

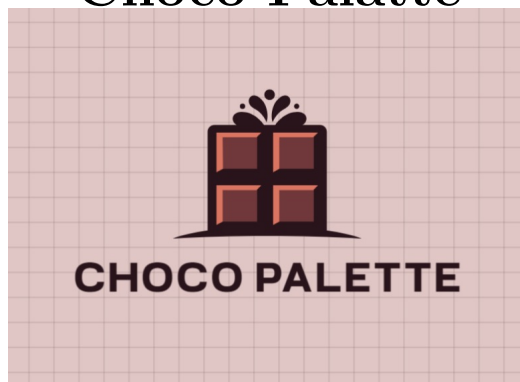


An-Najah National University

Faculty of Engineering & Information Technology

Computer Engineering Department

Choco Palette



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Disclaimer

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Abstract

Our hardware graduation project is a fully autonomous chocolate-making system that allows users to order customized chocolate products. This machine eliminates the need for a worker to make chocolates, saving both money and effort. It is user-friendly and safe, making it ideal for use in schools, universities, and institutions, offering a fresh and healthy alternative to traditional vending machines.

Our machine allows clients to choose the chocolate chips they want. Clients can select from predefined options such as nuts, blueberries, or raisins according to their preference. After choosing the chocolate and add-ons, the machine will start the process by measuring the correct quantity of chocolate and placing it into a pot for heating and mixing to make it liquid. Once mixed, the machine pours the chocolate into a mold. Finally, it adds the chosen nuts or blueberries, then dries the chocolate to create a chocolate palette, preparing the machine for the next order.

Additionally, our project uses multiple sensors to ensure that everything is done correctly and to achieve high accuracy.

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Chapter 1

Introduction

1.1 Background

Chocolate's journey from ancient luxury to modern delight is a testament to its enduring appeal. Initially revered by ancient civilizations as a rare and exquisite treat, chocolate has evolved from handcrafted indulgence to a widely mass-produced product. Despite its transformation, chocolate remains a cherished part of our culinary traditions. In today's market, consumers are increasingly interested in personalized options, driven by technological advancements and a quest for unique experiences.

However, while chocolate production has made significant strides, traditional machines still often fall short in providing customization and real-time feedback. Modern consumers seek not only high-quality chocolate but also the ability to tailor ingredients and processes to their individual tastes. This growing demand underscores a notable gap in the market, highlighting the need for innovative solutions that offer both flexibility and control in chocolate-making.

Chocolate Palate redefines the experience of enjoying chocolate by offering a level of customization and freshness that traditional chocolate dispensers lack. This innovative machine empowers users to craft their ideal chocolate mix by selecting specific ingredients and controlling the proportions according to their personal taste. Unlike conventional dispensers, Additionally giving users the flexibility to choose their favorite chocolate types, and toppings.

Moreover, the machine provides real-time information on the available ingredients and their quantities, ensuring that users are always aware of what's inside and how much is left. This transparency, coupled with the ability to order and adjust preferences remotely, makes Chocolate Palate a superior choice for chocolate enthusiasts who value both quality and convenience.

1.2 Purpose Of Project

Making a machine of making chocolate that works better for people today is the aim of this project. We're launching a mobile app so consumers can make chocolate easily according to their wishes, and we want to give them more control over how their chocolate are created. We will also receive real-time updates from the machine regarding the implement sensors and monitoring systems that provide real-time updates on ingredient levels and machine performance. This will include data on ingredient quantities, machine status, and progress of the chocolate-making process, ensuring transparency and ease of use for both customers and administrators. And the main object is to address the issues with the present of traditional machine of make chocolate and meet consumer demand for customized, tech-friendly experiences in the food sector.

1.3 Significance Of Our Work

As consumers increasingly seek convenience and personalization in type of their chocolates, the demand for easily accessible and highly customizable addition options is growing. People are more conscious about their health and want control over the ingredients in their chocolates. Moreover, the trend of ordering food and sweets like chocolate through mobile devices has become a standard expectation.

Our device is designed to meet these evolving demands. By offering a solution that allows for both customization and mobile ordering. We are developing a unique and user-friendly machine that empowers individuals to tailor their chooses and flavors of chocolate to their exact preferences. This innovation is poised to make a meaningful impact, enhancing the overall chocolate experience for everyone.

The integration of mobile technology and Internet of Things (IoT) features into chocolate making machines enables remote operation and monitoring. Users can control the machine via smartphone apps, receive real-time updates, and even automate the production process based on their preferences.

This project represents a significant step forward in the industry, providing a more personalized and efficient chocolate-making experience. By bridging the gap between traditional methods and modern technological expectations, we aspire to set a new standard in the field and cater to the evolving needs of today's consumers.

1.4 Report Organization

There are multiple parts to this report:

- First Chapter :

The project and its goals are briefly described in the introduction.

- Second Chapter : In this chapter, we will be revising all the important topics that we have already learned, besides the outward bound courses and also one of the most actual barriers we needed to overcome

while working on the project.

