Deliverable E - Project Plan and Cost Estimate

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Introduction

JAMZ Automated Delivery is a drone delivery service focused mainly on the shipment of food from restaurants to the client. Their drones are ready for use, however, some essential features, like a climate sensor inside the package, are not functional yet. The main goal of this project is to develop a reliable solution that generates information about the content of the package during delivery. The device should provide valid and consistent data on the temperature and humidity of the food and send a warning to the drone's microcontroller (Raspberry Pi) when the conditions inside the package are not ideal. In this document, the group D8 presents a detailed design of the project with drawings, a bill of materials and a plan for the execution and testing of prototypes 1, 2 and 3.

Changes were made to the initial design in order to reduce the final cost of the project. The team will use an Arduino Uno instead of an Arduino Mini .

Detailed design

The components of the three chosen subsystems are presented in this section with their corresponding technical drawings. The housing is divided in two parts, the base (figure 1.1) and the cover (figure 1.2), and has a rubber stopper (figure 1.3) and a cooler fan to control the heat (figure 1.4). 2 sensors (figure 1.5) are going to be used with an Arduino Uno (figure 1.6) on the final assembly (figure 1.7). Different views of the module mounted to the drone are also presented (figures 1.8, 1.9, 1.10, 1.11, 1.12).Circuit diagrams will be added at a later stage of the project once programming/power needs are determined.

