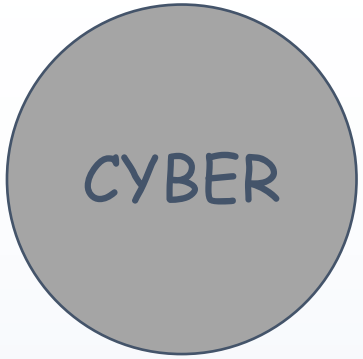

Autonomous UAV Capstone

Status Presentation I

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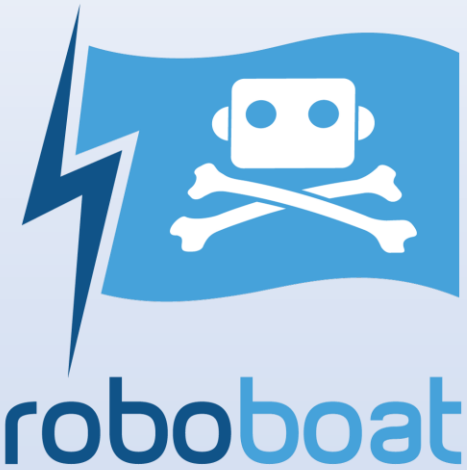
September 30th, 2021

Needs of the Service

- Mission Needs:
  - Conduct USCG Operations in innovative way
    - Only operational aerial vehicles are manned aircraft and ScanEagle Drone
  - No dedicated pilot
  - Extremely low cost
    - ScanEagle cost: $3.2 Million
    - Our projected cost: less than $1000
  - Cooperative solution
    - No entity of the Coast Guard is doing what we are.
  - Deployable from any CG Asset
- Concept of Operations:
  - Autonomous takeoff, flight, and landing
  - Image processing/target recognition
  - Capability for transporting small payload.
  - Communication between other drones/assets

The RoboBoat Competition

- RoboBoat is an international competition where an autonomous surface vessel performs navigating and docking tasks.
- Each ASV is allowed to cooperate with a UAV.
- Our role as the UAV:
  - Takeoff from and land on the ASV.
  - Locate and deliver a payload.
  - Fly desired search patterns.
  - Communicate findings with the ASV.



Initial Project Planning

- Create a fully-autonomous quadrotor
  - Build hardware
  - Simulate flight plan
  - Upload flight plan to hardware
  - Utilize computer vision for object detection
- Separation of tasks
- Adherence to Roboboat Competition Guidelines
- Satisfaction of stakeholders

Spring 2021 Debrief

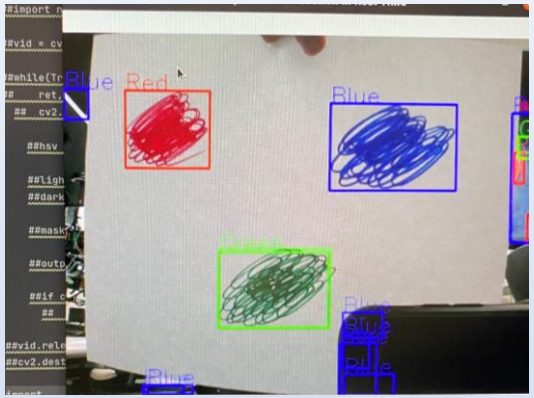
- A simulated testing environment would optimize testing efficiency and mitigate risk.
  - Breaking hardware during testing causes substantial setbacks.
  - Real-world testing is a time intensive task.
  - Provides a seamless transition to real-world testing.
- Previous limitations:
  - The 10-meter accuracy of standard GPS is insufficient.
  - Software limited a simulated testing environment.
- Recommendations for future development:
  - Efficiency comparison of automated search patterns.
  - Computer vision-controlled flight.

