Senior Design 1 Initial Project Document

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5D's of Dodgeball Drone

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Group B16

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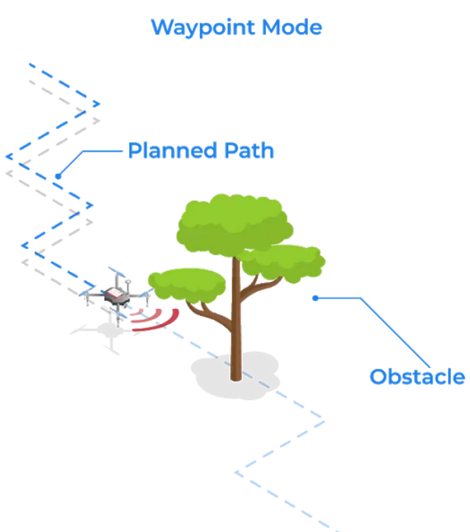
Project Narrative

With the rise of artificial intelligence in recent years, coupled with cheaply available multirotor platforms, autonomous drones are being used in more places. Furthermore, the jobs they perform are becoming increasingly complex. One of these roles is package delivery.

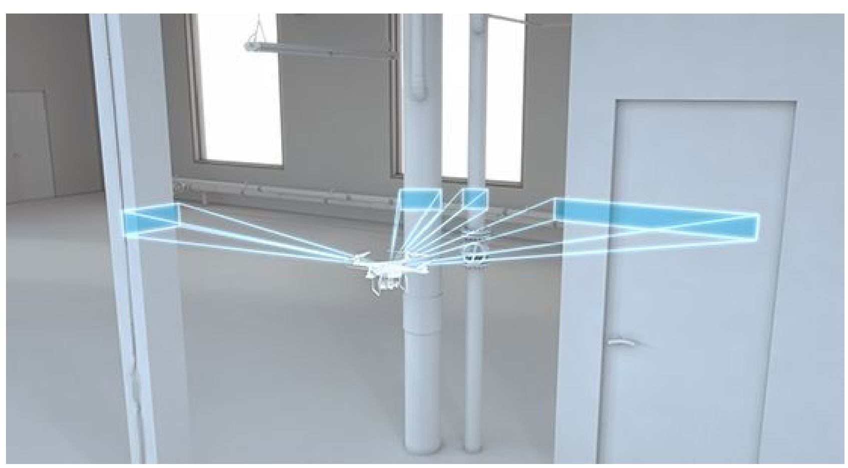
Online shopping has been trending upwards for years, and the recent pandemic has only accelerated this. This and other package shipping services require a cheap and scalable method for last mile delivery: the delivery from local distributors to customer's homes. Additionally, it can be problematic to deliver medical supplies and food to remote areas that are not accessible by vehicles.

Figure 1: Obstacle Avoidance



Drones are the perfect platform to fill this role. They are cheap and scalable, as well as being able to travel quickly and navigate to non-accessible places. However, one problem with current drones is that they lack the ability to detect and avoid local obstacles. A general course can be planned and followed using GPS and terrain mapping data, but there is still a need to avoid things like buildings, trees, and other drones **(Figure 1)**.

Figure 2: Proximity Detection



The project we are proposing is a payload delivery drone with the ability to detect and avoid local obstacles **(Figure 2)**, enabling fully autonomous package delivery.

Specifications

When deciding our specifications we wanted to keep it reasonable and affordable. In **Table 1**, the physical specifications were majorly influenced by costs because the larger the quadcopter the more expensive materials will be, but with that we needed a sweet spot of a size in order to fit the modifications. **Table 2** has our goals in terms of electrical performance by trying to maximize energy efficiency and increasing performance. **Table 3** goes into the type of sensor specifications we will need to fly the quadcopter/drone to the destination and be able to perform robot vision for the object detection system.

Table 1

Physical Specifications	
Physical Size of Drone	2 to 4 feet long
Number of Motors	4
Number of propellers	4
Number of Circuit Boards	3 (Flight Control, Controller, Accident Avoidance)
Number of Controllers	1
Weight of Drone (Without Batteries)	5 - 8 pounds
Weight of Batteries	1 pound
Payload Weight	0.3 - 0.5 pound

Table 2

Electrical Specifications	
RF of Controller and Drone	2 - 2.4 GHz
Voltage of Drone	13 - 15V
Battery Capacity	5000 - 6000 mAH
Time of Battery to Run	30 Minutes
Amount of Voltage in 1 cell of LiPo	3.6V
Controller Voltage and Current	7V and 1A

Table 3

Sensing Specifications	
Field of View	60 degrees horizontal (+- 10 Vertical)
Range of View	0.5 - 10 Feet
Measuring Frequency	10Hz
Autopilot	GPS
Number of Sensors	4 (IR, Camera, GPS, Altitude/Pressure)

House of Quality

Here we have our House of Quality in **Table 4**, Where we show a correlation between the customer requirements and the engineering requirements. We see this using the legend given in **Table 4.1** to correspond what we are seeing to what the data means, which shows a strong correlation of certain subjects like Accident Avoidance in the engineering requirements to the customer requirement of actual Package Deliverability and Safety of Package. We see in the "hat" or triangle at the top of the HOQ the correlation between different engineering requirements and how they relate to one another. Such as Timing Accuracy, Turnover Time, and Accident Avoidance having strong "+" relationships.

