Deliverable F - Prototype I and Customer Feedback

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Table of contents

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, group D8 presents a detailed description of the first prototype, the testing process and the analysis of the results obtained.

Feedback

The feedback is based on the client meeting that we had on March 2nd and PM's and TA'S advice from the bill of materials. The following table contains concept, description, and feedback we received.

Table 1. Feedback from the client meeting

Concept Title	Description	Feedback
Project Concept and/or application formulated	The statement to give the project it's direction and depth. Illustrate the project guid and the decisions that were made within the group .	The way that the presentation has been organized has been rewarded. It has been commented that the catalogue of presentations is straightforward and the team is on the right track. Before the meeting with the Client we were suggested by the TA to add a brief description on how the group plans to assemble

		the prototype.
System/sub-system model or prototype demonstration in an operational environment	A high fidelity system/component prototype that adequately addresses all critical scaling issues is built and operated in a relevant environment to demonstrate operations under critical environmental conditions.	It was suggested a range of responsibility and challenges and features for the sensor and arduino, to take into account. In the implementation, the data have to be constant and reliable. The professor had added that first prototype functionality available for demonstration and test. Well integrated with operational hardware/software systems demonstrating performability. Most software bugs removed.
Component validation	A medium fidelity system/component brassboard is built and operated to demonstrate overall performance in a simulated operational environment with realistic support elements that demonstrates overall performance in critical areas.	Junction box housing has been approved. It has been suggested to design a CAD model then 3D print it. It gives the ability to customize the dimension for zero cost. The idea of using a fan in the prototype has not been highly encouraged. The TA's noted that it can ruin with the temperature reading. The type of sensor that has been chosen by the group seemed to interest the clients. The clients praised the group for choosing a sensor that seemed to be more practical and different from other groups. Using glue in the final prototype has not been recommended. The TA's have noted that if the JAM'S company is interested in the prototype idea, it is going to be their responsibility to mouth the housing to the drone.

Prototype I

Description

Our first prototype called "SAAND" is a physical comprehensive prototype composed of one sensor DHT11, one microcontroller Arduino Uno and a housing LeMotech ABS IP65 Junction Box.

Objectives

The objective of this prototype is to test the code that will manage the data and the housing. The code should ensure that reliable and accurate data is received on the microcontroller so that, in a future prototype, we can correctly send a warning to the drone's microcontroller when the temperature and humidity are not in the ideal range. Since water resistance and temperature control inside the housing are requirements on our project, the prototype will be used to measure the temperature while the system is working to see if this causes any inaccuracy in the measurements and also be used to test the efficiency of its structure in preventing water from entering it.

Analysis of Critical Components

Critical components for the sensor

- One sensor: DHT11

Critical components for the microcontroller

- One microcontroller: Arduino Uno

Critical components for the housing

- One housing: LeMotech ABS IP65 Junction Box

Analysis of System Integration

The sensor will stay outside the housing to properly produce data of humidity and temperature, so it should be connected to the Arduino Uno through wires. A waterproof tube will connect the wiring from the microcontroller Arduino Uno that is inside the waterproof box to the sensor. 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.

Stopping Criteria of Tests

- No substantial change (± 0.1 °C for temperature and ±15 points for humidity) on the readings from the sensors after one hour of testing
- No substantial change in the temperature with the components inside the housing.
- Water does not enter the housing (it stays dry inside) after being 5 times underwater and in simulations of rain.

Tests

Tests were performed to evaluate the parameters of the prototype previously described. In this section, we describe in detail how the tests were held and what are the results obtained.

