Designing a Voice Accessible Vending Machine with Machine Learning Interpretation

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We certify that this assignment is the result of our own efforts.

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Abstract:

The objective of an AI vending machine is to construct a vending machine with complete functionality through audio description, while prioritizing the accessibility for the visually impaired. The system allows consumers to communicate with the machine through audio input. Key methods include the integration of motion sensor audio instructions, AI-driven speech recognition software, braille plates for labels, and many other features. Additionally, a Raspberry PI 5 was utilized to gain full control over the vending process. The AI-driven vending machine has fully replaced the pre-existing vending machine to operate for both visually impaired and non-visually impaired consumers.

1. Introduction:

Our project's objective is to design and construct a vending machine accessible through audio description. The core of our project goal is to be accessible for the visually impaired population through multiple improvements of a standard vending machine to accommodate for consumers. In addition to the standard function of the vending machine, we have added the ability for a visually impaired consumer to locate, communicate, and interact with the machine via voice alone. This voice interaction includes directions for how to interact with the machine. The user can access a list of available products, and price of said products. In response to consumer input, our project MRSTV, which stands for Machine Raspberry Pi Snack Talking Vendor, responds through a speaker with an appropriate response guiding the user. This allows consumers to identify what is inside the machine as well as selecting a product through audio input alone. These implementations have been added to a pre-existing Snackshop 6000 Series XL Vending Machine. These modifications include but are not limited to: Microcontrollers replacing the standard Vending Machine Controller (VMC), adding physical accessibility features, and active accessibility features to assist consumers. These modifications provide a solution to consumers that were previously unable to utilize a standard vending machine due to lack of vision. Through our extensive research and experiments, we hope our project will be fruitful in making the task of using a vending machine simpler for everyone.

2. Problem Definition:

2.1 Problem/Need:

Virtually no vending machines provide an accessible interface for individuals who experience vision loss. Visual impairments can be lifelong, or progressive, nevertheless those living with vision loss deserve independence just as we all do. Even having independence in something as simple as getting a snack from a vending machine can be fulfilling. It is for this reason that our team decided to start this project. We aim to provide an independent vending experience accessible to the visually impaired.

2.2 Intended user(s) and use(s):

Our design is intended to be usable by all typical vending machine consumers, with a special focus on including visually impaired consumers. Our project is functional as a typical vending machine and includes an accessible mode in which users can order and receive their snack using voice interaction with MRSTV.

2.3 Assumptions and limitations:

Since this project is version 1.0, we assumed our users speak English with a general American accent. Whisper by OpenAI has models that are trained on hundreds of thousands of hours of English audio from the internet, and accuracy is a parameter that they advertise. Therefore, MRSTV is able to handle most variations in speech as it detects keywords during the conversation through the Whisper program. Our team also assumed MRSTV will be placed in a room where the audio interaction won't be a distraction to others. For example, a breakroom or stairwell. It was important to strike a balance when designing this project. We included sensory cues to help the visually impaired identify our machine, but we also wanted to ensure that the presence of these sensory cues will not pose a significant disturbance to MRSTV's environment and those in it. Response latency did prove to be an issue but we addressed it by using unique programming techniques. The time between speaking to MRSTV and hearing MRSTV's response is called the response time, and time between encountering MRSTV and receiving your snack is referred to as the turnaround time. The average person spends about 30s at a vending machine. Having a long and

cumbersome interface can deter potential consumers that may see using MRSTV as an inconvenience. The accessibility mode for MRSTV is able to determine a consumer's selection and dispense the correct product in less than one minute. Since we are running a program that is recording audio and processing it every time the user speaks to MRSTV. Thus, we wanted this program to run very quickly and we needed to be careful to ensure the latency remains low. Our power supply isn't capable of providing the max current needed to run the raspberry pi at max clock speed, thus there is an average .2 seconds of additional latency that we needed to work around.

2.4 Design objectives:

The main project objectives were: adding accessibility for visually-disabled consumers, having our modified machine still work as a standard vending machine, and having an efficient vending machine algorithm to reduce additional time spent at the machine while using voice interaction. Accessibility for visually disabled individuals is paramount for our design and all objectives are based on this concept. This being said, it was important that standard vending machine use was maintained as an option. Users without the need for accessibility assistance may find it difficult to interact with the machine via voice input, and could potentially turn consumers away. Finally, the average user spends about ~30-45 seconds at a standard vending machine. The implementation of our accessibility assistance is responsive with the option for voice short-cuts or standard mode to accelerate the process if necessary.

3. Design Specifications:

Our project uses a microphone to pick up the voice of customers. Ultrasound sensors communicate with a Raspberry PI 5 to identify a customer's presence within a certain range. A card reader, bill acceptor, and coin mechanism communicate payment information to the Raspberry PI using a MDB to USB adapter. We implemented voice recognition by transcribing audio clips using whisper.cpp, then token analysis is performed on the string generated from whisper. The token analysis determines the action to be performed by the vendor. An N-ary tree stores the menus and products inside the machine. Instructions from the token analysis determine movements across the data structure. Once the order is determined and paid for using the payment peripherals, the Raspberry PI will communicate with an Arduino Mega 2560 to drive the motor assigned to the customer's selection.

4. End-Product Description:

MRSTV is a vending interface that can be communicated via voice commands, or used as a standard vending machine. MRSTV will acknowledge potential users when they step into range. When using voice interaction the machine responds with reasonable latency, and accepts cash and cashless payments.

5. Design constraints:

5.1 Economic

Those who would buy our project may not see the additional market of the visually impaired as a sufficient tradeoff for the increased cost when compared to ordinary vending machines. However, the visually impaired population makes up 2.5%, about 8.6 million Americans of the total population [8]. Additionally, by using an older model, Snackshop 6000 Series XL Vending Machine, we prove ease of implementation to newer model vending Machines. It is also possible that some companies will see MRSTV as an opportunity to appeal to a wider demographic of people.

5.2 Environmental

Many vending machines are stationed outside. This exposes them to the elements leading to potential sun and water damage. Many parts of the machine are made of steel. While steel is quite resilient, it is prone to rust at some point in the presence of oxygen. Similarly, if MRSTV was placed outside and additional noise is not filtered out, this would interfere with input strings from the consumer reducing effectiveness. While these factors are evident for machines placed outside, MRSTV is intended to be placed within a building away from these factors.

5.3 Social and Political

Vending machines are commonly damaged by customers upset with their service. Due to the nature of MRSTV, consumers may feel frustrated if they don't get the desired product in a timely fashion. Additionally, since MRSTV draws attention to itself it could potentially open the door to unwelcome comments on the user of the machine. The machine contains a speaker and emits audio, which may cause disruption depending on the location. Having discussed the social aspects of the machine now it is time to state its political aspects. There are those who may not value accessibility in society or may see the socially conscious nature of our project as unnecessary or unappealing. There are those who are doubtful of machine learning, artificial intelligence, and voice assistants. These people may believe that our project is a step in the wrong direction for society. For example, they may believe that this project is replacing human aid for the visually impaired. Others may not support a machine capable of recording audio being added to a space they frequent. They may see it as an invasion of privacy.

5.4 Ethical

Since MRSTV is a vending interface it is possible some may see the prices listed as unfair. Furthermore, if a visually impaired person's only vending option is our project, it is not unreasonable for them to believe that the prices in our machine have been marked higher than other machines. Snacks may sit inside a vending machine for a long period of time. If any snack expires, they are usually replaced the next time the machine is serviced. If there is an expired snack this poses no trouble for someone who can see clearly. However, it would be noticeably difficult for a person without sight to notice the snack had expired before consuming it. However, MRSTV will be serviced regularly like a standard vending machine, so as long as the service continues, expired products will never be an issue. Furthermore, MRSTV must be accurate in the dispensing of snacks, in the case of an allergy an incorrect dispense could mean trouble for the user. We have ensured there is protection in place to mitigate this hazard. MRSTV responds with the name of the item being dispensed and receives confirmation from the customer. The location within the machine, is directly tied to the audio that plays for a specific item, this means that barring any outside interference the snack that was relayed to the customer is the snack that gets dispensed. Some consumers may feel by providing their voice and payment information to a machine they may compromise their privacy. However, MRSTV will be using a secure company to process payments using the Verizon network which has multi layered security. All audio recordings are also deleted as soon as they have been transcribed so no customer voice is stored longer than it takes MRSTV to interpret their request.

5.5 Health and Safety

Allergic reactions are a possible hazard. MRSTV has no built in protections against accidentally consuming an item containing an allergen, instead for a person unable to verify the allergen by looking at the package MRSTV relies on said individual being aware of any potential allergies. Snacks may sit inside a vending machine for a long period of time. If any snack expires, they are usually replaced the next time the machine is serviced. If there is an expired snack, this poses no trouble to someone who is able to see clearly. However, it would be a lot more difficult for

a person without sight to notice the snack had expired before consuming it. This is a challenge faced by all packaged food that is apparently expired like expired dairy.

5.6 Manufacturability and Sustainability

Many vending machines are valued for their simplicity of design and ease of use. Our design adds complexity and additional power usage when compared to traditional vending machines. With more working parts needed to accommodate the visually impaired. It is our belief that a state of the art production of MRSTV could be produced using a specialized embedded system instead of our more general purpose Raspberry PI 5. This would reduce the complexity of our design allowing for more efficient use of hardware and energy. Since MRSTV is an older vending machine model, not many sustainability improvements have been made to the design. However, if adapted to more modern vending machines, MRSTV will adopt the sustainability techniques of the producer like reducing the power to run the machine and incorporate more energy efficient system design.

5.7 Global

Although English is a very common language across the world there are many different languages each with their own properties. Within America alone, there are on average 30 different accents for the English language[1]. Our large language model accommodates these ranges of accents to be able to include any potential consumer. With a tweaked system design and a larger language model MRSTV could potentially converse in multiple common languages. This would of course present new etymological challenges that are beyond the scope of this capstone project. This is especially true of languages that have unique inclusions such as body language and differing tones.

5.8 Cultural

Some may feel uncomfortable interacting with our project with voice communication. Especially in a place where it is normally quiet, such as a library. Depending on where a person is from and their culture, they may have a unique vocabulary. MRSTV's users may need to adjust the way they speak to maximize accuracy.

5.9 Cyber Security

MRSTV does not rely on bluetooth for the machine to work. The telemeter is connected through a company that utilizes Verizon/AT&T. Through these companies, we have multi layered security through the only path to "hack" the machine.

6. Design Phase Safety Details

6.1 Machine Transportation

When using a pallet jack it is important to ensure that the load is both centered and fully on the forks to prevent possible tipping. Another good safety measure is using a ratchet strap over the top of the load and under the forks to tightly hold the load down on the forks. Another strap can be used to tightly secure the load up against the back of the pallet jack to ensure it does not shift when moving. When moving the machine as a group we used these key safety measures to help reduce the chances of injury or catastrophic damage caused if the machine were to tip off the forks or shift.