Table 4

Project:	Dodge Ball Drone									
Date:		1/28/2021						+		
						+	+	+		
					-	-	-	+	-	
				+	-	-	-	+	-	-
			Functional Requirements							
		Direction of Improvement	▲	□	▲	□	▲	▲	□	□
Relative Weight	Customer Importance	Customer Requirements	Sensor Range	Payload Lift	Power Efficiency	Flight Speed	Accident Avoidance	Timing Accuracy	Turnover Time	Frame Durability
10%	5	Package Deliverabilty	●	○	●	○	●	●	●	▽
18%	9	Payload Weight	▽	●	●	○	●	●	▽	▽
4%	2	Delivery Time	▽	○	●	●	●	●	○	▽
16%	8	Cost	●	●	●	▽	▽	●	●	●
6%	3	Durability	▽	▽	▽	▽	▽	▽	▽	●
2%	1	Usability	▽	●	○	●	●	●	●	○
8%	4	Aesthetics	▽	▽	▽	▽	○	▽	▽	○
16%	8	Ease of Maintenance	▽	▽	▽	▽	●	▽	●	●
2%	1	Safety of Package	●	▽	▽	▽	●	●	▽	●
18%	9	Customer Requirement 10								
		Importance Rating Sum (Importance	306	398	470	186	514	498	442	422
		Relative Weight	9%	12%	15%	6%	16%	15%	14%	13%
		Our Product	1	2	3	4				
		Competitor 1	3	0	1	2				
		Competitor 2	1	4	2	1				
		Competitor 3	5	1	0	1				
		Technical Competitive Assessment								

Legend of HOQ

Table 4.1

Correlations	
Positive	+
Negative	-
No Correlation	

Relationships	
Strong	●
Medium	○
Weak	▽

Direction of Improvement	
Maximize	▲
Target	□
Minimize	▼

Block Diagram

Diagrams needed to represent this project would be a general flight diagram and then the software component. **Figure 3** represents the basic form of path that the drone will fly through in order to safely and accurately deliver a package to a GPS point. **Figure 4** shows a diagram of how the software will be performing.

