Automated Drink Maker

ECE 445 Design Document

Team 55

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1 Introduction

1.1 Problem:

In many industries, staffing has become a huge problem due to covid, and no area has been impacted more so than the restaurant industry. Even before covid, restaurants would have staffing shortages due to the limited number of people in the job pool, poor retention of these employees, and lack of motivation[1]. Now these problems are even worse due to the pandemic, and these businesses are suffering because of it. The wait times are now much longer at these establishments, and once loyal customers are leaving unsatisfied. This leads to bad reviews and less repeat customers, which severely hurts a company's income in these already tough times. For this reason, a lot of restaurants have permanently closed because of bankruptcy. Something has to change to fix this problem.

1.2 Solution:

Our team has come up with the idea to make a remotely operated autonomous drink maker. This will allow the waiter to put drink orders in while at the table and will free up time for them to help other customers in this new found free time. With this the problem of extremely long wait times at restaurants will be greatly reduced.

1. The remote control for the device will use bluetooth to communicate with the receiver, which will then tell the device's microcontroller which drink it will be making.
2. Once the process is started, a series of two motors will be used to hold up and dispense cups onto the rotating table.

3. The rotating table will be controlled by the microcontroller and a photosensor in conjunction. The photo sensor will inform the microcontroller when the cup is in place and then when filling is complete the rotating table will move the cup to the unloading area.
4. The filling system for the machine will be a gravity fed dispenser that will be operated by two solenoid valves. These valves will be connected to the microcontroller to make sure they are being operated correctly. The microcontroller will be incharge of the timing for the solenoid valves so that each cup is given the exact same amount of liquid.
5. The microcontroller for this device will be in charge of controlling the precise timing that will be needed for each component of our project. It will also be responsible for dispensing the correct drink.
6. The bluetooth device for our project will have a receiver to relay the data from the remote to the microcontroller, and a sender that will be transmitting the input from the buttons on the remote
7.

