Department of Computer Science & Engineering
The University of Texas at Arlington

Architectural Design Specification
CSE 4316: Senior Design I
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Team Hydro
Bluetooth Hydrometer

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Revision History

Revision	Date	Author(s)	Description
0.1	08.15.2020	AD	document creation
0.2	08.18.2020	GG	complete introduction and system overview
0.3	08.18.2020	RT,RB	complete system layers and subsystems
0.4	08.18.2020	AD	combined document together and convert to TeX

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1 Introduction

Fermentation is an important process of brewing beer. Key part of brewing beer with a certain taste and density requires fermenting beer at the right temperature for a certain period of time. For home-brewers, it can be tedious to keep track of temperature and density of beer during the fermentation process.

"Bluetooth Hydrometer" is a device designed to help home-brewers keep track of temperature and density of beer during the fermentation process. It floats on the beer inside the fermenting vessel while sending data to a smartphone via Bluetooth.

Bluetooth Hydrometer consists Arduino-nano with 9-axis inertial measurement unit (IMU) and temperature sensor. Temperature sensor reads temperature while IMU reads relative position when the device is floating. Arduino gets analog input from sensors and process data to get actual temperature and specific gravity of beer. Specific gravity is obtained from relative position of hydrometer inside the fermentation vessel. Once the process is done, data are sent to a smartphone via Bluetooth.

Temperature and density data are stored in a database for future reference and analysis. Mobile app provides visual interface to home-brewers at real time providing current temperature and specific gravity of beer.

2 System Overview

Overall system consists of three major layers, Sensors, Controllers (Hardware/Software) and UI/UX. Each layers has separate functions and interface with each other for data input and output. Sensors layer provide analog data to Controllers for further processing. After analyzing datas from sensors, Controllers provide digital datas to UI/UX for providing relevant information to user with good visual interface.

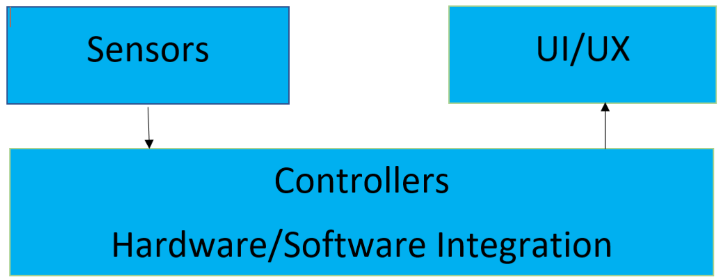


Figure 1: A simple architectural layer diagram

2.1 Sensors

Sensors layer for Bluetooth Hydrometer device mainly consits of two sensors, temperature sensor and 9-axis IMU sensor. Sensors are essential parts of Bluetooth Hydrometer which measure temperature and specific gravity of beer; which are the main requirements of the project. Temperature sensor provides analog temeperature read whereas, IMU provides relative position of Bluetooth Hydrometer during floatation. Temperature data and position data are read by Arduino nano in Controllers layer. Sensors, therefore provides necessary input data to Controllers.

2.2 Controllers

Aurduino nano 33 BLE is the heart of Bluetooth Hydrometer device. Nano is low-powered bluetooth enabled microcontroller which can read analog as well as digital inputs from sensors. Sensors provide critical analog datas for temperature and relative postion of hydrometer. Nano then process analog datas and provides actual temperature and specific gravity (depending on relative position) to UI/UX. Nano is programmed to handle analog data from sensors and provide output to UI/UX layer.

2.3 UI/UX

UI/UX is another important layer that provides user interface to user by providing actual data. Temperature and specific gravity data are visually and graphically presented to user through a mobile app or through a website. Datas from Controller are stored in a database and are analyzed through a software.