- Third Chapter (Literature review):chapter summarises what they[the researchers] found published before Read previous studies comparable to ours in nature.

- Chapter four (Methodology): - This chapter describes the approach adopted in developing and implementing automated "Candle Craft Line" machine system.

- Theoretically fifth and last chapter: - These two chapters discuss the results obtained with project implementation, argue in favor of or against initial objectives achieving a conclusion on this achievement.

and notice some of the features that may exist.

Chapter 2

Constraints and Earlier Coursework

2.1 Constraints

2.1.1 Material Selection Difficulties

Selecting the right materials for the project was a challenge because we could not get the materials details like strength, durability, and corrosion resistance. The wrong choice of materials can easily lead to a mechanical failure and the loss of the system's integrity.

2.1.2 Integration of Mechanical and Electrical Systems

Mechanical part integration with electricity became a task that took some efforts because we had prior limited hardware and software knowledge. We initiated the project by trying out different methods to balance the motor power with the mechanical load they were to be used with but all attempts have unknowingly resulted in the wastage of power.

2.1.3 Difficulty in Sourcing Specialized Components

Most of the mechanical components, for instance, some types of gears, bearings, and motor couplings were neither in stock on the shop floor nor available from the regular suppliers and were therefore either tailor-made or imported. As a result, this process was more cumbersome and it also delayed the arrival time of the key components.

2.1.4 Lack of Time

The time available is one of the most important things in a project. The collective time spent on multiple tasks such as research, communication, tests, development, the requirement understanding, and planning was extra beyond anyone's expectation. Not just that but also our inexperience made lack of experience led to inefficiencies, causing further delays that could have been better utilized anywhere where in the project.

2.1.5 Lack of Tooling

The process of making the components usually requires some tools that are unique to the job like cutting, preparing, and pairing, but these needed tools were quite expensive to acquire essentially made it not accessible to us. Thus, we had to ask for help from professionals from outside to handle some of the work that imposed the need for equipment so much as the shearing machine, carpentry, which added complexity and delays to the project.

2.1.6 Lack Of Mechanical knowledge

We only partly knew for sure the mechanics of the project, however, even with extensive research, something would stay unclear, and the deliberative and structural analysis of the project continued to require the experience of the mechanical engineer and people who are experienced of this field.

2.2 Earlier Coursework

The electronics course, especially in our early studies, taught us the basic principles of electronics that we used in the assembly and troubleshooting of the hardware components of the machine, such as sensors, motors, valves, and pumps.

Furthermore, the course related to microcontrollers by adopting the usage of PIC controllers, and was also very helpful. The knowledge we were taught enabled us to program the computer on board, necessary for the creation of the machine by using Arduino Mega and Uno. We also got trained on I2C and PWM and besides that, we got to know how to connect various components. With the help of this knowledge, we have been able to originate the core machine-running code, which was one of the essentials in the project.

The networks course taught communication protocols and basic networking skills which are why we were able to create the machine's networking infrastructure. And we needed a solution that would enable the users to control the machine remotely via an app and training them to

use the ESP device.

Finally ,The ability to approach the project methodically and make wise conclusions was provided by the Critical Thinking course, which was crucial to the project's success. The course helped us develop critical thinking abilities that let us see issues at an early stage, and so they were neither too hard to resolve nor expensive. This became even more crucial as the project progressed and we encountered design and power-related challenges.

Chapter 3

Literature Review

For millennia now, chocolatiers have been crafting chocolate, evolving from basic methods of processing cacao beans into simple treats to creating intricate, gourmet confections that delight the senses. This part will review the related literature on chocolate machines, IoT concepts, smart chocolate vending machines using sensor and actuator networks, and innovative chocolate machine design projects.

3.1 History of a Chocolate

Chocolate is a concoction as old and indigenous to the Americas, North America such that its history date back to some early civilizations of Mesoamerica or present-day Mexico combined with "a bitter drink" (by goncarabobo); Chocolate became more of an élite product in ancient times, as it was converted into a hallucinogenic for spiritual practices and to barter. The 19th century saw new technologies in chocolate producing, including the 1828 invention by Coenraad Johannes van Houten of the cocoa press that allowed for easier extraction of cacao butter from roasted beans—the fats needed to create more palatable solid and liquid forms—and made chocolate affordable to all. And Roberto VERNA discuss the theme of chocolate has been addressed several times in the seventh art, cinema. The films include: Chocolat, Like water for Chocolate, Hot Chocolate, Chocolate Factory, Lessons in Chocolate and Bianca.[1]

3.2 Traditional Chocolate Industry

Ways food experts used to make chocolate in the early days, included fermenting cacao beans after drying them and grinding then roasting. This continued until the 19th century when advancements like the cocoa press allowed for chocolate to be more readily available and, sub-

sequently, paved way solid chocolates. Call it a backlash against modernity, but in many cacao-producing areas today the traditional stone hand grinding of nibs for processing chocolate into hominy-like masa and small-scale fermentation is avidly retained as part of rich traditions. and in this article [2] shows what existing basic principles of chocolate making are and how they can be related to the processes used in its manufacture.