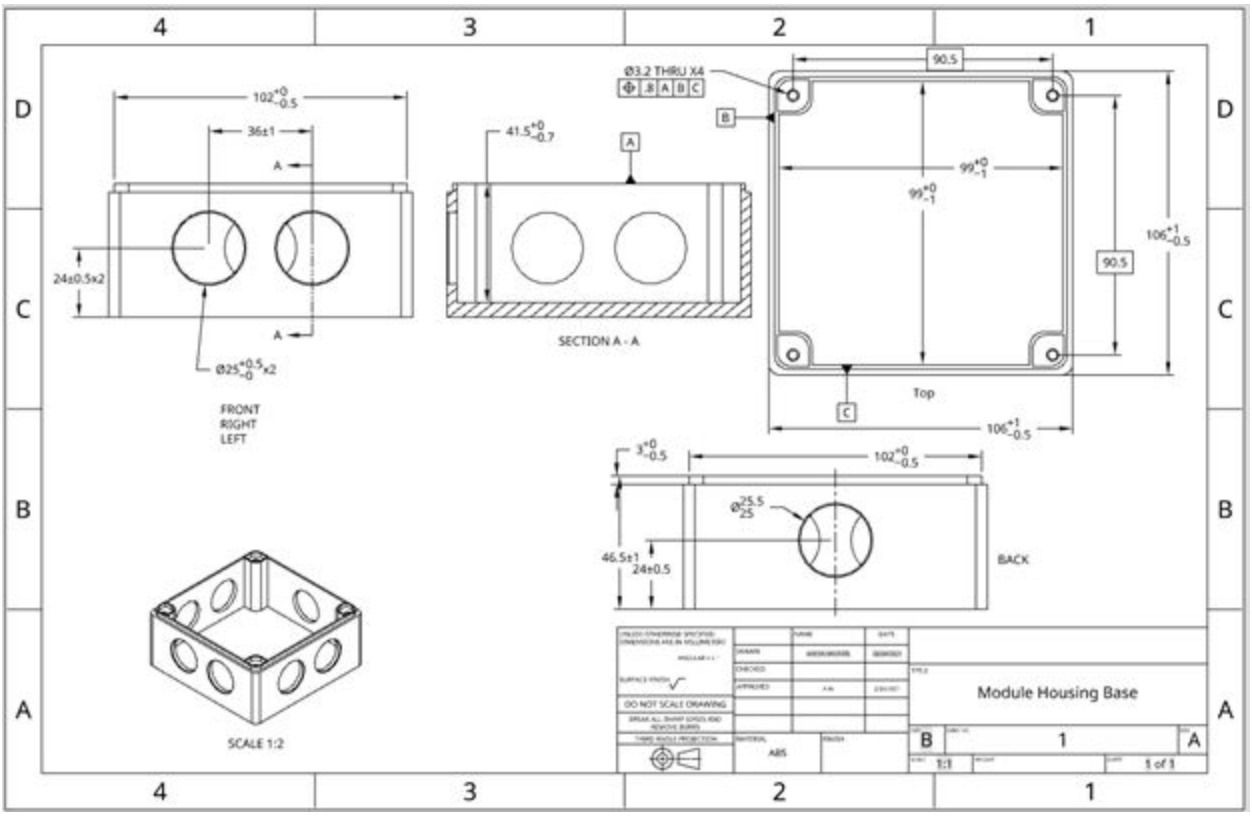

Figure 1.1 - Module Housing Base technical drawing

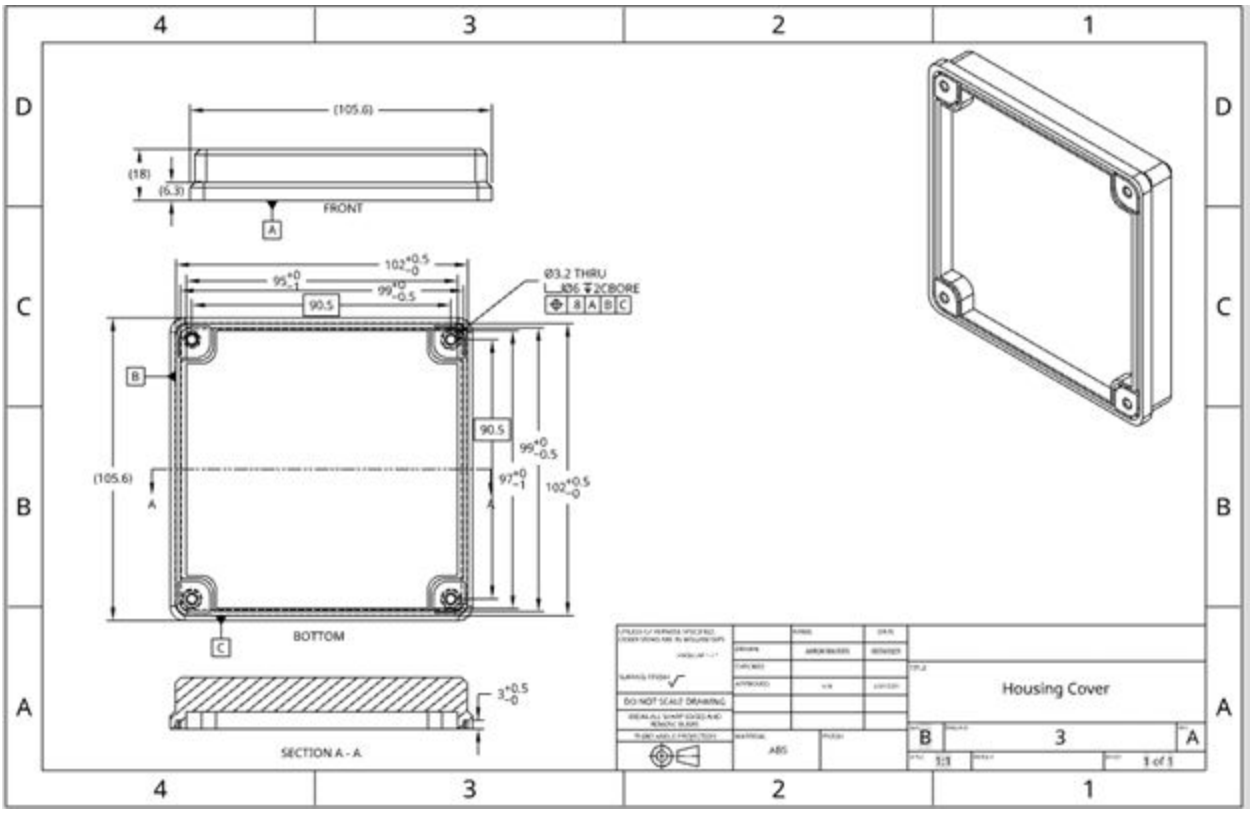

Figure 1.2 Housing Cover technical drawing

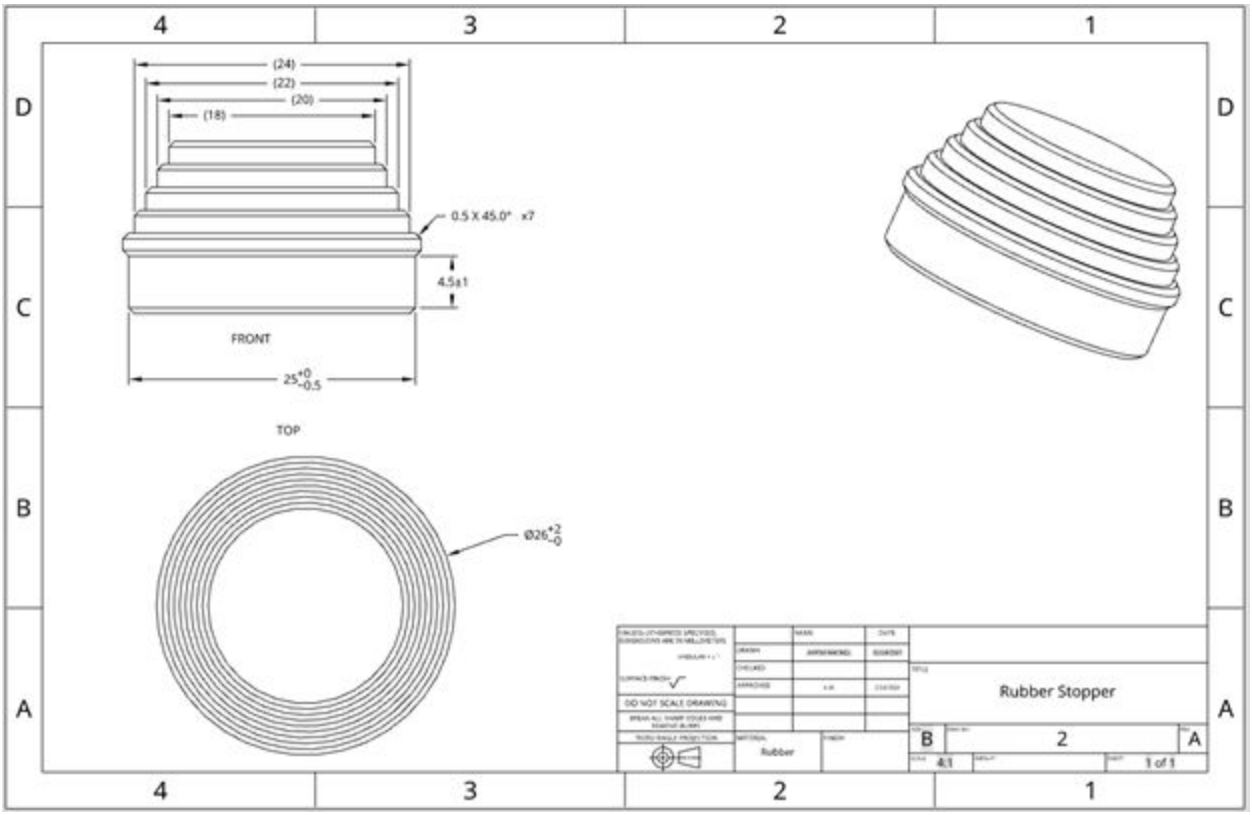

Figure 1.3 Rubber Stopper technical drawing

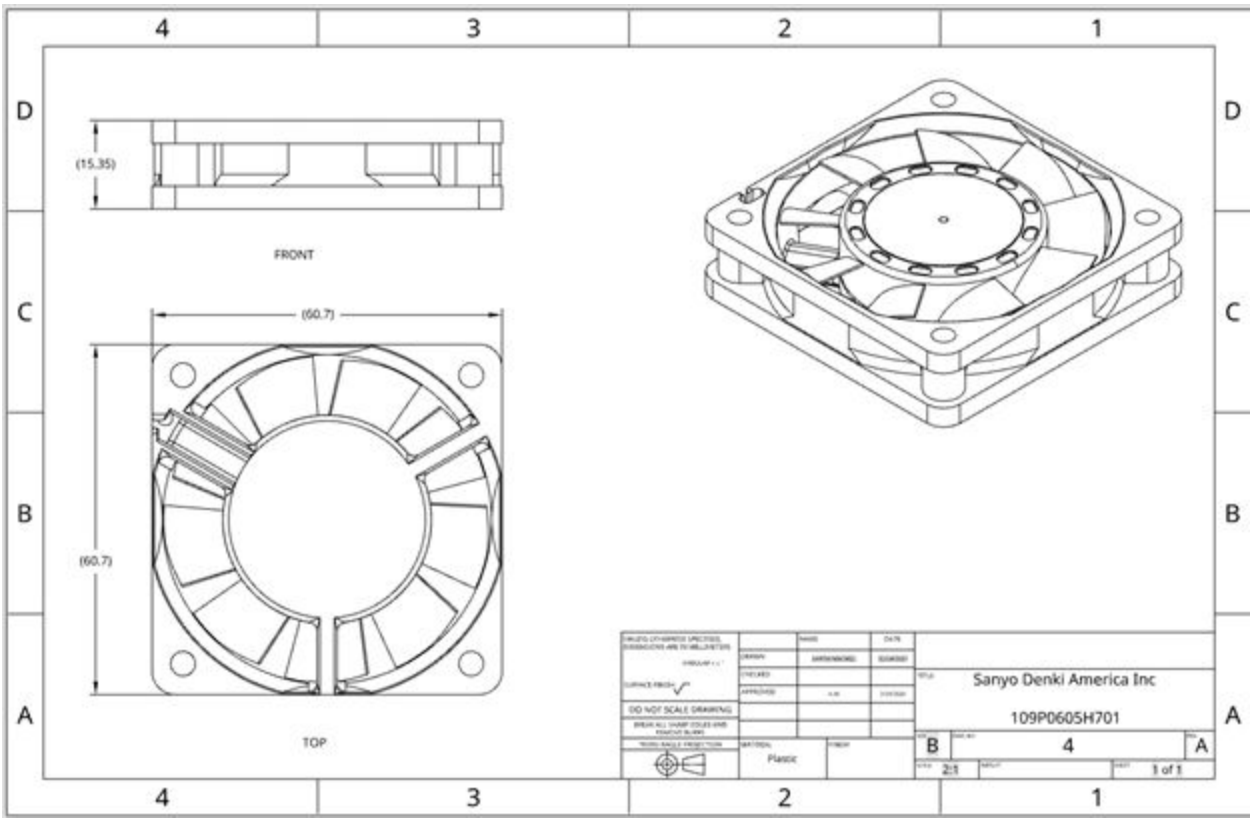

Figure 1.4 Cooler Fan technical drawing

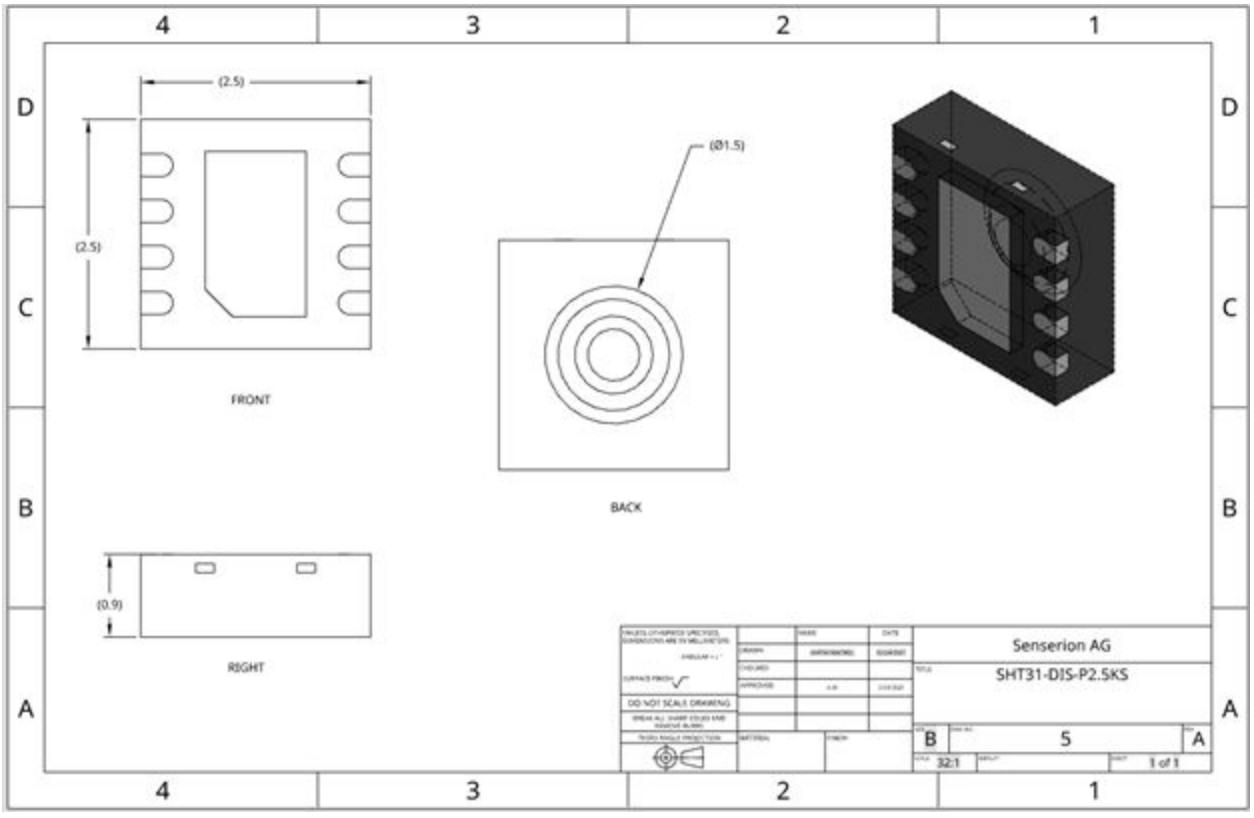

Figure 1.5 Sensor technical drawing

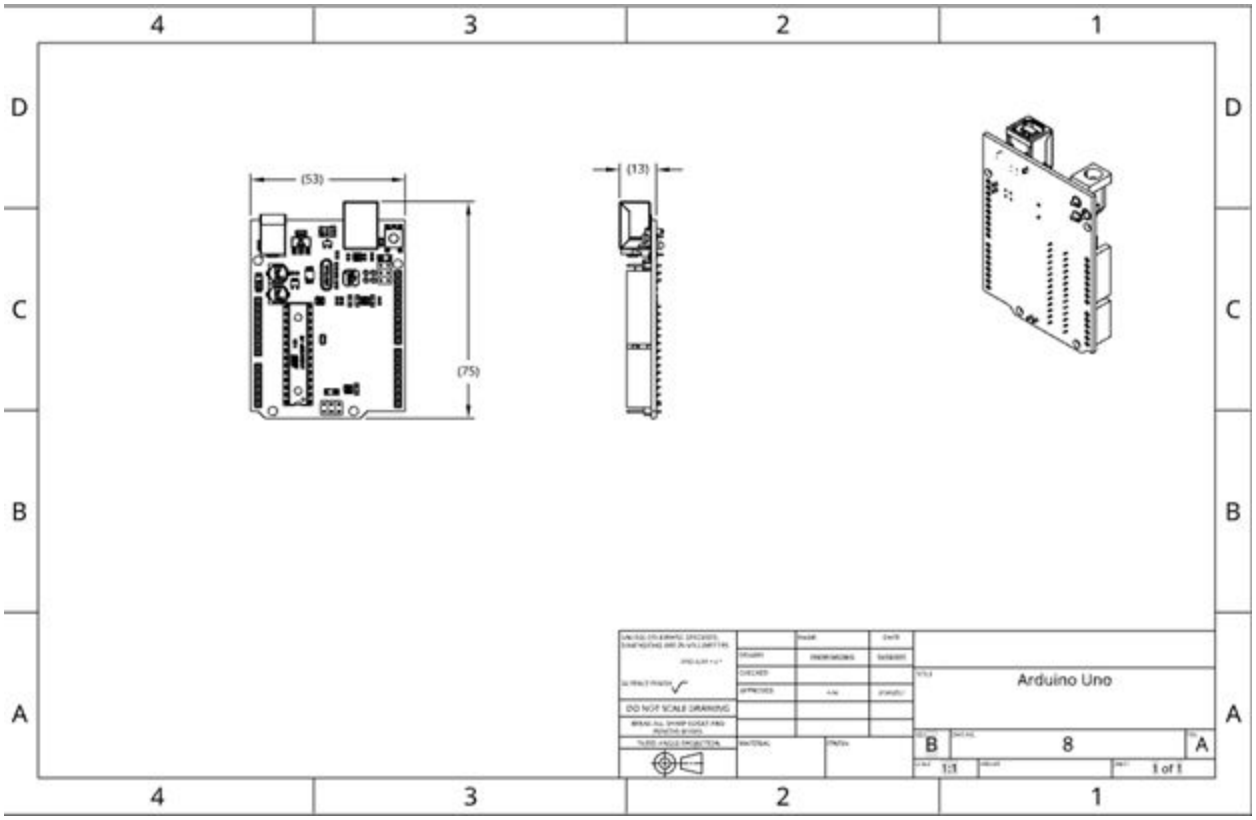

Figure 1.6 Arduino uno technical drawing

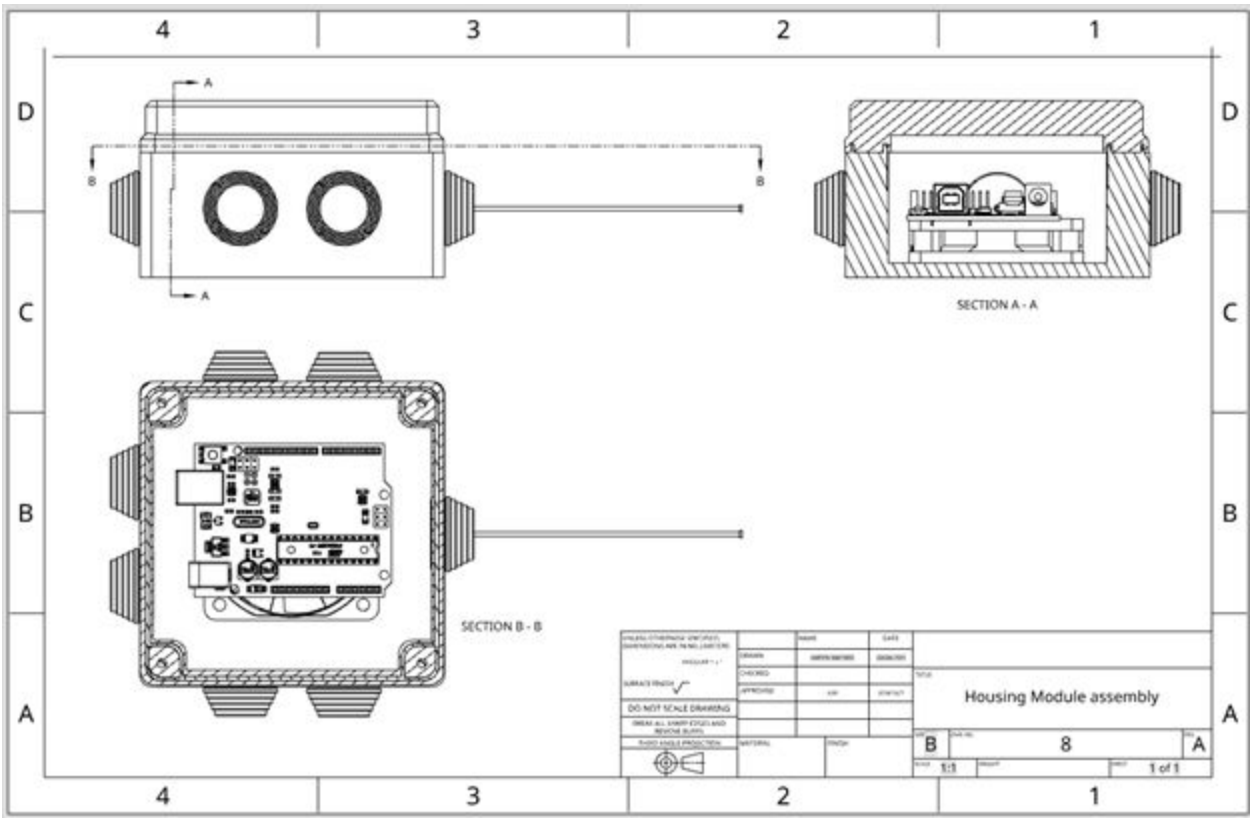

Figure 1.7 Housing Module assembly drawing

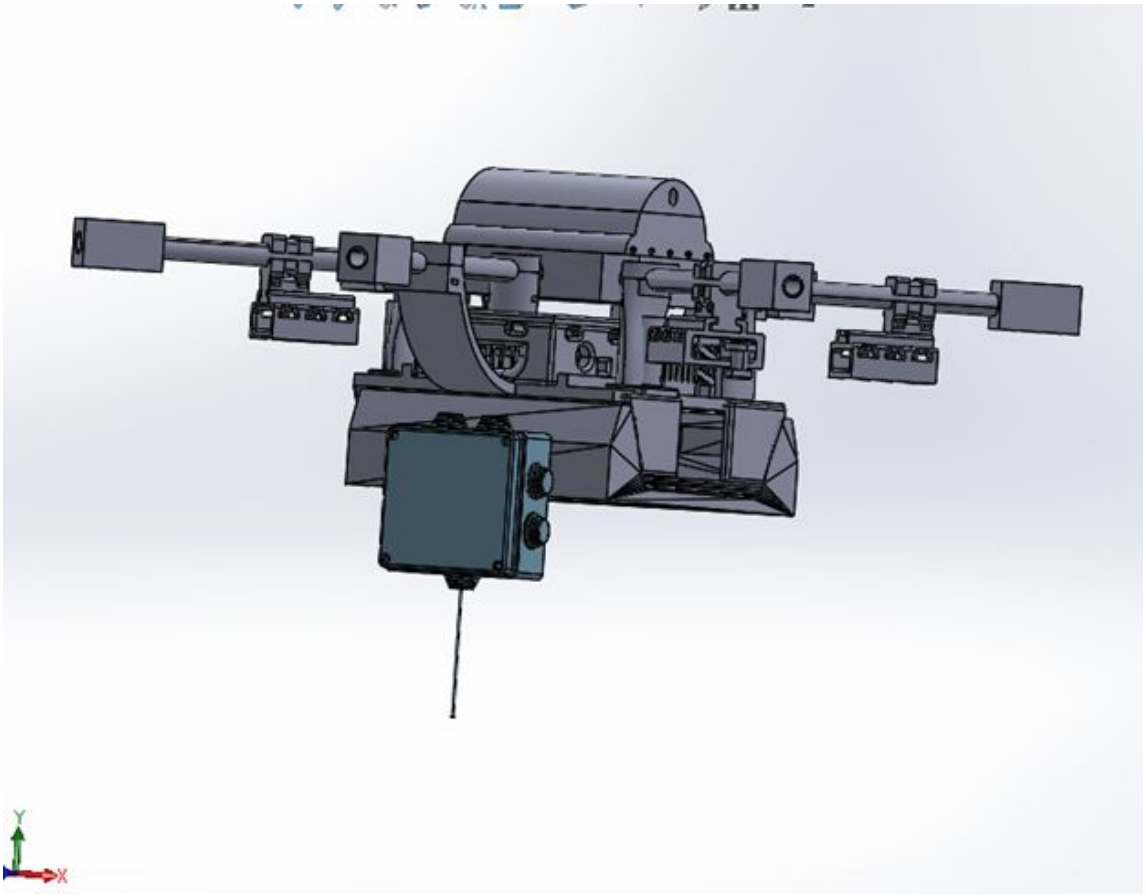

Figure 1.8 Module mounted to Drone Assembly - side view

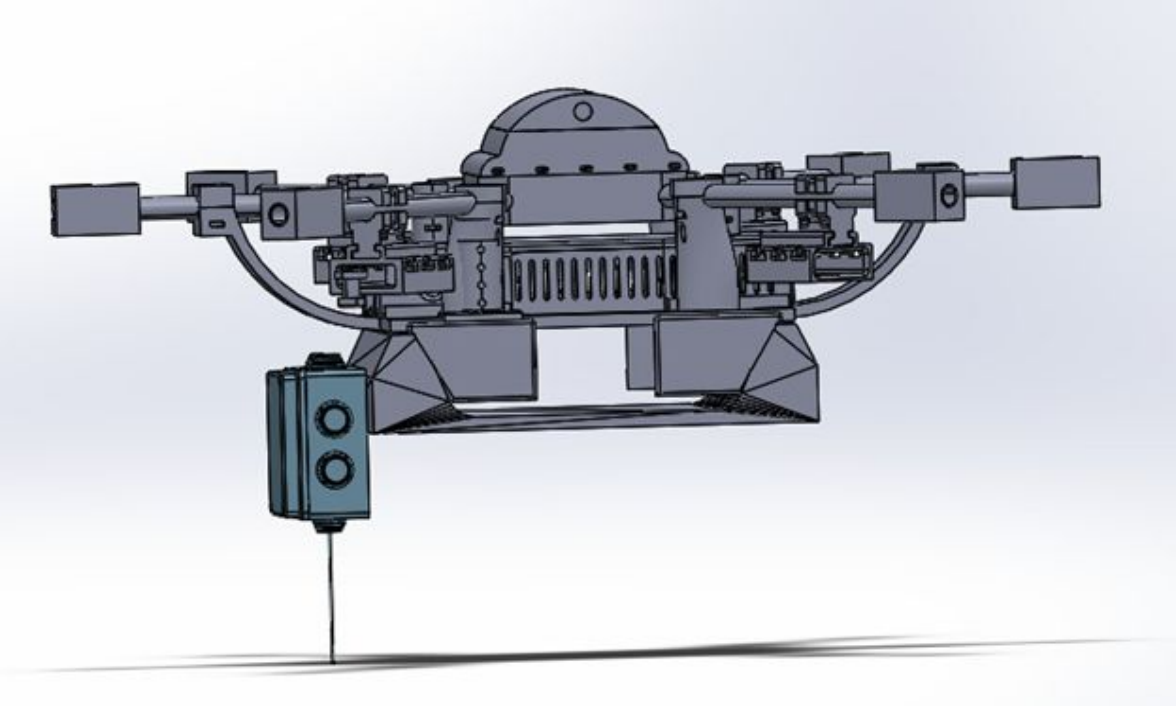

Figure 1.9 Module mounted to Drone Assembly - front view

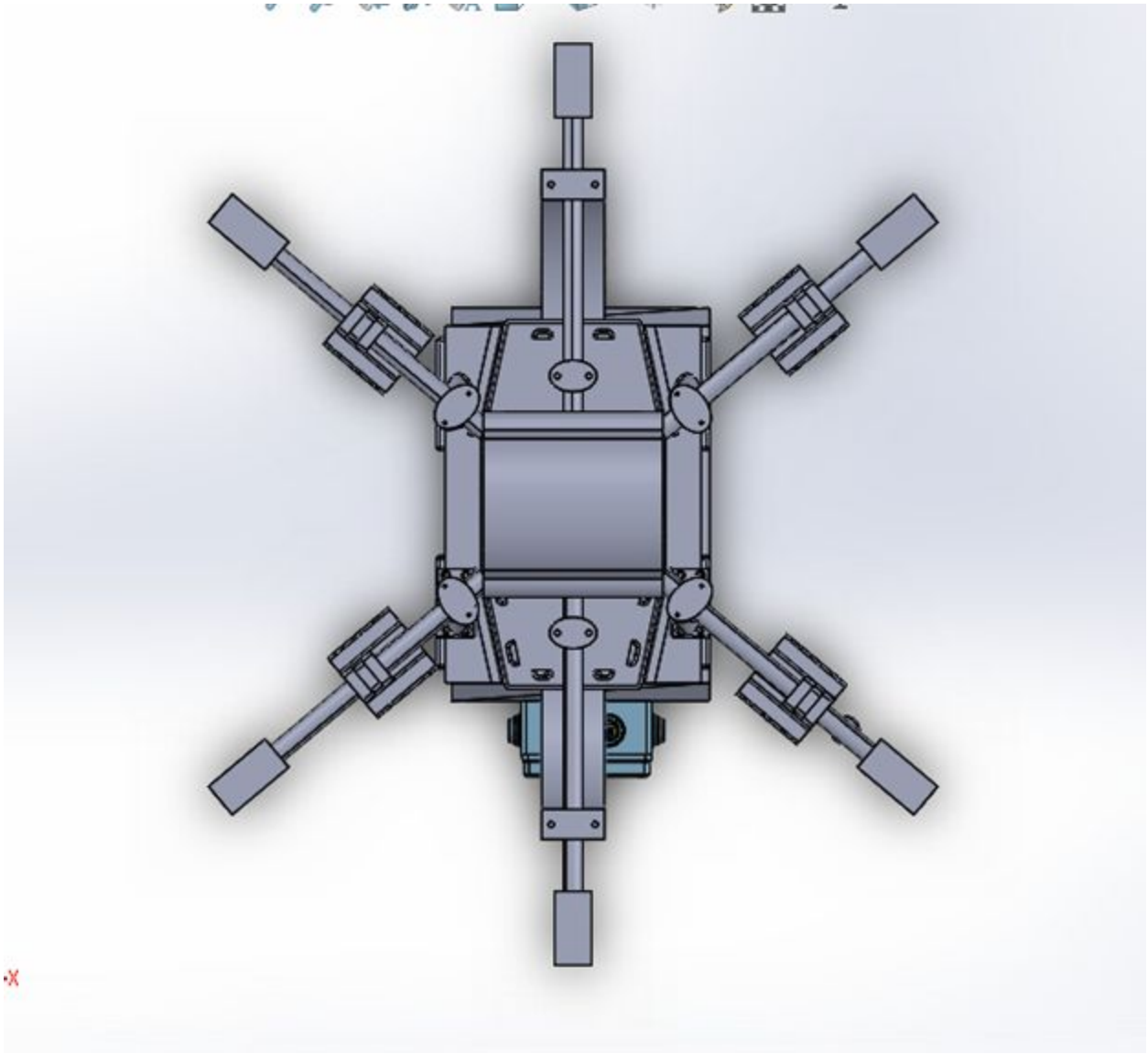

Figure 1.10 - Module mounted to Drone Assembly - top view

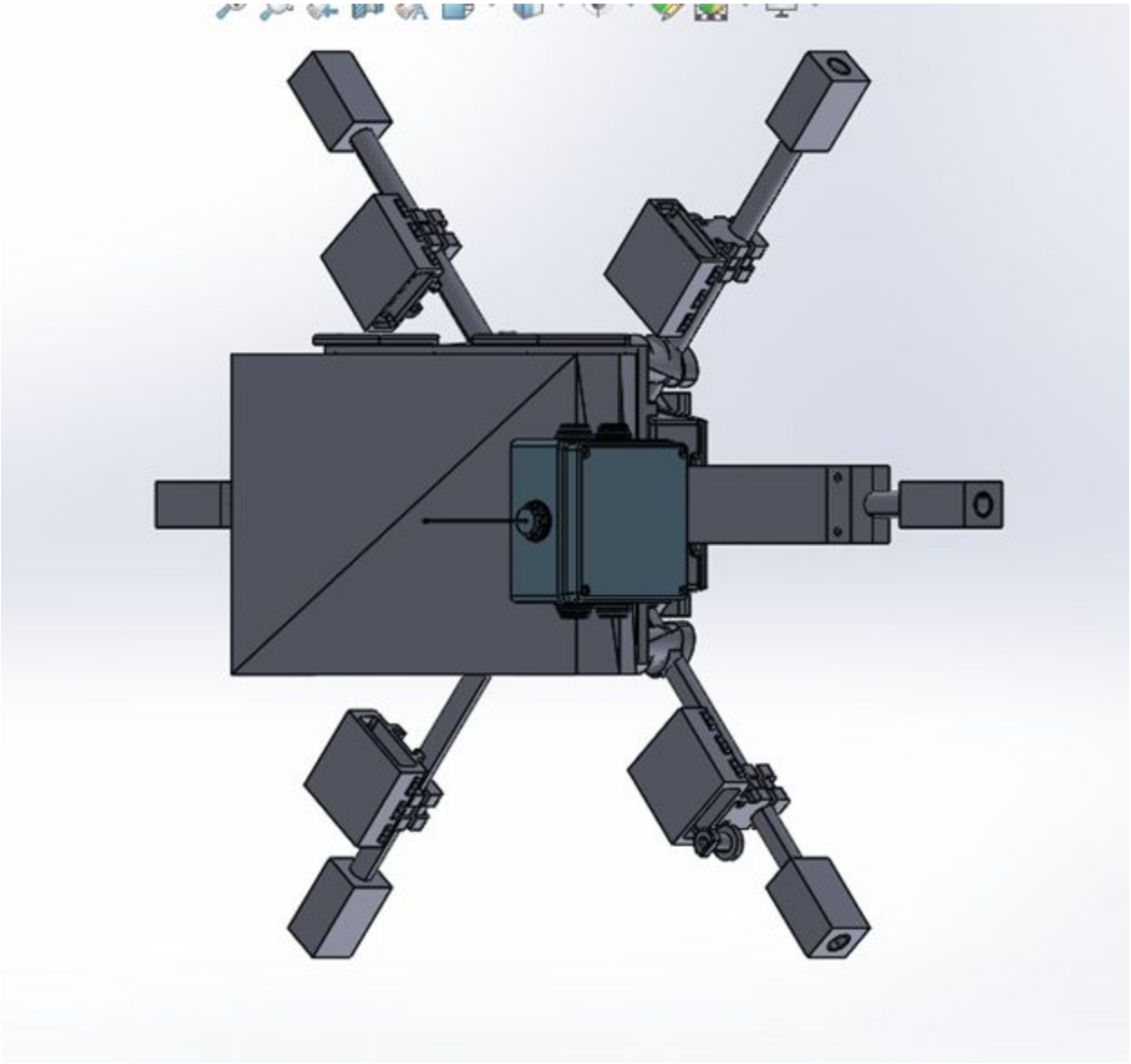

