Autonomous Swarm Drones

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Course: MAE 434W

Team Leader:

Natalie Jones

Team Members:

Maggie Atkinson

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Project Scope

Statement of Work (SOW)

From use in the military to the backyard, drones have slowly taken over modern life. These unmanned vehicles have risen quickly in popularity for private, industry, and government use around the world. However, one of the challenges facing usage of drone's is the ability to swarm them, as in ensuring that drones are able to fly in large groups without colliding with one another. This is not an easy task to accomplish, as it requires coordination between multiple different sensors and careful planning of flight paths. However, thanks to the increase in swarm-based robotic systems and development of new communication techniques, coordinating multiple drones is a more possible achievement [1].

The team for this design project will meet three days a week, the first day of the week (Monday) will be a meeting with the project advisor(s) to discuss project progress and to discuss relevant technical and non-specialized issues that the team is facing with the drone. The second day of the week (Tuesday) is our testing day, the team meets up to fly/test the drone and track down progress, record data, and note issues that were observed. The third day (Wednesday), the team will meet to discuss the required measures and steps that are needed to proceed further with the completion of drone assembly. Each week the team will progress more and report back to the project advisor back on Monday.

The team's budgeting plan for the project will be to request funds from the college for the necessary materials, including sensors, batteries, and other equipment. The team already has most of the hardware needed to build their first drone, so they will not need to request funding for those initial parts, although replacement parts may need to be purchased depending on the

circumstances. The team plans to propose a budget of approximately $3,500.00 to the college for the completion of the project.

By the end of this completed project, the team will be able to demonstrate stable hover capability of an existing quadrotor-type unmanned aerial vehicle (UAV) using system integration of mechanical and controller hardware. The demonstration of autonomous flight of the unmanned aerial vehicle (UAV). The development and testing of autonomous flight in multiple unmanned aerial vehicles.

Deliverables

Table 1- Deliverables

The table below represents the team's deliverables with a description and a deadline.

Deliverable	Description	Deadline
Approach	Complete Research on Ardu-Pilot/Copter to understand all the components of the drone in order for the team to succeed.	9/30/2022
Materials and Budget	Perform calculations and collaborate with instructors for what parts of the drone are supplied and what is needed. The team will make a budget proposal to submit to ODU for the parts that are needed.	10/28/2022
Drone Schematics	Acknowledge the use of brush motors/brushless motors with various types of wires connected to the speed controllers via signals.	11/11/2022
Prototype Drone Assembly	Construction of the drone prototype including	12/16/2022

	attachment of the sensors, frame, and motors. Same construction to the second drone to test swarm capabilities.	
Flight Testing	Autonomous flight test for both indoor and outdoor settings. Record results and any errors or issues found during tests of the swarm to fix on.	3/3/2023
Demonstration & Presentation	Demonstration of a live presentation or videos to show the swarm function of the autonomous drones and their purpose.	4/28/2023

Acceptance Criteria

1. Performance: Each drone should have autonomous flight capabilities and show self-correcting object avoidance behaviors in flight. An autonomous multi-drone swarm shall be able to complete tasks predetermined by the flight operating system without collision.
2. Quality Review: The objective is to build at a minimum two reliable and self-sufficient drones, capable of taking commands and performing fast corrections in flight. The main components driving the drones are the flight controllers and the object avoidance sensors. Having high quality sensors and a flight controller capable of receiving, computing, and outputting commands to the drone as fast as possible is crucial in the success of this project. Most of the budget will go to allocating these parts.

3. On-Time Delivery: With the budget restraints, the first drone will be built and tested by early next spring. A multi-drone swarm demonstration will be scheduled in the later part of the spring semester.

Work Breakdown Structure

As a group, we determined that in order to complete the project there are five tasks that need to be completed. The first task is to find out what parts are freely available and what parts or sensors we need to buy. This includes talking to our advisors and the drone club about what spare parts they have that we can use and researching what additional parts and sensors are needed for autonomous flight. Secondly, the drone parts need to be purchased. Once receiving funding from our advisor or from the university the missing drone parts will be ordered. Thirdly, the drone is to be built. Using the parts supplied by our supervisors and the drone club, the drone will be built out as best it can until funding can be supplied to purchase the additional parts upon which the drone will be able to be completed. The fourth task is to research and understand what software is going to be used and how to properly implement it. Finally after these steps are completed we will be able to fly the drone and start to run tests on its autonomy and swarm capabilities.

As a team we were able to determine what parts are freely available to us while having Tim and Daley research and find the additional parts and sensors for the drone. Maggie and Natalie are tasked with finding the best way to purchase the required parts in accord with our budget. Anzam and Anthony are tasked with building out the drone using the supplied parts. Austin, Logan, and Mahmoud are to look into what software is best and how to apply it to our drone and swam criteria. The flight testing will be a group effort as some of the previous tasks

will have been completed although during testing, new parts might need to be researched and ordered, revisions to the drone structure made, and having to fix software issues will reinstate each member back to their previous role. There will also be new roles and responsibilities created as development of this project continues.

