Hands Free Drinks Mixer

Team 40 – Dave Ha, Eric Mysliwiec, Matthew Gross
ECE 445 Project Proposal – Spring 2019
TA: Channing Philbrick

1. Introduction

1.1 Objective

Through experience, our group has determined that lines at bars can be overwhelmingly long due to staff being forced to constantly make drinks for clients and process their payments. Long lines at bars could be painful; depending on how long you wait in line away from your group, you could lose valuable time for socializing, and possibly change your mood. For bartenders, trying to find the right tab behind the bars could be challenging as well. Adding more staff to speed up the process is neither space nor cost effective, especially since some bars have very limited space behind the counter. We need smaller lines and faster processing at bars in order to increase the efficiency of sales, as well as reduce the amount of stress for both the bartenders and the customers.

The proposed solution of building an automated drink mixer will ensure that there are fewer tasks for bartenders, so the waiting time could be cut significantly. This machine will assist bartenders by serving customers who want preselected drink specials for the day. By having this system in place there can be a significant increase in the amount of drinks served in a given amount of time, as well as reducing the amount of tasks for bartenders.

1.2 Background

Places such as Pour Bros have incorporated RFID cards to track customers' drinks and then allows the customers to pour their drinks themselves. However, not all bars can transition to this style and atmosphere. Furthermore, Pour bros incorporates a large, clunky station as opposed to a personalized pouring experience. Our solution will differ in that it is smaller in size and is personalized, whilst adding the ability to transmit total sales data via Wi-Fi upon shutdown. This will streamline the sales process for bartenders and owners.

Additionally, through having an RFID scanner for cards, the system will remove the need for the bartenders to look for the right tab among many cards. To make the drinks, all that the bartender would need to do is scoop some ice with the cup, and put it on a slot in the machine. The only task that the customer needs to do is to place his RFID tag on the sensor and select the drinks through using the buttons; Ultimately, the responsibility falls upon the customer himself.

1.3 High-Level Requirements

The success of the project will be determined by the following quantified measurements:

- Has to be able to fill a standard solo cup(16 oz capacity) already half-filled (by height) with ice to ¾ of its maximum volume combined with the ice within 2 minutes using at least 2 different liquids
- Has to be able to scan at least 3 unique RFID cards and keep a log of tabs until shutdown of the system. Tabs must be able to hold at least 10 drinks

- Has to be able to send a small text file of log of tabs to an email through the Wi-Fi within a reasonable time(less than a minute, with full connection to an internet network)

2 Design

The system requires five main modules: the power circuitry module, motors module, sensors module, logic module and user interface module. The power circuitry ensures that the power from the wall outlet gets converted properly to usable voltages – 5V DC for the microcontroller and sensors and 12 VDC for the custom PCB and the motors module. The motors module controls the core of our system. This includes rotating the disk with the stepper motor and pumping/dispensing the liquids. The sensors module is used for the fine tuning of our system. Things like measuring the flow of liquids, calibrating the position of the cup and warning when an ingredient is low can all be done within the sensors module. The logic module is the brains of our system. This module uses data in two different way. Firstly, the microcontroller which takes input from buttons, RFID, and sensors and displays the control on LCD for proper drink selection. Secondly, the refill indication control which runs independently from the microcontroller, with driving logic from the weight sensors beneath each liquid tank. Finally, the user interface module allows the user to interact with the system. Any request for a drink or information being delivered to the user is done here. Independent from our system, a server or a network-connected computer is necessary to receive tab log file from the machine upon system shutdown sequence.