1.3 Visual Aid:

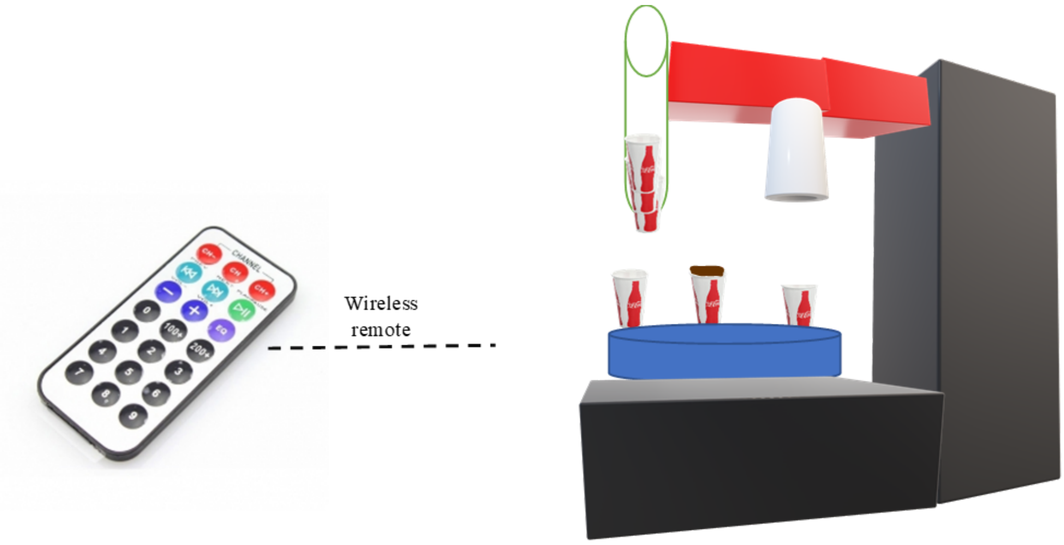

Figure 1

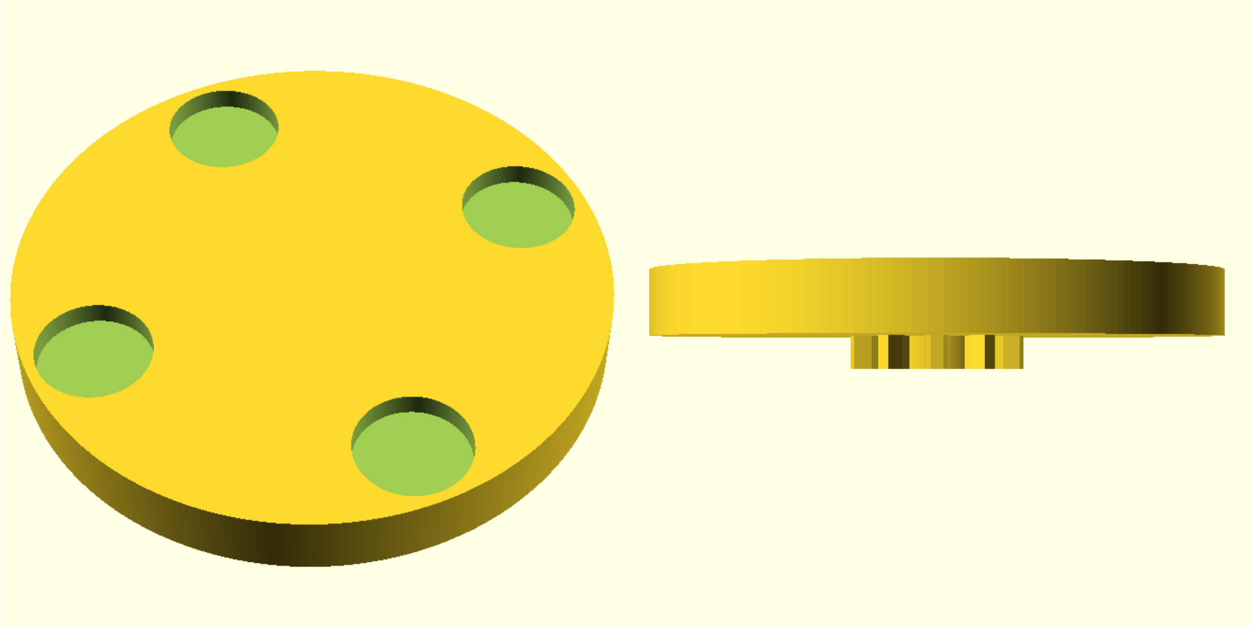

Figure 2

- Blue - Turntable
- Black - Stand and housing for our components. Such as a stepper motor, photo sensor, microcontroller, and bluetooth receiver.
- Red - Containers for our liquid. This also will hold the servo motors to control the valves.
- Clear - The cup loading and housing. This will have two solenoids for the loading of cups.

1.4 High Level Requirements:

The first thing that our machine has to do is drop cups one at a time on the the rotating table. We will use two servos to do this, one to hold the cups and the other to push the bottom one off. Without this, we won't have cups to fill.

The next requirement is that our rotating table has to move the cups properly. First, it has to move an empty cup under the nozzle on the dispenser. Then, once the cup is full, the table must rotate the cup out of the way in order to make room for the next one. This is also where the full cups can be picked up.

The dispenser must give the correct amount of soda at the right time. The cup needs to be 80% +/- 5% full once done, and the soda must correspond to the one selected on the remote. If the machine dispenses at the wrong time, it could spill soda everywhere, so the timing needs to be correct too.

The wireless remote needs to be able to communicate with the microcontroller. This is how we select the drink that we want, so if this doesn’t work nothing will. Pressing the button on the remote should dispense the corresponding drink into a cup.