Team lifting reduces the weight and distributes the work between each member making heavy lifting easier and safer reducing the risk of muscle strain or other injuries from over lifting. As a team we distributed the weight of the machine among four people by first wheelinging it over to the tailgate, using a pallet jack, and each of the four members took a corner from the bottom and tipped it into the back of the truck. This method also utilized the tailgate to absorb some of the weight making it easier and efficient to load and unload. When lifting heavy objects it is important to lift with legs to reduce back strain.

Importance of strapping the machine down properly when transporting the machine to campus reduced the chances of possible severe damage to the machine or injury of other motorists on the road. When transporting the machine we made sure we used at least three straps. Two ensured the machine was well anchored in with the final one being a safe in the case one were to fail. And one to ensure the machine is tightly held down in the back of the truck reducing the chances of the machine bouncing when we went over speed bumps. This also reduced the chances of the machine bouncing out of the truck causing a hazard for other drivers and severe damage to our machine. When using ratchet straps it is also important to ensure that the load being strapped down is under the rated load being strapped down. This is especially important when hauling heavy loads that may be susceptible to breaking light load ratchet straps. The vending machine we hauled weighs roughly 680 lbs. The straps we used to strap the machine down were rated for at least 750 lbs. to ensure they were susceptible to the weight of the machine safely with a bit of room for error in weight to ensure it is under the rated amount.

Subsystem Build/Testing Phase Safety Details -

6.2 Electrical Hazards

While building and testing our motor control circuits. We had to be careful to avoid working on the machine when it was live. Even when the circuit was not live we had to be cautious in case a grounded component became energized through a faulty connection. Electrical hazards can be mitigated through thorough checking and safe wiring practices.

6.3 Power tool safety

To install the new peripheral devices we added to the vending machine we needed to utilize a power drill and angle grinder. Proper PPE had to be worn when we used these power tools. This included hand protection for added grip and protection from sparks and hot scrap, as well as face shielding to protect our face from sparks and hot scrap. In addition to face shielding it was also wise to wear some sort of respiratory protection to prevent the inhalation of particles created from grinding or drilling.

6.4 Soldering

While working on our motor control circuit we had to solder some connections. It was important to understand proper usage of a soldering iron to avoid damaging any surrounding items or burning oneself. In addition to this it is important to have proper ventilation to avoid breathing any fumes generated. This can be achieved by working outside, using a fume hood if inside, or using a powerful fan and breath control.

System Integration Testing/Demonstration Safety Details -

6.6 Moving the machine around in building 4

For safety the machine was never moved without at least one other group member present and will not be moved through the halls without at least three group members present. Two members, one on each slide and one to watch for obstacles or hazards we may run into. To get the machine around the building a pallet jack was used, it was important to ensure clearance when releasing the jack to avoid crushing anything or anyone.

Final Project Use Safety Details -

6.7 Crushing hazards

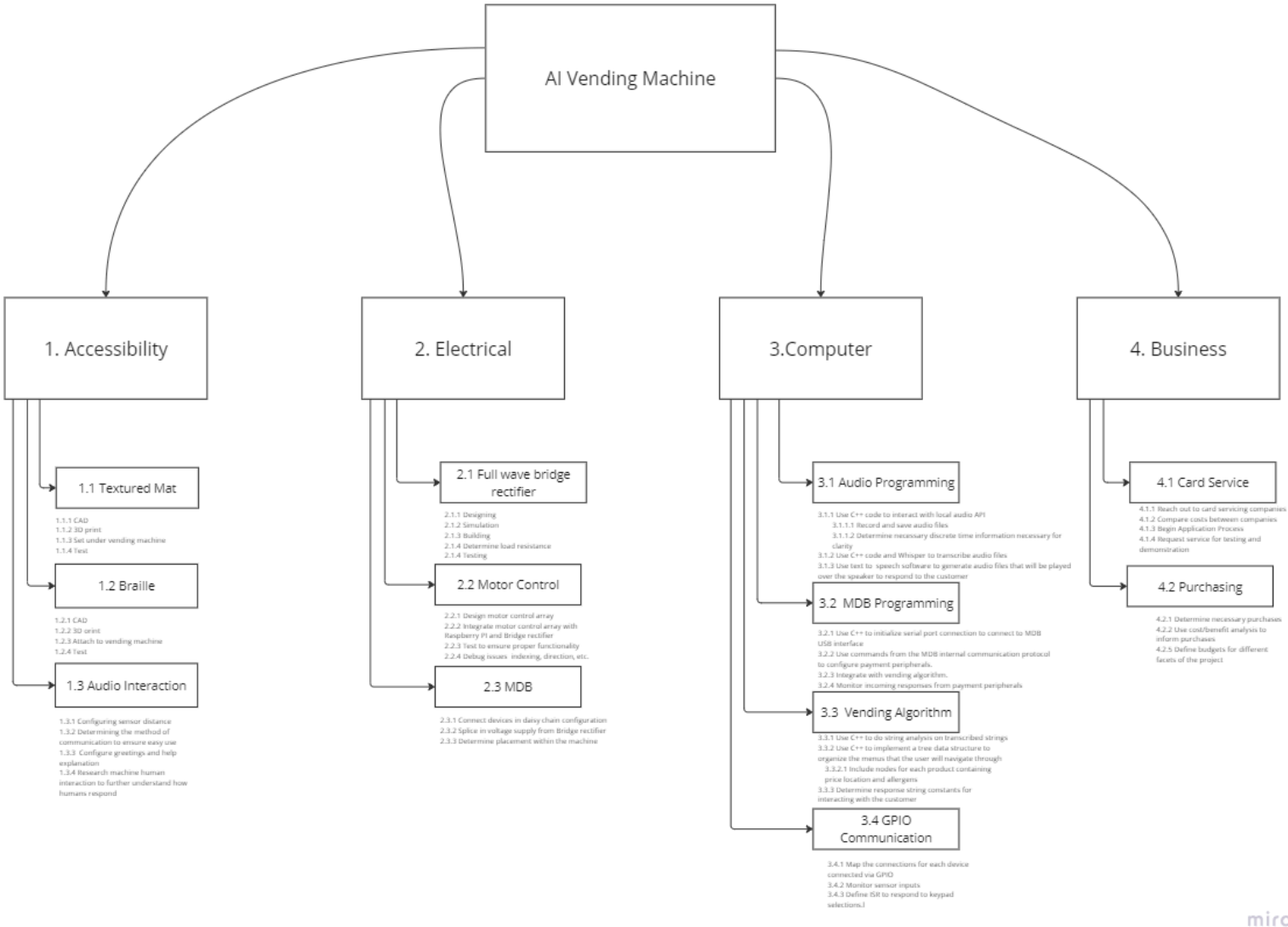
Like all vending machines, our project was very heavy and could easily crush someone if it were to fall on them. Since vending machines are often shaken or rocked by the customer when they don't function properly.

Engineering Standards:

NSF/ANSI 25-2023 - This industry standard sets minimum requirements for sanitation and food protection. This standard also defines requirements for a vending machine's performance and build. NSPE Code of Ethics for Engineers - These standards outline responsibilities all engineers must adhere to in professional practice. As we are aspiring engineers, following these standards while approaching the project will ensure we can maintain ethical practices and responsibilities. ULSE - UL 751 Standards for Vending Machines - These standards cover "self-contained, payment-accepting, vending machines that vend non-refrigerated products…"[9]. Our project relies on a non-refrigerated vending machine so these standards will need to be reviewed and implemented.

7. Technical Approach:

7.1 Work Breakdown Structure



A.I. Vending Machine

1. Accessibility
    1.1 Textured Mat
        1.1.1 CAD
        1.1.2 3D print
        1.1.3 Set under vending machine
        1.1.4 Test
    1.2 Braille
        1.2.1 CAD
        1.2.2 3D print
        1.2.3 Attach to vending machine
        1.2.4 Test
    1.3 Audio Interaction
        1.3.1 Configuring sensor distance
        1.3.2 Determining the method of communication to ensure easy use
        1.3.3 Configure greetings and help explanation
        1.3.4 Research machine human interaction to further understand how humans respond
2. Electrical
    2.1 Full Wave Bridge Rectifier
        2.1.1 Designing
        2.1.2 Simulation
        2.1.3 Building
        2.1.4 Determine load resistance
        2.1.5 Testing
    2.2 Motor Control
        2.2.1 Design motor control array
        2.2.2 Integrate motor control array with Raspberry PI and Bridge rectifier
        2.2.3 Test to ensure proper functionality
        2.2.4 Debug issues indexing, direction, etc.
    2.3 MDB
        2.3.1 Connect devices in daisy chain configuration

2.3.2 Splice in voltage supply from Bridge rectifier

2.3.3 Determine placement within the machine

3. Computer

3.1 Audio Programming

3.1.1 Use C++ code to interact with local audio API

3.1.1.1 Record and save audio files

3.1.1.2 Determine necessary discrete time information necessary for clarity

3.1.2 Use C++ code and Whisper to transcribe audio files

3.1.3 Use text to speech software to generate audio files that will be played over the speaker to respond to the customer