2.1 Block Diagram

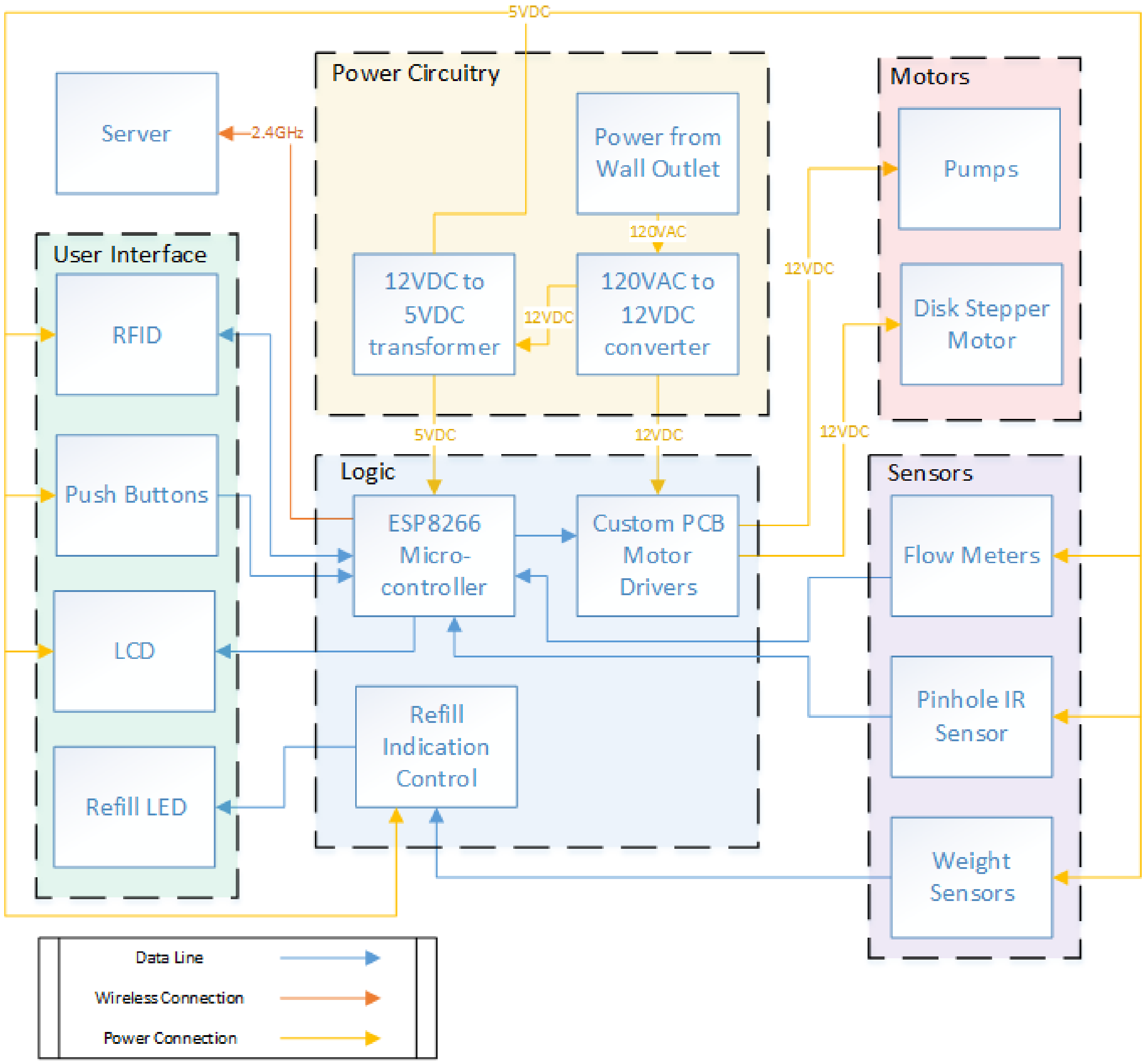

Figure 1. Block Diagram

2.2 Physical Design

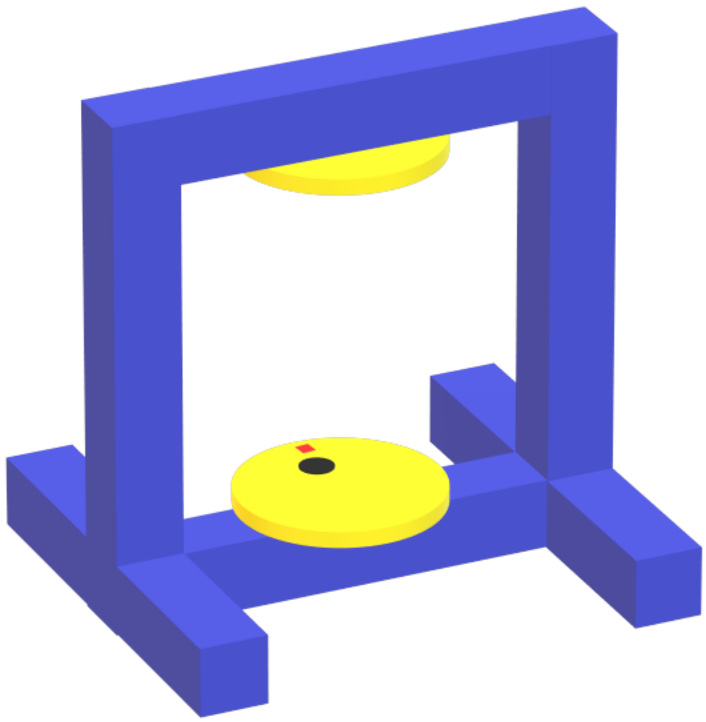

Figure 2. Physical Design

The blue parts in figure 2 will be cut from wood and fastened with screws and glue. The yellow disks will be 3D printed with the black cutout (see figure 2) used to hold the cup while the red cutout (see figure2) is used for calibration with an IR sensor. The top disk will be attached to the wooden structure with screws. The bottom disk will be attached to the stepper motor which will be sitting in a cutout in the wood (not shown). In the case that the disk struggles to support the weight of the cup, two supports can be easily added.

2.3 Power Circuitry

Distributing power to components is essential to the success of our project. Not enough power will cause the components to stop running while too much power could potentially ruin components.

2.3.1 Power from Wall Outlet

We will use the power coming from a wall outlet as our main power source for this project. This will be more than enough for our power consumption needs.

Requirement 1: Wall outlet must supply 120V within 10%.
Requirement 2: Wall outlet must supply 2A at a minimum.

2.3.2 120VAC to 12VDC Converter
Most components in our project will be unable to handle the 120V supplied by the wall outlet. This converter will lower the voltage to a much more usable 12V.

Requirement 1: Must supply 12VDC +/- 20% from a 120VAC source.
Requirement 2: Must maintain thermal stability below 100 degrees Celsius while supplying 5A at a minimum for a duration of 5 minutes.

2.3.3 12VDC to 5VDC transformer
There are some components in our project that can only withstand 5V. This transformer will turn our 12V voltage supply to 5V

Requirement 1: Must supply 5V +/- 10%.
Requirement 2: Must supply at least 1A.

2.4 Motors
The motors carry out the mechanical tasks of the machine, which in this case is the job of moving liquid from the tanks to the cup as well as moving the cup such that it accurately rests below dispensers for the duration of the pour.