2 Design

2.1 Block Diagram:

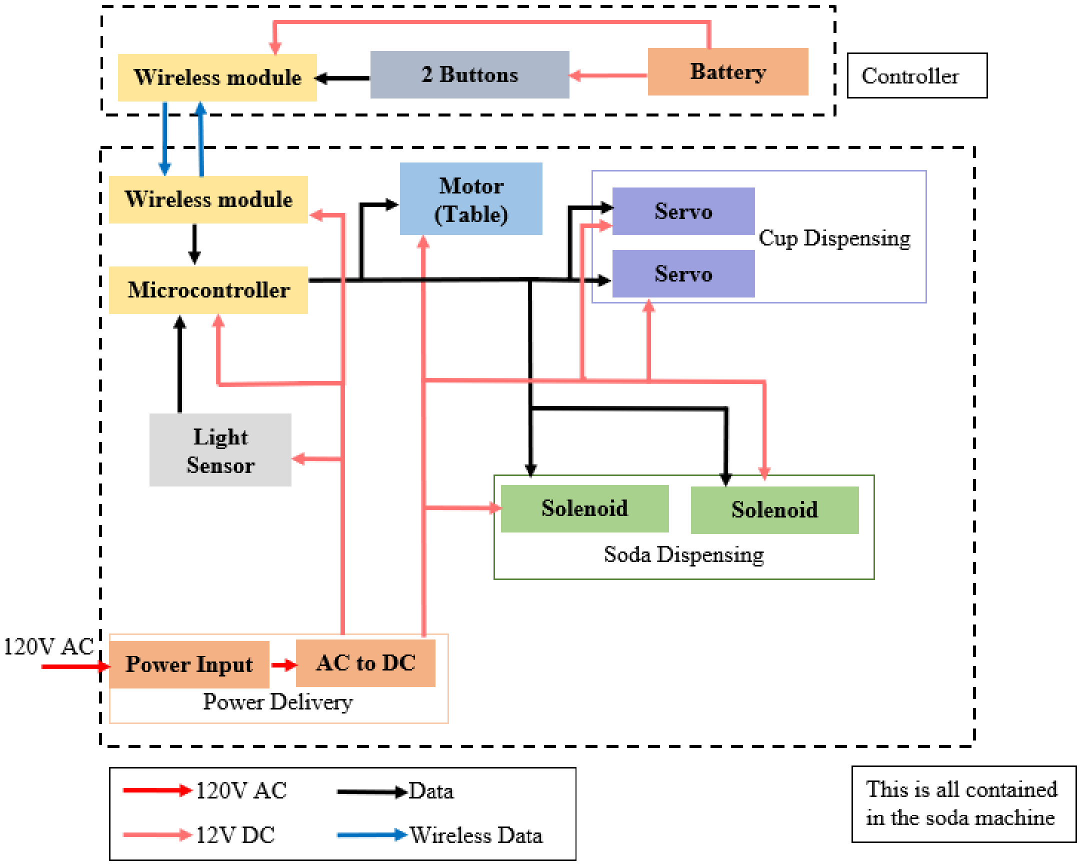

Figure 3

2.2 Flow Chart:

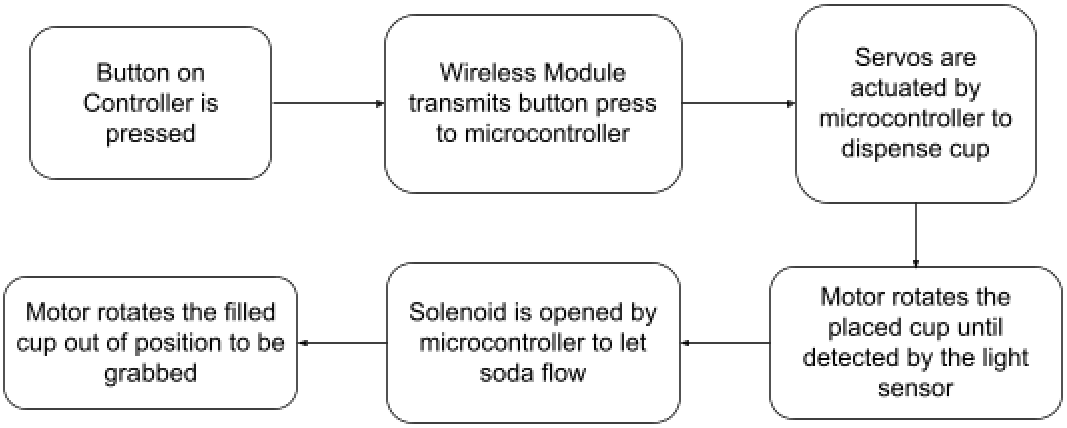
Button on Controller is pressed
Wireless Module transmits button press to microcontroller
Servos are actuated by microcontroller to dispense cup
Motor rotates the placed cup until detected by the light sensor
Solenoid is opened by microcontroller to let soda flow
Motor rotates the filled cup out of position to be grabbed

Figure 4

2.3 Circuit Schematics

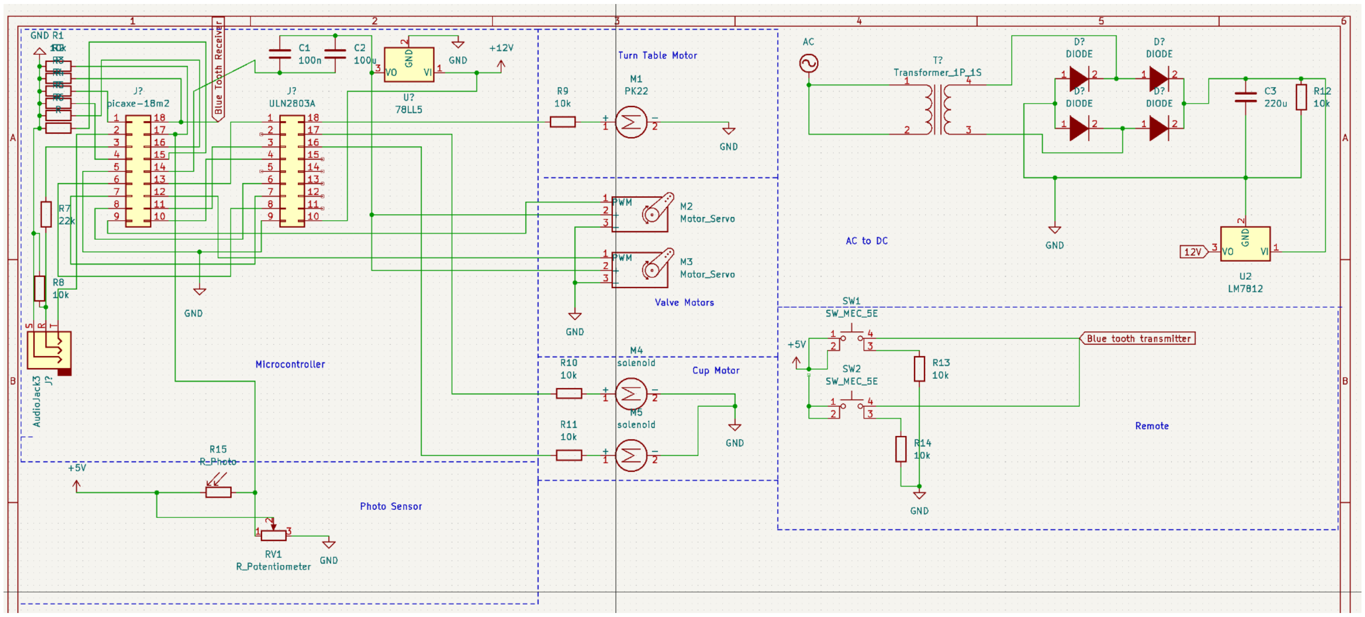

Figure 5

2.4 Subsystem Overview:

1. The power delivery subsystem’s purpose is to provide power to the actual soda machine. It consists of a power input to take 120V AC from a wall outlet. It then is paired with a device to change the AC input to DC output for the rest of the components in the machine to run off of.

