An-Najah National University

Faculty of Engineering & Information Technology

Presented in partial fulfillment of the requirements for

Bachelor degree in Computer Engineering

Hardware Graduation Project

Coffee Crush

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September 7, 2024

Acknowledgment

We would like to express our deep gratitude to our supervisor Dr. Ashraf Armoush for his unwavering support and insightful feedback that greatly contributed to the development of this project, it would not have been possible without his support.

Special thanks to Mr.Ala' Zorba for his great help in constructing the project.

Our gratitude goes to one another for the mutual support, cooperation, and joint commitment that resulted in the completion of this project.

Lastly, we would be remiss in not mentioning our families and friends, their belief in us has kept our spirits and motivation high during this process, and we would like to mention our colleagues who helped us when needed.

Disclaimer

This report was written by Ruba Qawareq and Marwa AbuSaa in fulfillment of the requirements for a Bachelor's degree in Computer Engineering. It has not been altered or corrected, other than editorial corrections, as a result of assessment and it may contain language as well as content errors. The views expressed in it together with any outcomes and recommendations are solely those of us. An-Najah National University accepts no responsibility or liability for the consequences of this report being used for a purpose other than the purpose for which it was commissioned.

Abstract

Most people need to drink coffee daily to start their activities energetically, so they buy a lot of ground coffee to boil it and drink it, so in our project we decided to design a machine to grind coffee and prepare it with the appropriate mixture and quantity based on the user's request in an effective and fast way.

The project objectives are to build the machine from scratch, starting from grinding the coffee beans to mixing them with other components specified by the user in the appropriate quantity to obtain the fresh mixture as desired by the user, then filling and sealing it quickly and effectively.

The machine is designed by using Arduino and connect it to a group of sensors that will manage the various operations of the machine, including the grinding method, and sensing the weight as an indicator that it is correct.

The machine will also carefully check all the steps. The quantity of coffee and other components must be checked if it is sufficient to prepare the user's order. If there is a shortage, the process will not be completed or done. The machine lowers the box automatically and constantly checks its appropriate position to avoid any mistake. The size of the box is one, it holds 50 grams or 100 grams. Finally, the machine provides the process of packaging the box well By lowering the box lid and pressing it.

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Chapter 1

Introduction

1.1 Statement of the problem

Due to the growing demand for fresh, customized coffee, customers want to control the quantities of coffee and cardamom based on their preferences. The problem is traditional coffee mills don't provide the customers with the ability to choose the quantities they prefer or order by mobile app and they don't provide real time feedback about what is inside and how much of a substance is remaining. This project, "Coffee Crush" aims to solve these issues by allowing customers to customize the coffee amounts and make orders through mobile application.

1.2 Objectives

Enabling customers to customize their coffee according to their preferences is the aim of the "Coffee Crush" project. The machine will allow customers to select their desired coffee weight they want at first, then choose their proffered coffee blend, and adjust the amount of cardamom. customers can do that through a keypad or a mobile application. also, it has an LCD screen to guide customers through the process, to ensure ease of use and keep user up to date. Furthermore, the machine will track the inventory levels of coffee and cardamom, when the amounts not enough the admin will be notified.

1.3 Significance

The "Coffee Crush" provides an automated production line for coffee, and it significant for several reasons:

- Improving customers experience by allowing customers to customize their coffee.
- The machine is integrated with a mobile app so it allows customers to place an order easily and track the process of production.

- The machine provides tracking for the levels of coffee and cardamom and it will notifies the admin when levels is low and not enough to ensure consistent service.

1.4 Organization of the report

This report is well structured to explain all the ideas of implementing the coffee grinding machine easily to the reader. It starts with highlight the problem that cause us to design this machine, then give a general background of the work, and the objectives of it.

Following this, the methodology section explains in detail the hardware components and software implementation. Then explain the results of testing the work and followed it with a discussion that analyzes these results in relation to the objectives of the project.

Finally, the conclusion section recap the main ideas and suggestions to the future work.

Chapter 2

Constraints and Earlier Coursework

2.1 Constraints and limitations

2.1.1 Insufficient Mechanical Knowledge

The main problem we had was the mechanical part, where we had several problems after the design of the project, the first was with the lifting of the mill to close it. The second problem was also the process of flipping the mill to empty it from the product. We have redesigned wood to be stronger and suitable for project.

2.1.2 Lack Of Time

As we know the organization of time is the key to a project's success. But because we're in a summer semester and the time is confined, it's been a challenge for us to look for the idea, identify the pieces, connect them and complete the project. Also, we have suffered from the roads and barriers leading to Nablus because we work at the university there. Additionally, the occupying army has been raiding our cities and obstructing us from reaching the university to continue building the project.

2.1.3 Unavailability of pieces

We had a problem with the unavailability of some of the electronic pieces we needed in the market, so we had to replace them with other pieces less efficiently, but they do the job.

2.1.4 Coast

The addition of other features of the project required a high cost as the project is designed for a small system.

2.2 Standards and Codes

- Our code is developed using the C++-written Arduino IDE, which support many libraries and functions which help us in writing code, which make it easy for us to control the hardware components via Arduino platform. The software system is written and designed to be in compliance with the standards and guidelines for the hardware components.
- We developed the mobile application using the React Native platform to enable users to control the machine and place orders remotely.

2.3 Earlier coursework

- The Microcontroller utilizing PIC controllers course which provide us good knowledge on how to program microcontroller and how to control all the components connected to microcontroller, and how to setup serial communication and how to use tools like I2C and PWM. all of these fundamental abilities enabled us to build our project.
- The Circuit and Electronics courses give us a good knowledge of basic circuits and electronic components. This was helpful for us when developing our project.
- Critical Thinking and Research Skills, in this course we learn how to write a scientific research and a good report. This course helped us to improve our critical thinking skills and how to search from reliable research.
- Networks course help us to understand the basics of networks and communication, so we are able to build network to enable user to control the system remotely via an app.

Chapter 3

Literature Review

Coffee is the leading global beverage after water and its trade exceeds US‘$‘ 10 billion worldwide [1]. Over 60 tropical and subtropical countries produce and export coffee, being for some of them the main agricultural export commodity [2]. Coffee is not only a drink but a part of history and global culture. Coffee is an indivisible part of the daily lives of millions of people around the world. The origin of coffee is Ethiopia, where the sponsor observed the impact of activated coffee beans on his livestock. Then coffee moved from there to Yemen, where it became a center for growing and trading coffee, and over time coffee spread across the Arab world, becoming part of social customs.

The coffee grinding stage is an important step during the production process that affects the quality of the final brewed beverage.

Coffee producers and consumers confirm the importance of optimizing the grinding process to achieve consistent and high-quality coffee. Given the growing demand for coffee around the world, improvements in grinding technology have played an important role in improving production efficiency and maintaining flavor integrity [2].

Coffee has transformed from a local drink into a global drink and an essential element of global culture. Today coffee is one of the most traded commodities around the world as it has become linked to the economy of many countries. The process of making coffee goes through several stages, starting from growing coffee beans in tropical areas, where climate conditions and altitude are key factors affecting cereal quality. Coffee is harvested in manual or mechanical ways, where mature grains are carefully selected. After the process of harvesting coffee beans begins, the process of processing coffee from roasting and grinding. Where coffee is roasted to different degrees as each degree of roasting affects the ultimate flavor of coffee. And finally, the grinding process comes to these grains. Due to the popularity of coffee and the spread of

traditional coffee mills in the market, we have built an automatic system where the user can determine the weight and mix the coffee he wants. The system grinds the grain, packaging it, and presents it to the user.

