or a data outlier?

Planned Schedule of Activities - Steven

- BuddyCam GPS App
  - Get improved location using Wi-Fi, cellular, and averaging
  - Ensure to correct any issues that come up

- Tracking Algorithms
  - Improve methods for in frame tracking
  - Implement a more robust form of drone movement command formation

Gantt Chart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3/16/18
3/21/18
3/26/18
3/31/18
4/5/18
4/10/18
IR Beacon on PCB
Refining App
Video Storage
Conditional Probability on 3 Inputs
Fine tuning server protocols
GPS Accuracy
Testing Final Product

Thank you

Questions