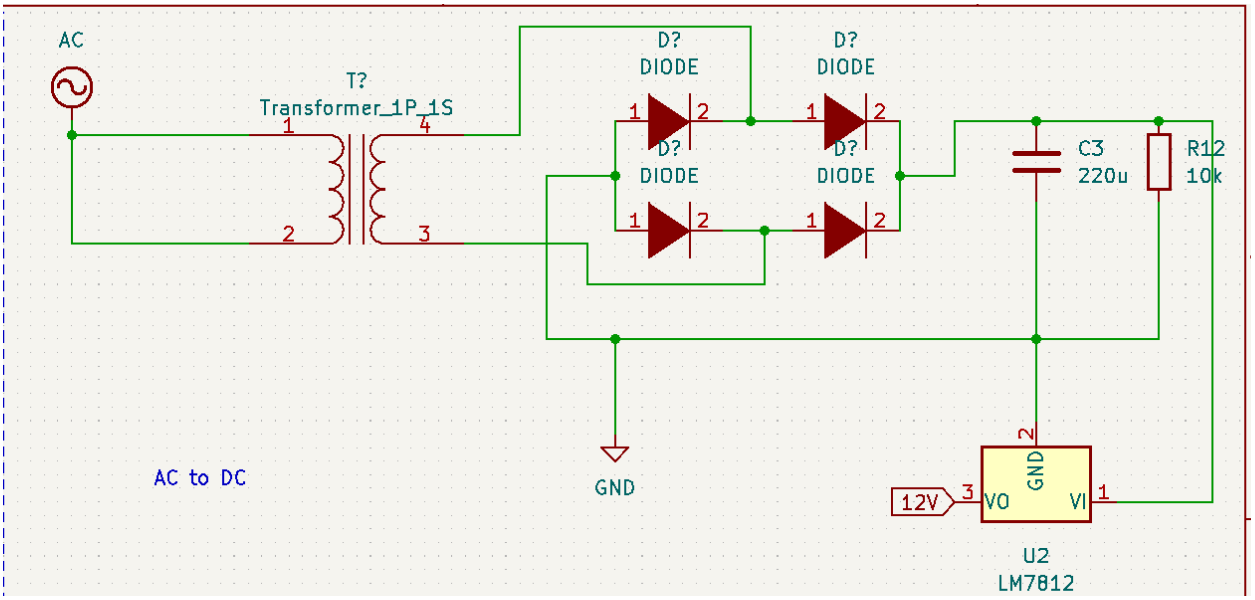

Figure 6

2. The controller subsystem is detached from the machine so it has its own power source in the form of a battery housed inside the controller. The other main component housed inside the controller are the four buttons, one button per drink in our machine. The buttons send data via Bluetooth to the microcontroller housed inside the soda machine.

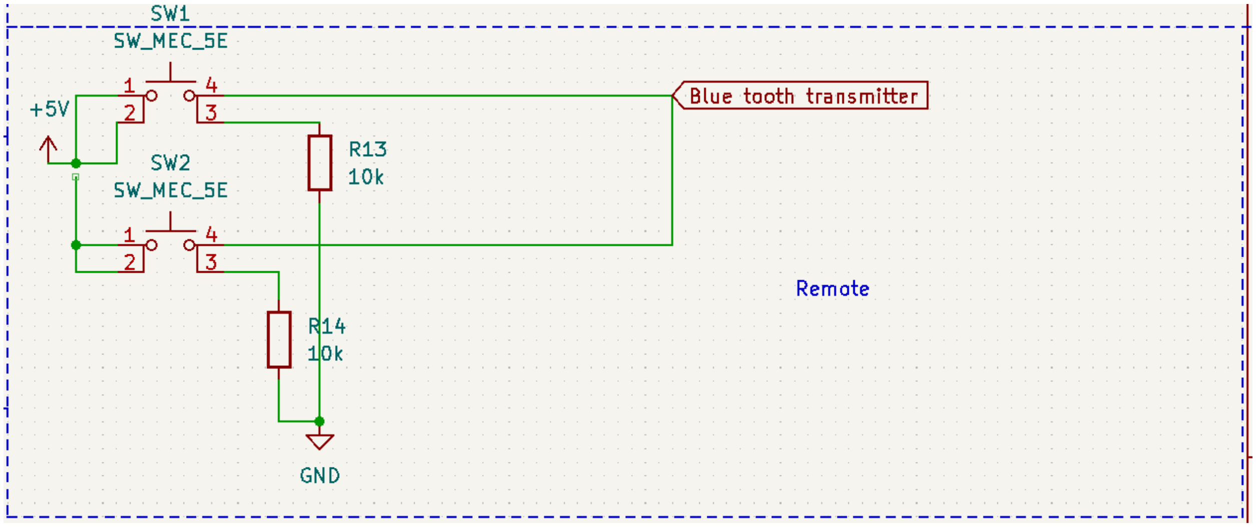

Figure 7

3. The microcontroller gets power from the power delivery subsystem and receives data from the controller. It uses that data to determine when to dispense a cup, when to move the conveyor, and when to dispense the soda. It will be the brain of the machine and have a hand in every aspect of the machine short of the power delivery.

