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

Architectural Design Specification
CSE 4316: Senior Design I
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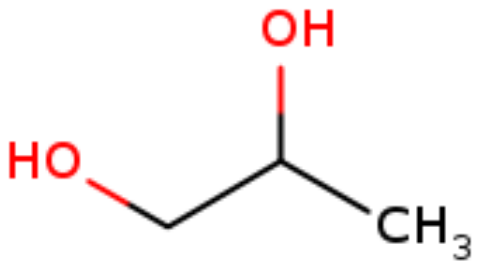

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Glycol Chiller Fermentation

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Revision History

Revision	Date	Author(s)	Description
0.1	11.03.2020	JB,AD,CG,ER,JV	document creation

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1 INTRODUCTION

Our product is a glycol Chiller for use during the fermentation phase of brewing beer. With our product, a user will be able to chill fermenting alcoholic intermediaries. The product will achieve this by cooling a reservoir of propylene glycol, and piping the fermenting wort through pipes in the reservoir. The product will be made with the cooling element from a consumer grade AC unit. The system will be controlled with a Raspberry PI with software pre-loaded onto the PI. The user will be able to interact with system via a touch screen display. On the display, the user will be able to set the desired temperature of the glycol reservoir, declare preset temperatures to use, and select a preset from the user defined presets. The product will only be able to chill the contents of one fermentation vessel at a time.The product will be a cooler used as the reservoir for the glycol, with the "internals" in an enclosure attached to the cooler.

The key requirements of our product include: chilling the contents of one vessel, user controlled temperature setting, and temperature reading accuracy.

If time allows the user will be allowed to interact with the system via a smartphone application and recipe files that allow automatic fermentation steps to be loaded and executed onto the glycol chiller without a user present at all.

2 System Overview

The Glycol Fermentation system will consist of three main layers: The Control System, Glycol Management System, and the Fermentation Management System. The Control System will communicate with both the Glycol Management System and the Fermentation Management System.

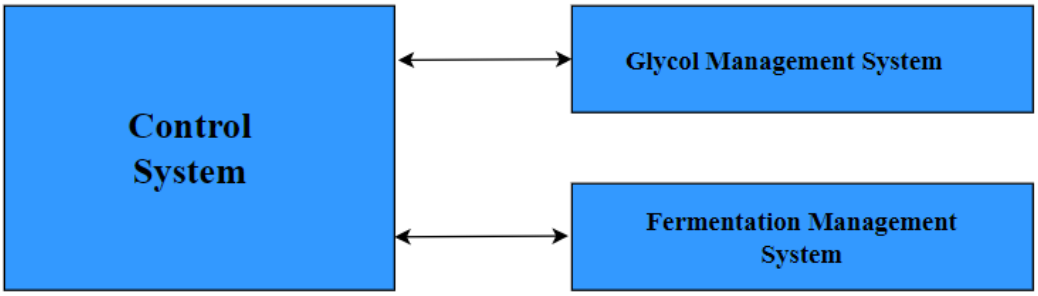

Figure 1: Penny Pitcher's Glycol Fermentation System architectural layer diagram

2.1 Glycol Management Description

When fermenting wort into beer, heat is released in the chemical reaction that ensues. For the beer to come out the way the brewer wants, the temperature needs to be held at a specific range of temperatures. This temperature range is managed by pumping glycol through a coil held inside the fermenter. The Glycol Management layer is in charge of cooling the glycol down to a low enough, constant temperature that allows for simpler calculations by the Fermentation management layer. This layer consists of a single subsystem, the AC Unit. As we are using an off the shelf AC Unit, we will be including a simulated subsystem description.

2.2 Fermentation Management Description

Part of the brewing process involves fermenting wort into beer. This is done in a separate system called the fermenter. The Fermentation Management layer will be interacting with said fermenter. In this layer we will be keeping track of the temperature inside of the fermenter as well as the specific gravity of the beer. These measurements will be taken with a Bluetooth Hydrometer and sent to the Control Layer. The subsystems of this layer include: Temperature sensor, Specific Gravity Sensor, and the Pump system.

2.3 Control Description

The Control layer will regulate the functionality of the overall system and its subsystems, including that of the Fermentation Management and Glycol Management layers. This layer will be facilitated through a Raspberry Pi and will come pre-installed with our custom built software for this purpose. Regarding user interaction, manual controls will be through the use of knobs and dials, and semi-automated controls will be applied through a mobile application.