Chapter 4

Methodology

The system structure, hardware components, the overall system design, and mobile app will shown in detail in this chapter.

4.1 Choosing the idea

The most important step in the project was to identify the idea of the project, we searched for several ideas but they were not appropriate, but from our frequent visits to coffee shops we found a high turnout of people the idea came from building an automated system to prepare coffee easily and quickly.

4.2 System Structure

The outer design of the project is shown in the figure 4.1.
It is constructed with three stages, we will discuss them separately in detail.

Figure 4.1: Outer design of the Coffee Grinding Machine

4.2.1 Choosing ingredients

It's the first stage in the coffee machine, it consists of three "Cereal Dispenser" containers for the first type of coffee, the other type of coffee, and cardamom pills. This container dropped the cereal by turning a knob which is connected to a motor that we set it up with determined steps to drop the ingredients in appropriate quantities based on the user's request. This stage is shown in figure 4.2.

Figure 4.2: Choosing ingredients.

4.2.2 Grinding ingredients

This is the second stage, which consists of an ingredients grinding mill which is connected to two motors, the first one is to turn the grinding mill to the right so that the ingredients can be placed inside. And turns it to the left as well to let the ground mixture fall into the box that will be packaged. The second motor is to lift the grinding mill up so that it can be securely closed with its cover, and then turn it on to start grinding. Upon finishing the grinding, the motor lowers it back to its original position. See figure 4.3.

Figure 4.3: Grinding Mill.

4.2.3 Packaging box

This is the final stage which consists of many processes.

4.2.3.1 Lowering the box

As shown in the figure 4.4, this is a 3D printing design, it holds the coffee boxes and connected to a motor that turns to let the box lower in the product line.

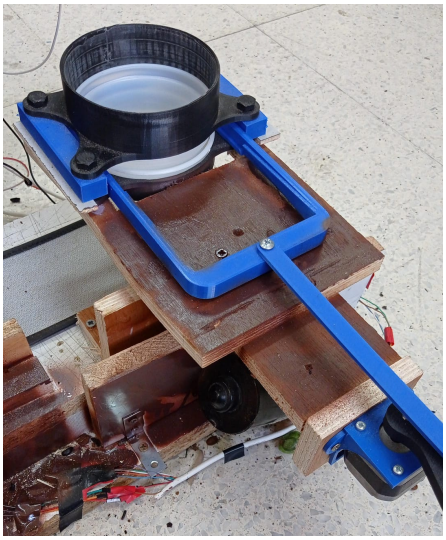


Figure 4.4: Lowering Box.

4.2.3.2 Product line

We created it as in the figure 4.5, its basic function is to allow the box to move on it with high precision and without defects, due to the presence of an object sensor connected to a motor that continues to move until the box reaches the first station, which is the dropping of the ground mixture into it. As for the second station, where the box stops, it is the process of tightly pressing it with its lid.

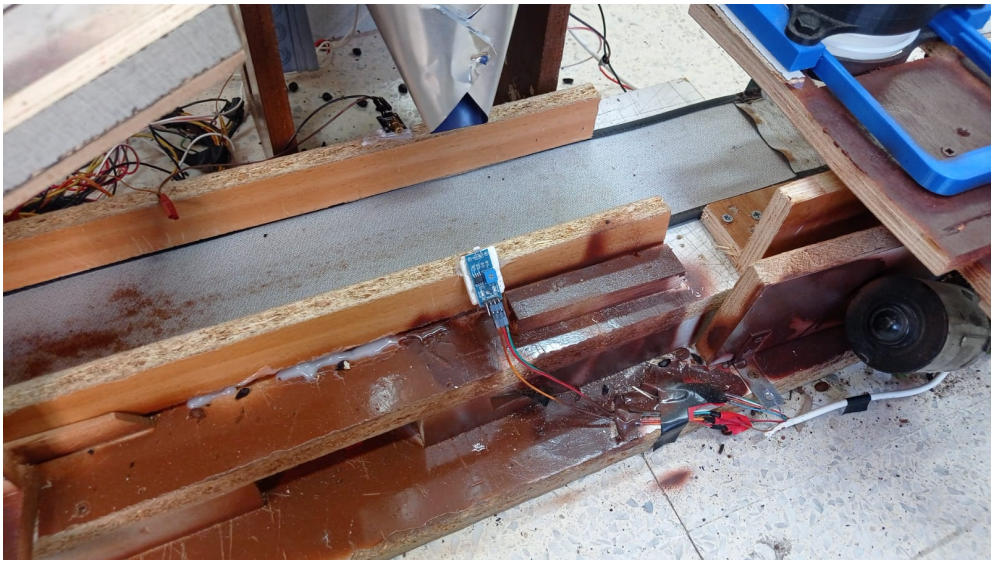


Figure 4.5: Product Line.

4.2.3.3 Lids line

We created it with a slight tilt as a lid warehouse, allowing the lid to fall precisely and easily onto the box when it reaches under it on the production line. 4.6

Figure 4.6: Lids Line.

4.2.3.4 Closing box

We created it as shown here 4.7, it is connected to a motor. When the box reaches with its lid placed on top of it, the motor starts to rotate, causing the circular piece of wood fixed at the bottom to press down on the lid, sealing the box tightly.

Figure 4.7: closing Box.

A complete picture of the third stage. 4.8

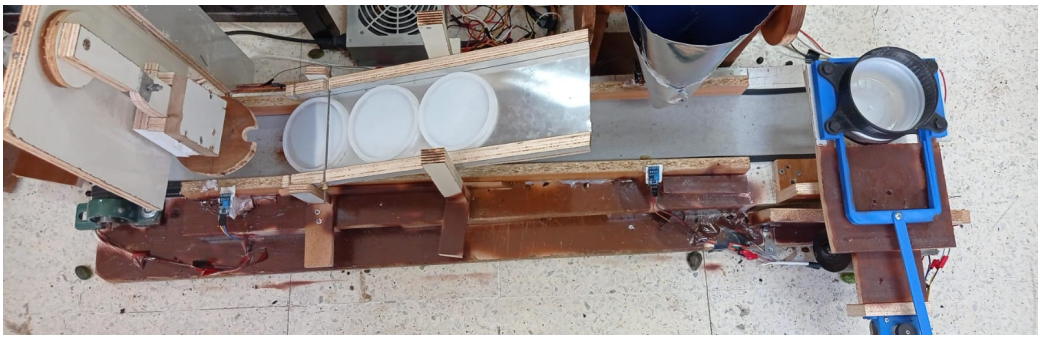


Figure 4.8: Packaging can.

4.3 Hardware components

4.3.1 Microcontrollers

Arduino Mega 2560

The Arduino Mega 2560 is a microcontroller board based on the ATmega2560 [3]. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.

