College of Engineering, Informatics, and Applied Sciences

SPECIFIC GRAVITY SENSOR

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INTRODUCTION

The goal of this project is to develop an IoT device that accurately measures a brewing liquid's specific gravity to 0.001 g/ml accuracy during fermentation. The device will also measure the temperature of the liquid. Our device will eliminate the need to open brewing containers to check on the brew, which reduces contamination risk and manual effort. Our sensor will also display real-time data, providing brewers a convenient monitoring solution.

SOLUTION

Solutions Explored

Flex Sensor: Attach a buoyant object with flex sensor to detects liquid density changes.

Hall Effect Sensor: Use hall effect sensor to measure a floating magnet's angle change.

Refractometer: Laser refraction angles indicate specific gravity.

Figure 1: Flex sensor prototype

Final Solution

Ultrasonic Sensor: An ultrasonic sensor mounted on top of the brewing apparatus measures the distance to a hydrometer submerged in the solution, calculating specific gravity from changes in the hydrometer's floating height. Simultaneously, the ultrasonic sensor also fulfills the requirement for temperature measurement.

Figure 2: Diagram for ultrasonic sensor and hydrometer.

Data Path and Display

Raspberry Pi is used for python script execution and data collection

Data is saved locally to InfluxDB using Telegraf

Data is saved to cloud using Google sheets API

Data is displayed in real-time using Grafana

TESTING

Accuracy Testing

-Add sugar

-Measure bobber height 5x

-Repeat until 1400g sugar

-Calculate accuracy (g/mL)

Adding Fruit

–Tested code to ensure fruit being added would not change the S.G.

-Average distance before fruit: 150.6mm

-SG before fruit: 1.0 g/mL

-Average distance after fruit: 164.8mm

-SG after fruit: 1.0 g/mL

Change in specific gravity per mm change in distance (0-350g)
0.002876879317
Change in specific gravity per mm change in distance (350-700g)
0.002824092541
Change in specific gravity per mm change in distance (700-1050g)
0.002364953887
Change in specific gravity per mm change in distance (1050-1400g)
0.002233274507
Average Change in Specific Gravity per mm of bobber height difference: 0.002574800063

Fermentation Testing

-Add 2kg of sugar to 16L of water

-Measure S.G. and calibrate

-Add yeast

-Monitor live data

CONCLUSION

In this semester we conducted a series of experiments with the ultrasonic sensor including validating its accuracy, assembling the product, integrating all the experimental components, data measurement, code debugging, and cloud data storage transmission. Finally, we conducted practical fermentation tests using yeast and sugar. The final test results showing 0.00257 g/ml were in line with the client's requirement of 0.0025 g/ml, achieving the objectives of the experiment.

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