3 Subsystem Definitions & Data Flow

The Glycol Chiller data flow starts at the control layer. The Raspeberry Pi first sends data out to the Glycol management layer to power on the AC Unit, then sends data to the Fermentation Management layer to handle the initial pump settings. After system startup, temperature and specific gravity readings will be flowing to and from the Fermentation Management layer. The control layer will be taking these readings and performing calculations on what settings to run the pumps dynamically, then sending that data back to the Fermentation Management layer to change said pump settings.

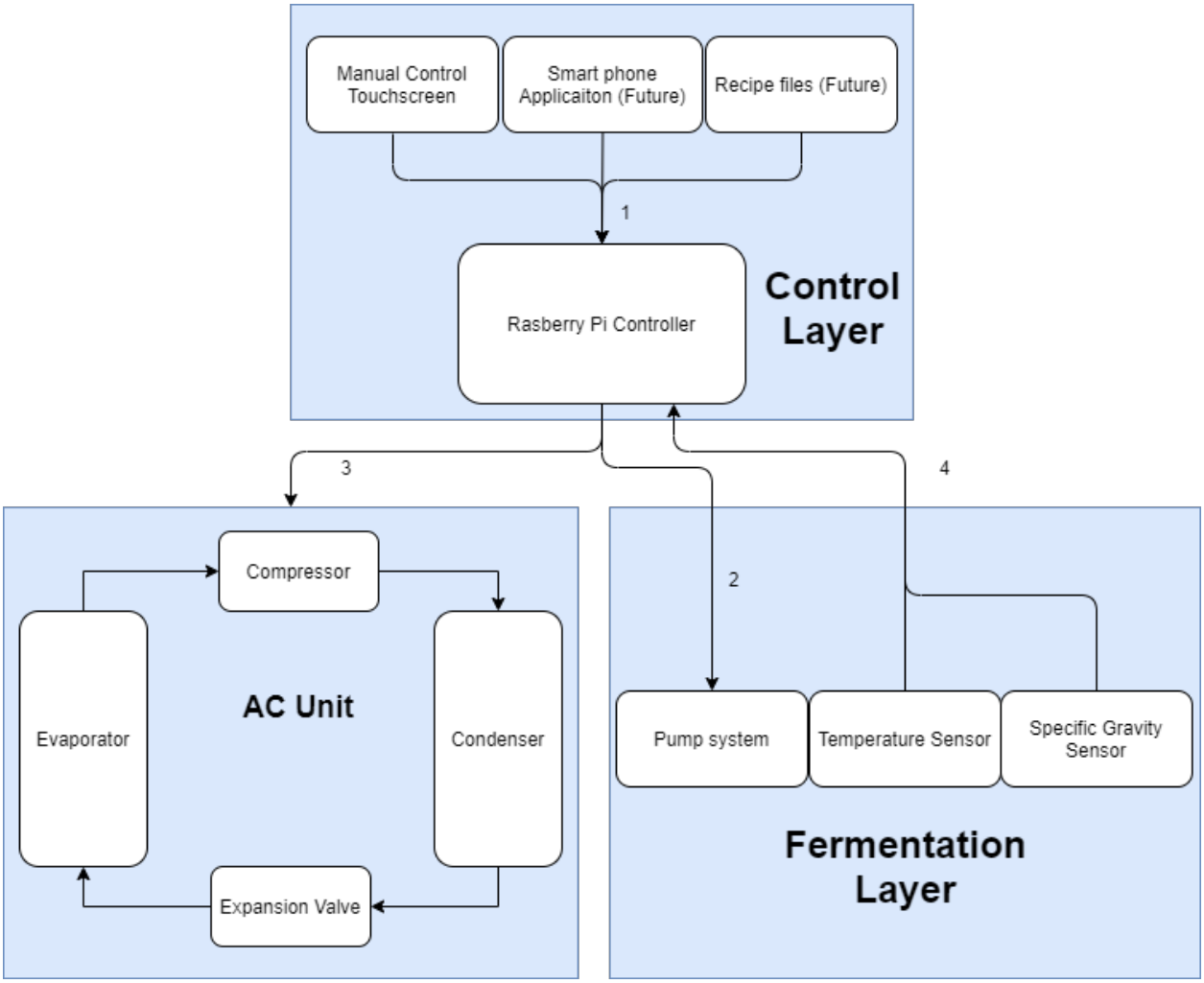

Figure 2: The three subsystems communicating

4 Glycol Management Layer Subsystems

This section describes the details of the Glycol Management Layer. This layer is responsible for chilling the glycol down to a temperature that can be used to cool fermenting wort in the fermenter. This layer consists of a single layer, the AC Unit.