3.2 MDB Programming

3.2.1 Use C++ to initialize serial port connection to connect to MDB USB interface

3.2.2 Use commands from the MDB internal communication protocol to configure payment peripherals.

3.2.3 Integrate with the vending algorithm.

3.2.4 Monitor incoming responses from payment peripherals

3.3 Vending Algorithm

3.3.1 Use C++ to do string analysis on transcribed strings

3.3.2 Use C++ to implement a tree data structure to organize the menus that the user will navigate through

3.3.2.1 Include nodes for each product containing price location and allergens

3.3.3 Determine response string constants for interacting with the customer

3.4 GPIO Communication

3.4.1 Map the connections for each device connected via GPIO

3.4.2 Monitor sensor inputs

3.4.3 Define ISR to respond to keypad selections

4. Business

4.1 Card Service

4.1.1 Reach out to card servicing companies

4.1.2 Compare costs between companies

4.1.3 Begin Application Process

4.1.4 Request service for testing and demonstration

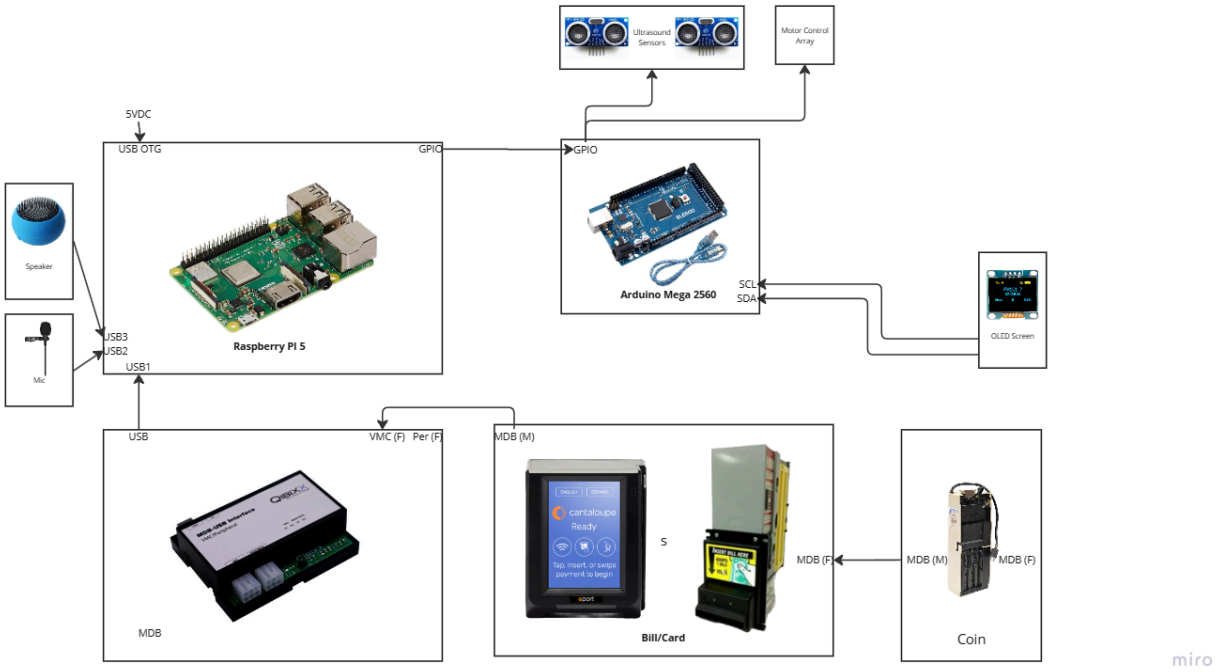
4.2 Purchasing

4.2.1 Determine necessary purchases

4.2.2 Use cost/benefit analysis to inform purchases

4.2.3 Define budgets for different facets of the project

7.2 Block Diagrams



7.3 Functional Requirements for Blocks

Table 1: Functional Requirements and Specifications of Raspberry PI 5

Requirements	Specifications
Functional Requirements	- Runs the MRSTV vendor program - Uses Whisper.cpp tiny model to transcribe recorded audio - Make decisions based on user input and other parameters - Maintain serial communication with MDB-USB interface
Performance Requirements	- Low Latency for transcribing audio - Use a state system to optimize power consumption
System Interaction	- Detect interrupts from the keypad - Record and stores user audio from the microphone - Play cached audio to the speaker - Communicate MDB commands serially to the MDB USB interface - Use GPIO to communicate motor number to Arduino - Use GPIO to read ultrasound status from the Arduino
Operator Interaction	- None directly, analyzes tokens from transcribed user audio
Software Interface	- SSH allows remote access to initialize MRSTV C++ program. While running it prints multiple debug and status statements to the command line.

Table 2: Functional Requirements and Specifications of Arduino

Requirements	Specifications
Functional Requirements	- Activate relays to drive the motor control array - Monitor object distance using ultrasound sensors
Performance Requirements	- Accurately respond to multiple 8 bit values to drive specific coils in the vending machine
System Interaction	- Connected to electronic switches on the relays that drive the motors inside the machine - GPIO connect to the Raspberry PI to communicate when an object is within range
Operator Interaction	- None
Software Interface	- .ino file contains a programmed loop running continuously on the arduino. Serial print information is also available by remote access ssh, and screening the serial port.

Table 3: Functional Requirements and Specifications of MDB USB interface

Requirements	Specifications
Functional Requirements	- serve as a hub between the payment peripherals and the raspberry pi
Performance Requirements	- Accurately transmit MDB commands based on serial input
System Interaction	- Establishes serial connection over USB type B connection with raspberry pi - Connected via MDB to payment peripheral chain
Operator Interaction	- None
Software Interface	- NA

Table 3: Functional Requirements and Specifications of Payment Peripherals

Requirements	Specifications
Functional Requirements	- Accept Bill Payments - Accept Coin Payments - Accept Card Payments
Performance Requirements	- Accurately accept currency - Return currency if necessary
System Interaction	- Connected to electronic switches on the relays that drive the motors inside the machine - GPIO connect to the Raspberry PI to communicate when an object is within range
Operator Interaction	- Insert Coins and bills - Tap, insert or swiping cards
Hardware Interface	- Coin slot - Bill slot - Card reader with OLED screen and card slots

7.4 Technical Details of Implementation

7.4.1 Theory and Calculations

The MDB peripheral connections run off of 24V/0.7A, the motors run off 24V/0.08A and include a switch to pulse the current to stop the motor after one full rotation. The Raspberry PI runs off of a 5.1V/3A rating.

Replacing the Vending Machine Control (VMC) with a Raspberry PIi we additionally need to implement appropriate vending machine logic through our program. To utilize Whisper AI, we need to implement our program to utilize the input string and tokenize it to run through our virtual VMC. Whisper AI will also need to use portaudio. The program works with all of the peripherals to send the appropriate logic through.

The machine we modified for this project is an AP-6000XL vending machine with the dimensions 35” in depth 33” width by 72” in height. For accessibility, we have a scent bead holder, braille lettering (figure 5), textured mats, vinyl covering, ultrasound sensors, and speakers. These implementations target each of the senses, except for taste, to accommodate visually impaired individuals. The scent bead holder is to target a visually impaired consumer's sense of smell to lead them to the machine. The braille lettering is on the machine for any visually impaired consumer's sense of touch for any letters/numbers on the machine. The textured mats are similarly using visually impaired consumer’s sense of touch if they have a cane to detect obstacles. The vinyl covering targets a partially-visually-impaired consumer’s sense of sight with a bright yellow color to help locate the machine. The speakers target the visually impaired consumer’s sense of hearing to communicate with MRSTV. The ultrasound sensor is used to detect consumers to enable MRSTV to start communication and the vending machine process.

Full wave bridge rectifier

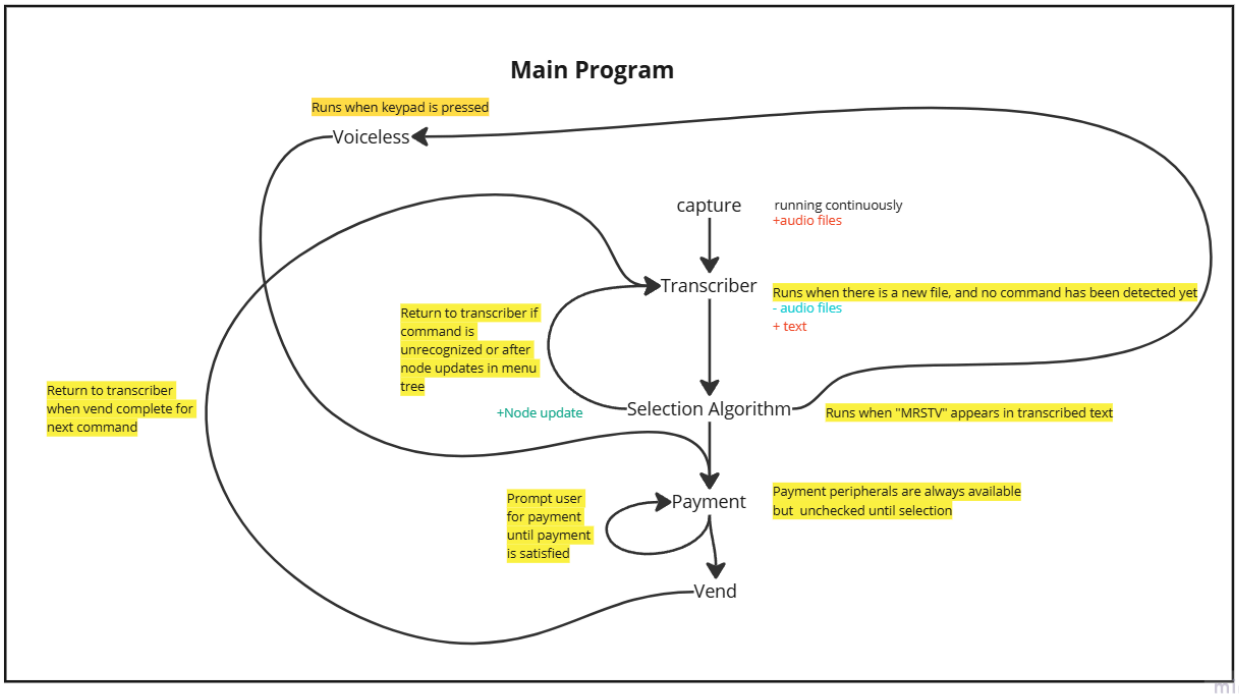
Both the vending machine peripherals, and the motor controller run off 24VDC. Inside the vending machine there are power connectors running from the transformer. These connections can provide 12.6, 28, and 117 VAC 60Hz. Using a

full wave bridge rectifier we can convert the 28 VAC to a usable DC voltage. A schematic of this circuit can be seen in figure 2. The circuit utilizes a smoothing capacitor in parallel with the load. We can adjust the capacitor value to adjust for the desired ripple in the rectifier output. The capacitance required for ripple band of (V peak - **α**Vpeak) is shown below

$$C = \frac{1}{2(1-\alpha)60*800}$$

Our load is still being determined so this capacitance value can be tuned at that time.