3.3 chocolate Industry in Factories

The contemporary chocolate industry is largely mechanical and entirely industrial, with little or no resemblance to its beginnings. This started in the 19th century with discoveries such as Coenraad Johannes van Houten's description of a process making it easier to remove cocoa butter from cacao beans, allowing for milk chocolate. This introduced a way to use chocolate in solid shapes, leading to our readily available mass-producing of the chocolate bars and confections we know.

Today, in a chocolate factory things can start with large-scale fermentation and drying of the cacao beans and end up roasting them to nip off your cocoa mass before many machines refine, conch (a process of aerating and smoothing out the chocolate) as well as tempering it until reaching the ideal creamy texture sleek appearance. This process wreaked havoc in the cocoa farming community even as the big chocolate companies like Hershey's, Cadbury and Nestle exploited these separation processes to churn out multiple variations of their products worldwide.

Automation in chocolate factories is like having a magic wand. It lets makers tweak the taste and feel of chocolate with amazing precision, ensuring every batch meets top-notch quality standards even when demand skyrockets. Thanks to this high-tech help, there's now an endless parade of yummy chocolates—from plain bars to fancy filled ones and everything sweetly coated in between—making it one of the most adored treats around the globe. Imagine walking into a room that smells like freshly made chocolate; that's what automation brings to life!

3.4 Similar Projects

Although numerous production lines have been used in the past, However, chocolate has not been produced before. So it is special and new, whether how it is used, and how many processes are carried out on it.

Chapter 4

Methodology

4.1 Hardware component

1- **Arduino Mega 2560**: The Arduino Mega 2560 is a microcontroller board based on the ATmega2560 (datasheet),It has: with Multiple input and output of analog inputs, hardware serial ports (UARTs),a crystal oscillator plus others. Most significantly, because it combines all the features of our project into one chip with a reasonable number to address its needs as long we have so much devices connected to micro controller.

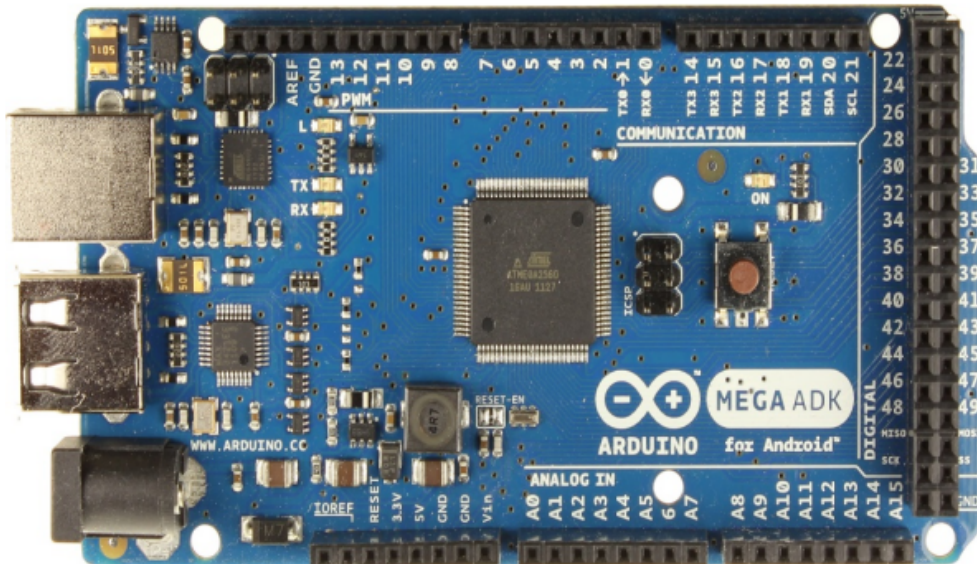


Figure 4.1: Arduino Mega 2560

2- **ESP32-DevKitC ESP32-WROOM-32U Core Board** In our project, we configured uart channel serial connection between the two microcontrollers, ESP32 and Arduino Mega. Additionally,

we developed an access point akin to a web server that enables users to connect to the Caffeine Shot machine network. Using their mobile devices, end users may buy personalized drinks from any location in the office thanks to the system's central access point. It also offers administrative features that enable real-time supply data to be viewed by building service contractors (BSC) and facilities management. As soon as an order is placed, the Arduino Mega receives it over the serial communication channel, and the chocolate preparation process begins immediately.



Figure 4.2: ESP32-DevKitC ESP32-WROOM-32U Core Board

3- J-5718HB2401 Stepper motor and YS-DIV268N driver

An electric motor that rotates due to electrical current passing through it is called a stepper motor. Although stepper motors can have large physical dimensions, they are often small enough to operate on milliampere-level current. The motor shaft rotates independently when the motor is exposed to current pulses. Stepper motors include input pins or contacts that let current flow into the motor's coil windings from an external supply source. The appropriate pattern of pulsating waveforms can generate the required electromagnetic fields.