4.1 AC Unit

This subsystem will be a re-purposed AC Unit. This subsystem will cool the glycol in the reservoir down to a useable temperature.

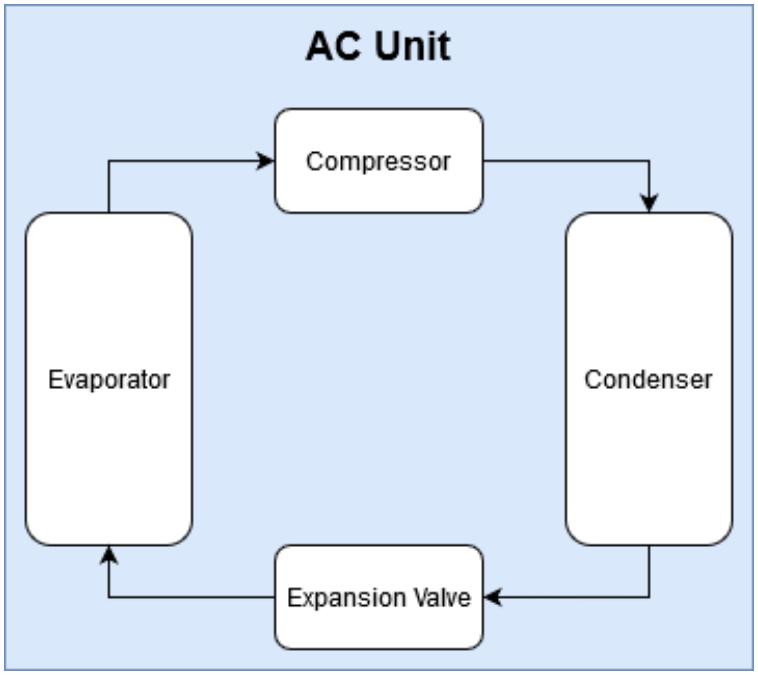

Figure 3: Subsystem Diagram of an AC Unit

4.1.1 Assumptions

This subsystem assumes that the unit will be constantly running while fermenting is happening. The subsystem also assumes the unit is set to the lowest temperature setting.

4.1.2 Responsibilities

The main responsibility of this subsystem is to cool the reservoir of glycol to a temperature that can be used in the chilling of the fermenting wort. This will be achieved by having the evaporator coils of the AC unit submerged in the glycol reservoir and the condenser coils outside of the reservoir. Having the unit on and running will result in the temperature of the evaporator coils lowering and in turn lowering the temperature of the glycol reservoir.

4.1.3 Subsystem Interfaces

This subsystem has no Interfaces. All operation of this layer happens independently within the unit itself. Power to the unit will be delivered upon flicking of a switch by hand.

Table 2: Subsystem interfaces

ID	Description	Inputs	Outputs
#01	Power to AC Unit	physical switch	unit power

5 Fermentation Management Layer Subsystems

The Fermentation layer contains three subsystems: Temperature sensor, Specific Gravity Sensor, and pump system. All of these subsystems help monitor the temperature in the fermentation container as well as manage the glycol being sent into the fermentation container.

Temperature Sensor, Specific Gravity Sensor, Pump System

5.1 Temperature Sensor

The first subsystem of this layer will be the temperature sensor of the Bluetooth hydrometer unit. It measures and sends the temperature reading from inside the reservoir to the Control Unit.