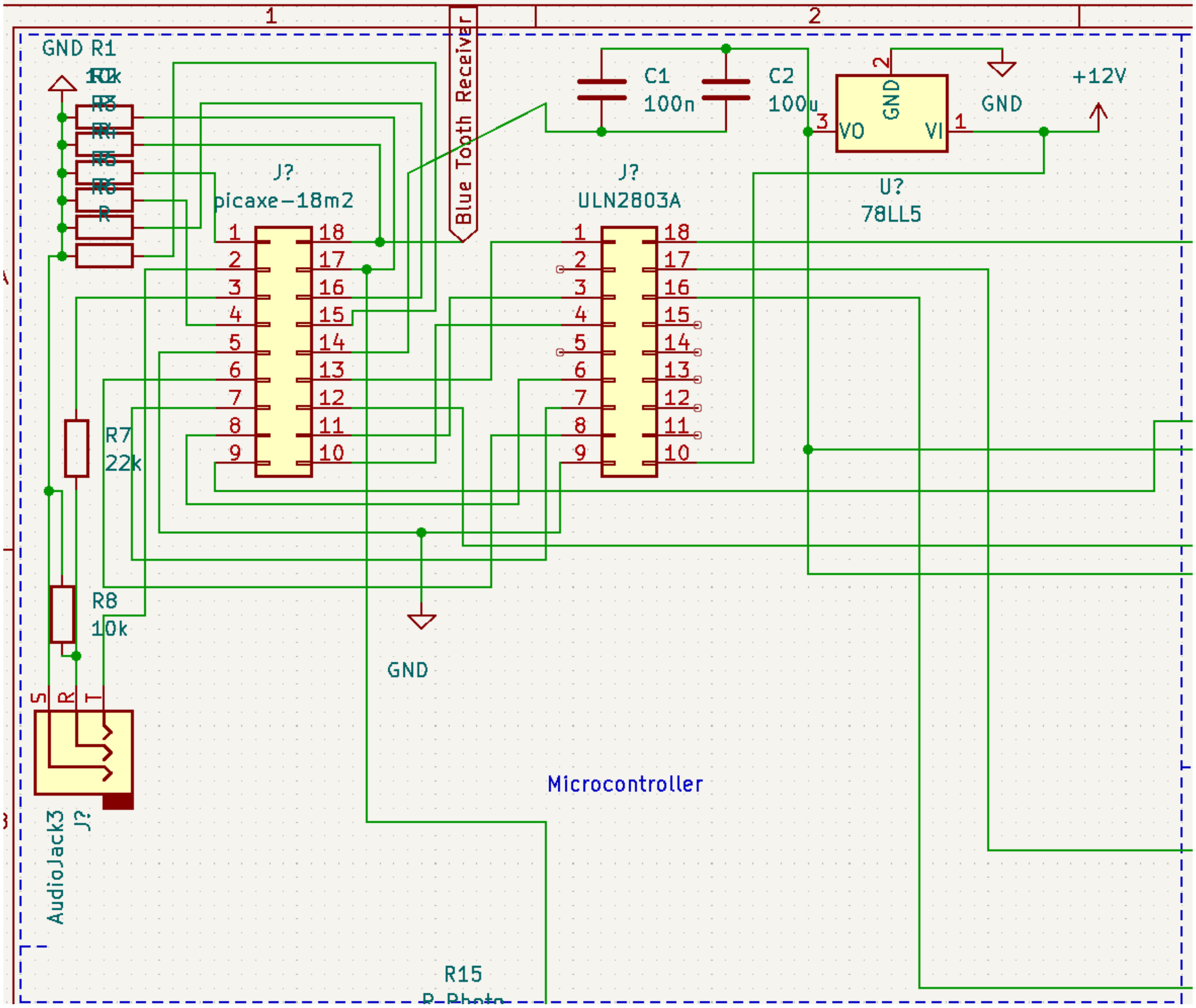

Figure 8

4. The cup dispensing subsystem has power given to it in order to run the two servos that will dispense the cups. One will drop the bottom cup onto the table, and the other will

hold the rest of the stack up so that we don't drop more than one cup. The servos will be timed and controlled by the microcontroller so that it works every time.