Figure 1.11 Module mounted to Drone Assembly - bottom view

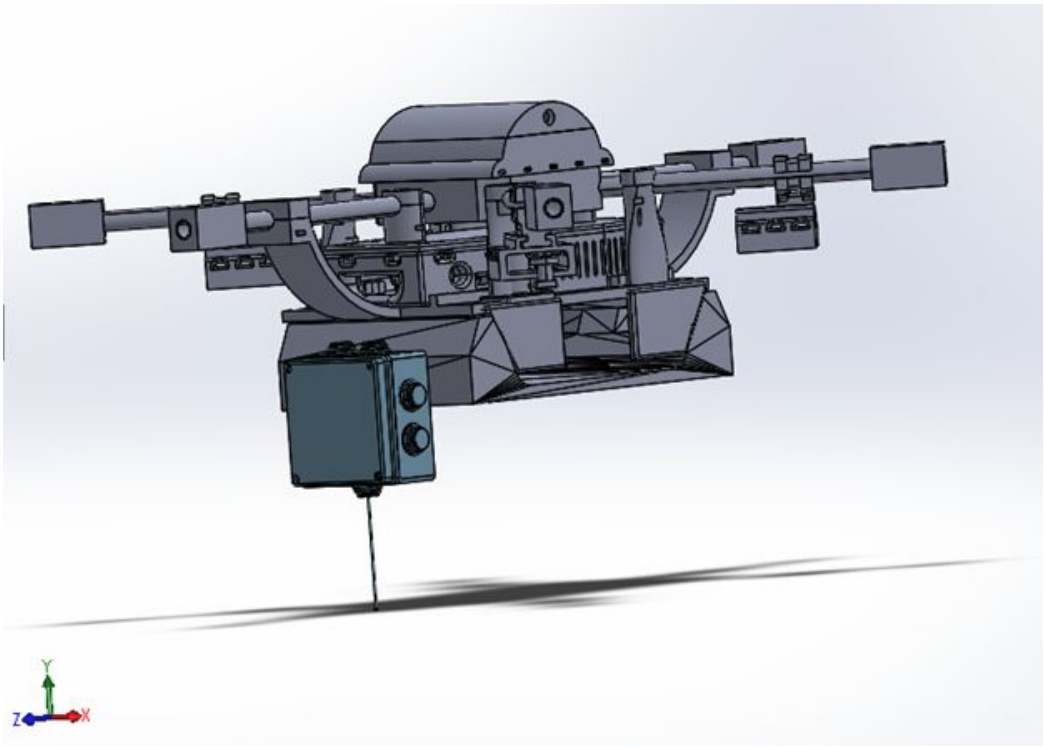

Figure 1.12 Module mounted to Drone Assembly - side view

Project Risks and Contingencies

For the humidity and temperature sensor project, money is a primary constraint, because needing to stay within a budget could have its setbacks. Sometimes the pricey equipment could indeed be a better option as it would be of better quality. The space inside the housing compartment needs to be big enough for both the microcontroller to comfortably fit inside, but yet compact so it does not cause extra weight for the drone. A project risk is maintaining the temperature inside the housing and making sure that it does not heat up nor cool down since the change in temperature could make the reading inaccurate.

Analysis of critical components

Critical components for the sensor

- 2×sensors Sensirion AG SHT31-DIHIH8120-021-001S-P2.5KS

Critical components for the microcontroller

- Arduino Uno