This stepper can support up to 20 kg of weight. For our project, it is mostly used to open and close the chocolate container so that the chocolate can fall into the mold.

We made use of a 12A powersource and the motors are driven by the YS-DIV268N driver. The motor coils were connected to the driver's A and B pins, the control pins were connected to the corresponding Arduino pins, and the negative pins were connected to the Arduino ground.

DC+ and DC- pins were supplied by a 12A power source. We developed a program that uses the pulse width modulation pins on the Arduino to provide code-based motor control. Every

motor has an enable pin that is always engaged. The direction pin is adjusted based on the direction of movement that is needed, thus it moves in a clockwise manner at first. However, after each order, it reflects its position and moves counter-clockwise until it returns to its initial position.

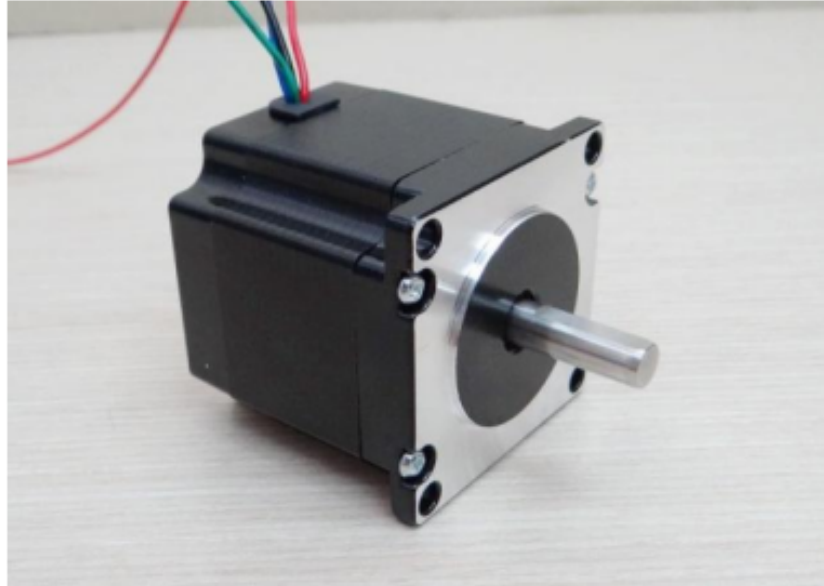


Figure 4.3: J-5718HB2401 Stepper motor

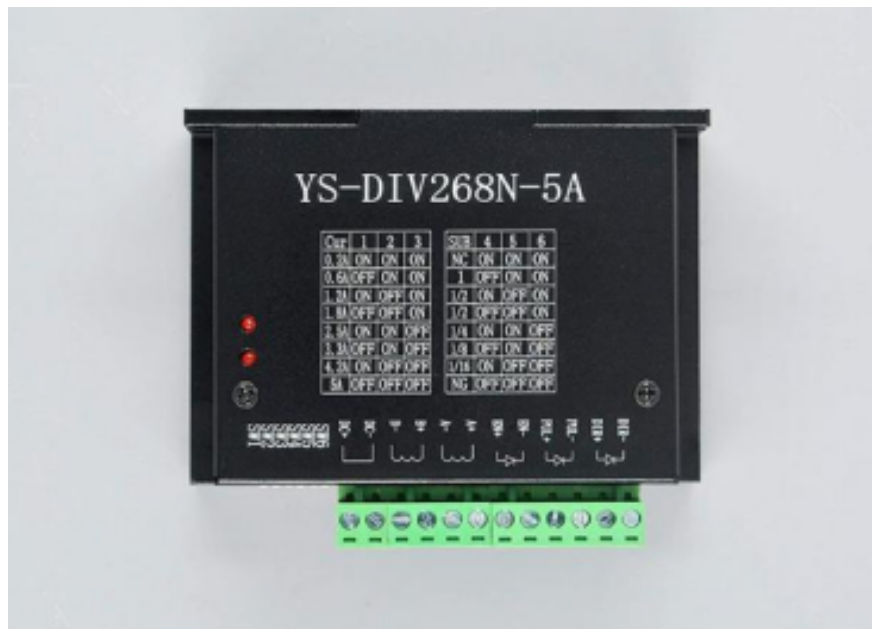


Figure 4.4: YS-DIV268N driver

4- JK42HS34-1334 Stepper motor and L298N motor driver

The dual H-bridges of the L298N module are capable of driving one of the stepper engine's

electromagnet coils. The stepper engine's shaft may move precisely in tiny increments forwards or backwards by turning on these coils in a predetermined order. The frequency of energizing these coils determines the motor's speed. The twin H-bridges of the L298N chip can manage one stepper engine or two DC engines.

The main objective in this project is to control the stepper engine's turning speed and direction, which in turn controls the container that holds almonds, blueberries, and pistachios. The L298N engine driver can provide a constant current of 2A and operates between 5V and 35V in power source scope per coil, rendering it compatible with most stepper engines.