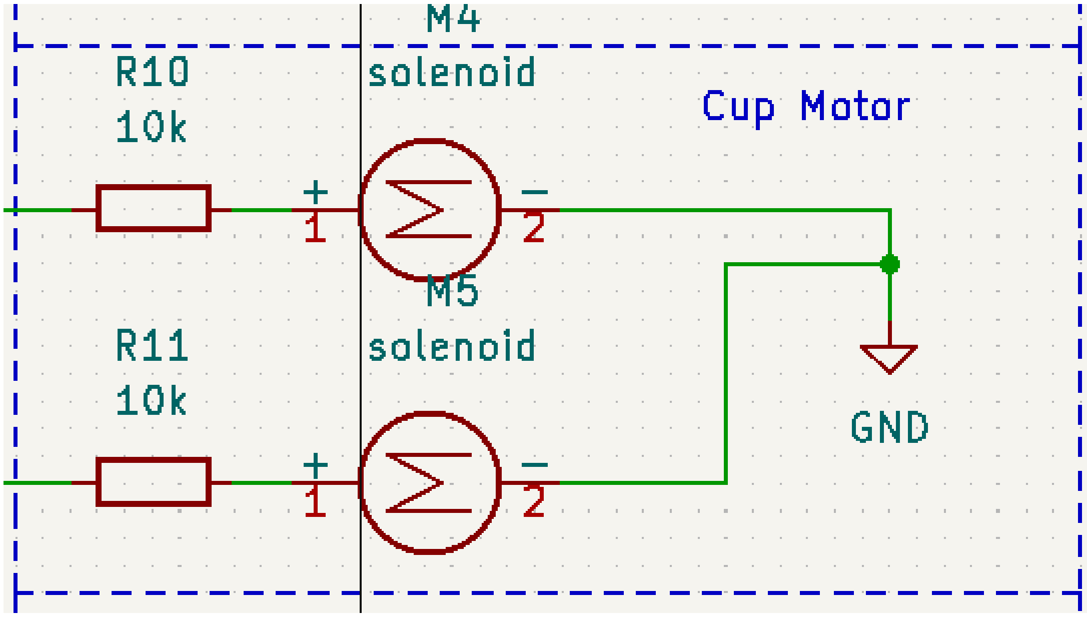

Figure 9

5. The rotating table will take data from the microcontroller in order to know when it should start moving after the cup has been placed on it. Then, it will then move the cup underneath the soda fountain waiting for the proper amount of soda to be dispensed. After the soda has stopped, it can then continue moving the cup around, and it can wait there to be taken by the user.

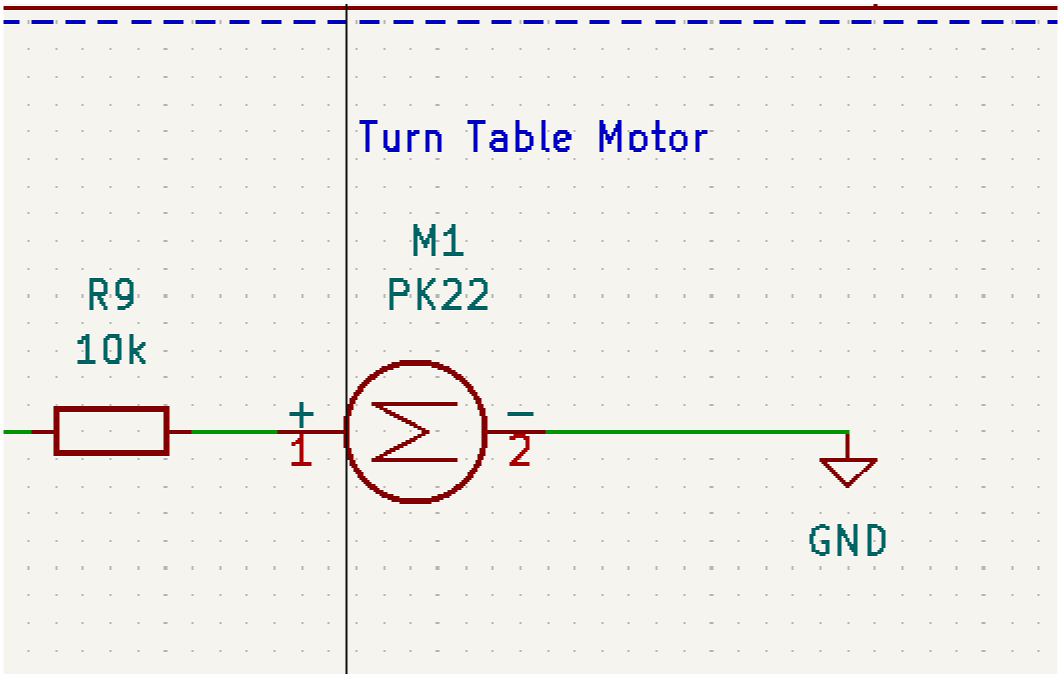

Figure 10

6. The soda dispensing subsystem is the final one. It takes power, data from the microcontroller, and uses solenoids, in order to dispense soda into the cup placed underneath it by the conveyor belt. We will use a light sensor to see when a cup is in position to have soda dispensed. There will be a timer in order to know when the solenoids should turn off to stop dispensing the soda. There are planned to be two solenoids total, one for each drink planned to be inside the soda machine.