7.4.2 Flow Charts



Main program structure

7.4.3 Schematics

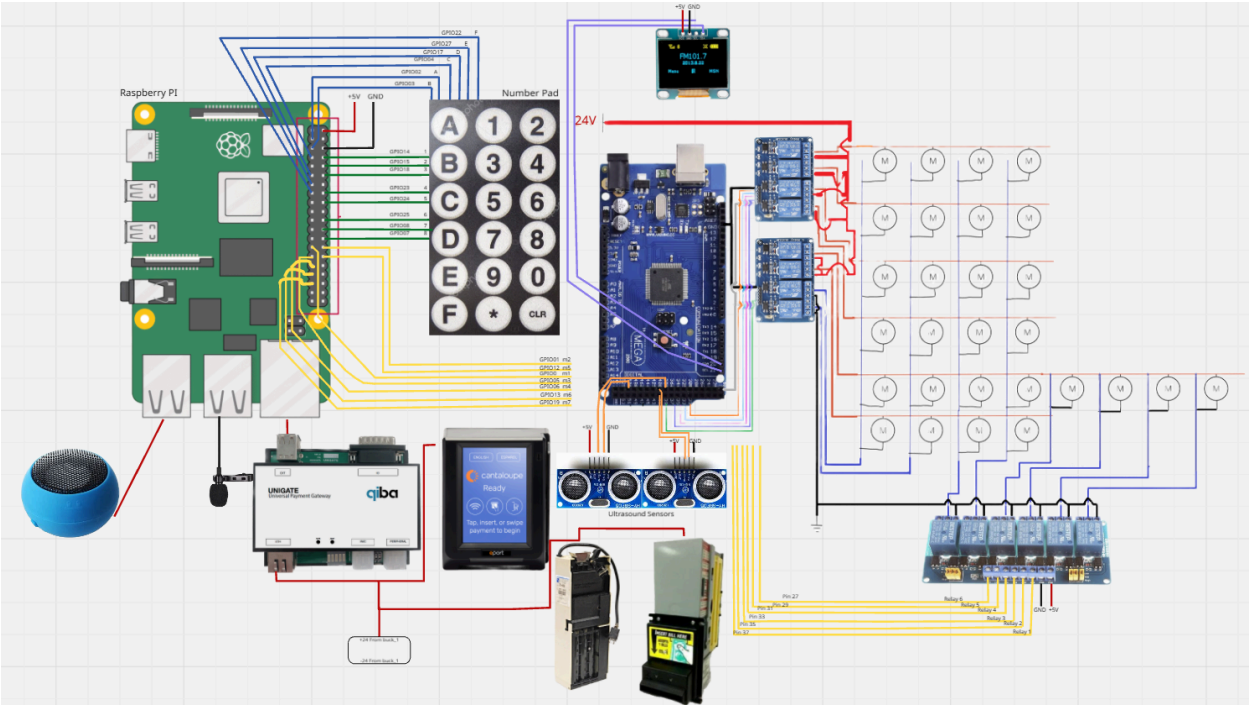


Figure 1. Vending machine Pin Diagram

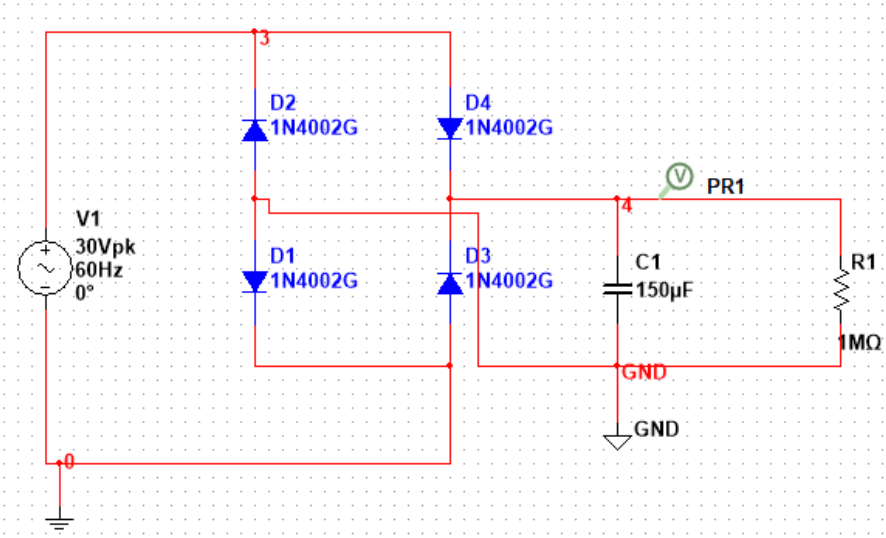


Figure 2. Multisim schematic showing the full wave bridge rectifier.

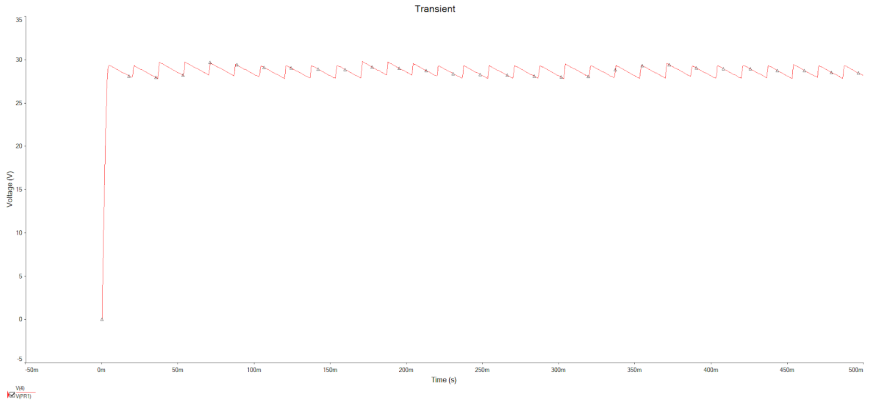


Figure 3. Transient simulation of the full wave rectifier at RL = 2kΩ

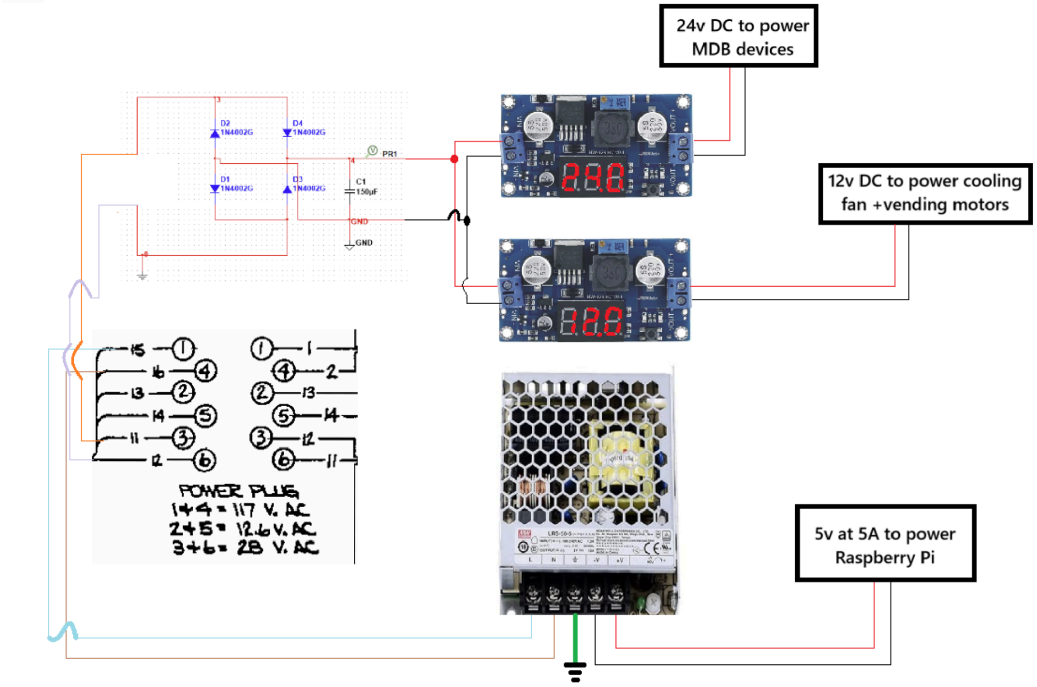
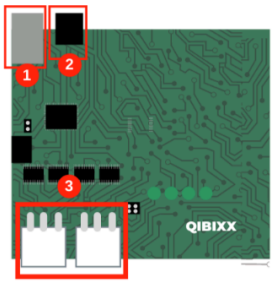


Figure 4. Power Supply schematic



Connector	Description
1	USB Connector , this connector is used for data communication with the host and also powers the unit (5V, up to 500mA)
2	TTL Connector (3v3 Uart). **Is also used as an input for Auto Mode.**
3	MDB Connectors - VMC (left) and Peripheral (right) 'VMC', is an MDB master interface suitable to **BE** a VMC and connect peripherals, and the right connector labelled 'Peripheral' is an MDB slave port which usually connects to a VMC or other MDB master

Figure 5. MDB-USB interface board layout [1]

7.4.4 Simulations

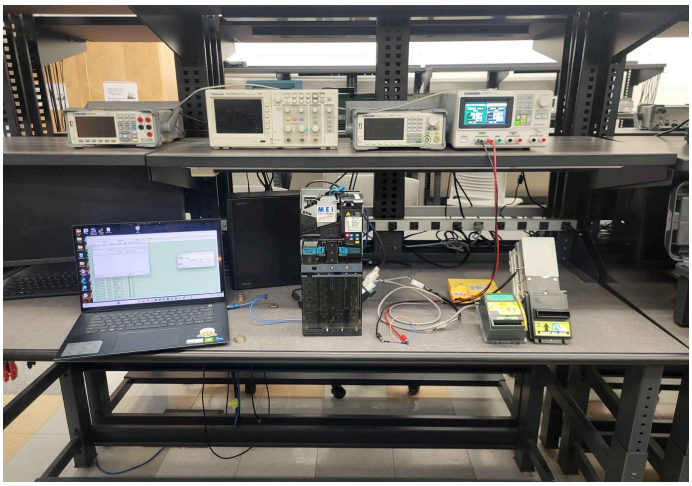


Figure 6. MDB Toolchest by Qiba was utilized to simulate a VMC allowing us to test and simulate the different forms of payment before applying them to the project.

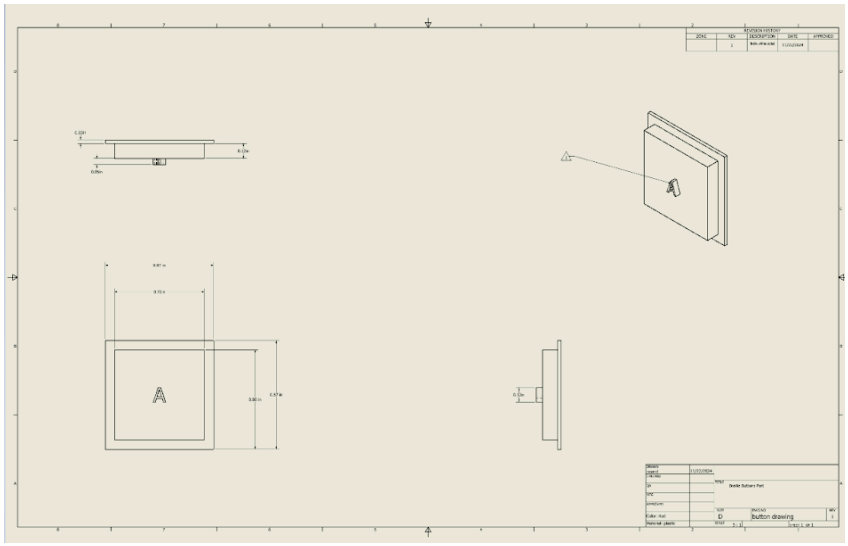


Figure 7. Part drawing of Button Design with Braille Representation
(This was done for all necessary buttons)