Figure 4.5: JK42HS34-1334 Stepper motor

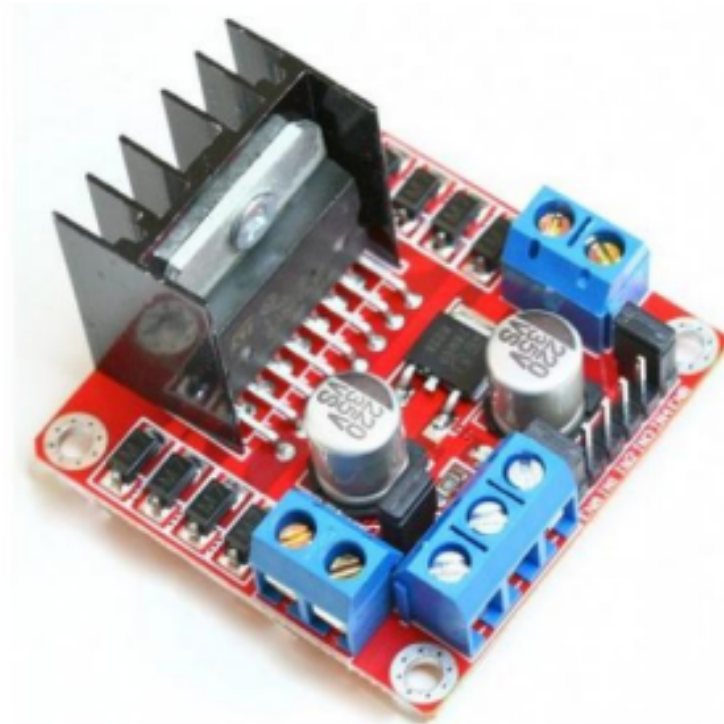


Figure 4.6: L298N motor driver

5- A4988 Stepper Driver

The A4988 is a microstepping driver with an integrated translator for simple operation that is designed to control bipolar stepper motors. This implies that we only need to use two pins from our controller to operate the stepper motor—one for directing rotation and the other for stepping. Five distinct step resolutions are offered by the Driver: full, half, quarter, eighth, and sixteenth steps. It also features a potentiometer for controlling the crossover-current protection, over-temperature thermal shutdown, and current output. The maximum current per phase is 2A if adequate extra cooling is provided, or 1A continuous current per phase in the absence of a heat sink or cooling. Its logic voltage ranges from 3 to 5.5 V. In this project we connect it with stepper motor to control or rotation of container contains chocolate.

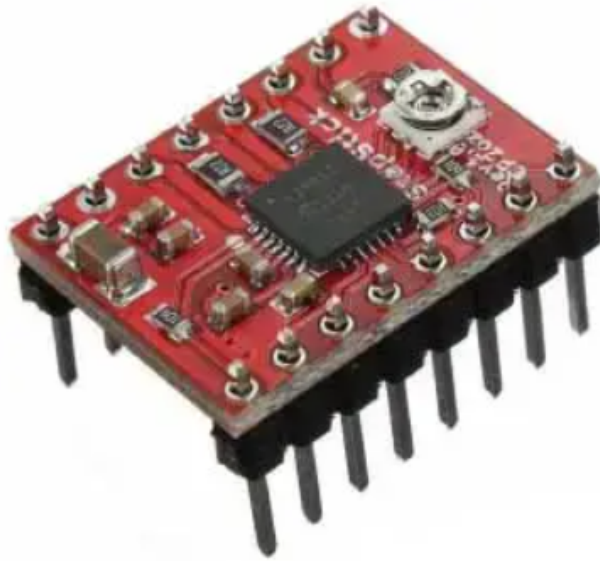


Figure 4.7: A4988 Stepper Driver

6- LDR Sensor Module

A light-dependent resistor (LDR) sensor module is a tool used to measure variations in light intensity. When the amount of light striking the LDR's surface grows, its resistance lowers, and when the amount of light drops, it increases. The voltage across the LDR lowers as the light intensity rises because the LDR's resistance drops. The digital output changes states based on whether the light intensity falls or rises, depending on how the module is configured. We used this in our project to determine whether an object was reached in a particular location.



Figure 4.8: LDR Sensor Module

7- temperature sensor

A temperature sensor is a gadget that takes a reading of the surrounding air temperature and interprets the information so that it can be used for control or monitoring. We use it to measure water to determine whether or not it has reached the boiling point by connecting it to resistance. How Operational They Are:

-Thermistors: As temperature varies, the resistance of the sensor also alters, resulting in measurements of the temperature. -Thermocouples: A temperature differential causes a voltage to be produced that is proportionate to the Seebeck effect. -RTD: Accurate measurements are made possible by the resistance's predictable increase with temperature. -Semiconductor sensors: Generate a digital signal or voltage that is precisely proportionate to temperature.



Figure 4.9: temperature sensor

8- **Laser**

A laser module produces a coherent, concentrated light beam that is frequently utilized for precise targeting or sensing applications. It consists of a driver circuit for power control, a laser diode, and frequently optics for beam shaping or focusing.