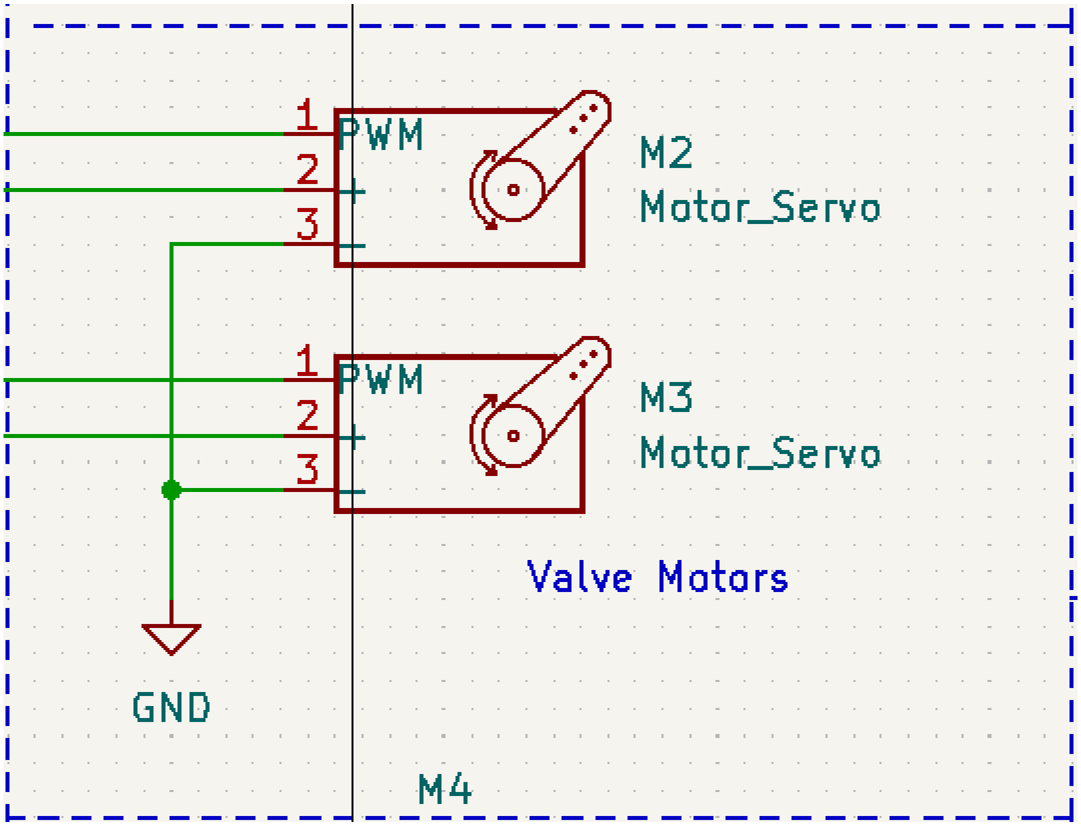

Figure 11

2.5 Subsystem Requirements:

1. The cup dispenser must be able to dispense one cup at a time without dropping the whole stack. If anything other than one cup comes out, we will count it as a failure. There will be two servos to do this, one to drop the bottom cup, and another to support the rest of the stack. All the movement will be done by servos controlled by the microcontroller.
2. The rotating table must move the cups to the correct positions at the correct time. A cup will be placed on it by the cup dispenser, and from there the table has to move the cup under the nozzle to have soda dispensed into it. After it is filled, the cup turns further around the table and is able to be picked up from there.
3. The soda dispenser must be able to sense a cup when it comes near, and begin to dispense the correct soda into the cup. The microcontroller needs to know which soda to dispense,

and then open a valve to allow the correct amount of soda into the cup so that it is full but not overflowing.

4. We must be able to use a controller to make the machine work. There will be two buttons on the controller, each one describing a different drink. When a button is pressed, a cup must be grabbed, moved to the dispenser, filled with the chosen soda, and then moved along to be picked up.

2.6 Requirements and Verifications

Controller	
Requirements	Verification
1. Machine dispenses cup from button press 2. Table waits for cup then moves into proper position 3. Correct soda is dispensed in proper amount based on which button is pressed	1. Verification for 1 a. Verify output voltage of 5V is outputted using multimeter 2. Verification for 2 a. Verify output voltage of 12V is outputted using multimeter b. Verify voltage appears shortly after cup has landed in at least 3 seconds c. Verify voltage is active until cup is detected by light sensor 3. Verification for 3 a. Verify output voltage of 12V is outputted using multimeter b. Verify voltage appears after light sensor detects cup in position c. Verify voltage appears for enough time for cup to be 80% +/- 5% filled

Cup Dispensing	
Requirements	Verification

1. Only one cup is dispensed at a time and lands in slot of table	1. Verification for 1 a. Apply voltage pulse of 5V to lower servo to release cup verifying that it lands in slot b. Apply same voltage pulse to close the prior servo c. Apply same voltage pulse to open top servo and lower cups to the bottom servo d. Apply same voltage pulse to close the upper servo e. Run multiple times to see consistency of dispensing system

Soda Dispensing	
Requirements	Verification
1. Able to differentiate which soda is dispensed 2. Soda is dispensed in order to fill cup 80% +/- 5% of the way to the top 3. Soda does not leak	1. Verification for 1 a. Apply voltage of 12V to solenoid to make sure the desired soda is the one let out b. Go back and forth checking for consistency 2. Verification for 2 a. Determine a rough time guess to fill cup volume to 80% b. Test and refine time value using graduated cylinder to get closer to an average of 80% c. Repeat for the other soda 3. Verification for 3 a. Fill containers as much as possible to create max possible strain on solenoid valves b. Find time needed after dispensing for dripping soda to leave the tubing