Table 2 - Responsibilities Summary

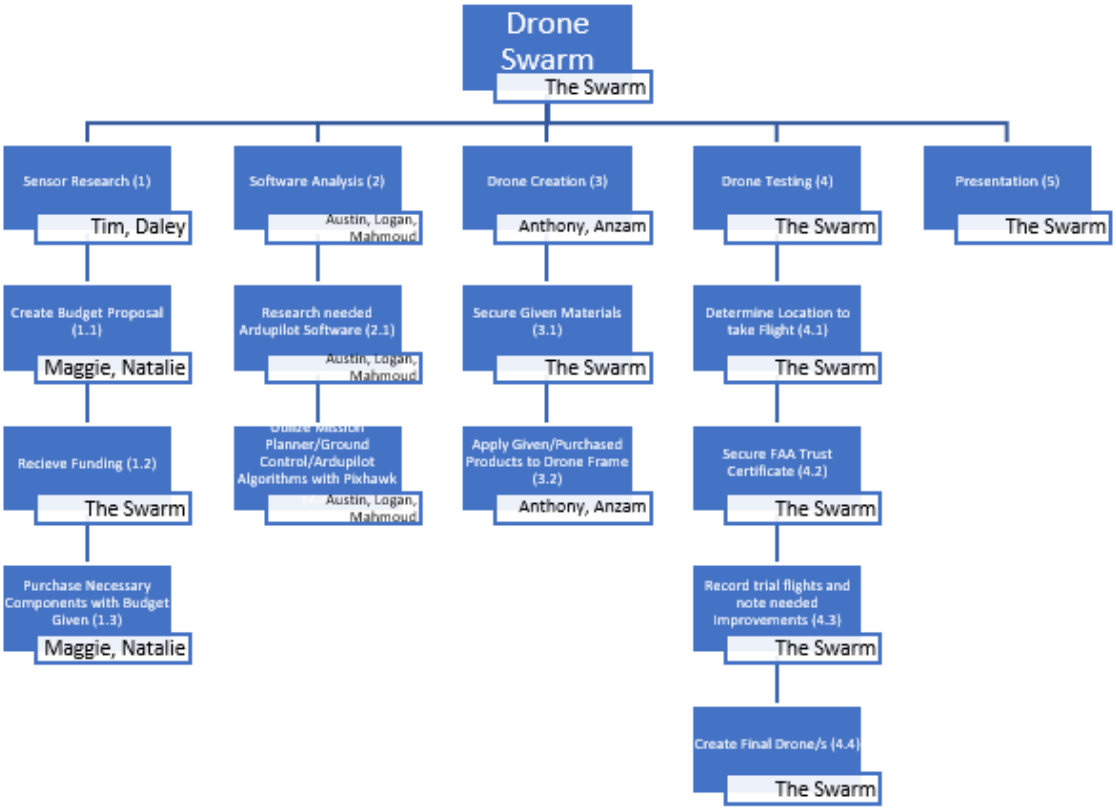
This table shows the summary of major deliverables and who is responsible for them.

WBS #	Description	Responsible	Deliverables
1	Sensor Research	Tim, Daley	Object Avoidance, Optical Flow, GPS Navigation sensors
2	Order Parts	Maggie, Natalie	Budget Proposal
3	Software Analysis and Implementation	Logan, Austin, Mahmoud	Ardupilot, Mission Planner, and Ground Control utilization
4	Drone Creation	Anthony, Anzam	Application of Flight Controller, Power Module, Sensors, Receiver Transmitter, Motor, and Battery on given frame
5	Drone Testing	Group	Indoor/Outdoor Flight
6	Presentation	Group	Midterm and Final

Work Breakdown Structure Graphic:

Graphic I - Work Breakdown Structure

This graphic shows the breakdown of work for our group to complete in an easy to read manner.



Responsibility Assignment Matrix:

The Responsibility Assignment Matrix shows in a convenient manner who has been assigned and held responsible for completion of each work item that was broken down in the Work Breakdown Structure.

Table 3 - Responsibility Matrix

This table shows all the major and minor deliverables and who is responsible for them.

- P = Primary Responsibility
- S = Supporting Responsibility

WBS Item	Work Item	Maggie	Daley	Logan	Natalie	Tim	Anzam	Anthony	Austin	Mahmoud
1	General Background Drone Research	s	s	p	s	s	s	s	s	s
2	Sensor Research		p			s				
3	Order Parts	p			s					
4	Software Analysis			s					p	s
5	Software Implementation			s					s	p
6	Drone Assembly						s	p		
7	Drone testing	s	s	s	s	s	p	s	s	s
8	Drone Revision	s	s	s	s	p		s	s	s
9	Presentation	s	s	s	p	s	s	s	s	s

References

1. W. Chen, J. Liu, H. Guo, and N. Kato, “Toward robust and intelligent drone swarm: Challenges and future directions,” *IEEE Network*, vol. 34, no. 4, pp. 278–283, Aug. 2020.

List of Contributions

Statement of Work: Maggie Atkinson, Mahmoud Zeid

Deliverables: Natalie Jones, Anzam Sheak

Acceptance Criteria: Anthony Torres, Anzam Sheak

Work Breakdown Structure: Daley Goff, Austin Worrell

Responsibility Table: Logan Johnson, Tim Kent