We created tripwires, measured distances, and detected objects using the laser module in our project. We have constructed systems that are able to recognize when the beam is broken and initiate the intended action by merging the laser module with a light sensor.



Figure 4.10: Laser

9- Ultrasonic Sensor

A gadget called an ultrasonic sensor uses high-frequency sound waves that are inaudible to humans to estimate an object's distance from it. By timing how long it takes for sound waves to bounce off an object and return to the sensor, the sensor can determine the distance.

To track the amount of components left in the container containing the chocolate and almonds, our solution uses an ultrasonic sensor to detect distance. The administrator receives this information, allowing them to restock the supplies as needed.



Figure 4.11: Ultrasonic Sensor

10- Peltier and fan

For cooling applications, Peltier modules, also called thermoelectric coolers, work well when

combined with fans. This is an overview of how they work and are used:

The Peltier effect, which results in a temperature differential between two surfaces when an electrical current is sent through it, is the basis for how a Peltier module functions. There is a change in temperature from one side to the other.

To maximize cooling, a fan is employed to dissipate heat from the hot side of the Peltier module. Peltier modules are inefficient and can produce a lot of heat on one side, so the fan's ability to circulate air over the hot side enhances cooling performance.

In actual use, the Peltier module would be oriented with the cold side facing the area you wish to cool and the hot side facing the fan. This configuration is used to both continuously maintain the temperature of raw chocolate inside a container and to cool chocolate after it has been made.

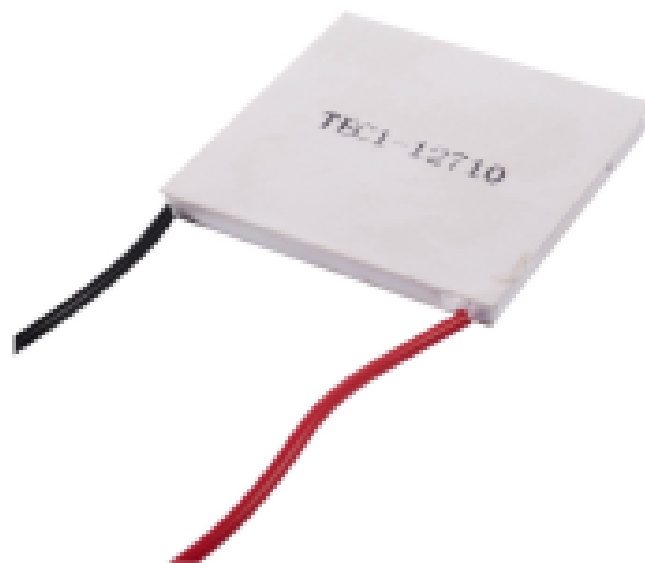


Figure 4.12: Peltier

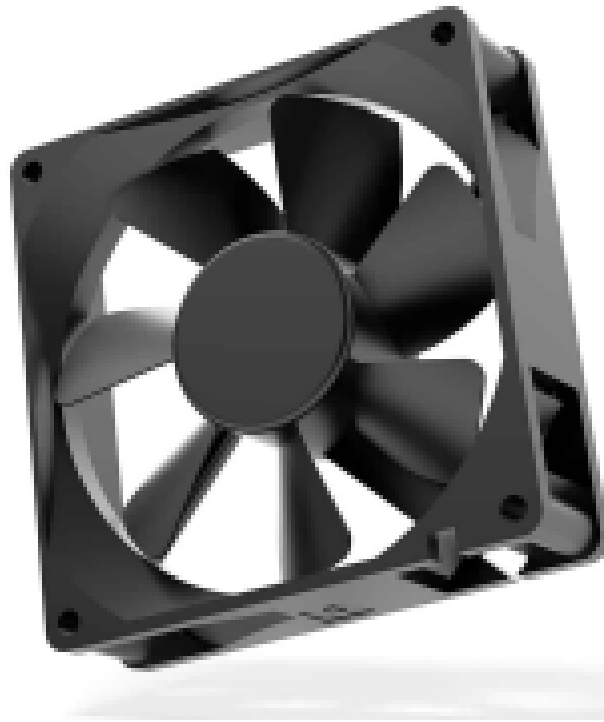


Figure 4.13: Fan

11-Heater

We used the 220 volt water heater that we had. It's connected to a relay that the Arduino manages, determining when the heater turns on. The primary objective of the water heater is to maintain hot water at predetermined intervals. It ensures that the water will be heated for a chocolate water bath.



Figure 4.14: heater

12-Relay

A basic electromechanical switch is called a relay. Relays are switches that link or disconnect two circuits, just like regular switches do when we manually close or open a circuit. However, a relay employs an electrical signal in place of a manual process to control an electromagnet, which then connects or disconnects another circuit. We use different channels (one, two, and four), and we essentially use them for every aspect of the project.