Figure 3: Flight Path Diagram

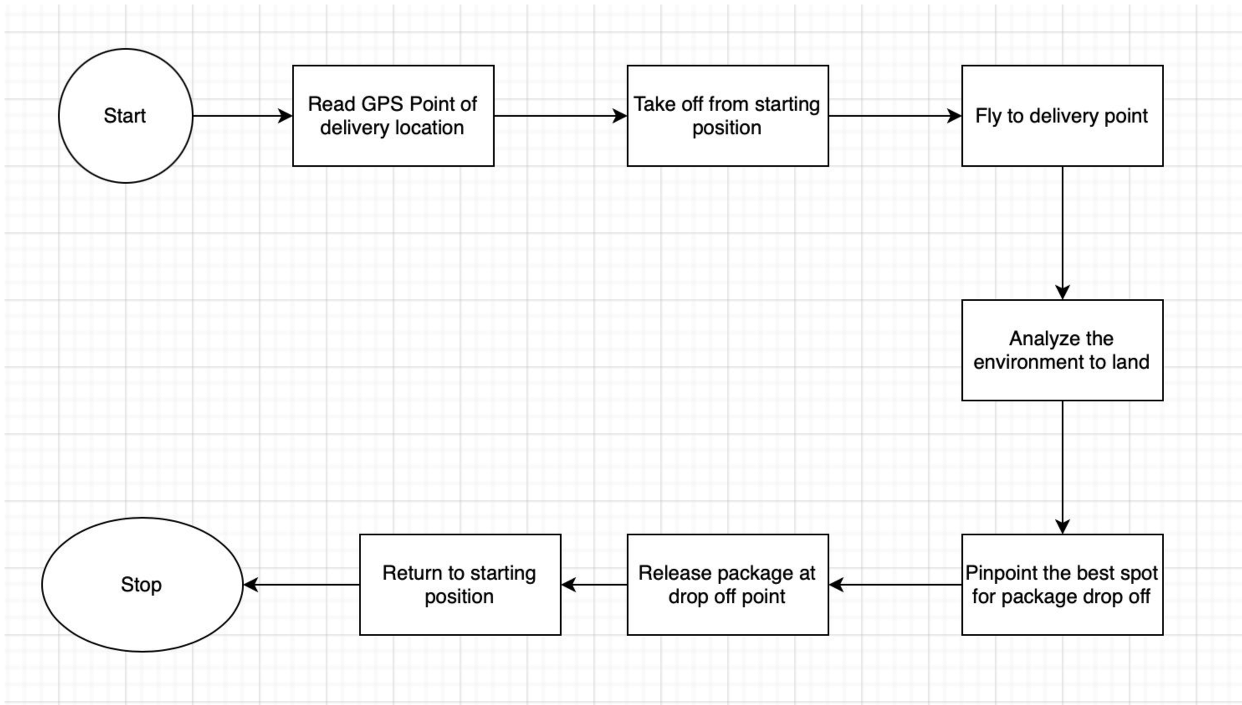
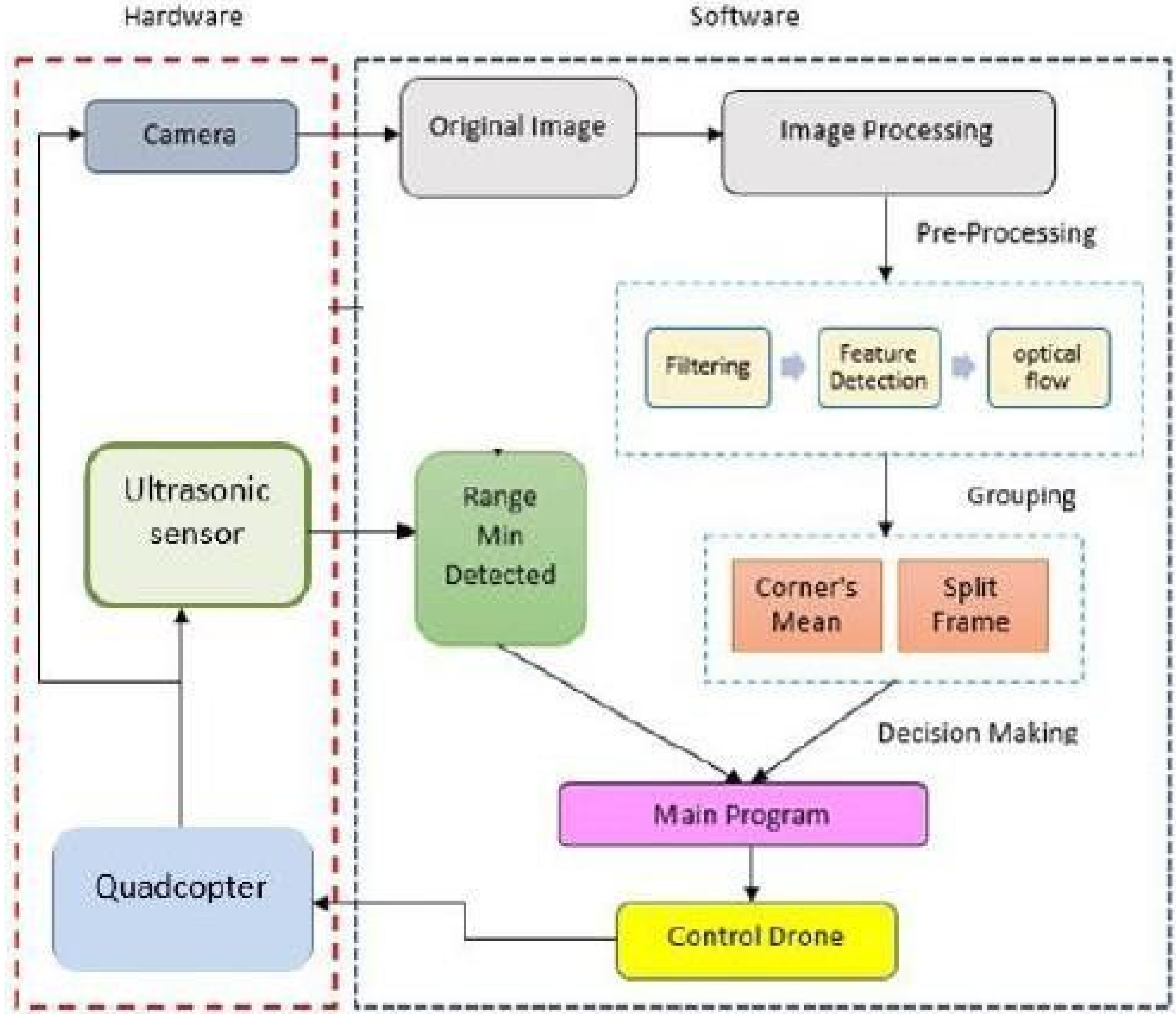


Figure 4: Software and Hardware Diagram



Project Milestones

For our project, we created our milestones by starting with the hard deadlines given by the course and then dividing that up into smaller personal group deadlines that will keep us on track. **Table 5** contains our deadlines for the first half of the project that concentrates with research and structure, then **Table 6** contains how we are splitting up the research that will be going into creating the main paper and helping with ideas. **Table 7** contains a more vague outline for how implementing and creating will go in the second half.