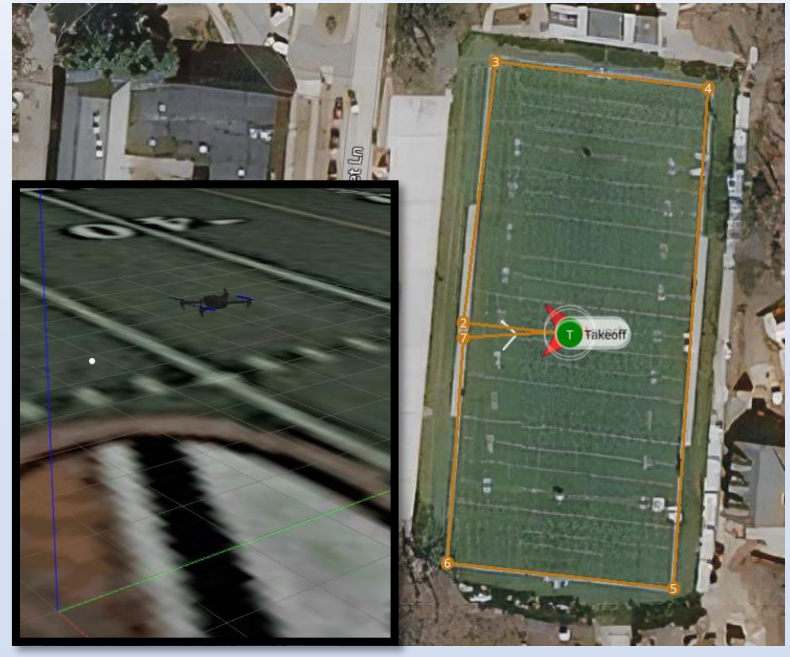
Frameworks & Hardware We Plan to Use

- Hardware
  - Commercial
    - Real-time Kinematic Positioning
      - A subset of GPS Positioning
  - Proprietary
    - “Gripper" to facilitate transportation of "small" objects
- Frameworks
  - Gazebo – Robot Simulation Made Easy
    - High-performance physics engine
      - Allows for deterministic simulation and analysis of changes in a low-cost environment
    - Software-in-the-Loop (SIL) simulation platform
      - Interfaces with PX4 flight controller and simulates closely a world
  - GitHub Repositories
    - Allows for succinct documentation and an exact replica of timelines
  - OpenCV
    - Open-sourced computer vision and machine learning library.
      - Enables identification, modeling, and tracking of a variety of objects

Current Progress

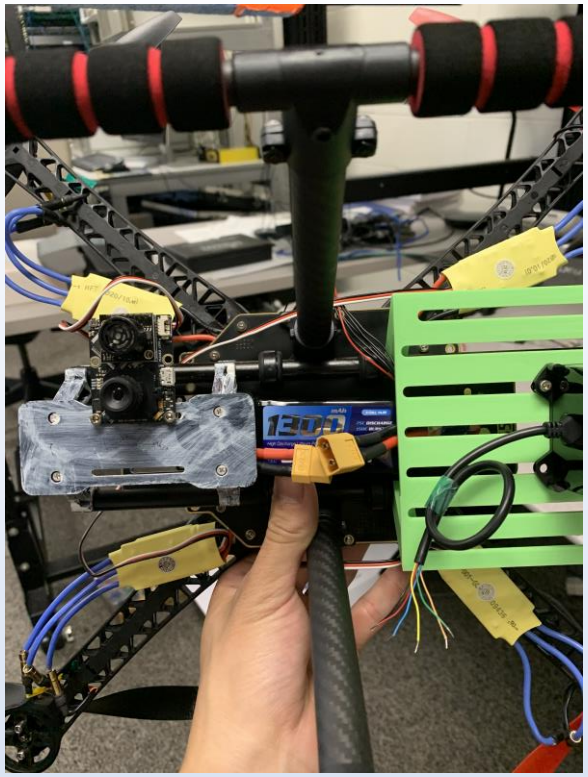
- Flight Development Environment:
  - New software stack identified.
    - Chosen to facilite SITL simulation.
  - All software has been installed and is functioning.
- Computer Vision:
  - Live video
  - Color detection
  - Edge detection in stills
- Physical Drone Build
  - Accurate SolidWorks model





Projected Progress

- Drone to Software Interface
  - Configure autopilot parameters unique to the drone.
  - Gazebo and SolidWorks Implementation
  - Organization
  - Parts/3D Printing
  - Gripper Mechanism
- Computer vision
  - Edge detection in video
  - Shape detection
  - Run scripts on Raspberry Pi



Questions?

- Validate sufficient analysis and planning have been conducted to begin project and ensure resources, activities, schedules, and tools are allocated.
- Schedule and scope feasible?
- Project management plan with schedule, cost estimate
- Have you reviewed lessons learned from previous groups?
- Mission needs statement and conops
- Background research and technologies planned to leverage?
- Initial project plan
- Processes, rules, workflows using to deliver final project
- Clear vision of mission need and conops
- Stakeholders
- Plan to communicate with stakeholders
- Awareness of risks