Critical components for the housing

- Housing LeMotech ABS

- Fan

Analysis of system integration

The sensors will be connected to the Arduino Uno through wires. The data received will be interpreted using a code and a warning will be sent to the drone's microcontroller if the temperature is below or above the accepted range and/or the humidity is above a certain limit value. A waterproof tube will connect the wiring from the Arduino that is inside the waterproof box to the drone's microcontroller (Raspberry Pi). All the sensors will stay outside the housing to properly produce data of humidity and temperature.

Bill of Materials

Table 1.1 - Bill of Materials (BOM)

No	Item	Qty	Unit cost ($)	Total cost ($)
1	Sensor SHT31-DIHIH8120-021-001S-P2.5KS	2	7.26	14.52
2	Arduino Uno	1	32.99	32.99
3	LeMotech ABS IP55 Junction Box	1	14	14
4	Jumper wires	40	0.07	2.95
5	Resistors	5	0.16	0.79
6	Gorilla glue	1	8.48	8.48
7	Cooling fan 109P0605H701	1	14.32	14.32
	Total Cost (without tax and shipping):	$88.05		

Note: The team already has the Arduino Uno, jumper wires and resistors. The cost without these items would be $51.32 (without tax and shipping).

Google Sheet link for BOM:

https://docs.google.com/spreadsheets/d/1iihVSED1DZq8Mgnv3xbhRJ4wevrKvLOHmLdIixAuALM/edit#gid=0

Plan for Prototype 1

Tasks

Table 2.1 - Tasks for prototype 1 and corresponding descriptions

No	Task	Description
1	Feedback from the client	Consider client's or teacher's assistant's (TA) comments to improve the design
2	Analysis of critical components	Analysis of critical components of the three subsystems based on the needs of the client
3	Analysis of system integration	Analysis of the integration of the three subsystems
4	Define stopping criteria	Criteria to stop testing, such a certain result achieved
5	Feasibility study	Determine if the prototype is feasible considering money, time and physical constraints