2.4.1 Pumps
The pumps will have different dispensing rates depending on the type of liquid being dispensed. Per expectations, there will need to be a larger rate of dispensing for non-alcoholic drinks than alcoholic.

Requirement 1: Alcoholic liquid pumps must provide at least 100 ml of fluid per minute
Requirement 2: Non-alcoholic liquid pumps must provide at least 250 ml of fluid per minute

2.4.2 Disk Stepper Motor
The stepper motor will allow us to position the cup under whatever nozzle is about to be dispensing. It will have a two way communication with the microcontroller to verify its movements.

Requirement 1: Stepper motor must be able to accurately align a given nozzle within 1 inch from the center of the solo cup.
Requirement 2: Must be able to calibrate itself within .5 inch of the IR marker on disk.

2.5 Sensors
Using sensors in our project will provide the microcontroller and the user with important information to allow smooth functioning. It is important to position the cup in the correct location, dispense the correct amount of fluid, and warn the user when an ingredient is running low.

2.5.1 Flow Meters
The flow meters will increase accuracy in dispensing of the liquids. Attached to the tubing, it will collect the flow data real-time and send it to the microcontroller to logically calculate when to stop the dispensing. Since standard volume of a red solo cup is 12 fl.oz = 355ml[2], we will have two set volumes

that the flow meters need to collect data, to correctly calculate the volume of dispensing: without ice(in which we would need standard 355ml), and with ice(filling half of the cup, thus 355/2 = 178ml)

Requirement: Must be able to accurately calculate the volume in 2 modes: no ice(355ml +- 10%), and ice(178ml +-10%)

2.5.2 Pinhole IR Sensor

The pinhole IR sensor will allow us to calibrate the stepper motor positioning of the cup with the microcontroller. This is necessary to do at startup as well as during use in order to avoid error in the stepper motor positioning.

