GNG1103[D] – Engineering Design
Course Project
Group C7

Project Deliverable D: Conceptual Design

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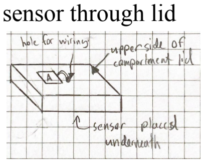
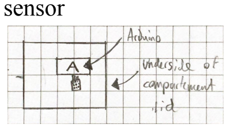
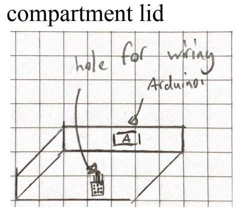
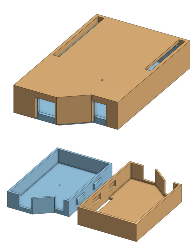
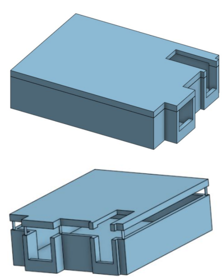
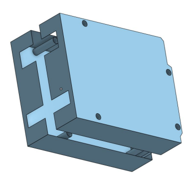
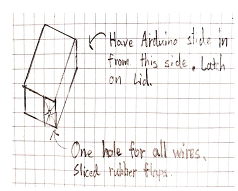
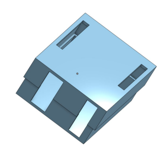
Introduction

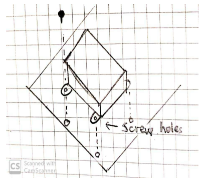
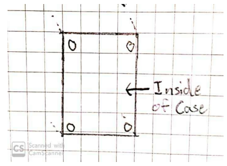
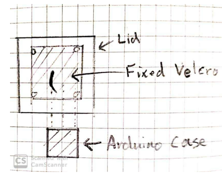
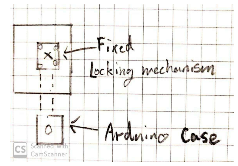
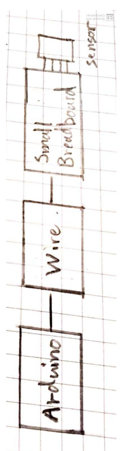
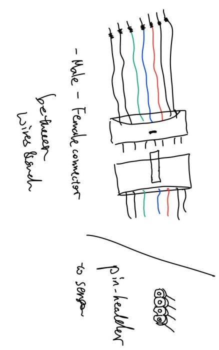
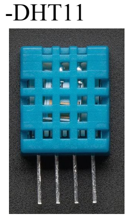
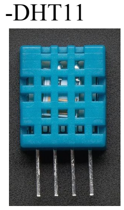
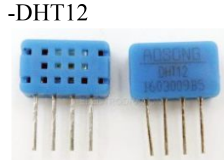
Continuing along our path to finding a solution to a working temperature/climate sensor, we have separated our project into subsystems, each consisting of multiple design concepts using the information gathered from the client and reorganized in our past deliverables. The focus of this document is to present the ideas that our team members have come up with in order to bring forward the most suitable concepts to combine them into more refined global concepts.

Subsystems and Concepts

Our group has decided to separate our design into seven subsystems and attempted to create sketches for each concept to convey their main ideas. *Table 1* contains this information alongside a brief description explaining how each idea may function.

Table 1: Concepts for each Subsystem

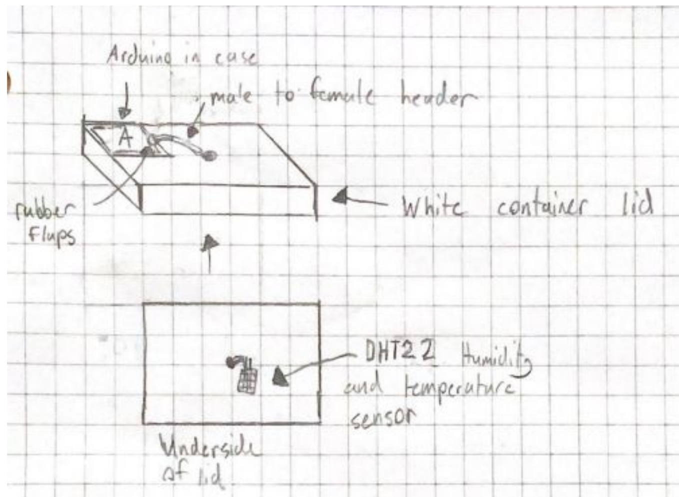
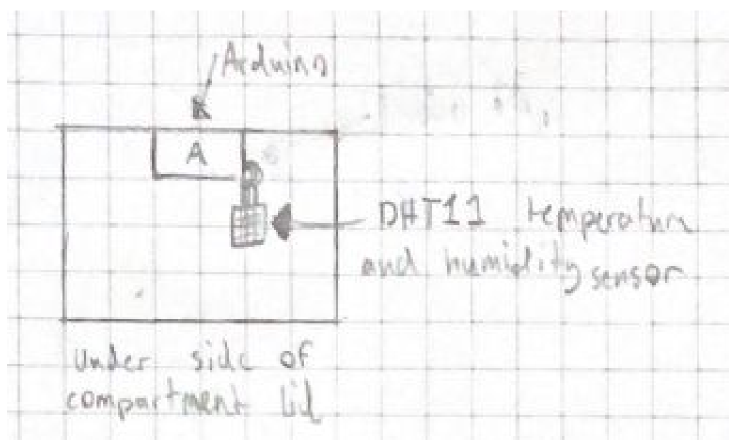
Subsystem	Concept 1	Concept 2	Concept 3	Concept 4	Concept 5
Arduino Case Placement	-Arduino housed above the compartment lid -Wire connecting to sensor through lid 	-Arduino housed on underside of compartment next to sensor 	-Arduino housed with raspberry pi in main drone with wiring to temperature sensor	-Arduino attached to the side of the compartment lid 	-Arduino attached on the underside of white lid, offset to the side where there is room..
Physical Design for the Arduino Housing	 -Snaps into place using divots in the plastic on the sides to close the case securely - Multiple holes for wires	 -Divots on corners for maximum reliability -Material is made from reinforced plastic - Multiple holes for wires	 -Slides open and close using tubes -Allows opening for connections but provides sturdy protection, especially in cases of falling -Material is made from reinforced plastic		