Primary processor of Arduino Mega 2560 board is ATmega2560 chip which operates at a frequency of 16 MHz. It accommodates a large number of input and output lines which gives the provision of interfacing many external devices such as motors, sensors, drivers and relays, and all hardware components that are needed to accomplish our project. The board also features a USB serial processor ATmega16U2 which acts an interface between the USB input signals and the main processor. 4.9

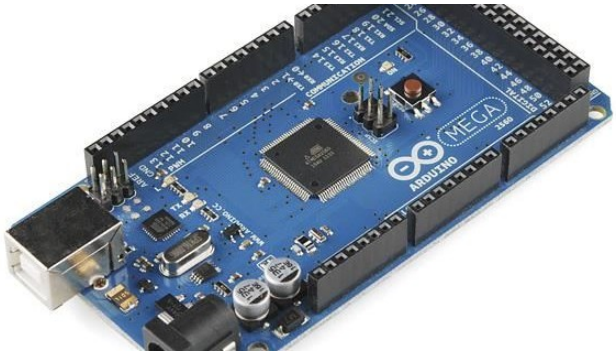


Figure 4.9: Arduino Mega2560

Esp32-WROOM-32

Based on the ESP8266 Wi-Fi transceiver module and the CH340 USB converter chip, this compact (Open Source) development and prototyping board is ideal for IoT applications.
The Wi-Fi module is compatible with the 802.11 b/g/n standard at 2.4 GHz, has an integrated TCP/IP stack, 19.5 dBm output power, data interface (UART / HSPI / I2C / I2S / PWM) and PCB antenna.
It also has a micro USB connector and reset button. Programmable with Arduino IDE, it includes interpreters for processing commands for languages such as LUA [4]. We used it in our project to connect it with the mobile application that we have created. 4.10

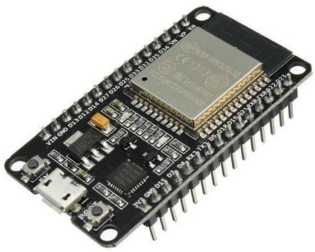


Figure 4.10: Esp32-WROOM-32

4.3.2 Input/Output Devices

LCD and I2C

This LCD screen 4.11 is a 16x2 character LCD display with an I2C interface 4.12. It has two rows for text display, with each row able to show up to 16 characters. The white characters will be displayed on a blue background, providing a clear and visually appealing display.

In our project, there are many components are connected to Arduino pins, therefore, we were careful to use fewer pins for each component so that we wouldn't have to use another Arduino. Additionally, wiring and connections can become quite complex. To address these issues, we introduce this I2C 16x2 Arduino LCD display, which utilizes the I2C communication interface. This means that it only requires 4 pins to connect the LCD display, including VCC, GND, SDA, and SCL instead of using a minimum 6-pins. Using the I2C interface allows us to save at least 4 digital/analog pins on the Arduino, this makes the project's connections easier and more convenient.[5].

We used them in our project to display the instructions that help the user use our machine such as choosing the type of coffee and amount of coffee, and display their choices from the keypad.

Figure 4.11: 16x2 LCD Screen

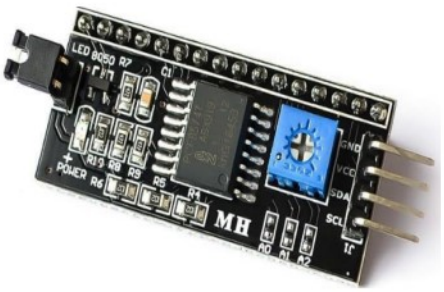


Figure 4.12: I2C LCD Driver

Keypad

A matrix keypad consists of switches arranged in a row-column matrix configuration. When a button is pressed, it connects a specific row to a column, allowing us to scan the array and identify the pressed button. The pinout for an Arduino 4×4 keypad typically consists of 8 pins, 4 for the rows and 4 for the columns. These pins can go to any digital Arduino pin. 4.13

Figure 4.13: 4x4 Keypad

We used it in our project to help user select the choices to make the order he want, by pressing on the determined button.

After LCD displays a "Welcome" message, it displayed these messages:

- Choose type of coffee: 1. Brown 2. Black 3. Mixture

  - If choice was 1 or 2 the second message is displayed, if choice was 3 the third message is displayed.
- Choose amount: 1. 100gm 2. 50gm
- Choose Brown-Black: 1. 80-20gm 2. 50-50gm
- Choose Hel amount: 1. Little 2. More
- Press * to start

  - If the user presses * this message is displayed: "DONE! Start processing..."

  - If the user presses #, the previous list is displayed, so there is flexibility in the process to help the user re-select if he selects a wrong choice or changes his mind.

  - If the user presses any wrong number: "Please, choose the correct number!" is displayed.

  - If amount of coffee or Hal isn't enough in the containers according to the Ultrasonic sensor: "Amount of coffee/Hal isn't enough, Add more coffee/Hal" is displayed for 10 seconds until we refill containers.

4.3.3 Power Devices

Power Supply

ISO-450 ATX Computer Power Supply 350W, 5V 32A, 12V 16A, we used it to supply some of our components that needed a voltage, it provided us with 12v, 5v, 3.3v, and Ground, we used 12v for motors and 3.3v,5v for lasers.

Figure 4.14: Power Supply

4.3.4 Sensors

Ultrasonic Sensor

The HC-SR04 is a cost-effective and easy-to-use distance sensor with a measurement range from 2 cm to 400 cm. It measures the distance to an object by using sound waves. We used three of them to measure the amount of coffee and Hal in the containers, if the container is empty, if the amount of coffee is less than 100gm or 80gm or 50gm or 20gm -because these quantities that our project is provided- and if the amount of Hal isn't enough also. If this happens, there is a notification message is displayed to the user in the LCD as we mentioned above in the Input/Output Devices section.

Figure 4.15: Ultrasonic Sensor

LDR Sensor and Laser

It is a type of resistor that operates based on the principle of photoconductivity, meaning its resistance varies with light intensity. Specifically, its resistance decreases as the light intensity increases.

We directed the laser light onto the LDR sensor, so its state was HIGH, means there is no object detected, but when an object is detected, it means that this object blocked the laser light from the LDR sensor, so its state changed to LOW.

We used 2 LDRs and a laser for each one, the first LDR was to detect if the moving coffee box on the product line reaches exact position where the grinding mill is dropped the coffee, the second LDR was to detect if the moving box reaches the position where the wood will pressed the lid on box to close it.

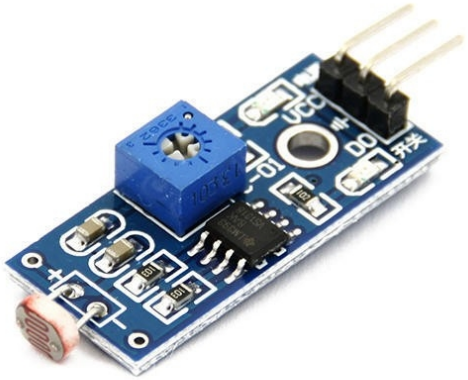


Figure 4.16: LDR Sensor

Figure 4.17: Laser

Weight Sensor and Amplifier

The Load cell sensor is an elector-mechanical sensor used to measure the weight of items. The load cell sensor has two ends one is connected to base or frame the other one is free to carry the item to be weighted. Load cell detect the changes in resistance when carry load, than produce a proportional voltage change. However, the produced voltage is too weak to be processed by the Arduino. So, we use HX711 amplifier, which is a high-precision 24-bit analog-to-digital converter (ADC). Its working principle based on amplifies the small signals coming from load cell and convert them into digital data that can be easily read by Arduino. So, we use the Load cell with Hx711 to measure the weight of box to ensure that the amount produced is the same as the user order.