3 Subsystem Definitions & Data Flow

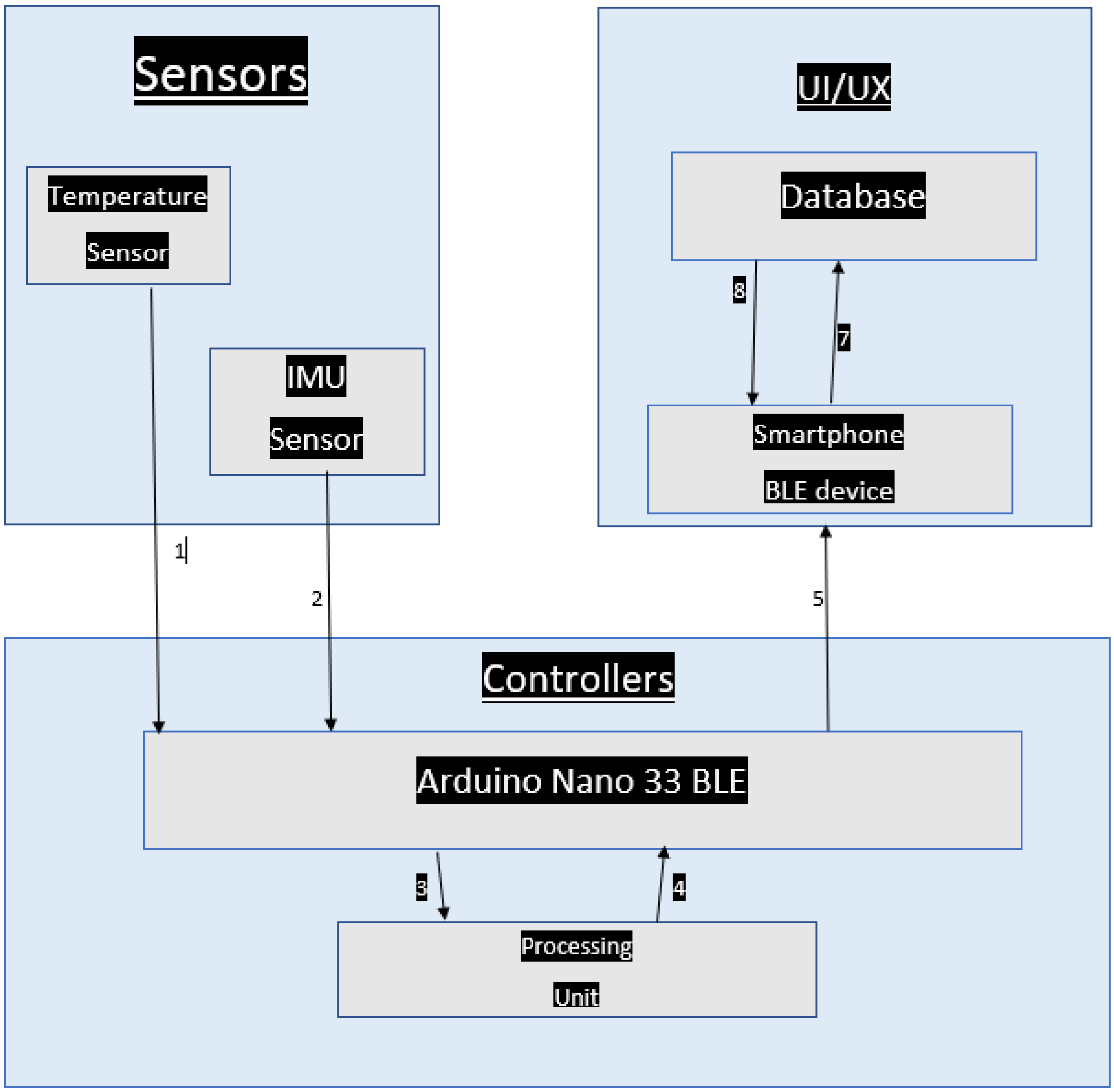


Figure 2: A simple data flow diagram

4 Sensors

4.1 Temperature Sensor

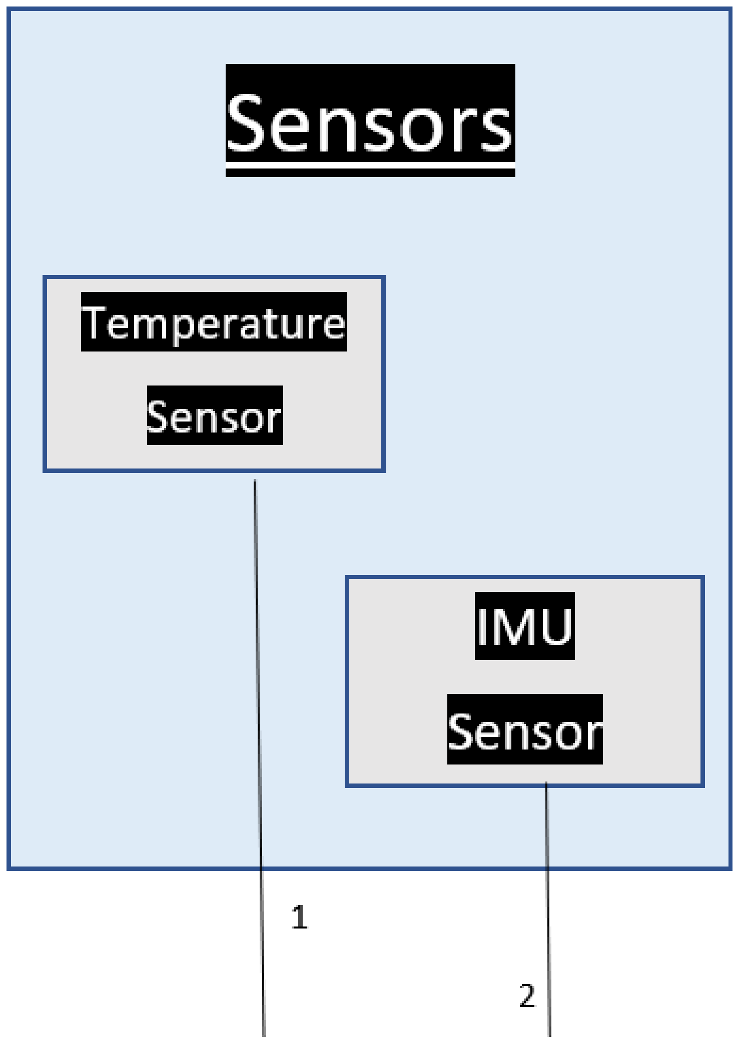


Figure 3: Sensor subsystems description

4.1.1 Assumptions

Temperature sensors are basically conducting metal having some resistance which can measure temperature in the form of electronic signal. Temperature sensor used in hydrometer has an accuracy of +-1.5 degree C.

4.1.2 Responsibilities

It stores temperature in the form of electronic signal and changes whenever the temperature changes.Temperature sensors only one function is to send the analog data of temperature to Arduino nano.

4.1.3 Subsystem Interfaces

Each of the inputs and outputs for the subsystem are defined here. Create a table with an entry for each labelled interface that connects to this subsystem. For each entry, describe any incoming and outgoing data elements will pass through this interface.

