Autonomous Drone Swarms

Final Presentation

Department of Mechanical & Aerospace Engineering
Old Dominion University

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OLD DOMINION UNIVERSITY
IDEA FUSION

Introduction

- Drones are becoming a more popular technology, commercially, recreationally, and by government use
- The ability to fly them in a group is needed for commercial and military use
  - Delivery for companies like Amazon
  - Drone usage in the military can reduce deaths
  - Delivering supplies to people who are quarantined or the elderly/disabled

Accomplishments

- Full construction of both drones
- Manual + independent autonomous flight for both drones
- Designed and printed: propeller guards, custom camera + gps, and custom lidar mounts

Challenges

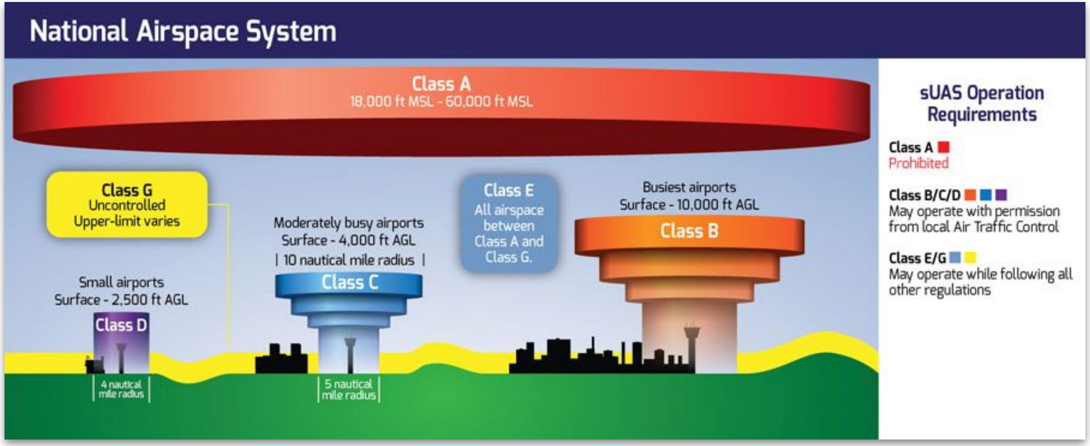
We faced a several challenges throughout our project cycle. These challenges include:

- Part shipment delays
- 3D Printer sizes to accommodate for 10 inch propellers
- Initial object avoidance crash
- ArduPilot Lidar programming for awareness and object avoidance
- Difficulties finding a location to perform test flights

Engineering Standards

There are several engineering standards that we follow as guidelines for this project. The many principles and ethics are set by the organizations below.

- ASME: The American Society of Mechanical Engineers
- IEEE: The Institute of Electrical and Electronics Engineers
- FAA: Federal Aviation Administration

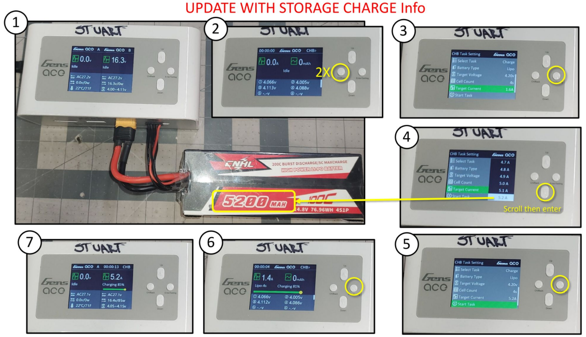


Engineering Standards (cont.)