Table

Requirements	Verification
1. Table can hold the cup and keep it from falling or spilling 2. Table stops rotating from detection of cup by light sensor 3. Table rotates once cup is filled with next slot in position for next cup to be dispensed	1. Verification for 1 a. Dispense cups using cup dispensing method stated above b. Run table with unfilled cup viewing how stable it is c. Repeat b with a filled cup 2. Verification for 2 a. Place light sensor verifying it interrupts rotation of table 3. Verification for 3 a. Use timing from soda dispensing verification b. After rotation is complete, repeat verification 1 to ensure it has rotated the proper amount

Power Delivery	
Requirements	Verification
1. AC to DC converter can provide the 12V +/- 10% necessary to power the separate parts of the machine	1. Verification for 1 a. Measure output voltage with reference to ground using a multimeter to verify 12V +/- 10%

2.7 Tolerance Analysis:

There are a lot of aspects to this project that could break the whole thing. If the remote doesn’t work, we won't be able to dispense any soda. If the cup dispenser doesn’t work, we won’t have any cups to fill. If the conveyor doesn’t work, the cups won’t be in position to be filled by the machine. If the dispenser doesn’t work, we may overfill the cup or not fill it enough. We could also dispense the wrong drink, which would also be a failure.

The vast majority of these errors will be solved with proper coding. A lot of it comes down to timing, which electronics can do very well when designed correctly. Making sure this works will be the hardest part of the project, but we are confident that it will be done.

Our product will have a large focus on consistency across uses. We want it to dispense the same amount of soda into a cup every time, at the right time. To test this, we will be looking at the fill level of the cup after the soda is dispensed. We will check to make sure that the level stays near the top of the cup every time, at approximately 95% full. If we need to be more precise, we can always check the exact volume using a graduated cylinder. Other testable components are simple “yes or no” questions, such as if the cup is dispensed properly, does the machine dispense the correct soda, does the soda fill the cup or pour onto the floor. Making sure the table rotates correctly will also be tested, but again that's really only yes or no.

Unit testing can be done with oscilloscopes and multimeters on individual parts. Motors are driven at 12V, so we can measure the voltage along those lines to make sure they are active at the right times. This can be used to test the solenoids and DC motor for the table. The servos are driven by a PWM signal, so we will use an oscilloscope to measure the signal.

3 Cost and Schedule

3.1 Cost Analysis:

- Labor [3]:
    - Computer Engineer (1 person)
        - $47/hour * 80 hours to complete * 1 person: $3760
    - Electrical Engineer (2 people)
        - $38/hour * 80 hours to complete * 2 people: $6080
    - Total Labor: $9840
- Parts:
    - Microcontroller: $6
    - DC motor: $20
    - Servos: $15 for a 2 pack
    - Light Sensor: $10

  - Solenoids: $10 x2
  - Total: $71
- Totals:
  - $9840 + $71 = $9911

3.2 Schedule:

Weeks	Work to be completed that week
2/21	Complete our design document and our design document review. Also, complete the soldering assignment.
2/28	Order parts to be sent to the machine shop. As well as, get our pcb design approved.
3/7	Fill out team evaluation form 1. Speak with the machine shop about the progress of our design. Start working on our remote and bluetooth receiver.
3/21	.Assemble our PCB and start work on coding our microcontroller.
3/28	Work on personal progress reports and start testing our subsystems
4/4	Work on our demo and our final paper.
4/11	Work on our demo and our final paper.
4/18	Work on our demo and our final paper.
4/25	Perform our final demonstration and prepare for our presentation.
5/2	Perform our final presentation, turn in our final paper, and fill out the final team evaluation.

4 Ethics and Safety

There are a few safety concerns with making a machine like ours. First of all, it will need to be cleaned periodically, so that bacteria doesn't grow inside. We can do this by running warm, soapy water through the machine to flush out any leftover drink, and clean the tubing too. The dispenser also has moving parts that can create a pinch point. This can be partially combated by shrouding moving parts like servos, but the exterior will still move. However, since it is an autonomous machine, people shouldn't need to be around while it is moving. Warning labels will be applied in case though, so that people are aware of the pinching dangers. We will also have electronics around liquids, so those will be waterproofed as well to prevent short circuits and shock hazards.

We will be following the IEEE code of ethics in all ways possible. We will design our machine to be safe and not cheap, to protect the users from harm when operating the device. We will seek assistance when necessary, and credit all help which we receive. We will hold each other accountable to this code of conduct, and make sure that all tenants are being followed. The full code of ethics can be found here.

5 References

[1] *10 restaurant staffing issues and how to address them*. GloriaFood Blog. (2021, November 9). Retrieved February 11, 2022, from https://www.gloriafood.com/restaurant-staffing-issues

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[4] Picaxe Microcontroller Datasheet: https://picaxe.com/docs/picaxe_manual1.pdf. Accessed 23 February, 2022.

[5] AC to DC power supply: https://www.circuitlab.com/circuit/wrfeu3/120vac-to-12vdc-power-supply/. Accessed 23 February, 2022.

[6] Transistor Array Datasheet: https://www.ti.com/lit/ds/symlink/uln2803a.pdf?ts=1645742600950&ref_url=https%253A%252F%252Fwww.google.com%252F. Accessed 23 February, 2022.