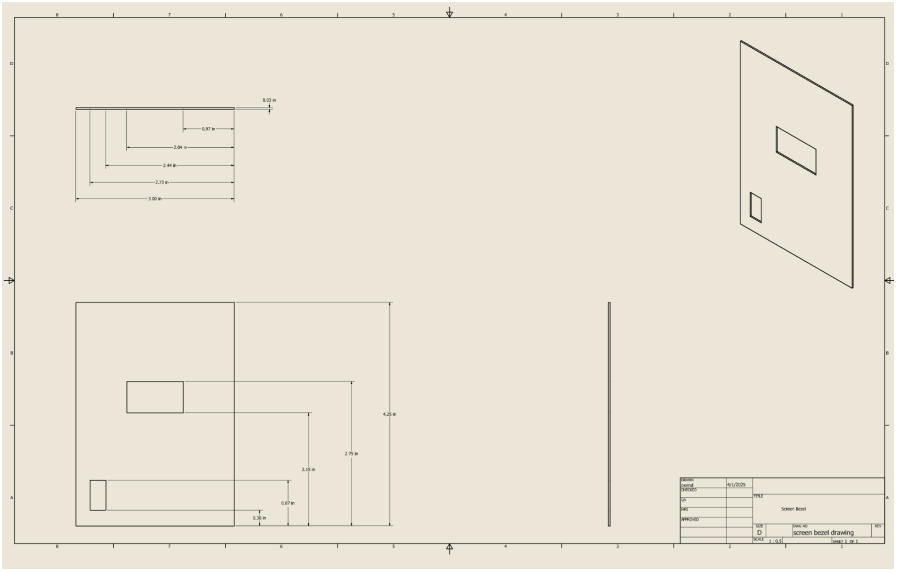


Figure 8. Part Drawing of OLED & Microphone screen

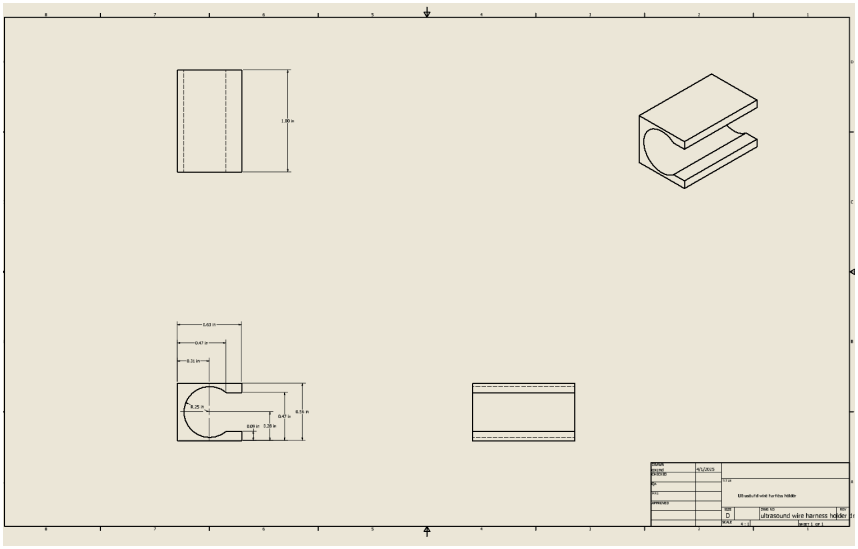


Figure 9. Part Drawing of Wire Harness Bracket

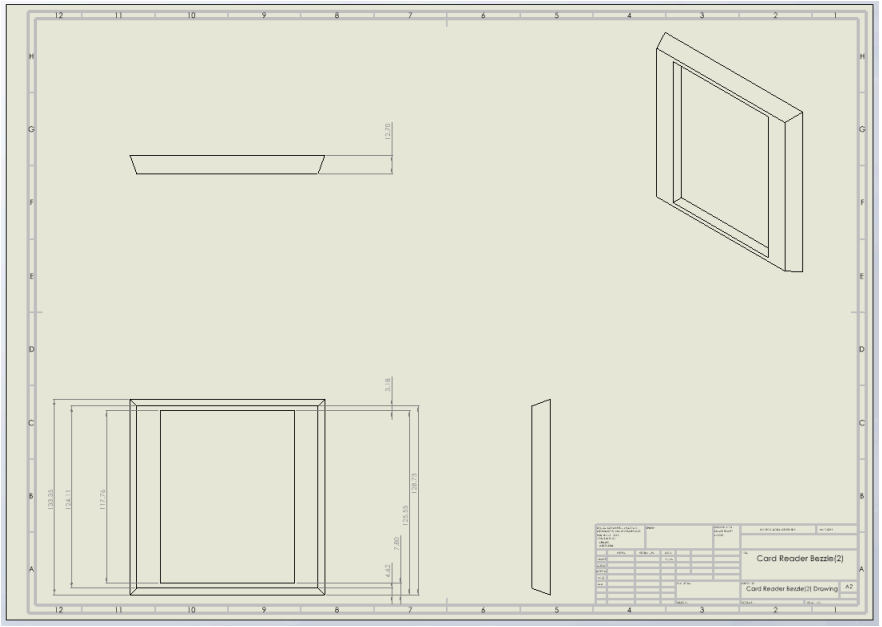


Figure 10. Part Drawing of Card Reader Bezel

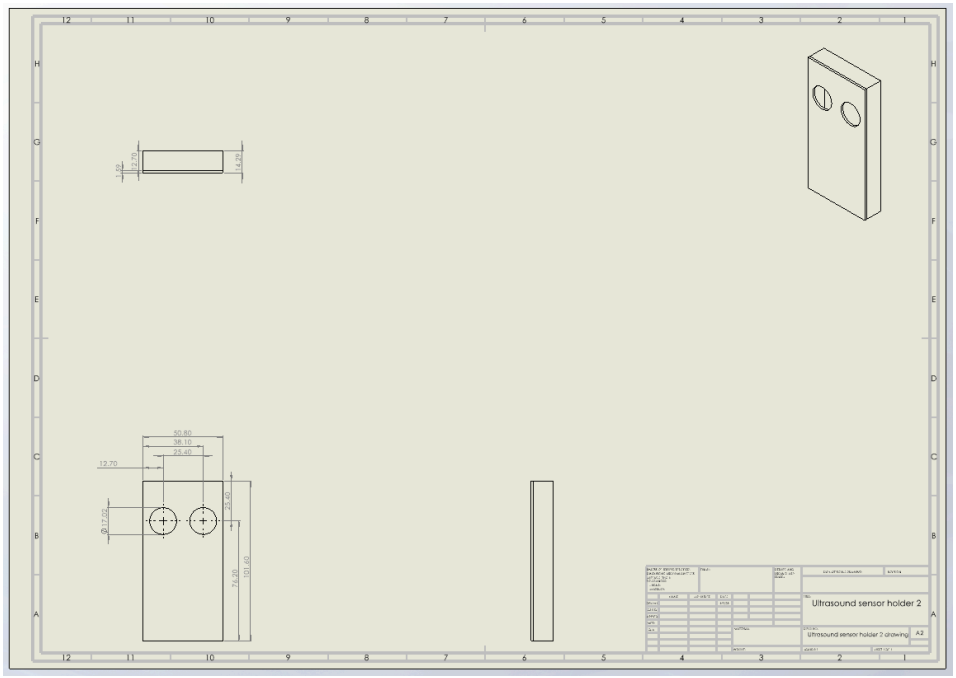


Figure 11. Part drawing of Ultrasound sensor holder

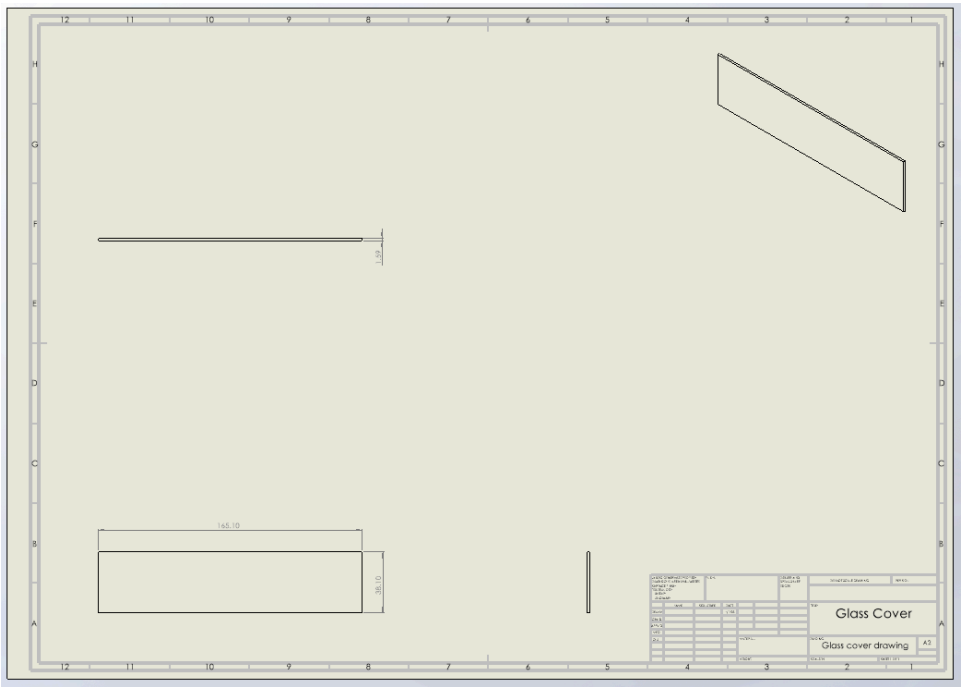


Figure 12. Part drawing of Glass Cover

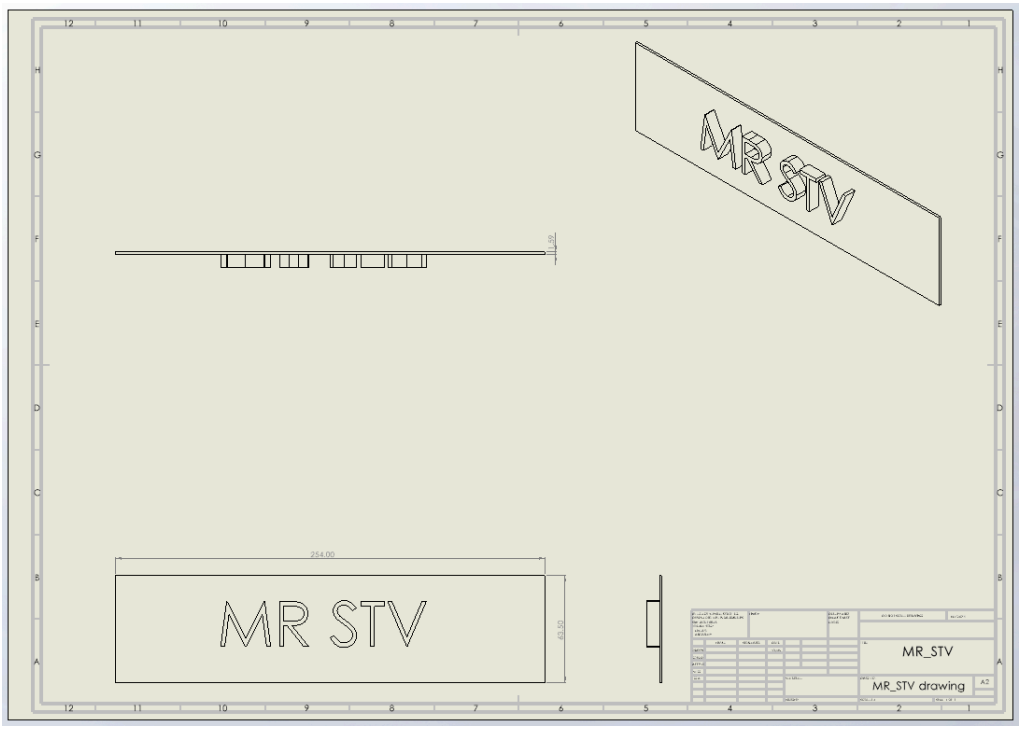


Figure 13. Part drawing of MR_STV

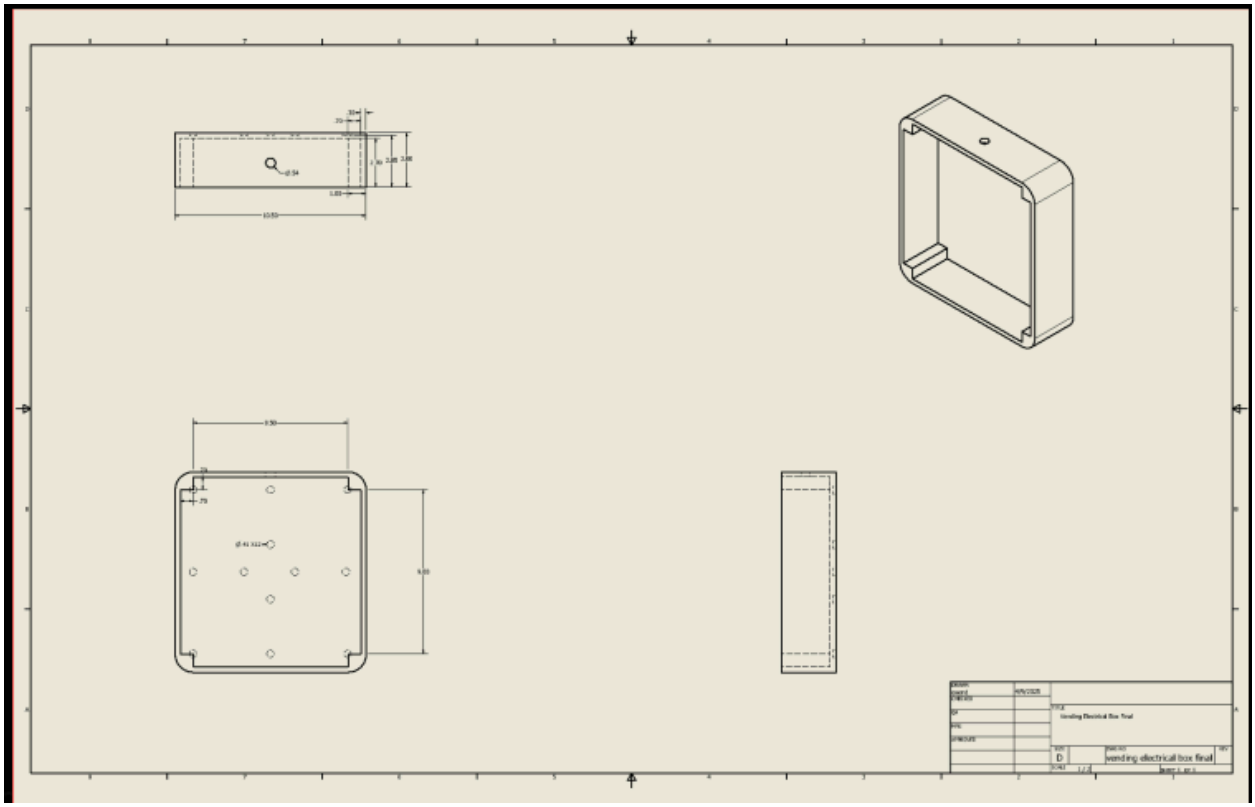


Figure 14. Part drawing of vending electrical box

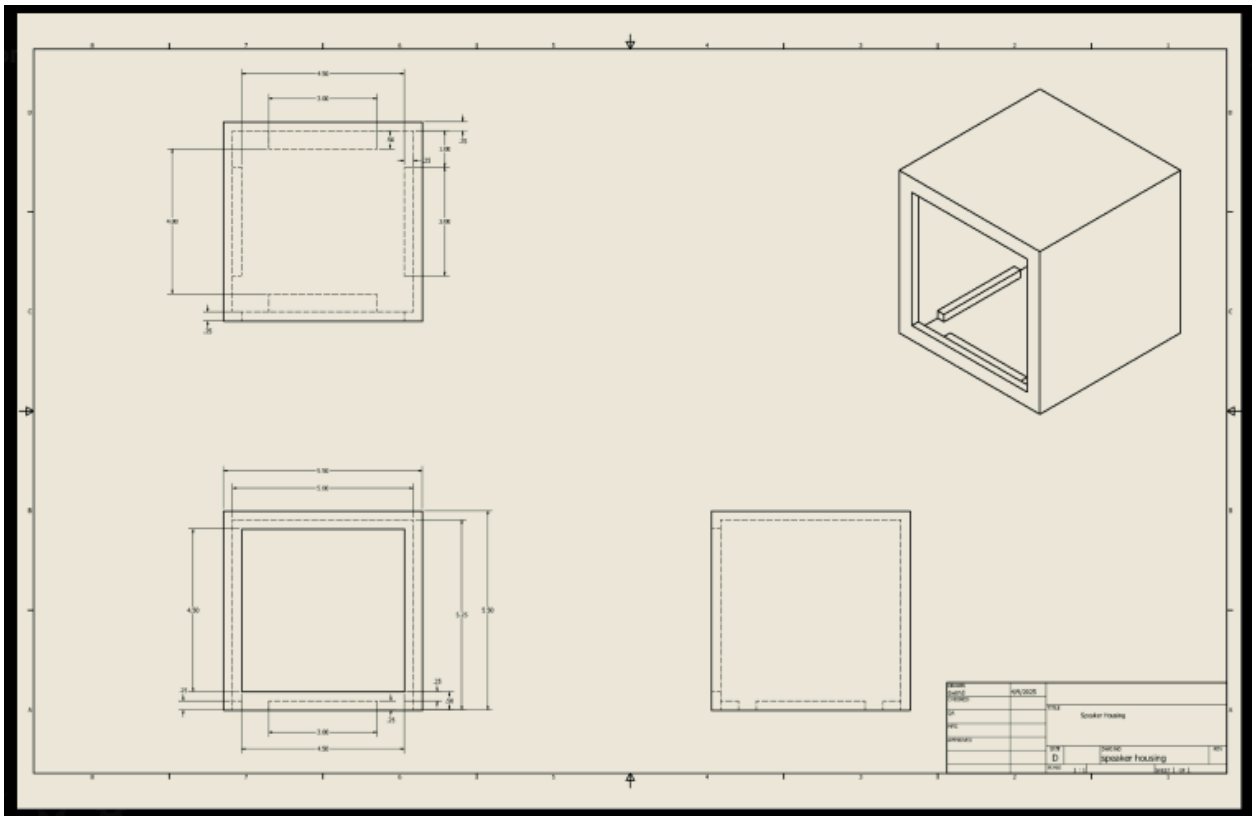


Figure 15. Part drawing of Speaker housing

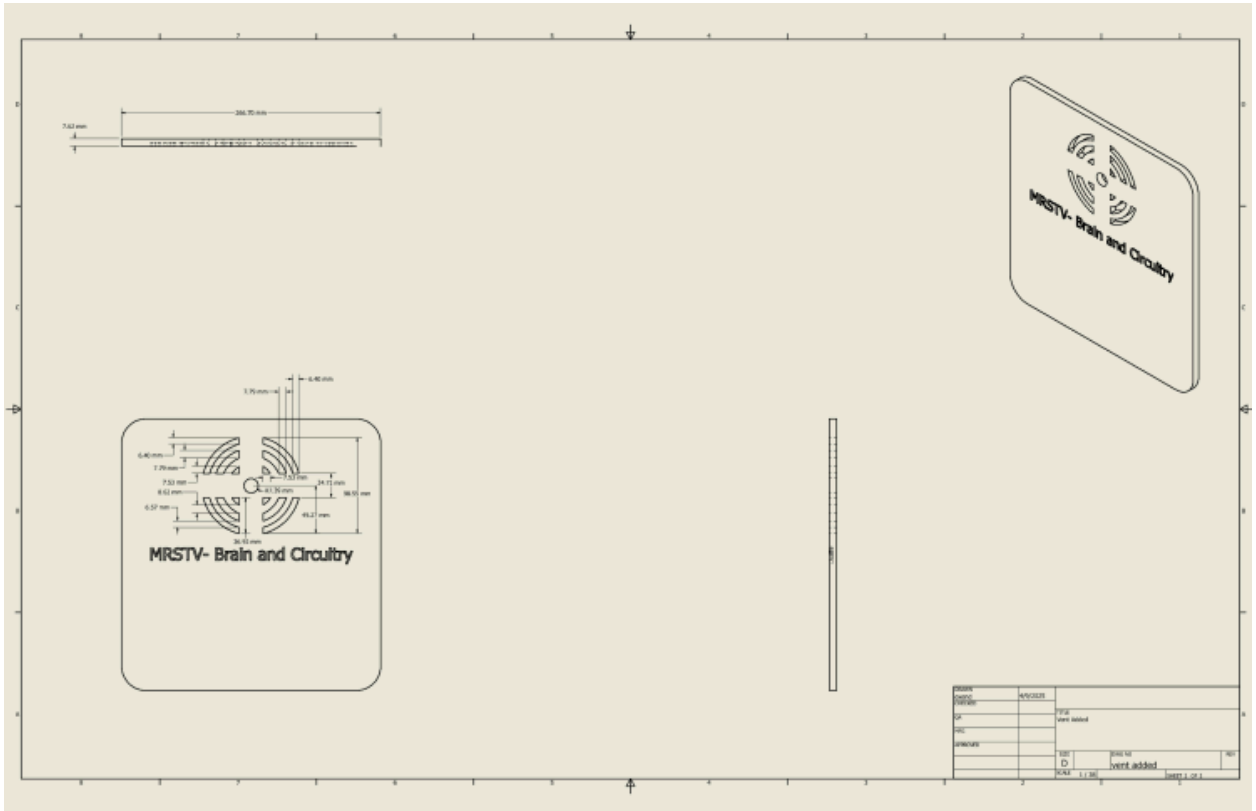


Figure 16. Part drawing of vent for electrical box

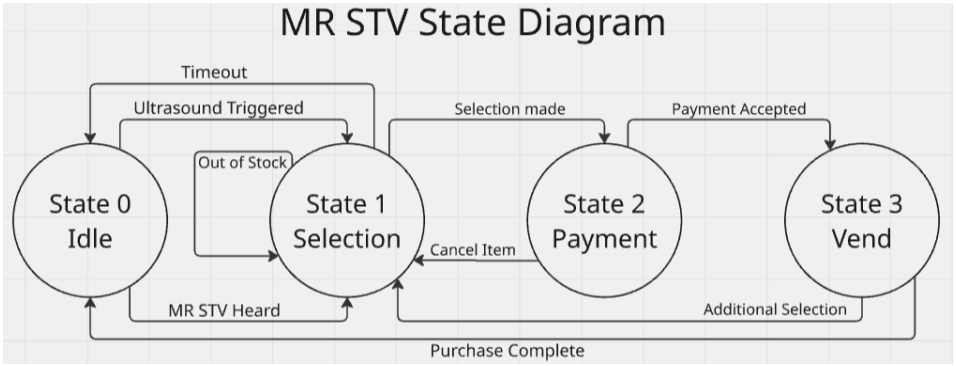


Figure 17. State Diagram for MR STV's program logic

7.5 Brief Discussion of Other Technical Approaches Considered

While our project for the most part has retained the same structure that was intended at the beginning we did consider using different methods of achieving the final product. Originally we planned to use the coin mech, and bill validator connectors that came with the machine. Due to complications with lack of documentation of the connectors on our machine we decided to use MDB. When we first started the audio programming we were using an API called portaudio. At this point in time we were having complications with WSL since the audio programming was linux based. We ended up going ahead with a different audio API miniaudio. Miniaudio was more straightforward and lower impact despite accomplishing the same result as portaudio, so we decided to use it going forward. Another area we differed from our original design was instead of utilizing a P-channel mosfet for controlling ground collection for the columns. We took another approach when we ran into complications. This is due to the P-Channel mosfet requiring some sort of voltage to operate making this approach not a feasible solution. As another approach we used relays to either open or close the connection to ground depending on which column the selection was in.