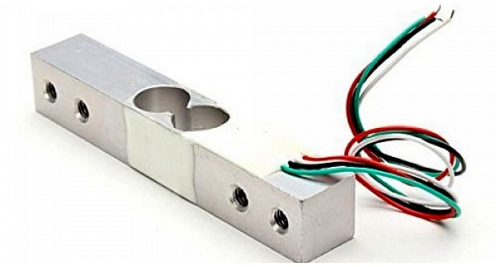


Figure 4.18: Load Cell Sensor

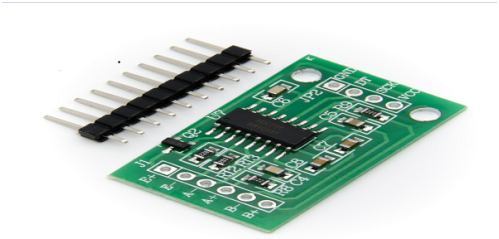


Figure 4.19: Load Cell Amplifier HX711

4.3.5 Motors and Drivers

4.3.5.1 Stepper Motors

NEMA17 Stepper Motor

The National Electrical Manufacturers Association (NEMA) defines a set of standards used to dictate tolerances for many products, including step motors. Step motors are categorized by NEMA frame size, such as "size 11" or "size 23" or "size 34". NEMA 17 stepper motors are those that have a 1.8 degree step angle (200 steps/revolution). [6]
It's a bipolar four-wire stepper motor, its coils can take a maximum current rating of 3.5 A each and one can also apply voltage inputs that range from 3 to 12 volts. It can rotate in two directions: clockwise and Counterclockwise.

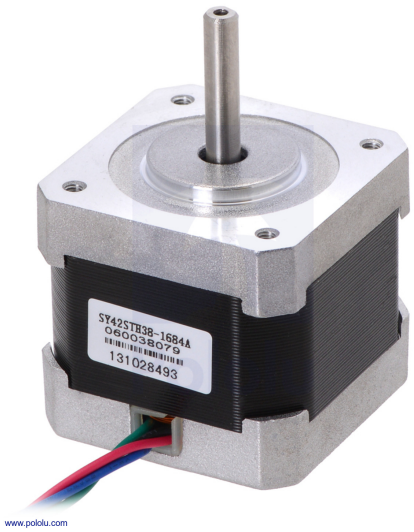


Figure 4.20: NEMA17 Stepper Motor

We used three of them for the containers in stage one which is Choosing Components, one motor for each container. By trial and error, we set it with a number of steps and the number of times to rotate to drop the required quantity, which means if the user wants 80gm of coffee, after we tried, we set it with 100 steps and rotate 2 times in the 2 directions.

To drive the motors, we used the H-Bridge Driver 4.21 with a 12v power supply for one motor. For the other two motors, we used the A4982 driver, because of the lack of H-Bridge pieces and its price which is higher than the A4982 price.

We also used one of this type of motor in the packaging box stage, especially in lowering the box into the product line. The motor rotates 200 steps making the box fall into the product line. And we connected it to the H-Bridge Driver.

L298N Motor Drive Controller Board Module Dual H-Bridge

It is typically used to control motor speed and rotation direction. It's a powerful little motor driver with a heavy duty heat sink. We used it to drive the stepper motor and control its direction to rotate it in two directions and control its speed to suit our process.

Figure 4.21: H-bridge

A4982 Driver

The A4982 is a complete micro-stepping motor driver with a built-in translator for easy operation. It is designed to operate bipolar stepper motors in full-, half-, quarter-, and sixteenth-step modes, with an output drive capacity of up to 35 V and ±2 A. We used it to drive stepper motors and control their speed and direction.

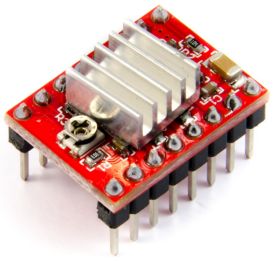


Figure 4.22: A4982 Driver

We connected it with a 100µF capacitor on a board shown in figure 4.23. the whole connection is shown in figure 4.24, we connected the 4-wire of stepper motor with it and supplied it with 12v from the power supply, and 5v from Arduino.

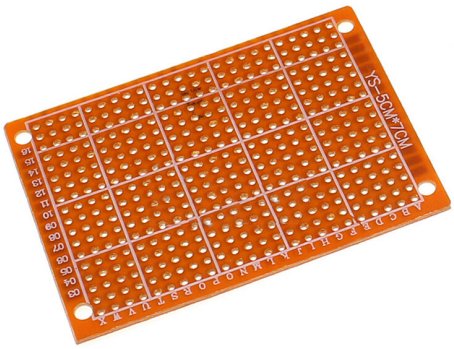


Figure 4.23: PCB Board

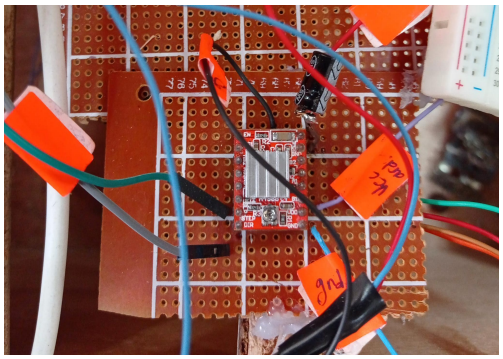


Figure 4.24: A4982 Driver Connections

J-5718HB2401 Stepper Motor and YS-DIV268N Driver

We chose this motor, which is a four-wire bipolar stepper motor that delivers high accuracy and efficiency. It was selected not only because of the precise motion control but also because of the motor's power, which is imperative to the movement of the grinding mill. The snap from this stepper motor helps to steady the dynamics of the working mill which means that it can be able to perform with a lot of force, this is required when turning the grinding mill.

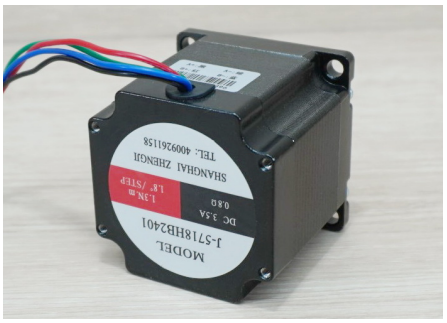


Figure 4.25: J-5718HB2401 Stepper Motor

We set the motor first to rotate 50 degrees to the right to receive the coffee and Hal beans from the containers, and then return to its original position. After grinding the coffee, the motor rotates 300 degrees to the left to drop the ground coffee into the box.

To drive the motor, we used YS-DIV268N driver 4.26. We connected it with a 12V power supply. The motor coils were connected to the A and B pins of the driver, while the control pins (direction, step, and enable) were connected to the corresponding Arduino pins, with the negative pins unified with the Arduino ground.

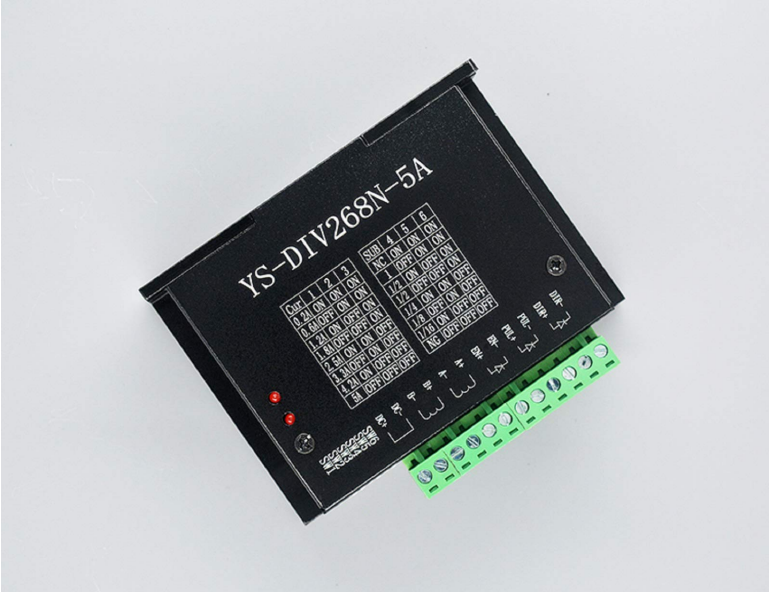


Figure 4.26: YS-DIV268N Driver

4.3.5.2 DC Motors

SG37BL-A DC Brushless Gear Motor

We used it in our project for the process of closing the box; it rotates in both directions, causing the wood attached to it to lower onto the box and press down on the lid, then it rises to complete the closed box's movement. We turned the DC motor using the relay which we will discuss later.