6	Purchase components	Buy components approved by the teacher assistant (TA) on the Bill of Materials (BOM)
7	Documentation	The document should contain all steps of the testing process, as well as pictures and codes that were used. There should be a section with assumptions done during the tests and their justifications
8	Testing (Code and hardware) I. Code for the sensors II. Housing heat test III. Housing water test	Three tests are going to be performed, each of them with a specific objective I. Ensure that the code is effective in receive the data from the sensors and sending it to the other microcontroller II. Evaluate the efficiency of the mechanism designed to control heat III. Evaluate the waterproof feature of the housing
9	Analysis of data	Analyse the data collected during testing

		part I (Code for the sensors) on the criteria of reliability and time spent to send the data to the microcontroller
10	Testing errors	List and analyse all mistakes done during the testing procedure and document them to prevent future errors on the next prototypes
11	Presentation of the prototype	Show the teacher's assistant (TA) and, if possible, the client, the first prototype. Collect information on new needs and improvements that can be done to attend the client needs

Schedule for testing

Table 2.2 - Schedule for Prototype 1

WBS	Task	Plan Start	Plan Finish	Days
	Prototype 1	March-1	March-7	13
1	**Test Case Design**	March-1	March-3	2
1.1	Design Function Test			
1.2	Incorporate Test Data			
1.3	Define the system/ Acceptance Tests			
1.4	Review/ Approve Design			
2	**Prototype Build**	March-3	March-4	1
2.1	Build Test			
2.2	Define the Metric Objective			
2.3	Review/Approve Plan			
2.4	Assemble Prototype			
3	**Arduino Testing**	March-4	March-7	3
3.1	Basic Program For testing			
3.2	**Prototype Testing**	March-4	March-7	3
3.3	Develop Test script			
3.4	Ressas Team, Procedure			
3.5	Theoretical Based Testing			
3.6	Review/Approve Test Development			