Key standards that were monitored and executed in practice as as follows:

- FAA licensed flyers must
  - Ensure drone is registered through the FAA if weight > 0.55 lbs
  - Must keep drone below 400 ft in uncontrolled airspace
- ASME regulations to maintain and repair our UAV to follow health and safety protocol
  - Ensures the safety of civilians and environment
- IEEE regulations to utilize environmentally safe electrical boards and parts
  - Lithium batteries for drones to be supervised and balanced after each test flight
    - Store and charge batteries away from flammable objects
    - Room temperature and dry environment
    - Fireproof LipoSack, ammo box, or a cash box

UPDATE WITH STORAGE CHARGE Info



LiPo Batteries are quite volatile and require special precautions.

Rule of thumb: 80/20 rule: Discharge no more than 80% of the battery.

Drone Design

Flight Time at Full Power:

5200mAh/(35x1000 mA/A)x0.8x60 min/h = 7.2 minutes

Drone: 1761.6 g

Voltage Current Relationships for DC Motors

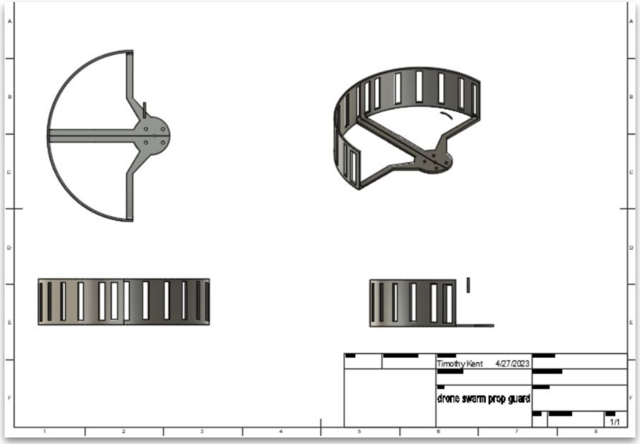
$Speed \propto V$

$Torque \propto I$

- Frame/Motor/Propeller: Hexsoon Edu-450 V2
- Cube Orange Autopilot Flight Controller: Cube Orange+ Standard Set ADS-B (IMU V8)
- Distance Sensor: Ultrasonic Distance Sensor - Hc-Sr04
- Object Avoiding Sensors: Lidar-Lite, Slamtec Rplidar A1-360 Laser Range Scanner
- Optical Flow Sensor: Hereflow – Ir-Lock
- Camera: Siyi Ip Camera For Siyi Ak28 Vd32 Mk15
- Battery Charger: Gens Ace Imars Dual Channel AC200W/DC300W Balance Charger Black
- Battery: Tattu 5200mAh 14.8V 35C 4S1P Lipo Battery Pack
- Transmitter/Receiver: SIYI MK32 Long Range Remote Controller with 7 Inch HD High Brightness LCD Touchscreen
- Prop Guards, Camera+GPS mount, Lidar mount: PLA Filament (Plastic, Fiberglass, Carbon Fiber)

AutoCAD Modelling

- Using Fusion360 software, we modelled prop guards and sensor mounts that would be suitable for our two Hexsoon drones in both indoor and outdoor environments
- Prop guards to almost fully encompass the drone perimeter
  - Protects against collision and injury to nearby pedestrians
  - 4 * 10” Propeller guards made of PLA Filament
- Mounts for our sensors
  - Lidar 360, GPS, and Camera made of PLA Filament



Drone Construction

- Two drones were built with identical design.
- Frame was chosen for aerodynamic design, which allowed the drone to waste less battery
- Designed and 3-D printed prop guards and mounts for 360 Lidar, GPS and Camera installation

Method

Non-Autonomous Sensors

SIYI MK32 remote controller

Cube Orange+

Speed Controller

Autonomous Sensors

Here Flow

Sonar Range Finder

GPS Module

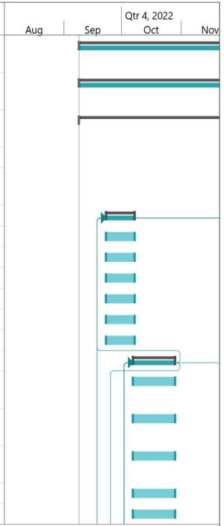
Slamtec Rplidar
(Object avoidance sensor)