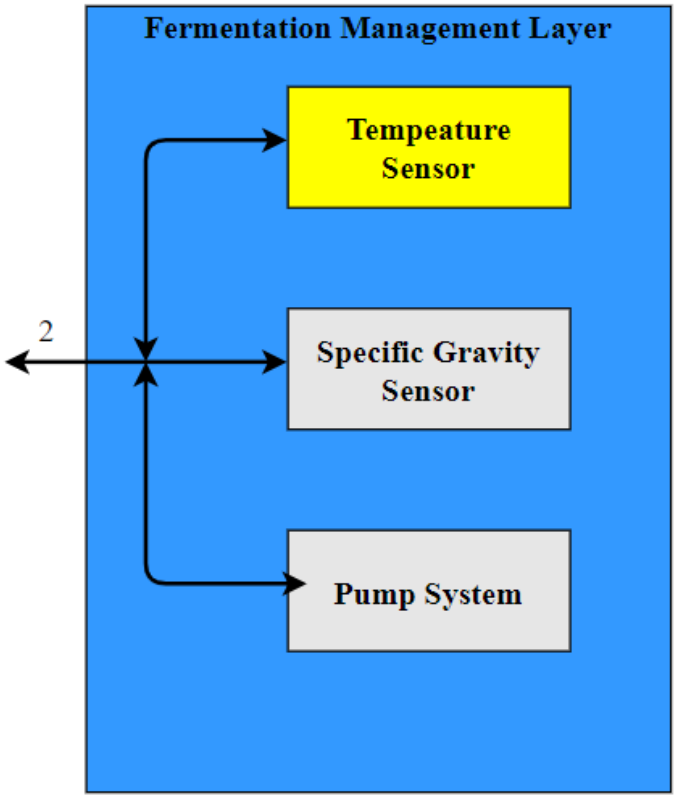

Figure 4: Temperature Sensor subsystem description diagram

5.1.1 Assumptions

This subsystem assumes that a Bluetooth hydrometer will sit inside the reservoir containing the beer in order to measure the temperature of the liquid.

5.1.2 Responsibilities

The responsibility of this subsystem is to send the temperature reading of the liquid to the control unit when asked. Based on the temperature read by this subsystem, the control unit will be able to determine whether to increase or decrease the temperature inside the reservoir containing the beer.

5.1.3 Subsystem Interfaces

Table 3: Subsystem interfaces

ID	Description	Inputs	Outputs
#01	Temperature Reading	N/A	Temperature of beer inside the beer reservoir to the Control Unit

5.2 Specific Gravity Sensor

This subsystem is similar to the temperature sensor, and is also the part of a Bluetooth hydrometer. It measures and sends the readings of specific gravity of fermented beer in the reservoir to the Control Unit.

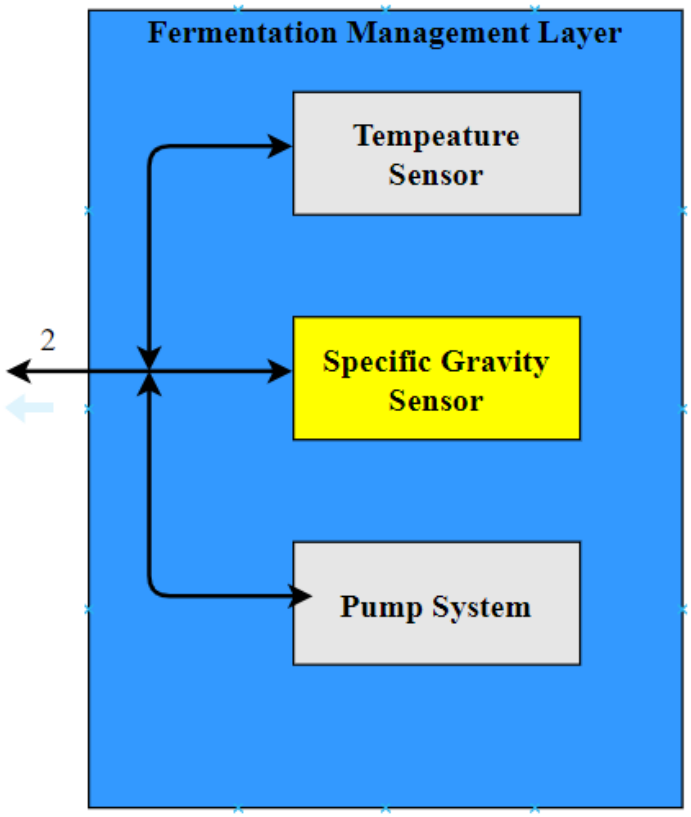

Figure 5: Specific Gravity Sensor subsystem description diagram

5.2.1 Assumptions

This subsystem also assumes that a Bluetooth hydrometer will sit inside the reservoir containing the beer in order to measure the specific gravity of the beer.