Figure 4.27: DC Motor

Other type of DC Motor

We used an existing motor in the car's wipers that operates as a DC motor. Look at the figure 4.28. We used 2 of them, one for raising and lowering the grinding mill to be closed with its cover, and the second for the production line to make it rotate continuously. These motors are

also operated using relays. We used it because of of its strength which is essential for carrying and lifting the mill.

Figure 4.28: Wipers Motor

Usually, this type of motor is driven by the BTS7960 Driver -An illustrative image of it can be found in Appendix A. We started with it, but it burned out. As we mentioned about the constraints we faced, this type of driver is out of stock in stores and will take time to arrive, so the solution was to use a relay.

4.3.6 Other Components

4.3.6.1 Relays

A relay is an electronic switch that can be used to control high voltage and current loads using a low voltage and current signal, it is used to activate and deactivate the operation of other appliances within the same or different electrical network.

In our project, we used 3 relays; the first one was one-channel, we connected it with the grinding mill to turn it on for some time then turn it off. The second relay was two-channel, it was connected to a DC motor that lifts the grinding mill. The third one was four-channel, we used each pair of them together for the DC motor on the production line and for the DC wipers motor.
Its operation is easy to use and program because it is just turned on/off for some time.

Figure 4.29: Relay one channel

Figure 4.30: Relay 2 channel

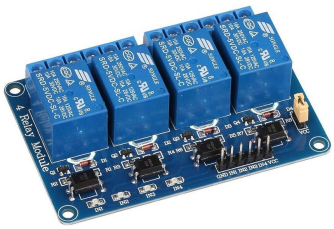


Figure 4.31: Relay 4 channel

4.3.7 Spice grinder

We use this machine for milling the coffee. It operates on 220v, and we connect it with one channel relay to control it.

Figure 4.32: Coffee Grinder

4.3.7.1 Wires

Intercom Wires

We used them for wiring and connecting different components. We benefited from its length.

Figure 4.33: Intercom Wire

Arduino Wires

We used them to connect the components to the Arduino.

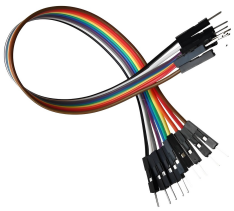


Figure 4.34: Male to Male Wires

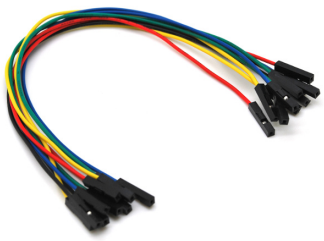


Figure 4.35: Female to Female Wires

Figure 4.36: Male to Female Wires

4.4 Mobile Application

A mobile application build to control the system, the user can make an order from the app as he does from the keypad. the figures below show the application interfaces.

4.4.1 Welcome Page

This the main interface when the user open the app, when user click on continue button it navigates to Home page to order.

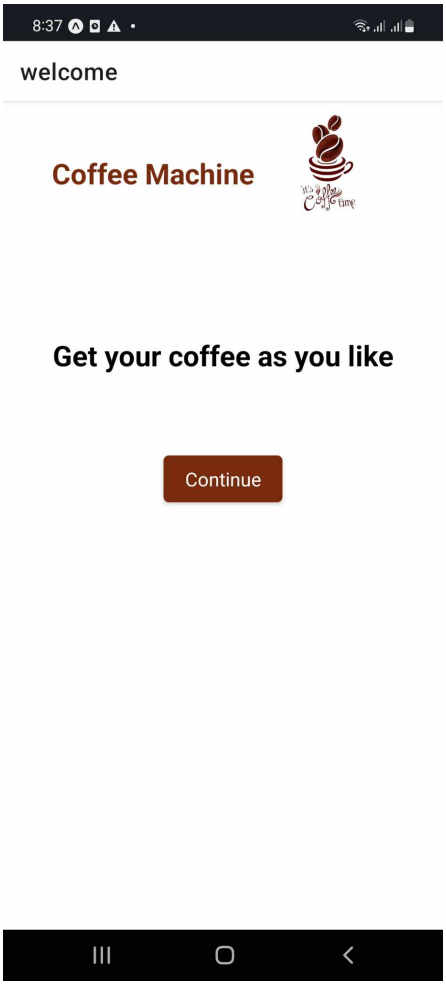


Figure 4.37: Welcome Page

4.4.2 Order Page

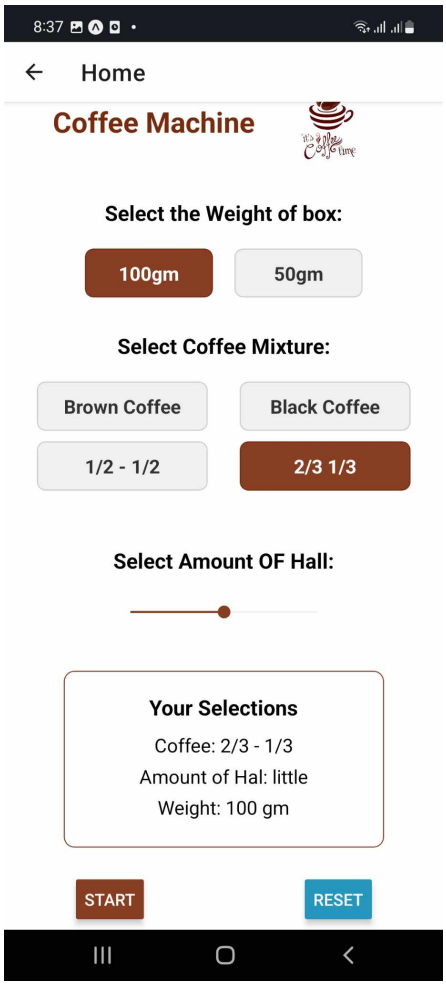


Figure 4.38: Order Page

In this interface, the user can make an order. This page enables the user to customize their order. First, they select the weight and mixture they want, then select the amount of cardamom, and finally click on the start button to begin preparing the order.