Table 2: Subsystem interfaces

ID	Description	Inputs	Outputs
	Temperature interface	N/A	output 1

4.2 IMU Sensor

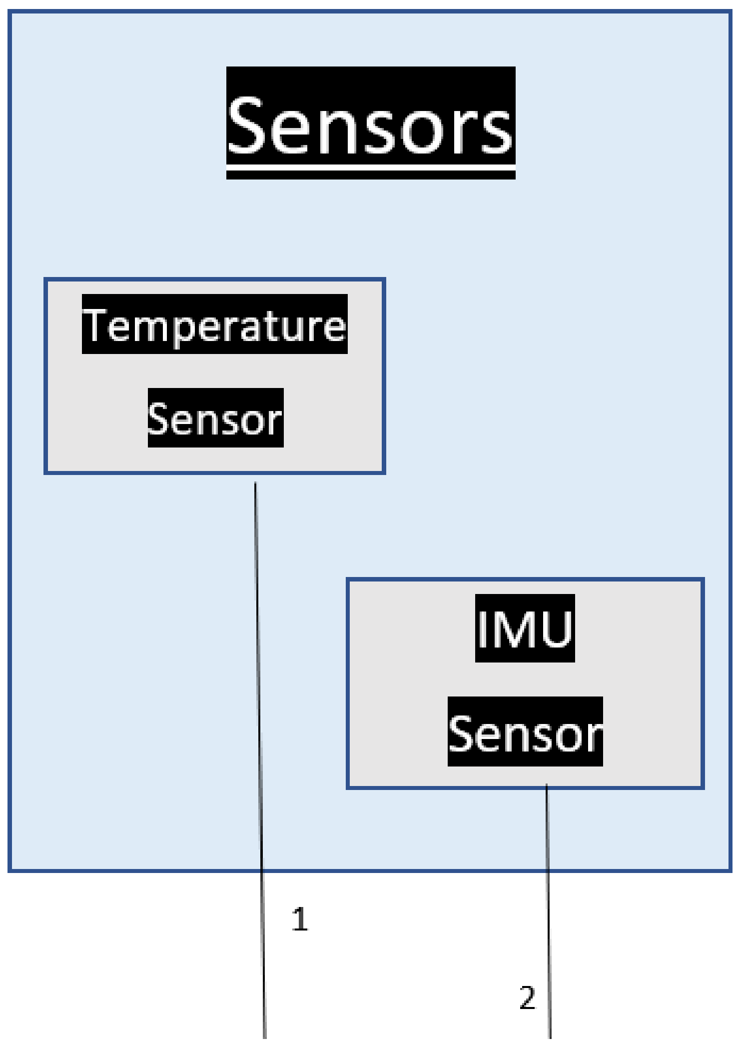


Figure 4: Sensor subsystems description

4.2.1 Assumptions

4.2.2 Responsibilities

Arduino nano 33 BLE is an advance microcontroller, it consists of 9-axis Inertial Measurement Unit (IMU) which refers to built in gyroscope, accelerometer and magnetometer.

While floating, IMU send data to nano about it's position which is the primary function of IMU sensor.

4.2.3 Subsystem Interfaces

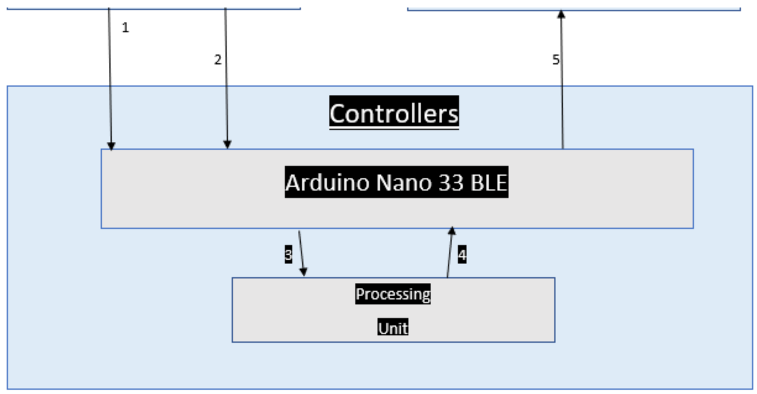
Each of the inputs and outputs for the subsystem are defined here. Create a table with an entry for each labelled interface that connects to this subsystem. For each entry, describe any incoming and outgoing data elements will pass through this interface.

Table 3: Subsystem interfaces

ID	Description	Inputs	Outputs
	IMU interface	N/A	output 2

5 Controller Subsystems

5.1 Arduino Nano 33 BLE



5.1.1 Assumptions

Not applicable

5.1.2 Responsibilities

The main responsibility of Arduino nano is to receive anlog signals from temperature sensor and IMU sensore. CPU inside then process analog data then transfers process data to UI/UX layer via bluetooth.

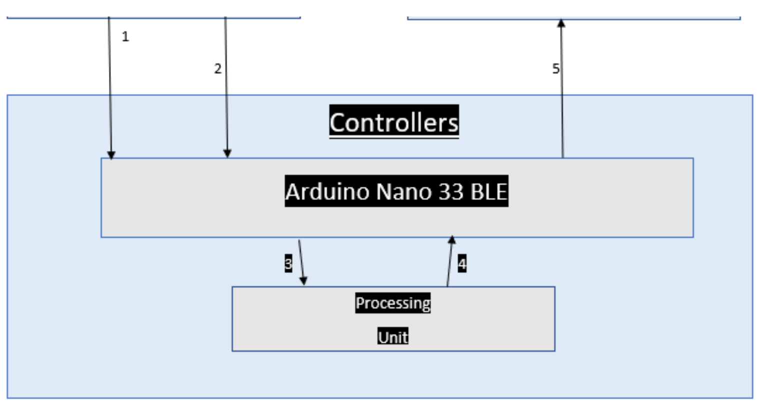
5.1.3 Subsystem Interfaces

data elements will pass through this interface.