5.2.2 Responsibilities

The responsibility of this subsystem is to send the specific gravity reading of the liquid to the control unit when asked. As the fermentation process begins, the specific gravity changes. The control unit stores this data for further use.

5.2.3 Subsystem Interfaces

Table 4: Subsystem interfaces

ID	Description	Inputs	Outputs
#01	Specific Gravity Reading	N/A	Specific Gravity of beer in the reservoir to the Control Unit

5.3 Pump System

This subsystem is the one that pumps the chilled glycol into the reservoir that contains the fermented beer.

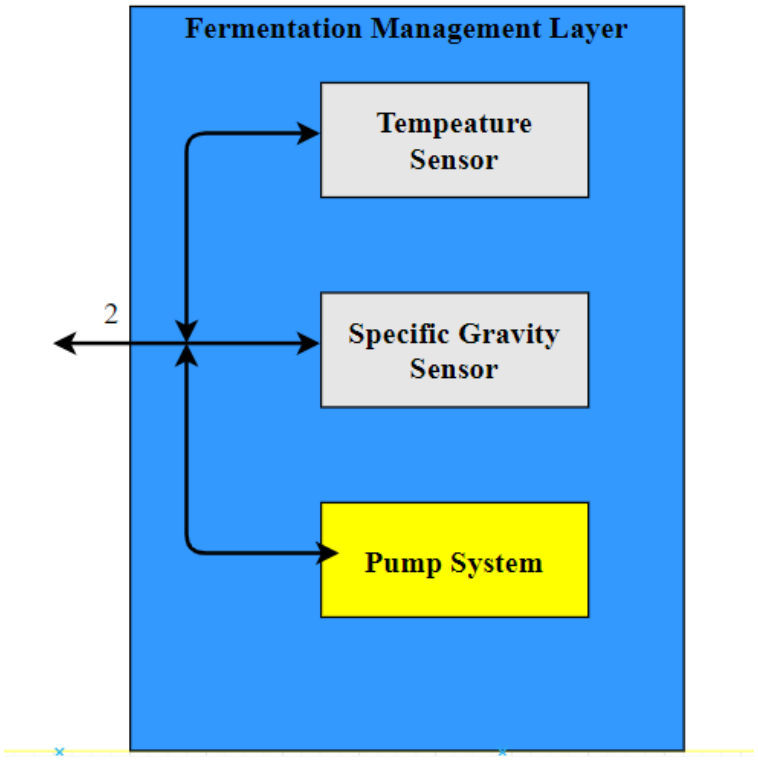

Figure 6: Pump subsystem description diagram

5.3.1 Assumptions

This subsystem assumes that the glycol reservoir contains chilled glycol. It also assumes that the control unit will control the speed of the pump and the flow of glycol into the beer reservoir by using

PID control mechanism.

5.3.2 Responsibilities

The main responsibility of this subsystem is to continuously pump the chilled glycol from glycol reservoir to the reservoir containing the fermented beer until the desired temperature is achieved.

5.3.3 Subsystem Interfaces

Table 5: Subsystem interfaces

ID	Description	Inputs	Outputs
#01	PID Controller Signals	PID Controller signals from Control Unit to the Pump	N/A
#02	Chilled Glycol circulation tubes	N/A	Chilled Glycol from the glycol reservoir pumped to the beer reservoir through tubes/pipes

6 Control Layer Subsystems

This section describes the details of the Control Layer. The subsystems that we have determined to make up the input section of the control layer include the manual control Touchscreen Display, the smart phone Mobile Application, and Recipe File Reading Subsystems. Each of these subsystems are different methods of inputting commands towards the controller application subsystem that will be running on the Raspberry Pi.