4.4.3 Feedback Page

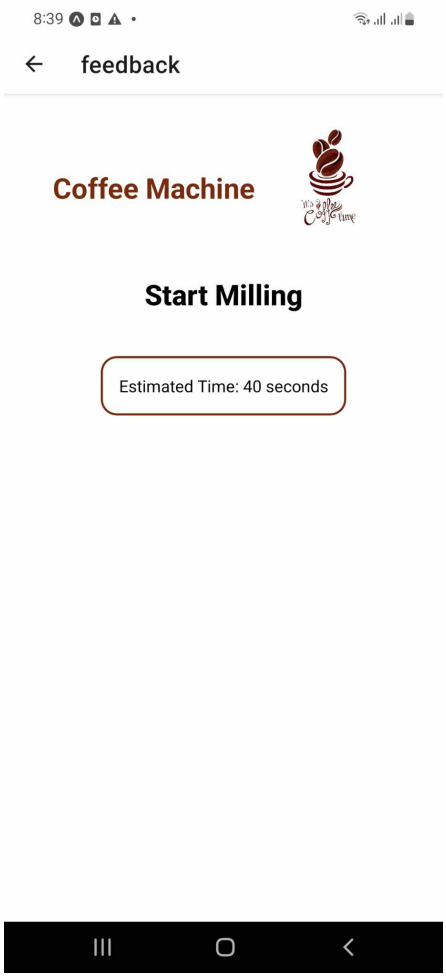


Figure 4.39: Feedback Page

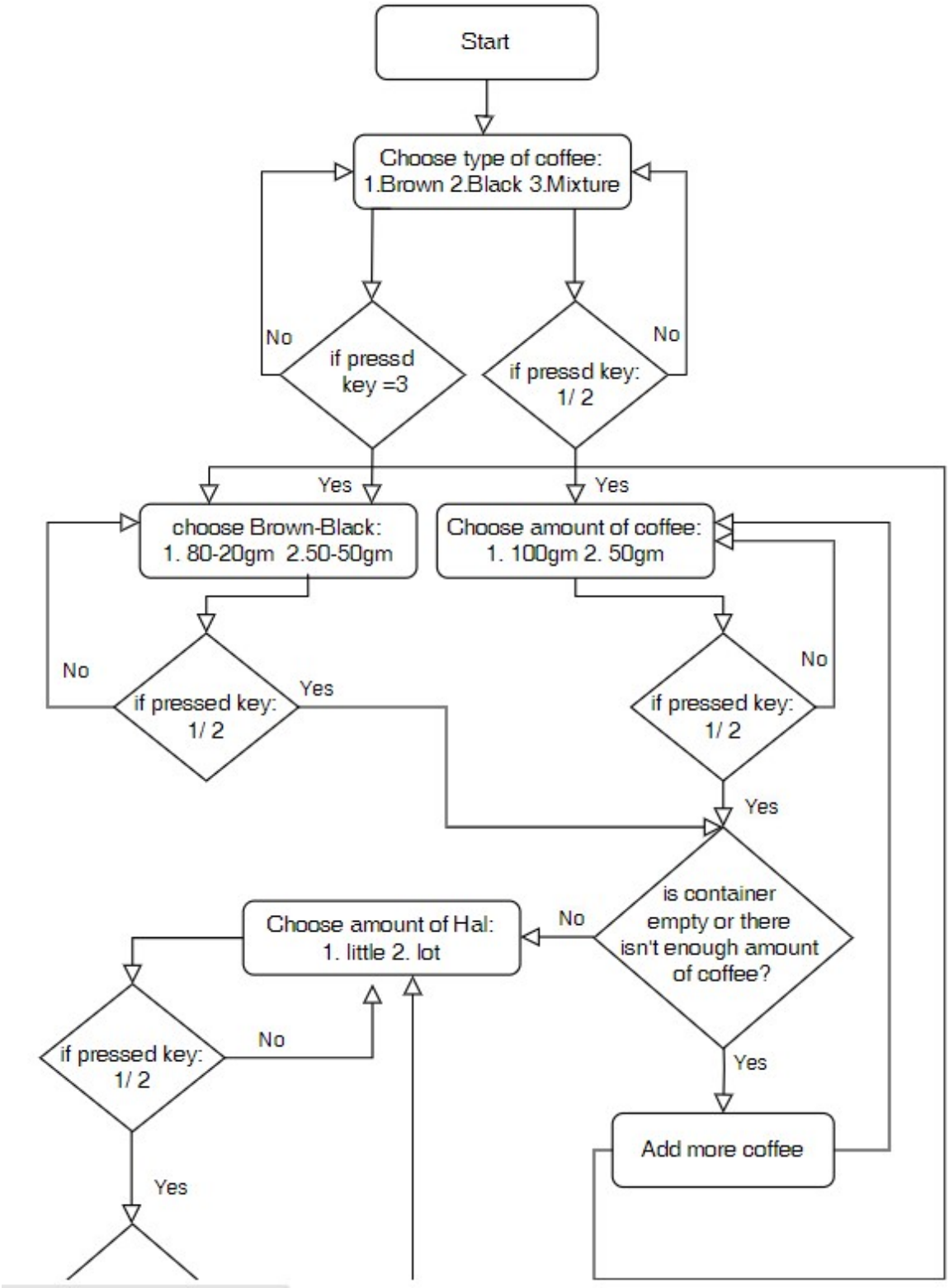
This interface shows the messages returned from Arduino. so it display what happen to the user with estimated time for each station to keep user up to date of what is happening.

4.5 Flow Chart of system

The system works as follow:

4.5.1 Choosing Ingredients Stage

Initially, all components are stopped waiting for the user to enter his choice.


Start
Choose type of coffee:
1.Brown 2.Black 3.Mixture
No
if pressd
key =3
No
if pressd key:
1/ 2
Yes
Yes
choose Brown-Black:
1. 80-20gm 2.50-50gm
Choose amount of coffee:
1. 100gm 2. 50gm
No
if pressed key:
1/ 2
Yes
No
if pressed key:
1/ 2
Yes
is container
empty or there
isn't enough amount
of coffee?
No
Choose amount of Hal:
1. little 2. lot
if pressed key:
1/ 2
No
Yes
Yes
Add more coffee

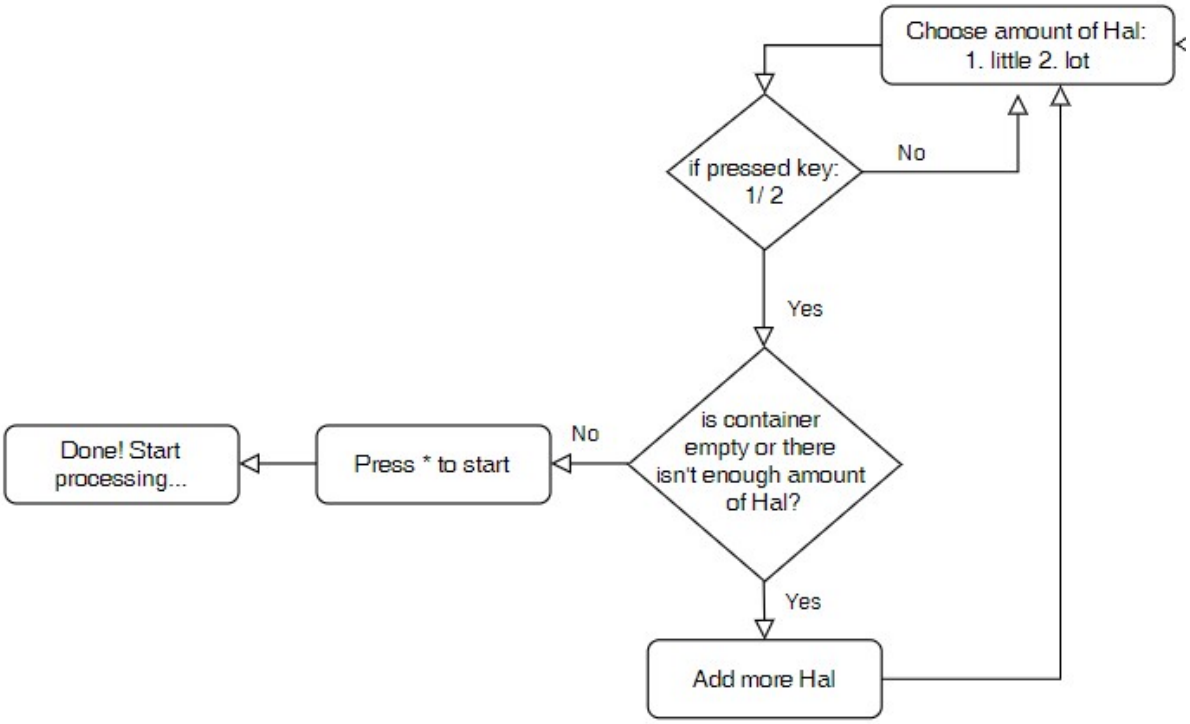


Figure 4.40: Stage1 Flow Chart

If the user enters the wrong choice, a "Please, choose correct number!" message is displayed on the LCD for 2 seconds, then the previous list reappears.