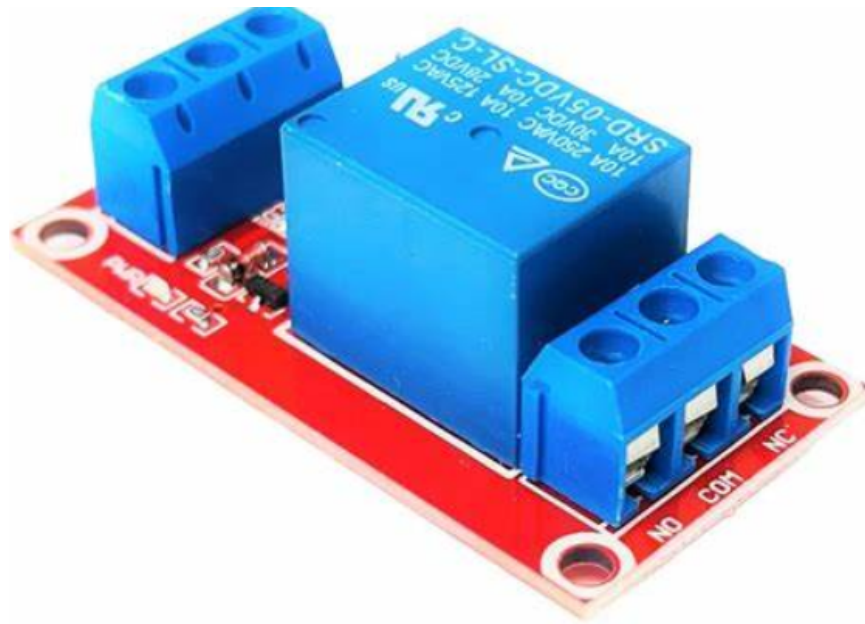


Figure 4.15: Relay

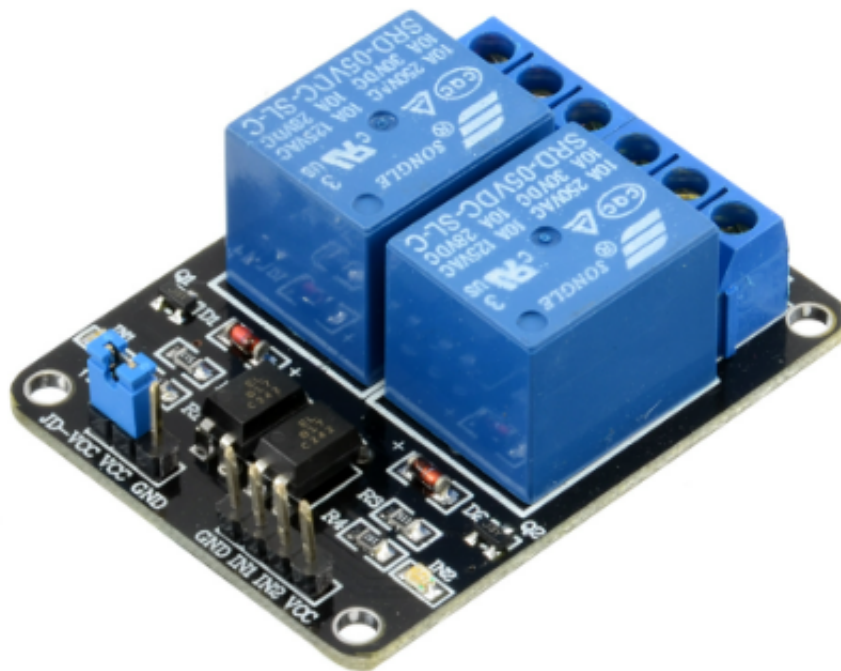


Figure 4.16: Relay

13-Pumps and Tubes

To clean it, we use it to transfer water from a bottle to a chocolate bar.



Figure 4.17: Pumps and Tubes

14-Volve

A non-pressure valve was utilized to control the amount of water are pumps



Figure 4.18: Volve

15-On/Off switch

We used an on/off switch to control the power supply. and limit switch to change direction of motor if click of it



Figure 4.19: On/Off switch



Figure 4.20: Limit Switch

16-Wire

For different connections, we employed three different types of wires: male-to-male, female-to-female, and male-to-female.



Figure 4.21: Wire

16-Power Supply

We decided to use a computer power supply to meet the voltage needs for our project because it can deliver the 5 volts required for various devices and the 12 volts needed for stepper motors and pumps. Furthermore, the power supply provides an adequate current output to fulfill the requirements of our project.



Figure 4.22: Power Supply

17-Keybad

A keypad is a group of buttons grouped in a matrix so that the row and column coordinates of each button may be used to identify it. Keypads are frequently used as input devices for systems based on microcontrollers, such as those constructed using the Arduino platform.

We have included the keypad as an input device into our project so that patrons can choose the drink of their choice. This is accomplished by giving the consumer precise and unambiguous instructions on the attached LCD display, which they can enter into the keypad to verify their selection.