Requirement: Must be able to detect the cutout in the bottom disk within .25 inch from cutout

2.5.3 Weight Sensors

The weight sensors will be used to detect when an ingredient is getting low. It will then notify the user by lighting up an LED. In order to know the proper weight at which we notify the user we will be using our own bottles of uniform weight.

Requirement 1: Must be able to withstand up to 2.042 kg
Requirement 2: Must be able to measure with a precision 100 g

2.6 Logic

The logic unit serves as a central processing unit for all of the data collected through the sensor, giving orders to specific modules or devices as needed. It will get the RFID id input and store it in a log of tabs, as well as sending the data to the server(or an email). It will control selection of drinks through push buttons, as well as displaying different drinks to the LED. Furthermore, it will make sure that the cups rotate the right amount of steps to correctly position beneath the required nozzle for the drink recipe.

2.6.1 ESP8266 Microcontroller

The microcontroller, powered by 5VDC, will run the written program to interface all data and make decisions accordingly. The program could be divided into six parts:

1. Establishing connections with all sensors and modules, and initializing all signals and data structures to zeros
2. Wait for customer interaction through an RFID sensor, and show selection menu on the LCD screen when the user scans his id/sensor
3. Interact with user choices through button signals: navigating through the menu, and selecting/cancelling order
4. Updating the data structure with proper key-pair value of user ID and number of drinks bought
5. Sending rotation signals to the step motor, and liquid dispensing signal to the peristaltic pump to make the mix according to the recipe stored in the program.
6. Reset and align the disk to its zero position, indicating that the drink is done. Return to step 2
7. Upon holding the cancel button for 3 seconds, initiate the shutdown sequence; send the log file to an email(server), and power off the motor. Indicate on LCD that the machine is good to be unplugged.

Requirement 1: Must provide successful throughput to make and receive TCP requests with our server at startup and shutdown

Requirement 2: Must be able to connect and communicate with all other sensors and UI devices(Pinhole IR, Flow meter, RFID, Buttons and LCD).
Requirement 3: Must be able to execute the program written and stored on the microcontroller.

2.6.2 Custom PCB Motor Drivers

We will need a separate system of transistors in order to control the pumps and stepper motors so that we do not damage the microcontroller by drawing too much current from it. To use the least amount of current through the microcontroller, we will have the control pin drive a MOSFET which will allow a 5VDC voltage to turn on a BJT. The BJT will then take the 12VDC from our power supply to drive the motors. The motor circuitry will also be protected using varistors to handle any sudden spikes in voltage from a blockage or mechanical failure.

Requirement 1: Must provide 12VDC +/- 1V and at least 0.5A to drive the pumps and stepper motor
Requirement 2: Must provide circuit protection to handle feedback of up 12V + 10 VDC from motors

2.6.3 Refill Indication Control

This will be another custom built PCB, utilizing a voltage divider made up of a potentiometer and a varying resistance from the weight sensor to turn on an LED when the weight drops to within the sensor's range of sensitivity [3] of 10% of the maximum estimated filled weight of our tanks.[2][5]

Requirement: Must drive an LED when weight drops to 270 grams +/- 100 grams

2.7 User Interface

User interface will provide means for the user to interact with the system. Through the RFID sensor, the user will be able to let the system know who's buying the drink, and increment the value on the tab. Through the buttons, the user will be able to select the drinks, and cancel the order during the selection stage. The LED will display relevant information as the user progresses through the order. Furthermore, the refill LED will light up when the liquid tank runs low.

2.7.1 RFID

The RFID sensor will need to correctly read the unique value stored in a card, namely i-cards. Furthermore, it will need to communicate with the ESP8266 microcontroller and send the data over to be processed.

Requirement 1: Must be able to read at least 3 different RFID tags, each within 0~3 seconds
Requirement 2: Must be able to send the collected RFID tag id value to the microcontroller instantaneously

.