- **Code for the sensor**

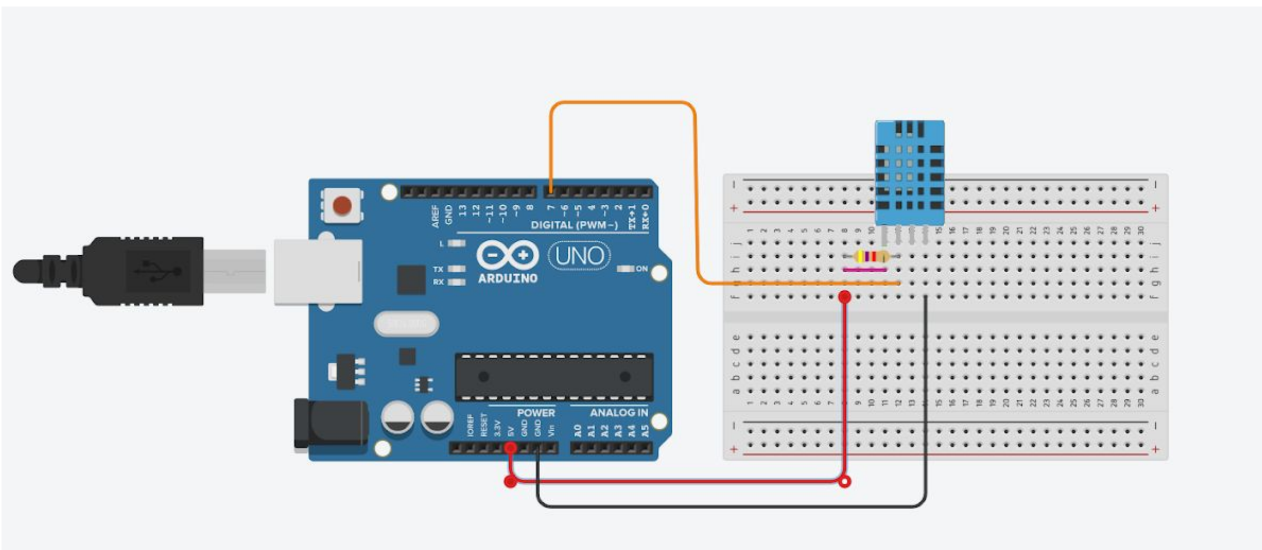

Figure 1.1 - Simulation of the circuit using an Arduino Uno, a breadboard, a resistor and used for the code testing.


```
#include <dht.h>

#include <dht.h>

dht DHT;

#define DHT11_PIN 7

void setup(){
  Serial.begin(9600);
}

void loop(){
  int chk = DHT.read11(DHT11_PIN);
  Serial.print("Temperature = ");
  Serial.println(DHT.temperature);
  delay(1000);
  Serial.print("Humidity = ");
  Serial.println(DHT.humidity);
  delay(1000);
}
```

Figure 1.2 - Code used for the sensor

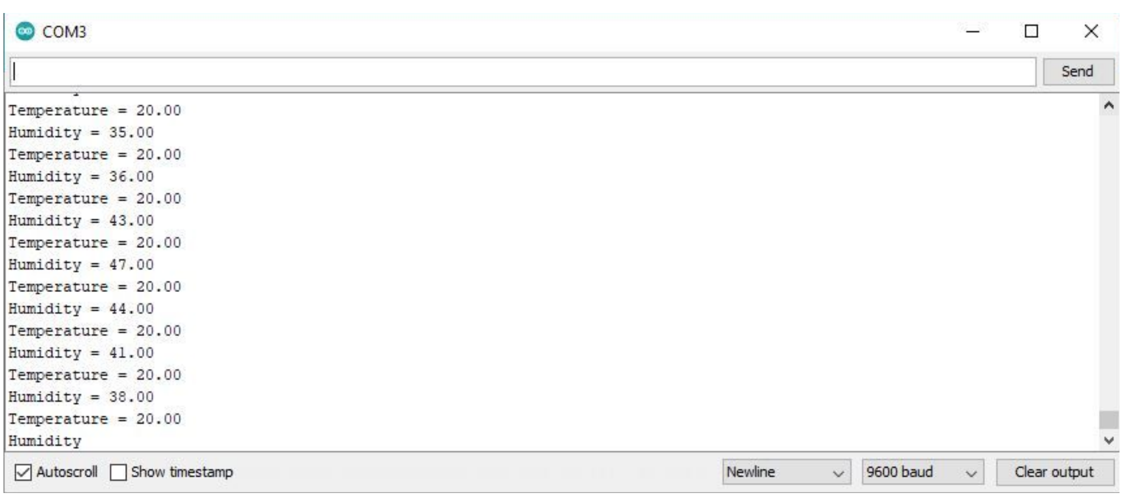

Figure 1.3 - Data received from the sensor

Testing method

Physical Prototype Testing

Estimate Duration Time

1 hour

Description of Prototype

Code that receives the information from the sensor and prints it on the serial monitor.