Software - Programming Methods

- Installing Firmware
- Ardupilot : Pixhawk : Mission Planner : Flight
- GPS Module
- Limitations

Gantt Chart

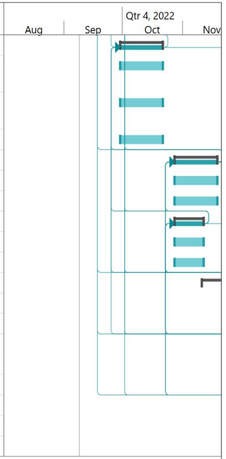
ID		Task Mode	Task Name	Duration	Start	Finish	Predecessors	Resource Names
1			**Autonomous Swarm Drone**	**166 days?**	**Fri 9/9/22**	**Fri 4/28/23**		
2			**I. Research Aurdo-Pilot/Copte**	**166 days?**	**Fri 9/9/22**	**Fri 4/28/23**		
3			**II. Collaborate with instructors**	**166 days?**	**Fri 9/9/22**	**Fri 4/28/23**		
4			A. Meet with	166 days	Mon 5/1/23	Mon 12/18/2	6,13,19,23,26,29,	
5			B. Meet with ODU Drone	149 days	Mon 5/1/23	Thu 11/23/23	6,32,29,35	
6			**III. Materials**	**11 days?**	**Fri 9/23/22**	**Fri 10/7/22**	**23,29,32,13,19,3**	
7			A. Frame	11 days	Fri 9/23/22	Fri 10/7/22		
8			B. Motors	11 days	Fri 9/23/22	Fri 10/7/22		
9			C. Propellers	11 days	Fri 9/23/22	Fri 10/7/22		
10			D. Speed Cont	11 days	Fri 9/23/22	Fri 10/7/22		
11			E. GPS	11 days	Fri 9/23/22	Fri 10/7/22		
12			F. Blade Guar	11 days	Fri 9/23/22	Fri 10/7/22		
13			**IV. Budget**	**16 days?**	**Fri 10/7/22**	**Fri 10/28/22**	**23,26,29,32,35**	
14			A. Smart Transmitter/R	16 days	Fri 10/7/22	Fri 10/28/22		
15			B. Cube Orange	16 days	Fri 10/7/22	Fri 10/28/22		
16			C. Battery/ Battery	16 days	Fri 10/7/22	Fri 10/28/22		
17			D. Sensors	16 days	Fri 10/7/22	Fri 10/28/22		
18			E. Replaceme	16 days	Fri 10/7/22	Fri 10/28/22		



Project: Drone_Project
Date: Tue 1/17/23

Task | Split | Milestone | Summary | Project Summary | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | External Tasks | External Milestone | Deadline | Progress | Manual Progress

ID		Task Mode	Task Name	Duration	Start	Finish	Predecessors	Resource Names
19			**V. Sensors**	**16 days?**	**Fri 9/30/22**	**Fri 10/21/22**	**13,23,26,29,32**	
20			A. Optical Flow/ Hear	16 days	Fri 9/30/22	Fri 10/21/22		
21			B. Non-GPS Navigation	16 days	Fri 9/30/22	Fri 10/21/22		
22			C. Object Avoi	16 days	Fri 9/30/22	Fri 10/21/22		
23			**VI. Software**	**16 days?**	**Fri 10/28/22**	**Fri 11/18/22**	**26,29,32,35**	
24			A. Mission Pla	16 days	Fri 10/28/22	Fri 11/18/22		
25			B. Q-Ground (	16 days	Fri 10/28/22	Fri 11/18/22		
26			**VII. Drone Scher**	**11 days?**	**Fri 10/28/22**	**Fri 11/11/22**	**29,32,35**	
27			A. Brush Motc	11 days	Fri 10/28/22	Fri 11/11/22		
28			B. Brushless M	11 days	Fri 10/28/22	Fri 11/11/22		
29			**VIII. Prototype**	**26 days?**	**Fri 11/11/22**	**Fri 12/16/22**		
30			A. Assmebly	12 days	Mon 5/1/23	Tue 5/16/23	31,32,35	
31			B. Pre-Test	15 days	Mon 5/1/23	Fri 5/19/23	32,35	
32			**IX. Flight Testing**	**40 days?**	**Mon 1/9/23**	**Fri 3/3/23**	**35**	
33			A. Indoor	19 days	Mon 1/9/23	Thu 2/2/23		
34			B. Outdoor	22 days	Thu 2/2/23	Fri 3/3/23		
35			**X. Final**	**11 days**	**Fri 4/14/23**	**Fri 4/28/23**		
36			A. Demonstat					
37			B. Presentatic					