Fixing Arduino Case In Place	 - Screws mounted on external protrusions of the case - Arduino case attached directly	 - Screws mounted on the inside of the case - Arduino case attached directly	 -Fixing Velcro with either screws/glue. - -Arduino case attaches to this fixed module	 - Another fixed module that's not Velcro. -Arduino case attaches to this fixed module	-Just simply glue the Arduino Case onto the lid -All designs here can be applied to fixing the sensor in place as well. Sensor could also have a small housing/frame
Temperature Sensing Physical Wiring	 -mini breadboard to service the sensor	 -Straight wiring with resistors -Wires are braided	 -Use pin male-female header & connector	-All concepts will have sensors attached to the underside of the white lid	N/A
Sensor Type/Model	-On/Off Temperature sensing via physical thermometer	-Thermistor and corresponding wheatstone bridges -pros : easily to calibrate, longer theoretical life -cons: more complex, requires more frequent maintenance; more	-DHT11 	-DHT22 	Bimetallic strip
Humidity Sensing	Hygrometer	Separate sensing module based on metal oxides	-DHT11 	-DHT12 	N/A

Global Concepts

Using the concepts designed in the previous section, we can put together the most promising concepts to create global/functional concepts. *Table 2.1* presents the sketches of each concept, while *Table 2.2* provides descriptions of concepts and discusses their corresponding pros and cons for each idea.