If the user enters #, the previous list appears in case the user wants to change his choice.

4.5.2 Grinding Ingredients Stage

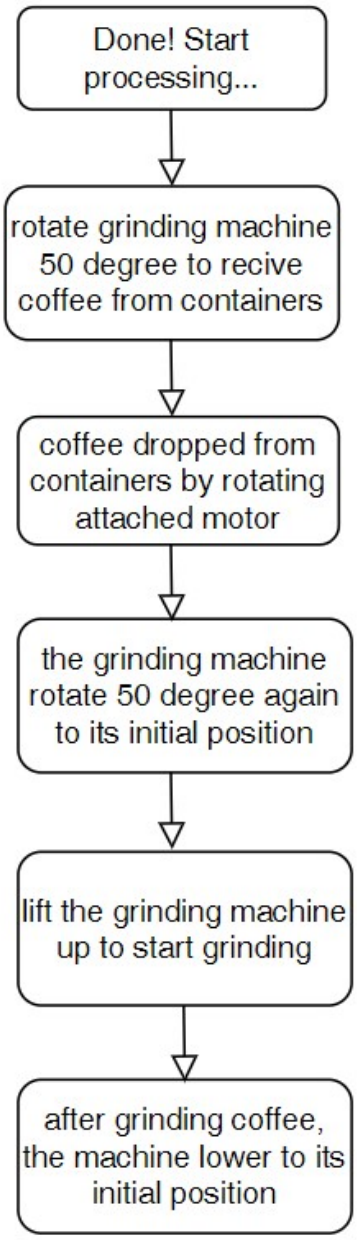
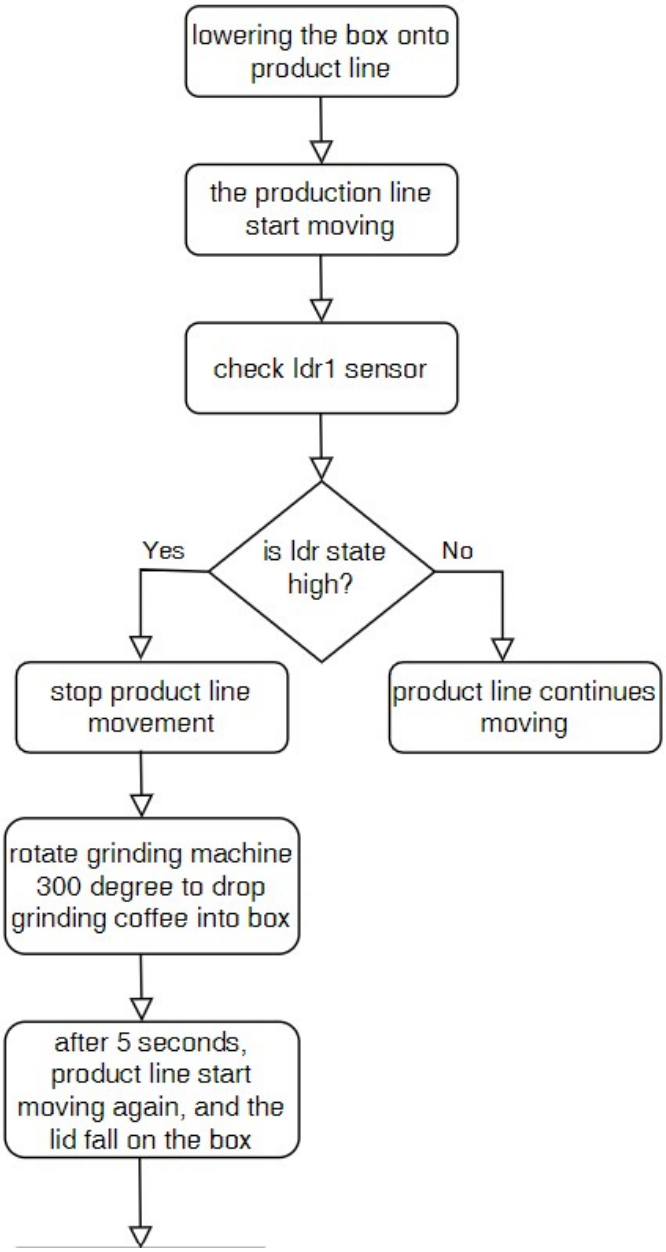


Figure 4.41: Stage2 Flow Chart

4.5.3 Packaging Box Stage



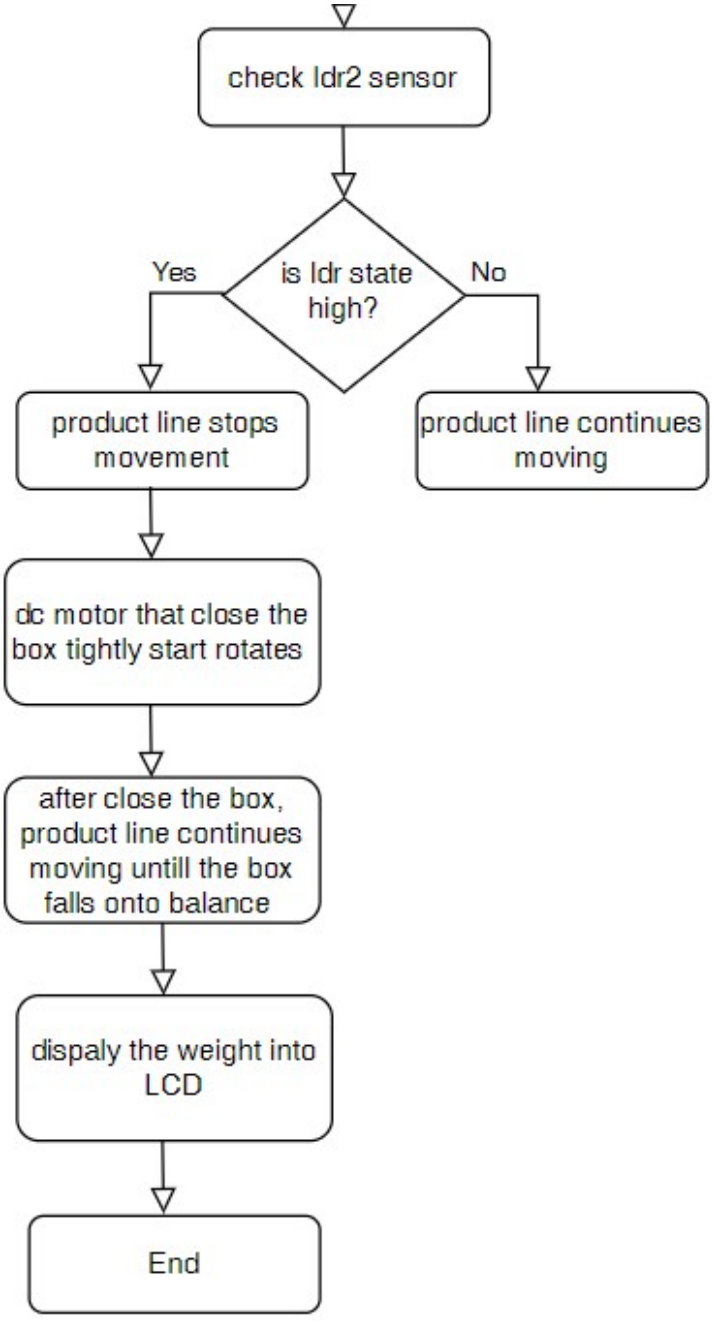


Figure 4.42: Stage3 Flow Chart

- There is an important point: at every stage, feedback is sent to the user by displaying it on the LCD.