Table 5

#	Task	Start	End	Status	Responsible
1	Ideas	1/11/21	1/29/21	Completed	Group B16
2	Project Selection and role Assignment	1/25/21	1/29/21	Completed	Group B16
3	Divide & Conquer 1	1/25/21	1/29/21	Completed	Group B16
4	Divide & Conquer 2	2/1/21	Feb 12	In Progress	Group B16
5	Table of Contents	2/1/21	4/27/21	In Progress	Group B16
6	20 Page Submission	2/1/21	2/16/21	In Progress	Group B16
7	40 Page Submission	2/16/21	3/9/21	In Progress	Group B16
8	60 Page submission	3/9/21	4/1/21	In Progress	Group B16
9	80 Page Submission	3/9/21	4/5/21	In Progress	Group B16
10	100 page Submission	4/5/21	4/15/21	In Progress	Group B16
11	First Draft	2/1/21	4/20/21	In Progress	Group B16
12	Final Document	2/1/21	4/27/21	In Progress	Group B16

Table 6

Research, Documentation, & Design					
14	Frame design	2/1/21	4/2/21	Researching	Raymond & Austin
15	Sensors	2/1/21	4/2/21	Researching	Raymond & Austin
16	Motors and blades	2/1/21	4/2/21	Researching	Raymond & Austin
17	Controler	2/1/21	4/2/21	Researching	Raymond & Austin
18	PCB Layout	2/1/21	4/2/21	Researching	Raymond & Austin
19	Power Supply	2/1/21	4/2/21	Researching	Raymond & Austin
20	Computer Vision options	2/1/21	4/2/21	Researching	Ellie & Dan
21	Algorithm code outlines	2/1/21	4/2/21	Researching	Ellie & Dan
22	Languages to code in	2/1/21	4/2/21	Researching	Ellie & Dan
23	platforms for the code	2/1/21	4/2/21	Researching	Ellie & Dan
24	Set up Github repository	2/1/21	4/2/21	Researching	Ellie & Dan

Table 7

Senior Design 2					
25	Build Prototype	TBA	TBA	TBA	Group 16
26	Testing & Redesign	TBA	TBA	TBA	Group 16
27	Finalize Prototype	TBA	TBA	TBA	Group 16
28	Peer Presentation	TBA	TBA	TBA	Group 16
29	Final Report	TBA	TBA	TBA	Group 16
30	Final Presentation	TBA	TBA	TBA	Group 16

Project Budget

For our budget we are preparing for the worst so that if something goes wrong we will have wiggle room to buy more, we understand things will break or be defective so we made sure to plan accordingly. As seen in **Table 8** we have allowed ourselves to have multiple drones propellers and batteries in case things go south or break. In **Table 9** we allow ourselves to have multiple IR Sensors due to our research showing they don't always work effectively and it is cheaper to buy in bulk. Additionally, we will use numerous cameras and altitude sensors to make sure we can fly safely and effectively. For **Table 10** we are planning to have a radio controller to help with returning the drone and with troubleshooting to make sure our drone runs as we want it to. We believe RF would be the best way for the drone to communicate and a charger to make our batteries a little more eco friendly.

Table 8

Physical Components	
Drone Final x 1	$150 - 200
Testing Drones x 2	$100
Propellers x 20	$20
Housing Compartment x 1	$50
Batteries (Drone and Sensors) x 3	$200

Table 9

Sensor Components	
Altitude Sensor x 2	$30
IR Sensor x 9	$20
Camera x 3	$200

Table 10

Electrical Components	
RF Transmitter x 2	$14
Controller	$130
Charger	$50

Conclusion/Goals

The 5D Dodgeball Drone will be able to show how object avoidance can be accomplished for autonomous drones used for package delivery. By optimizing the use of power and sensors we will create a drone that can properly deliver a package while also avoiding objects. This project will incorporate machine learning to optimize how the drone will travel and delivery while avoiding objects. On the electrical side, it will work on optimizing the batteries and controls with sensors. Embedded systems will be used to help communicate the system holistically and perform the mission. We will also be trying to maximize on a smaller budget than typical companies, which will hopefully lead to showing this advanced technology is affordable.