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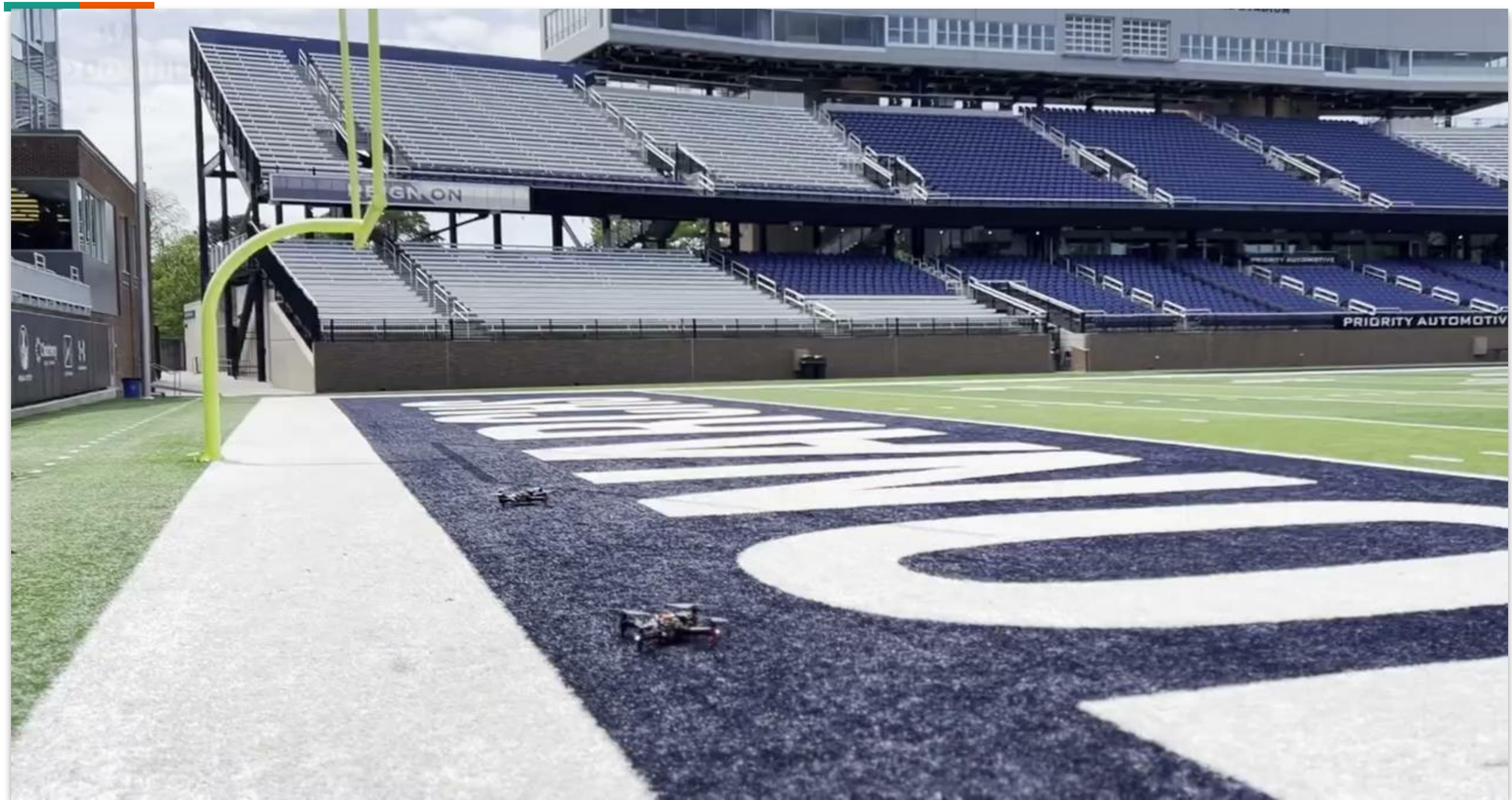
Website