Figure 4.43: Examples of feedback.

Chapter 5

Results and Discussion

After much effort and challenges, we were able to build a complete and integrated project, where we developed a production line for grinding coffee beans with many characteristics and features, the most important of which are the basic features that any production line relies on.

Our project is distinguished by focusing on selecting the right blend of coffee, packaging it well, and fully automating the process.

We supported the project by creating an easy-to-use mobile application that allows users to place their orders remotely without having to stand next to the machine and enter their requests via the keypad.

The final product of our Coffee Grinding Machine is shown in figure 5.1

Figure 5.1: Final Product

Challenges We Encountered and Their Solutions:

1. We deal with electronic components and mechanical assemblies, which requires prior knowledge and mechanical expertise that we did not have. Therefore, we taught ourselves. When a component stops working, we look for the reason and solution ourselves, so we gained a lot of experience in this field.

2. The primary root for establishing a coffee grinding project was the coffee grinder. There was difficulty in searching for a small one that grinds well and is designed to fit the project's construction method.

The model of the grinder shown in picture 5.3, which carries two motors, one of which is a stepper and the other is a car wiper motor, broke down a lot due to the weight of the car wiper motor, which the wood design could not support and there was no balance on both sides. This resulted in the wood breaking and the motor detaching from it. After many experiments and attempts, we found the appropriate design that will withstand the power of the motor and eliminate the unbalance at both ends of the grinder.
The previous design shown in figure 5.2.

Figure 5.2: First design of coffee mill

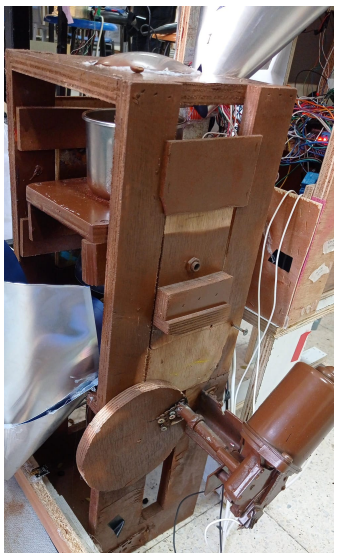


Figure 5.3: Latest design of coffee mill

3. Determine the downloaded quantity:

We faced a problem with the lack of a suitable place to install the weight sensor to ensure the amount of coffee dispensed based on the user's request. The solution was to adjust the number of motor rotations for each quantity; for instance, if the amount is 100 grams, the motor rotates three times, with each rotation consisting of 100 steps, and so on. However, we encountered an issue with the accuracy of the dispensed amount, as the coffee beans were getting stuck, preventing the motor from rotating to release the beans. Therefore, we trimmed a bit from the edge of the blade to facilitate the flow of the beans and properly adjusted the blade's position.

4. Falling lid precisely and easily onto the box:

The first structure of this process was as shown in figure 5.4. We discovered that the lid was not being placed on the box accurately and in the correct position. We tried to always position the lid in a way that it would fall onto the box precisely, but there were several mistakes at times. After many attempts, we decided to add another piece that would help the lid fall onto the box with great precision as shown in figure 5.5.

Figure 5.4: First design of lids line

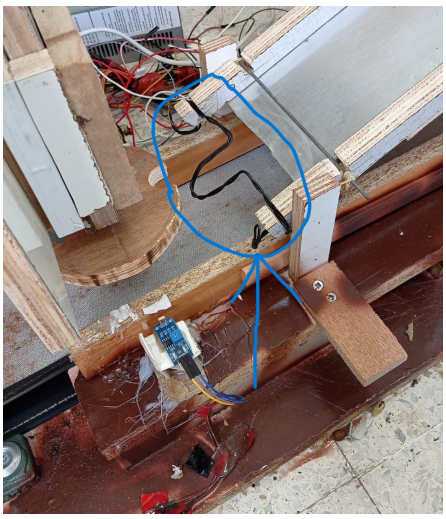


Figure 5.5: Latest design of lids line

Chapter 6

Conclusion and Future work

6.1 Conclusion

A smart coffee grinding machine has become a reality, we have been able to build a coffee production line. We have built an automatic system that facilitates the user's demand. The user able to order through keypad or from the mobile application.

Our project allows the user to prepare his order as he likes as the user can choose the weight he wants and choose the mix he prefers. After preparing the order, the machine supports filling the box and sealing it properly for serving.

Building the project was not easy. We had many problems starting with mechanical problems related to design and then technical problems in terms of identifying the necessary pieces and how to connect them in the right way.

6.2 Future work

Certainly, there are some matters related to the project that we are looking to develop, including:

- Adding more types of coffee that result in several special mixtures.
- Do not stick to one box size and add several sizes.
- Adding a weight sensor in the appropriate location to rely on it for ensuring the accuracy of the amount of coffee based on the user's request instead of determining the number of motor steps.

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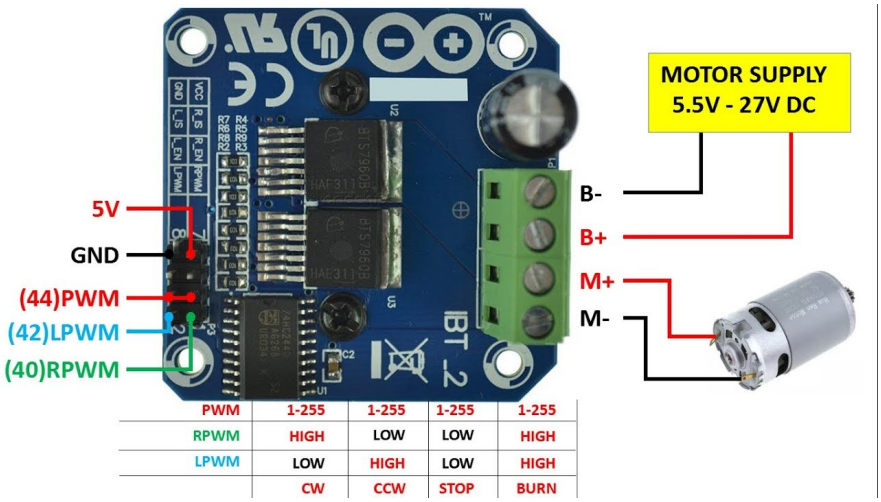
Appendix

A An illustrative images of the BTS7960 Driver



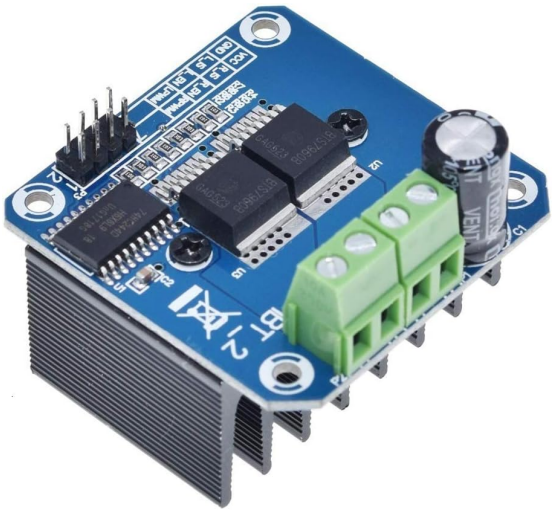


Figure 1: BTS7960 Driver