2.7.2 Push Buttons

Push buttons, powered by 5VDC transformer, will need to correctly send the push signals to the ESP8266 microcontroller upon being pressed and released. There will be four buttons: left, right, select and exit/shutdown. Button logic is explained in the Microcontroller submodule section 2.7.1.

Requirement 1: The push buttons must be easily pressible by an inebriated individual.
Requirement 2: Must not have accidental mechanical failures.

2.7.3 LCD
The LCD, powered by 5VDC transformer, will display the value formed by the Logic module through getting the input from the microcontroller. Will display drink names during selection, and the ID upon scanning the RFID.

Requirement: Must display the value set by the logic module(ESP8266)

2.7.4 Refill LED
The refill LED will display to the operator when a tank is needing to be refilled.

Requirement: Must be clearly visible from 2 meters away with a drive current of 10mA.

2.8 Server
The server will receive the log of bar tabs upon the shutdown sequence from the microcontroller. Through the Wi-Fi module, the microcontroller will send a text file of entries, which consist of key-value pair from user ID to number of drinks purchased. Since having a server is outside the scope of this class and project, we will simply receive the data through an email.

Requirement: Must be able to receive email from the Wi-Fi module on ESP8266.

2.9 Risk Analysis

The block we see as the biggest risk to the project is the stepper motor. This block is a core function of the project and without it the project is a total failure. While there are other blocks, such as pouring the liquid, that are vital to the success of our project, they are much more simple and not as big of a concern. Getting the disk to move to precise locations and being able to calibrate this is not a simple task. If we can get this block to work then our project should be a success.

3. Safety and Ethics

While discussing the ethics of our project we determined that there are two main issues that we could potentially run into. The first is the potential to over-serve customers by having an automated drink system put into place. This is a conflict with IEEE Code of Ethics 7.8.1 which states we must hold in high value the " health, and welfare of the public."[4] To solve this we plan on putting a drink limiter that can be tied to an individual's account. After a predetermined limit is reached, they will need approval in order to place their order. The second issue is the potential to serve customers who are underage. Allowing this with our technology, especially on a college campus, would be a clear conflict with our pledge to "to avoid real or perceived conflicts of interest"[4] In order to prevent this, we will be requiring the bar to register an RFID only to customers who provide proper identification. Our project does not deal with batteries or any other potential safety issues, and uses no voltages above a normal household outlet. Given that the outlet is following IEEE standards, it should have it's own circuit protection. In addition to this, and to protect the people and technology in use within and around our product, we have selected a power source that contains short-circuit protection, over-voltage shutdown, and an internal fuse to ensure the protection of the community's health. One possible safety issue we could foresee happening is a faulty stepper motor. If by some Act of God or through some mechanical problem the stepper motor malfunctioned, it could spin out of control and send parts of our projects and drinks flying. To solve this problem we plan on adding a kill switch that will manually force a shutdown on motors sub-system.

References

[1] “DID YOU KNOW?,” About PET | PETRA: Information on the Use, Benefits & Safety of PET Plastic., 2016. [Online]. Available: http://www.petresin.org/news_didyouknow.asp. [Accessed: 08-Feb-2019].

[2] DNews, “Did You Know the Solo Cup is also a Measuring Cup (for Booze)?,” Seeker, 13-Jun-2012. [Online]. Available: https://www.seeker.com/did-you-know-the-solo-cup-is-also-a-measuring-cup-for-booze-1765829437.html. [Accessed: 08-Feb-2019].

[3] “FSR 400 Series Data Sheet,” Adafruit CDN Shop. [Online]. Available: https://cdn-shop.adafruit.com/datasheets/FSR400Series_PD.pdf. [Accessed: 07-Feb-2019].

[4] Ieee.org, "IEEE IEEE Code of Ethics", 2016. [Online]. Available: http://www.ieee.org/about/corporate/governance/p7-8.html. [Accessed: 7- Feb- 2019].

[5] “Questions from andrew, a student,” Math Central Quandaries and Queries, Oct-2017. [Online]. Available: http://mathcentral.uregina.ca/QQ/database/QQ.09.06/s/andrew1.html. [Accessed: 08-Feb-2019].