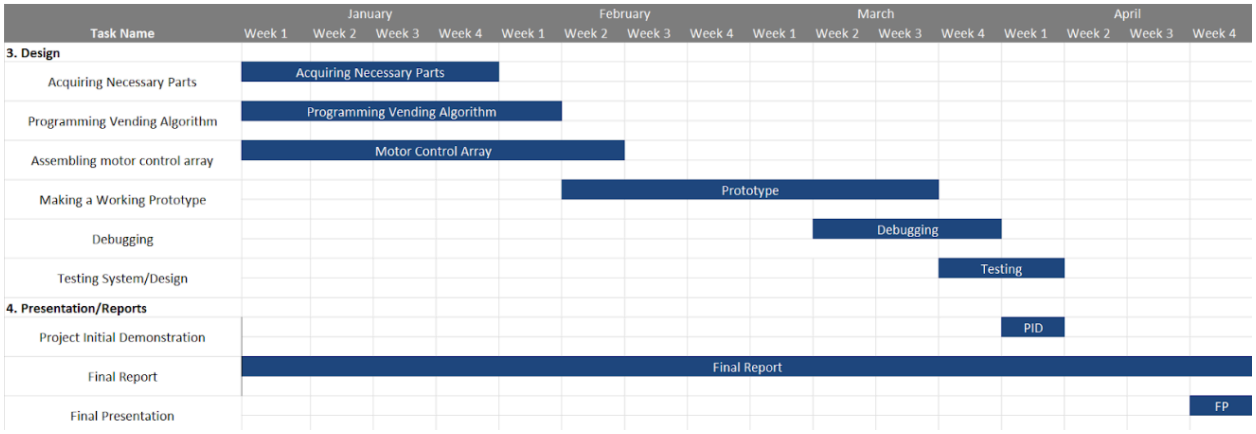
8. Part List utilized in build phase

Parts	Manufacturers	Quantity	Price
MEI CPI VN25P2	MEI/CPI	1	$254.72
Engage Cantaloupe card reader +telemetry	Cantaloupe	1	$375.15
Coin Changer Acceptor Mars VN4510	Mars	1	$183.38
Cashless service	Cantaloupe	3	$9.99
Buck Converters	Seloky	1 (5-pack)	$7.99
Anti-Fatigue Floor Mat	Envelor	1	$39.99
JOUNIVO USB Microphone, 360 Degree Adjustable Gooseneck Design	Jounivo	1	$16.99
USB Microphone Lavalier Lapel Clip on Mic with 6.56ft Cable for Laptop, Computer	NowTH	1	$11.99
5V 5A USB Type C AC Adapter	Raspberry PI	1	$12.99
Qiba MDB USB Standard	Qiba	1	$231.54

Qiba MDB Toolchest License	Qiba	1	$425.71
AP 6000XL vending machine	Automatic Products	1	$0 (already in possession)
HC-SR04 Ultrasonic Sensor	OSEPP Electronics LTD	4	$0 (already in possession)
0.96 inch LCD OLED Display Board Module 12864 128X64 IIC I2C SSD1306	Teyleten Robot	1 (5-pack)	$13.85
MEGA R3 Board ATmega 2560	ELEGOO	2	$0 (already in possession)
Mini USB External Speaker	Adafruit	2	$12.50
Raspberry PI 5	Raspberry PI	1	$50
150µF capacitor	Nichicon	3	$2.60
1N4002 rectifier diodes	Comchip Technology	6	$0.78
25W Power Supply	MeanWell	1	$19.88
		Total	$1869.89

Table 1. Part and Price Lists

9. Gantt Chart



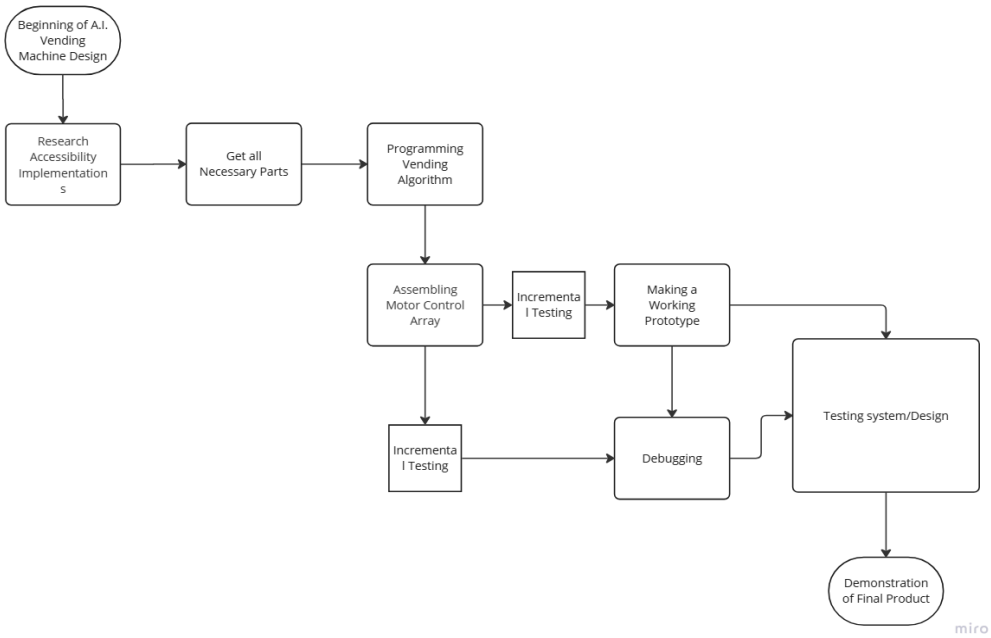
10. *Testing Approach:.*

For the first phase of testing, we have utilized student volunteers, friends, and family to test MRSTV's capabilities. The initial test run will include all volunteers, without visual impairment, to use a blindfold with no prior knowledge of how to use MRSTV. Once the first test run is finished, the participants will remove the blind fold and attempt to order a snack by whatever means they choose. Additionally, for participants with visual impairment they will perform two test runs using different payment methods of their choosing. While participants use the machine, a project member will be taking various forms of data: time to receive product (Tr), time to receive product before becoming familiar with commands (B_{Tr}), time to receive product after becoming familiar with commands (A_{Tr}), difficulties faced while using the machine, and suggestions from participants to improve functionality.

11. Final Product/Project Results:

The final design of the product is as follows: The vending machine is colored black and yellow like a bumble bee, and it has the words MRSTV printed on top of the machine. There are two small plastic boxes under the dispenser opening that each have an ultrasound sensor that is used to detect anyone approaching the vending apparatus. The machine is able to function as a standard vending machine or by audio interfacing in accessibility mode. MRSTV is able to interpret queries from the user with an accuracy of 85%, with a minimum time to receive a snack of 40 seconds. Our project supports both cash, and cashless payments.

12. *Flow Chart of Design Process*:



13. Conclusion:

Our team went through significant struggles at each stage of the project. However, through hard work, diligence, and self improvement we were able to produce a project that every member of the group is proud of. The efforts involved to create MRSTV have sharpened everyone's hard skills, and given us ample opportunity to work on our soft skills. This project will remain a strong representation of computer aided design, circuit design, C++ programming and embedded systems on our portfolios going forward. We hope that with this design we advance the movement for accessibility for all peoples in the vending machine industry. The work we did for this project has not been done in any instance as far as we are aware. So it is our belief that this project will contribute to the advancement of an accessible society.

14. Assessment of Math, Science and Engineering Topics:

Table 3: Assessment of Math, Science and Engineering Topics

Topics	Dante Gordon	Devan Rivera	Bryan Oxender	Darrell Wilson
CAD/modelling/simulations	**1**	**1**	**4**	**4**
Chemistry courses	**1**	**1**	**1**	**2**
Circuits	**4**	**4**	**4**	**2**
Communications	**1**	**2**	**1**	**1**
Computer Architecture	**2**	**3**	**3**	**1**
Control Systems	**1**	**1**	**1**	**1**
Digital Design	**4**	**4**	**4**	**1**
Electromagnetic	**1**	**3**	**2**	**1**
Electronics	**4**	**2**	**3**	**1**
Engineering Software tools	**4**	**3**	**3**	**1**
Fluid/Thermodynamic systems	**1**	**1**	**1**	**1**
Image Processing	**2**	**1**	**1**	**1**
Industrial/Manufacturing Engineering	**1**	**1**	**1**	**1**
Material Science	**1**	**1**	**1**	**3**
Math courses	**3**	**3**	**3**	**3**
Mechanical Engineering	**1**	**1**	**1**	**1**
Microprocessors/Interfacing/Embedded Systems	**4**	**3**	**4**	**1**
PC Board	**2**	**3**	**3**	**1**
Project Management	**4**	**4**	**4**	**1**
Physics courses	**2**	**3**	**2**	**2**
Power Engineering	**3**	**1**	**3**	**1**
Programming	**4**	**3**	**3**	**1**
Signal and Systems	**2**	**2**	**1**	**1**
Soldering/welding	**3**	**3**	**4**	**2**
Statics and Dynamics Course	**1**	**1**	**1**	**1**
Statistics	**2**	**2**	**2**	**1**
System integration	**3**	**2**	**3**	**1**
Very Large Scale Integration (VLSI)	**1**	**1**	**1**	**1**
Others: List	**N/A**	**N/A**	**N/A**	**N/A**

15. Team Activity Report.

Table 4: Team Activity Report – Summary of Contributions by Team Members

	Team Members			
Sections	Dante Gordon	Devan Rivera	Bryan Oxender	Darrell Wilson
Abstract		X		
1.0 Introduction	X	X		X