Description of Results to be Recorded and how these results will be used

The data printed on the serial monitor shows the temperature and the humidity readings obtained from the sensor. These results will be used to guide the team on future tests since they demonstrate considerable reliability from the code, mainly when the results are compared to instruments that measure temperature and humidity in the closed environment where the tests took place after one hour of testing.

- **Housing Heating Test**

Figure 2.1 - Arduino Uno inside the housing for the heating test

Figure 2.2 - Data obtained from the sensor inside the housing

Figure 2.3 - Code used for the house heat test

Testing method

Physical Prototype Testing

Estimate Duration Time

1 hour

Description of Prototype

Conventional materials according to different use environments typically within five years or more,thermal deformation temperature: 40 to 85 degrees.

Description of Results to be Recorded and how these results will be used

After an hour in the closed housing, the sensor data has hardly changed. Therefore, we can see that the microcontroller itself does not overheat. Further testing will have to be done to see how the temperature deviates when the housing is left out in the sun for an extended period of time.
All software has been thoroughly debugged and fully integrated with all operational hardware and software systems.

- **Housing Water Test**

Figure 3.2 - Housing waterproof test

Figure 3.2 - Inside of the housing was not affected by the water.

Testing Method:

Physical Prototype test

Estimated Test Duration

1 hour

Description of Prototype

Internal convex plate for the circuit board waterproof, protection grade reaches more than IP56, water will not enter even when it is raining.

Description of Results to be Recorded and how these results will be used

After testing the IP65 rated gasket seal on the housing, we can see that the inside of the housing remains dry.

The final product in its final configuration is successfully demonstrated through test and analysis for its intended operational environment and platform.

Analysis of data

While testing the code, the data that was observed was consistent and reliable enough in an open environment, however the conditions made it more difficult to get accuracy on the measurements or humidity. The code could collect the data from the sensor and show it on the display successfully.

In regards to the readings from the sensor, the sensor and the arduino were inside the housing to measure any temperature change. The sensor worked well in a closed environment and the data that was obtained continued consistently even with a greater delay (60000 ms).

Testing errors

In regards to the testing errors, since the current sensor that was used for the testing is not the one we will include for our final project, different results may be obtained when we implement the Sensirion AG SHT31-P2.5KS sensors. We also found that increasing the data reading delay to 60s helped the sensor display more consistent and reliable data. In the future prototypes, we will need to establish an optimal delay time for the code to ensure sensor data is consistent and reliable.

Conclusion

The results obtained from the tests helped the team to better understand the behaviour of the code and to define expected results for the project when the sensor that will be used for the final project arrives. The tests for the housing showed that it is efficient in protecting from water and that the components won't substantially change the temperature inside the housing. Therefore, the same housing will be used for the final project and we will be performing more tests using a similar structure for the code as the one tested on this prototype.

Project Plan Update

We are waiting for the sensors to arrive next week so that we can test the code that will be used for the final project. On Deliverable G, the main goal is to develop a code that receives reliable data from the sensors and sends a warning to the drone's microcontroller when the temperature or humidity are not in the ideal range pre-defined by the client. The detailed plan for the next deliverable is presented on our project file on Wrike. It can be accessed with the following link:

https://www.wrike.com/frontend/ganttchart/index.html?snapshotId=EMFdUC5hW3EGnt61zyNDF7T5EvUovd4F%7CIE2DGNBVHA3TCLSTGE3A