Table 2.1: Sketches of Global Concepts

Global Concept #	Sketch
1	
2	

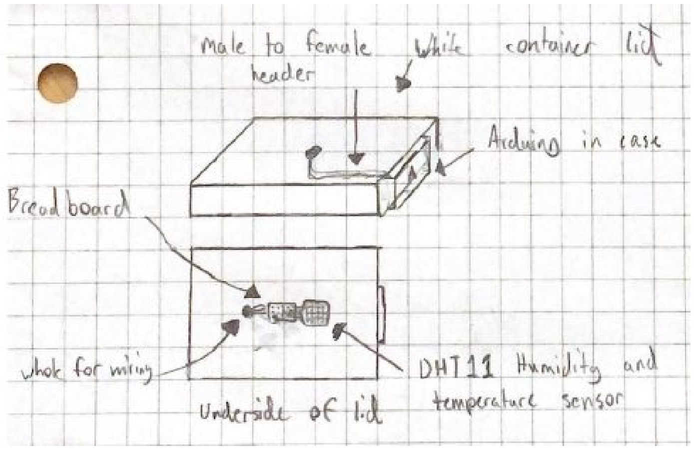
3	

Table 2.2: Details of Global Concepts

Global Concept #	Description	Pros	Cons
1	● The Arduino is **housed above** the compartment lid(Contingent on the amount of room available there, move to underside if required) ● Arduino is housed in standard case with one **rubber flapped** hole for the wires ● Sensor is **attached on the underside** of the lid ● Sensor is connected directly to Arduino via **male-female wires**, **braided** if possible ● **DHT22** temperature and humidity sensor ● Arduino case is **fixed in place with screws**	● DHT 22 is more accurate than the DHT11 (+/-0.5 degrees Celsius), has both humidity and temperature sensor ● Arduino is protected from potential risk of damage ● Rubber flaps offers fixed wires and waterproofing ● Braided wires offer durability ● Very simple to fix the Arduino case in place	● May be difficult to create the rubber flaps on the arduino casing ● Need to make a through hole in the lid to connect the arduino and the sensor ● High cost ● Less modular than a velcro/lock mechanism for fixing the Arduino case
2	● The Arduino is **housed on the underside,** offset to the side ● Arduino is housed in standard case with **multiple holes** for wires ● Sensor is **attached on the underside** of the lid ● Sensor is connected directly to Arduino via **male-female** wires ● **DHT11** temperature and humidity sensor ● Arduino case is **fixed in place with screws**	● DHT11 sensor has both temperature and humidity sensors, and cheaper than its counterpart DHT22 ● Arduino is protected from potential risk of damage ● Arduino is placed in unused space ● No through hole needed ● Low cost ● Very simple to fix the Arduino case in place	● DHT11 sensor is not as accurate as the DHT22 (+/-2 degrees Celsius) ● No rubber flaps to keep the wires fixed ● Shift to the center of mass of the box ● High humidity from the food may cause faster decay of the Arduino ● Less modular than a velcro/lock mechanism for fixing the Arduino case ● Harder access the Arduino

3	• Arudino is **housed on the side**, on the outside of the compartment • Arduino is housed in standard case with **multiple holes** for wires • Sensor is **attached on the underside** of the lid • Sensor is serviced by an **breadboard** which is connected directly to the Arduino • **DHT11** temperature and humidity sensor • Arduino case is fixed in place with **velcro or other locking mechanism**	• DHT11 sensor has both temperature and humidity sensors, and cheaper than its counterpart DHT22 • Arduino being on the outside provides more space for the storage container • Breadboard offers room for additional circuits/components • Very modular as the Arduinos can be easily swapped • Easy to access the Arduino	• DHT11 sensor is not as accurate as the DHT22 (+/-2 degrees Celsius) • No rubber flaps to keep the wires fixed • Arduino is more exposed to the elements, potential risk of damage • Need to make a through hole in the lid to connect the arduino and the sensor • The fixing mechanism is more complex

Concept Selection

To decide which global concept our group will continue to work on, we have created the following selection matrix in order to clearly see the value of each concept and make comparisons between the three global concepts.

Table 3: Selection Matrix

#	Criteria	Weight (1-5)	Concept		
			1	**2**	**3**
1	Data Collection	5	5	4	4
2	Data Transfer	5	4	4	4
3	Data Precision	5	5	4	4
4	Modularity	4	2	2	3
5	Cost ($)	4	2	4	3
6	Physical Size/Dimensions	3	3	3	2
7	Additional Data Collection	1	1	1	1
8	Aesthetics	2	4	2	4
9	Lifespan	3	4	2	4
Total			116	100	111

Final Analysis and Decision

As a team we reviewed key aspects of the three global concepts and decided that global concept one is our most suitable solution. While there are many shared/similar features across the three global concepts, concept one boasts the best balance between feature functionality, complexity, and cost. One of the most important advantages that the first global design has is a highly accurate temperature sensor with an error range within a single degree. As our client stipulated, the quality of data is of paramount importance. So the inclusion of a more accurate sensor for 5-10 dollars premium is more than worth it. Global design one also includes various quality of life features such as braided/grouped wires and sliced rubber flap for the wires to go through. These inexpensive bonus features will help keep the wires organized and easy to manage. The location that the Arduino case is mounted must also be considered. For design one, this is above the white and blue lid component and its primary advantage is that it is not completely exposed to the elements like in concept 3 and offers reasonable ease of access to the Arduino. This location may be subject to change as more information is gathered for the space above the white-blue lid components.

Though the final decision was that design one was overall the best choice, there are also many noteworthy advantages that design two and three have. For example, design 3 has the arduino case fixed to the outside of the box. This significantly increased the accessibility of the Arduino. But ultimately, having the Arduino completely exposed in the open is not a trade off we were willing to take. Design three also includes a fixed locking mechanism that the arduino case can attach/detach to. This amplified the modularity of the system at the cost of higher complexity. This feature may be ported to design one contingent upon its cost and complexity. Overall, design one remains the most reasonable solution.

The selection matrix (*Table 3*) serves to compare the important design criterias for each design. It provided us with a framework to quantify and compare the three designs. After tallying the scores, the selection matrix (*Table 3*) clearly indicates that design one has the highest overall score, and meets all of the client's important criteria. Through the design matrix, we also recognized that although all three concepts scored rather poorly in "additional data collection", its overall importance and relevance to our project's focus rendered it a much less pertinent criteria to consider. Some causes for hesitation regarding concept 1 is the costly design and non-modularity; however, the client made it clear that we should favor a more expensive design(within reason), assuming it is more advantageous.

Conclusion

Our team was able to create some preliminary sketches and designs for the integration and operation of the temperature sensor module, and we are confident in our ability to accomplish our goal. We will now start looking at creating prototypes of the sensor and the housing along with designing for a suitable sensor connector.