3.7	Improve Idea			
4	Prepare for second Prototype	March-7	March-7	

Plan for Prototype 2

Tasks

Table 3.1 - Tasks for prototype 2 and corresponding descriptions

No	Task	Description
1	Feedback from the teacher's assistant	Consider the teacher's assistant's (TA) comments and, if a meeting to present the first prototype to client was possible, also the client's comments to improve the design
2	Analysis of new critical components	Analysis of critical components that were added based on the new needs of the client
3	Analysis of system integration	Analysis of the integration of the three subsystems considering the addition of new components, if needed
4	Define stopping criteria	Criteria to stop testing, such a certain result achieved
5	Feasibility study	Determine if the prototype is feasible considering money, time and physical constraints
6	Purchase components	Buy new components, if needed, that were approved by the teacher assistant (TA) on the updated Bill of Materials (BOM)
7	Documentation	The document should contain all steps of the testing process, as well as pictures and codes that were used. There should be a section with assumptions done during the tests and their justifications.
8	Testing (Code and hardware) I. Refined code II. Housing heat test III. Housing water test	Three tests are going to be performed, each of them with a specific objective I. Refine the previous code on the data transmission performance and reliability II. Refine the system that controls heat III. Refine the waterproof feature of the housing

9	Analysis of data	Analyse the data collected during testing part I(Refined code) on the criteria of reliability and time spent to send the data to the microcontroller
10	Testing errors	List and analyse all mistakes done during the testing procedure and document them to prevent future errors on the next prototypes
11	Presentation of the prototype	Show the teacher's assistant (TA) and, if possible, the client, the second prototype. Collect information on new needs and improvements that can be done to attend the client's needs.

Schedule for testing

Table 3.2 - Schedule for Prototype 2

WBS	Task	Plane Start	Plan Finish	Days
	Prototype 2	March-8	March-14	6
1	**Project Planning & pre**	March-8	March-8	1
1.1	Summarize finding from Prototype 1			
1.2	Purchase the required hardware			
1.3	Describe the Current Version of Prototype			
1.4	Describe the Description of Change			
2	**Test Plan**	March-8	March-8	1
2.1	Build Test Plan			
2.2	Define the Metric Object			
2.3	Review/Approve Plan			
3	**Test Case Design**	March-8	March-8	1
3.1	Design Function Test			
3.2	Design GUI Test			
3.3	Define the system/ Acceptance Tests			
3.4	Review/ Approve Design			
4	**Test Development**	March-8	March-8	1
4.1	Develop Test script			

4.2	Ressas Team, Proceder			
4.3	Review/Approve Test Development			
4.4	Refine the test			
5	**Prototype Build**	March-9	March-11	2
5.1	Design Function Prototype			
5.2	Order Part for prototype			
5.3	Assemble Prototype			
6	**Arduino Testing**	March-11	March-11	1
6.1	Static Testing			
6.2	Program for Final Product			
6.3	Precies Sensor Timing			
7	**Prototype Testing**	March-12	March-14	2
7.1	Theoretical Based Testing			
7.2	Purely Experimen Testing			
7.3	Tightness Testing			
7.4	Size Testing			
7.5	Final Adjustment			
7.6	Issue Resolution			
7.7	Improvement Idea			
7.8	Affected Section of the test Plan			
8	Prepare for third Prototype	March 15		

Plan for Prototype 3

Analytical model

https://cad.onshape.com/documents/3cb60712ab82f7623b835fe5/w/bad75c53562fb0357d9b2eb4/e/f367755923ee9e5c9890f043

Tasks

Table 4.1 - Tasks for prototype 3 and corresponding descriptions

No	Task	Description

1	Feedback from the teacher’s assistant	Consider the teacher’s assistant's (TA) comments and, if a meeting to present the first prototype to client was possible, also the client’s comments to improve the design
2	Analysis of new critical components	Analysis of critical components that were added based on the new needs of the client
3	Analysis of system integration	Analysis of the integration of the three subsystems considering the addition of new components, if needed
4	Define stopping criteria	Criteria to stop testing, such a certain result achieved
5	Feasibility study	Determine if the prototype is feasible considering money, time and physical constraints
6	Purchase components	Buy new components, if needed, that were approved by the teacher assistant (TA) on the updated Bill of Materials (BOM)
7	Documentation	The document should contain all steps of the testing process, as well as pictures and codes that were used. There should be a section with assumptions done during the tests and their justifications.
8	Testing (Code and hardware) I. Refine code II. Final project test	Two tests are going to be performed, each of them with a specific objective I. Refine existing code to improve the reliability and integration of all sensors II. Test all components together: the housing, the code and the sensors.
9	Analysis of data	Analyse the data collected during testing part I(Refined code) on the criteria of reliability and time spent to send the data to the microcontroller
10	Testing errors	List and analyse all mistakes done during the testing procedure and document them to prevent future errors on the next prototypes
11	Presentation of the prototype	Show the teacher’s assistant (TA) and, if possible, the client, the third prototype. Collect information on new needs and improvements that can be done to attend to the client's needs.

Schedule for testing

Table 4.2 - Schedule for Prototype 1

WBS	Task	Plane Start	Plan Finish	Days
	Prototype 3	March-15	March-28	18
1	**Project Planning & pre**	March-15	March-17	2
1.1	Map out the Functional Requirement			
1.2	Map out the Functionality			
1.3	Summarize Finding From prototype 1&2			
1.4	Describe the Current Version of Prototype			
1.5	Describe the Description of Change			
2	**Prototype Build**	March-18	March-20	3
2.1	Design Function Prototype			
2.2	Assemble Prototype			
3	**Conduct System Testing**	March-21	March-22	1
3.1	Complete system Test plan			
3.2	Complete system Test case			
3.3	Review/ Approve System plan			
3.4	Execute the system plan			
4	**Arduino Test**	March-22	March-24	2
4.1	Static Testing			
4.2	Precies Sensor Timing			
5	**Prototype Testing**	March-24	March-26	2
5.1	Set up the testing environment			
5.2	Confirm Integrity, functionality and Performance			
5.3	Dynamic Testing			
5.4	Thickness Testing			
6	Final Adjustment	March-26	March-28	2

Conclusion

The schedule and tasks defined on this document will be used in the next week to guide the development and testing of our first prototype.We are waiting for approval on the BOM to continue implementing the

project prototypes. We will follow the established project plan, and assign tasks to team members to remain on schedule for the next deliverable.