University of Ottawa
GNG 1103: Engineering Design

Project Deliverable F: Prototype I and Customer Feedback

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Abstract

In the following deliverable, the first prototype is presented and discussed. The prototype is created from simple household materials to showcase the client our preliminary idea. Client's feedback is recorded and discussed on how we intend to incorporate this feedback. Additionally, system analysis is performed to outline how the device is expected to function. Detailed test plan is updated from the previous deliverable as well as the bill of materials, target specifications, and the design itself.

Wrike Snapshot: The trial for Wrike ended, so we could not update Wrike and provide a snapshot. We reached out to TAs for assistance but were not able to receive a resolution before submitting this deliverable.

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1. Introduction

Beer fermentation is a delicate process that has a lot of factors at play. In order to ensure a proper fermentation process, sugar levels need to be monitored. This can be done in a multitude of ways. Currently, our client uses a hydrometer to perform such measurements, but is seeking a more automated and easy way to do so. Our team proposed to create a device that will measure specific gravity of wort using the flotation angle and be wired to an outside port for easy removal. In the following deliverable, we will be presenting our first prototype and discussing client's feedback. We also intend to reflect on our current stage, where we plan to go from here, how we will be testing our device at each stage as well as how we will be incorporating our client's feedback along the way.

2. Client's Feedback

After our first client meeting, where we presented our primary ideas on our specific gravity measurement device, we received some important client feedback. The client's reactions to our device ideas were very positive and didn't give us much criticism to work with to improve our design. The clients feedback helped reinforce our ideas and confirmed that we were taking our client's needs into account. The client showed interest in some of our more out of reach ideas such as a notification system related to graphed specific gravity measurements. Overall, this feedback, while it doesn't provide any specific changes or concerns to our design it doe confirm that we are headed in the right direction and meeting our client's needs.

3. Prototype I

As presented, the prototype has two main components: the sensors and the microcontroller (Node mcu Wi-Fi module). The sensors consist of a temperature sensor and an accelerometer/gyroscope. First, the sensors are placed in a plastic container, allowing the liquid's density to be calculated. The reasoning for this method is that the chosen sensors will allow us to get the required density while being food-safe and waterproof. A wire then connects the sensors to the microcontroller, which receives the sensors' data and processes it to be transferred to a computer by USB wire so it can be graphed and easily read. The microcontroller is then kept in an enclosed wooden box to ensure the safety of the components. The prototype also considers the port, which will be waterproof by clamping a flat piece of material and shoving the wire through a hole. Altogether, the known needs of the client are met by the prototype; its ability to measure the specific gravity of the beer, waterproof, food safe, and process the data into understandable data.

Image 3.1: Prototype I

4. System Analysis

Overall, the system has many parts which come together to make everything functionable. We have the tank, which is what we will be working on and that is where the measurements will take place inside. We will have a sensor pill which has a temperature sensor and an accelerometer attached onto it, and then will be attached with a string taking it to the port. Physically, the sensor pill has to float on the surface of the fluid in the tank, for that we have to make sure the buoyancy correlation of the fluid/pill is perfect. The materials used for the pill will be able to float due to their low density relative to the fluid in the tank. But if needed, we can make buoyancy calculations using the formula

Fb = pgV, in which Fb is the buoyant force, p is the density, g is gravity, and v is the volume, this formula can be changed to correlate both the densities of the fluid and the pill by making them equal to each other

p(fluid) * g * V(fluid) = p(pill) * g * V(pill)

The silicon wire, attached to the pill will be attached to the port of the tank, which is located on the side, which leads to a node mcu board which takes in the readings and sends them to a laptop to be displayed.

5. Project Updates

Our team reviewed our list of materials one more time and we have decided to simplify our design by removing the additional battery. This design option was an optional request. If the time and budget permit us to add more functionality to our design, our team will reconsider adding it back in.

Table 6.1: Updated Bill of Materials

Material	Quantity	Total Cost (CAD)	Source
MDF	2x2 feet	-	MakerLab Store
Wood Glue	2 mL	-	MakerLab Store
Accelerator	1	6.99	https://www.amazon.ca/Robojax-MPU-6050-Gyroscope-Accelerometer-Raspberry/dp/B07DLQL96
Gyroscope	1	11.00	https://www.amazon.ca/Neuftech-MPU-6050-3-Gyroscope-Accelerometer-Crafting
Node mcu Wi-Fi Module	1	6.33	MakerLab Store
USB Cable	1	7.00	MakerLab Store
USB-AC Adapter	1	7.00	MakerLab Store
Temperature Sensor	1	13.44	MakerLab Store
Silicone	1	16.35	https://www.amazon.ca/Clear-Food-Grade-Silicone-Sealant/dp/B0063U2RWU/ref=sr
Wire	5 feet	5.00	MakerLab Store
	Total	**$73.11**	

6. Prototype Test Plan

For Prototype I, we worked on creating a simple assembly of our future device. Since one of our biggest challenges is going to be buoyancy of the device, we made sure to create and test a set up in which the sensors can be placed and sealed inside of. It worked well and we are hoping to use that set up for the future prototypes. Additionally, we brainstormed what will go into our future code for this device. Code testing will happen with Prototype II as well as other testing as outlined below.

Table 6.1: Prototype II Test Plan and Schedule

	Test	**Objective**	**Schedule**
Test 1	Verification of assembly.	If any structural changes were to be made, the device would be verified again to confirm its assembly.	November 10th. Test duration: 5 minutes.
Test 2	Device buoyancy.	Device to be placed in the water with wiring to verify its buoyancy and to make sure wiring does not affect it.	November 10th Test duration: 10 minutes
Test 3	Code testing.	Verification of the code using node mcu module and PC if any changes were made.	November 10th Test duration: 10 minutes
Test 4	Sensors testing to verify their performance.	Device to be placed in the water to receive measurements.	November 10th. Test duration: 30 minutes.
Test 5	Wi-Fi Module	Verification of proper work of the Wi-Fi module.	November 10th. Test duration: 10 minutes

Table 6.2: Prototype III Test Plan and Schedule

	Test	**Objective**	**Schedule**
Test 1	Device assembly.	Last verification step that all parts are put together aesthetically but also correctly. No leaks through the port entry.	November 20th. Test duration: 5 minutes.

Test 2	Code testing.	Last verification of the code using node mcu module and PC that it runs smoothly.	November 20th Test duration: 10 minutes
Test 3	Sensors testing to verify their performance.	Device to be placed in the water to receive measurements.	November 20th. Test duration: 30 minutes.
Test 4	Verification of device fitting set design criteria.	Verify design compared to set parameters and client's feedback.	November 20th. Test duration: 15 minutes.

7. Glossary

Microcontroller - circuit that can be coded to do particular needs has memory, io ports, and processor.

Accelerator/Gyroscope - Checks the concurrent axis of the component in x,y, and z coordinates

Specific gravity - The relative ratio of density in comparison to the substance of a given reference material

8. Conclusions

In conclusion, the fermentation process has various stages that need to be monitored and controlled to receive a successful outcome. Measurement of sugar levels by the use of specific gravity is one way to ensure the process is right on track. To automate this process and make it smoother and easier, our team has developed an idea for a device that will measure specific gravity by using buoyancy angle while floating in the tank. In this deliverable we presented the first prototype of such a device and discussed its system and how it will operate. We also discussed our client's feedback, which was overall very positive and encouraging. Our team feels on track with our goals and that our device is fitting the design objectives. Our plan is to continue developing our prototype to present an even more put together device next time. We intend to perform various testing as outlined in this document to ensure it measures specific gravity as it should and fits our client's requirements.