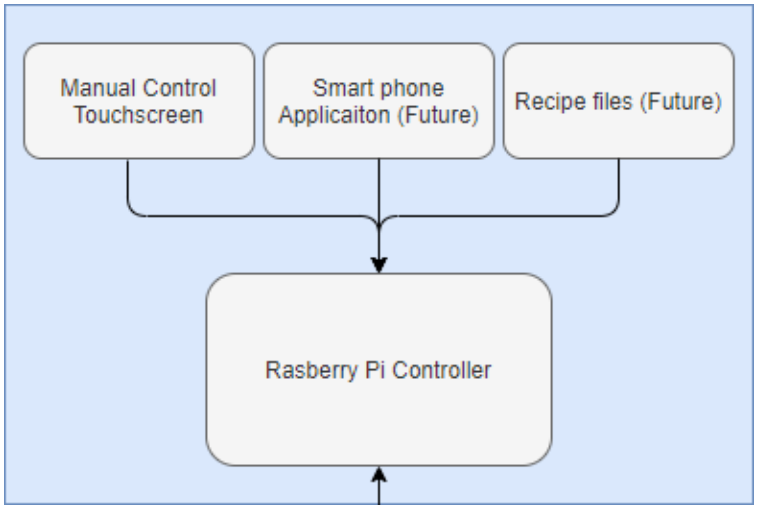

Figure 7: Control Layer subsystem description diagram

6.1 Touchscreen Display Subsystem

The first implemented subsystem will be a touchscreen display mounted to the Glycol Chiller and connected directly to the Raspberry Pi control unit. This subsystem serves as the primary method for user input via manual control.

6.1.1 Assumptions

This assumes the controller application has a GUI displayed on the touchscreen that can be used to easily string commands. Additionally, it is assumed that commands initiated through the touchscreen display will activate functions within the Fermentation Management Layer and the Glycol Management Layer.

6.1.2 Responsibilities

The main two responsibilities of this subsystem will be to handle manual user input by forwarding it to controller application on the Raspberry Pi and display the controller application's output. The screen will receive input via touchscreen gestures on a GUI display that will send commands to the control system.

6.1.3 Subsystem Interfaces

Table 6: Subsystem interfaces

ID	Description	Inputs	Outputs
#01	Description of the interface/bus	Touchscreen based commands	Commands to the controller application via a GPIO connector Status display

6.2 Mobile Application Subsystem

The secondary user input method will be a software application made for smartphones that will forward commands over the internet to the controller application. Controls would be similar to that of the system's built-in display but on a mobile user interface.

6.2.1 Assumptions

This assumes that the smartphone's Internet connection is stable enough to submit coherent commands, assumes that the user has a smartphone at all, and lastly assumes that the controller application has a GUI that can be displayed on the smartphone.

6.2.2 Responsibilities

This subsystem is responsible for relaying commands to the controller application. It is also responsible for displaying the results of those commands and the GUI interface required to input those commands. In this way it will be very similar to the touchscreen subsystem but just on a mobile application.

6.2.3 Subsystem Interfaces

Table 7: Subsystem interfaces

ID	Description	Inputs	Outputs
#01	TCP packets sent over LTE to the controller application	Touchscreen based commands	Commands sent in packets to the control application

6.3 Recipe File Reading Subsystem

The last input method will be customized recipe files that the control unit will use to completely automate the fermentation process.

6.3.1 Assumptions

This assumes the user has an easy way to place recipe files on the Raspberry pi or to create them within our controller application's GUI. The communication route would probably require a thumb drive or an Ethernet connection of some kind.

6.3.2 Responsibilities

This subsystem is responsible for saving fermentation recipes and the ability to parse those recipes to be passed to the controller application.

6.3.3 Subsystem Interfaces

Table 8: Subsystem interfaces

ID	Description	Inputs	Outputs
#01	Logical Bus Connection	Recipes XMLs	Recipe instructions passed to the controller application

6.3.4 Controller Application

The controller application itself that be in charge of managing the other layers.

6.3.5 Assumptions

-assumes communication between layers happens perfectly.

6.3.6 Responsibilities

This subsystem is responsible for communication between the different layers and any level of automation that will be implemented.

6.3.7 Subsystem Interfaces

Table 9: Subsystem interfaces

ID	Description	Inputs	Outputs
#01	GPIO wires	Touchscreen	Fermentation and Glycol layer control signals
#02	Description of the interface/bus	Mobile Application	Fermentation and Glycol layer control signals
#03	Description of the interface/bus	Recipe Files	Fermentation and Glycol layer control signals

REFERENCES