2.0 Problem Definition	X	X	X	
2.1 Problem/Need	X	X	X	
2.2 Intended user(s) and use(s)		X	X	
2.3 Assumptions and limitations	X		X	
3.0 Design Objectives	X			
4.0 End-Product Description	X	X	X	X
5.0 Design constraints	X	X		X
5.1 Economical	X	X		X
5.2 Environmental	X	X		X
5.3 Social and Political	X	X		X
5.4 Ethical	X	X		X
5.5 Health and Safety	X	X		X
5.6 Manufacturability and Sustainability	X	X		
6.0 Engineering Standards				
7.0 Technical Approach	X		X	
7.1 Functional Block diagrams	X	X		X
7.2 Functional Requirements for Blocks	X	X		
7.3 Technical Details	X	X		
7.3.1 Theory and Calculations				
7.3.2 Flow Charts	X	X		
7.3.3 Schematics			X	
7.3.4 Simulations	X			X
7.4 Other Approaches			X	
Change the list as appropriate for the project				
8 Part List and Budget			X	X
9 Gantt Chart	X	X		
10. Testing Approach		X		
11. Final Product/Project Results			X	X
12. Flow Chart of Design Process		X	X	
13. Conclusion				X

References	X	X	X	

16. References:

[1] “How many accents does the US have?”, NCESC, Jun. 23, 2024. (Accessed Nov. 22, 2024) ,https://www.ncesc.com/geographic-pedia/how-many-accents-does-the-us-have/

Appendix A

Devan M. Rivera

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850.902.6944
Devanm611@gmail.com
https://www.linkedin.com/in/devan-rivera-970668349/

Objective

An aspiring computer engineer eager to contribute to an innovative organization, leveraging strong academic background and skills acquired through education to drive impactful results.

Training and Skills

- Excellent work ethic with strong organizational and communication skills
- Microsoft Suite programs such as Internet Explorer, Edge, Word, Excel, PowerPoint, Outlook, Google Chrome
- Tech Savvy
- Outstanding customer service and interpersonal skills
- Quick learner and skillful multi-tasker
- Programming Languages: C, C++, C#, and Assembly

Education

Bachelor of Science, Computer Engineering Expected May 2025
Minor in Computer Science
University of West Florida, Pensacola, Florida
GPA: 3.11
Relevant Coursework: Software/Hardware Integration, Data Structures and Algorithms 1/2, System and Networks 1/2, and Capstone Design 1/2

Associate of Arts Degree May 2021
Northwest Florida State College Niceville, Florida
GPA: 3.75
Honors and Achievements: Cum Laude

Professional Experience

University of West Florida August 2024 – Present
Teacher's/Lab Assistant, Digital Logic, Electric Circuits 1, and Professional Ethics
- Supervises students during lab protocols to ensure necessary safety requirements are met
- Aids students in developing necessary techniques in a lab setting
- Reviews of ethical standards, grading ethical analyses and case studies
- Assists Teacher with preparation of lab work and sensitive equipment

Marquis Cinema 10, Crestview, Florida May 2023 – Present
Movie Usher and Box Office Cashier
- Maintains high standards of customer service during high-volume, fast-paced operations
- Receives and processes payments via cash or card and processed returns
- Cleans facility and ensures customer safety measures are met
- Communicates with customers and creates customer connections

Vans, Pensacola, Florida December 2023 – January 2024
Seasonal Sales Associate

- Provides customer service and communicated with customers to meets needs
- Receives and processes payments via cash or card and processed returns
- Ensures store is recovered and consumer ready by meeting brand standards
- Adheres to policies, procedures, and procedures that align with company directives

Panera Bread, Crestview, Florida February 2023 – May 2023
Opening Cashier and Bakery Advisor

- Received and processed payments via cash or card and processed returns
- Provided customer service and handled customer requests
- Prepped food for daily service and upheld food safety standards
- Communicated with customers and created customer connections

Rollerworld of Crestview, Crestview, Florida June 2022 – December 2022
Skate Guard

- Maintained a safe environment for children
- Identified problematic situations and resolved conflicts
- Maintained roller skate stock and cleanliness of rink
- Communicated with customers and provided customer service

DAESA Team at University of West Florida, Pensacola, Florida August 2021 – May 2022
Technology Repair Assistant

- Identified staff computer problems and assisted with software-based program issues
- Repaired faulty technology in a timely manner
- Overviewed over 3,000 computers for maintenance
- Prepared computers with necessary software for use
- Maintained stock of extra computers and other forms of technology

Wendelta Incorporated, Crestview, Florida July 2019 – May 2021
Cashier

- Provided excellent customer service in high volume situations.
- Stocked and replenished merchandise according to store merchandising layouts
- Operated a cash register for cash, check and credit card transactions
- Maintained high standards of customer service during high-volume, fast-paced operations
- Maintained customer satisfaction and quality product

*Professional references available upon request.

Darrell Wilson II

darrellwilsonii@yahoo.com • 850-516-4436

EDUCATION

University of West Florida, Pensacola, FL **May 2025**

Bachelor of Science, Engineering Technology, GPA: 2.16
Relevant course work: Programming for Engineers, Mechatronics and Lab, Computer Aided Design, Supply Chain Logistics Management, Engineering Economy

PROFESSIONAL EXPERIENCE

UWF Facilities Maintenance, Pensacola, FL **May 2018 – Dec 2021**

OPS Laborer

- When I worked as an OPS laborer (which was a part time job) I worked with the electricians, painter, plumber, locksmith, roofer and carpenters. Though I mainly worked with the locksmiths and electricians. The main thing that the job taught me was independence, that is it taught me how to work on my own at times and not to depend on a coworker to help at all times. In those days I was also a licensed forklift driver.

Battery Source (store #19), Pensacola, FL **Dec 2021 – May 2024**

Sales Associate, Storage Manager

- As a Sales Associate I was tasked with fixing and selling golf carts, selling batteries and providing assistance to customers. A large part of the job was interacting with customers which gave me much experience with talking and understanding people. Teamwork was also an essential part of the job. There was 4 of us there who would have to stay at the store 10 hours a day, so getting along with my fellow worker and working with them was an important skill for me to learn.
- As Storage Manager I was tasked with taking care of and renting out storage units. This gave me experience in being responsible for a part of the property.

PROJECTS & EXTRACURRICULAR

Capstone 1 **Aug 2024 – Dec 2024**

- Capstone 1 and later 2 is a class where you must work with a team of 3 to 6 people to build an engineering project. The project in question is called: A.I. Vending Machine which is a vending machine made specially for those who are visually disabled.

Activity **Aug 2024 – May 2024**

- Each of us is tasked with a different part of the project to work on. A lot of the task are worked on by multiple people. I'm working on Accessibility, CAD, and Programming. Speaking of CAD, I have been trying to 3D print a part for the A.I. Vending Machine.

SKILLS

Programming languages: C Programming

Computer software/ frameworks: SolidWorks, CodeBlocks

Bryan Oxender

Pensacola, FL, 32534.
(765)838-9547 | beo3@students.uwf.edu | linkedin.com/in/Bryan-Oxender1 | portfolium.com/beo3

Education

Bachelor of Science in Electrical Engineering — Pensacola, FL
The University of West Florida, GPA 3.39 — *May 2025*

Dean's List — Pensacola, FL
The University of West Florida — *Fall 2020, Fall 2022, Fall 2023, Summer 2024*

Work Experience

Advanced Vending machine LLC Owner — July 2024 - Present
Pensacola, FL

- Restored three broken vending machines back to working condition
- Introduced the idea of adding accessibility to modern vending machines to help those who are visually impaired

PeterBrooke — Dec 2022 - 2024
PeterBrooke Chocolatier INC — *Pensacola, FL*

- Skills utilized: Good customer service, determination, always putting forward best effort, time management

Alvin's Island — Jun 2022 - August 2022
Marco Destin INC — *Pensacola, FL*

Publix May 2021-September 2021 — May 2021 – September 2021
Publix Super Markets INC — *Pensacola, FL*

Projects

Miniature Elevator – Aug 2024 — Aug 2024

- Built an elevator prototype capable of lifting 3 lbs with regenerative braking."
- Gained CAD and C# Arduino programming skills despite project challenges.

AI Vending Machine for Accessibility) — Aug 2024 - Present

- Designing an accessible vending machine for visually impaired users
- Enhancing team management and problem-solving skills.
- In the end I hope this will help solve the accessibility issue visually impaired people may run into when using a vending machine

Community Service

Park Cleanup - Martin Luther King Day — Jan 2023

Baptist Christian Ministry Work Day — March 2022

KA Fraternity Shoe Drive — September 2022

Church Mission Trip - Myrtle Beach, SC (One Week) — August 2017

Technical Skills and Training

- **Video Editing:** Final Cut Pro and Logic Pro (audio), Photoshop editing
- **Electrical Wiring and Soldering**
- **Computer Aided Design (CAD):** Inventor and 3D printing
- **Certification:** SolidWorks Associate certificate – Summer 2023
- **Apple Devices:** Proficient user
- **Purdue University Computer Science Camp:** June 2017

Dante Gordon

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linkedin.com/in/dante-gordon-7b2079192
github.com/dxg76

Summary

Undergraduate Engineering Student at University of West Florida with 3 years of OOP experience. Pursuing a career in Embedded software engineering.

Skills

- Computer Aided design with Solidworks
- Software experience
    1. Matlab
    2. Multisim
    3. Microsoft office
    4. Visual studio
    5. Linux OS
- Programming Languages
    1. C++
    2. AVR assembly
    3. VHDL
- Electronic Configuration
    1. Solderless Connections
    2. PCBs
    3. Arduino
    4. AVR architecture
- Electronic Instrumentation
    1. multimeters
    2. oscilloscopes
    3. function generators

Education

May 2025

University of West Florida, Pensacola FL

Bachelor of Science in Computer Engineering

Bachelor of Science in Electrical Engineering

GPA: 3.68

Student of the year Computer Engineering 2025

Certifications

Certified SolidWorks Associate
ServSafe Food Safety Certificate

Experience

October 2021 - Present

Crumbl, Pensacola FL - *Baker*

- Managing time and resources such as dough, and glaze maintaining a balance of availability and freshness for the prepared cookies
- Communicating with management and employees to adapt to the changing work environment
- Instructing and guide new employees
- Employing friendly, clean and responsive customer service
- Operating Industrial Mixers and convection ovens safely

August 2022 - November 2023

Smoothie King, Pensacola FL - *Team Member*

- Recommending products dependent on customers needs, and preferences
- Upselling smoothie enhancements where appropriate
- Balancing greetings, taking intercom orders and smoothie creation
- Cleaning all smoothie instruments including bins, pumps and scoops

December 2018- July 2021

Walmart, Panama City FL - *Front End Associate*

- Overseeing cash, card, and check transactions
- Assisting customers in locating products and services throughout the store
- Maintaining product placement and tidiness of work station