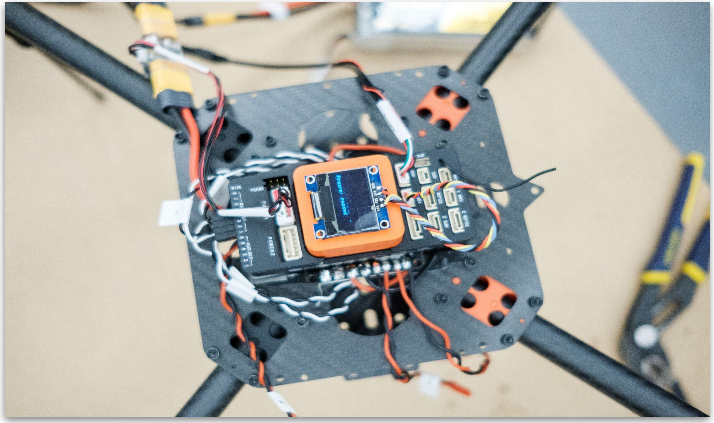
- The website is fully furnished and completed
  - Respective documentation of weekly progress meetings and the entire project life cycle are attached
- Website Link: http://dasp.mem.odu.edu/~swarm_sp23/index.html

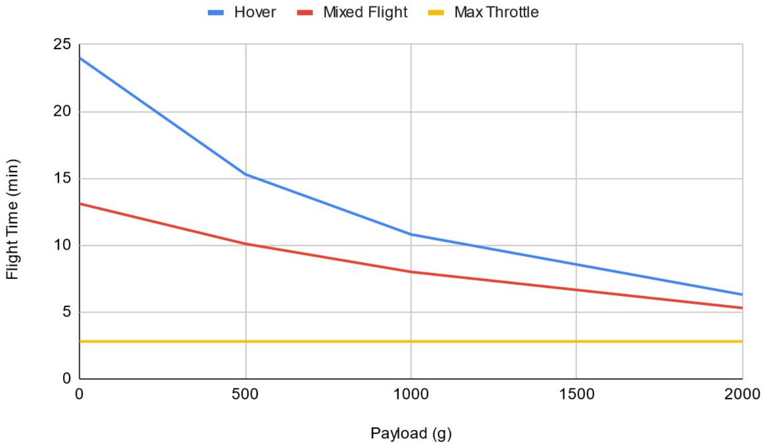
Final Flight



Future Project Goal

- According to Dr. Kapia, our project is a foundation for future students to build upon
- Next year's class will be able to:
    - Finish programming Lidar with complete object avoidance
    - Construct a third drone to add to the swarm and test more "follow-the-leader" type scenarios
    - Add payload to the drones to highlight their full practicality





Acknowledgements

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Old Dominion Drone Club:

Rob Stuart, Ana Eggleston (Secretary), Jack Hawkins (President)

Thank you to Dr. Zhang and the class for being a part of our project journey!

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