Table 4: Subsystem interfaces

ID	Description	Inputs	Outputs
	Controller interface	input 1 input 2 input 4	output 5

5.2 Processing Unit



5.2.1 Assumptions

Hydrometer is always turned on whenever it's inside the fermentation vessel. Since, position of hydrometer is needed for specific gravity, it's assumed that the hydrometer is floating.

5.2.2 Responsibilities

60 MHz CPU is responsible for processing temperature and specific gravity data, that it receives from sensors attached to Arduino nano. Arduino nano is programmed to handle those data whenever nano is turned on. It outputs the accurate temperature and specific gravity data after processing.

5.2.3 Processing Unit Interface

Table 5: Subsystem interfaces

ID	Description	Inputs	Outputs
	Processing Unit Interface	input 3	output 4

6 Phone Layer Subsystems

In this section, the mobile application used to control the hydrometer will be outlined. The user will interact with the hydrometer application, which will send the request to the server.

6.1 Control Application

The mobile control application will be how users interact with the hydrometer after it has been placed inside a brew container. Users will be able to toggle when the hydrometer reads data and be notified of when the resultant specific gravity measurement is of the user's chosen setting.

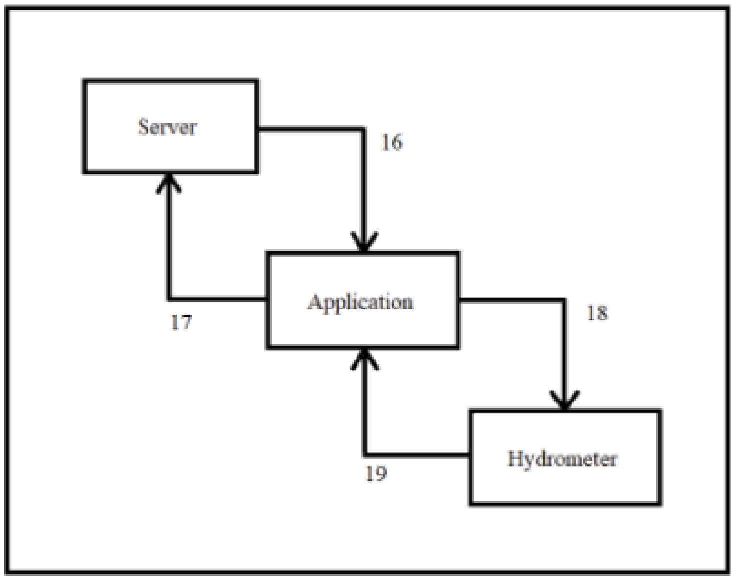


Figure 5: Mobile Phone Subsystem

6.1.1 Assumptions

Data will be sent via bluetooth, as a constant stream of read-in tilt positions. The phone will have bluetooth capabilities, with an internet connection. The hydrometer itself will not be interacting with the server directly.

6.1.2 Responsibilities

The application will be the only way for the web server and hydrometer to communicate. Data will automatically be sent from the application to the server once received. Any return data will be sent in response from the server after processing, or the next time the user loads the application.

6.1.3 Subsystem Interfaces

Incoming and outcoming data elements that will pass through the mobile phone subsystem are as follows:

6.2 Database subsystem

The database will be where all data on an hourly/daily basis will be stored. This data will be stored for use and analysis by the user at the time of their choosing.

ID	Description	Inputs	Outputs
#16	Server Response	Application forwarding hydrometer data	Data processing
#17	Application Request	Sending data & application requesting processing of sent	N/A
#18	Application Response	N/A	Application forwarding processed data from server to hydrometer
#19	Hydrometer Request	Hydrometer's stream of tilt data	N/A

Figure 6: Mobile Phone Subsystem

6.2.1 Assumptions

The assumption made for the database is that it will strictly be for analytical purposes. Data stored there will be sorted by hourly and daily. Database syntax will use the SQL syntax.

6.2.2 Responsibilities

Database will store all data given to it from the control application. Data stored here is data the user needs to keep track of the brewing process.

6.2.3 Subsystem Interfaces

Table 6: Subsystem interfaces

ID	Description	Inputs	Outputs
20	data storage	data from user	N/A