Figure 4.23: Keybad

18-LCD and I2C

In our concept, information and instructions are presented using a 20x2 Liquid Crystal Display (LCD), which offers a straightforward, user-friendly interface. In addition to providing users with input prompts and guidance, it also displays pertinent feedback based on their actions.

In addition, we used an I2C Serial Interface Adapter to make the LCD and microcontroller connection easier. With just two I/O pins needed, this adaptor saves wiring by converting parallel signals to I2C communication. Additionally, it maximizes wiring efficiency and available space by supporting numerous devices on a single I2C bus.



Figure 4.24: LCD and I2C

19-Mixer With Dc Motor

we use to mixer to stir and mix the chocolate.





Figure 4.26: mix

4.2 Machine work

4.2.1 Turn on Heater

We turn on heater inside water 6 minute to do heat of water to use in Water bath process.and we cover the water with foil to preserve the steam.



Figure 4.27: Modes

4.2.2 User Input

In this part ,user select any mode you prefer and selected addition of chocolate (almonds,pistachio,blueburry or plain) using kaypad or mobile application.

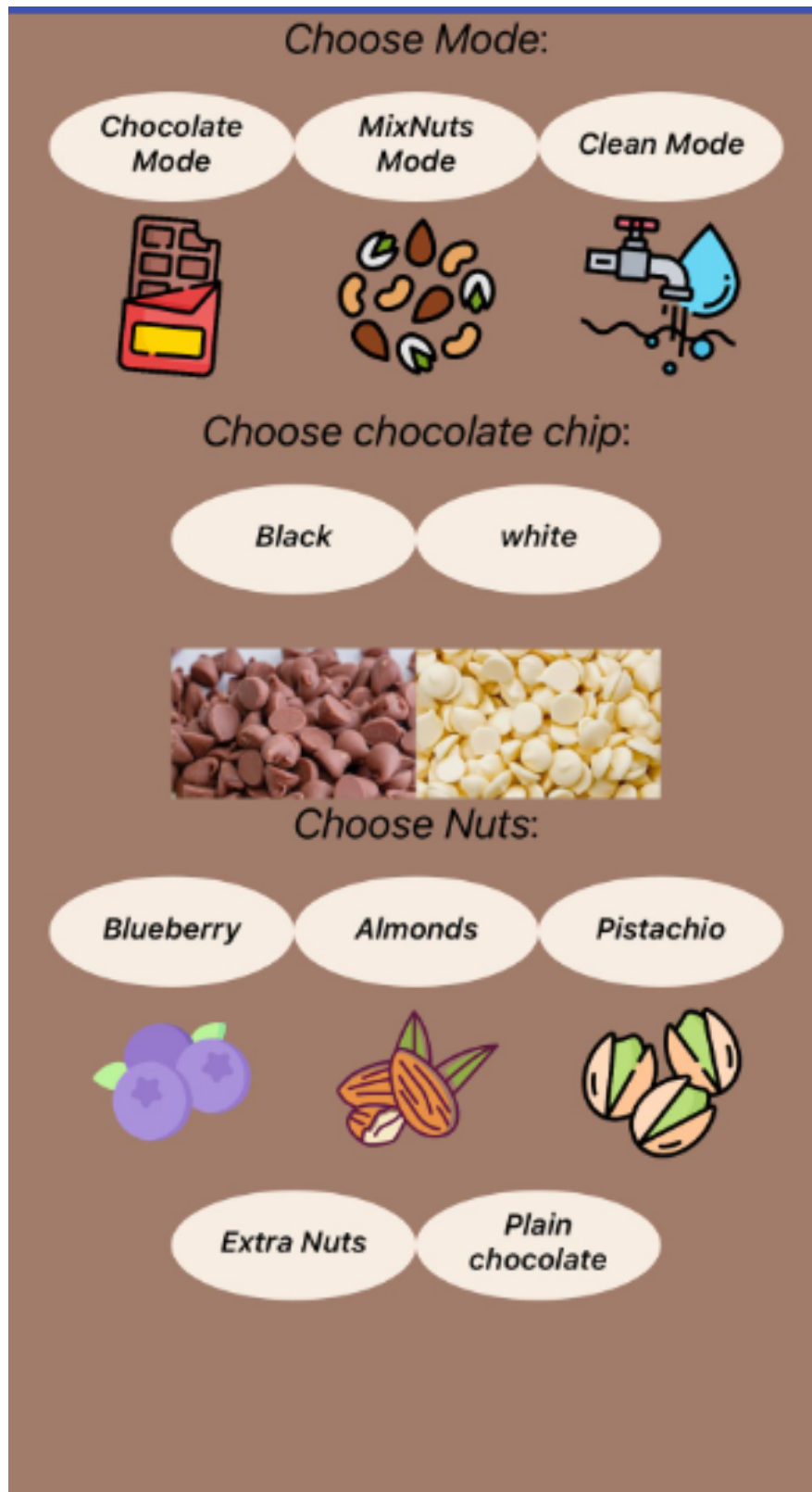


Figure 4.28: mobile app

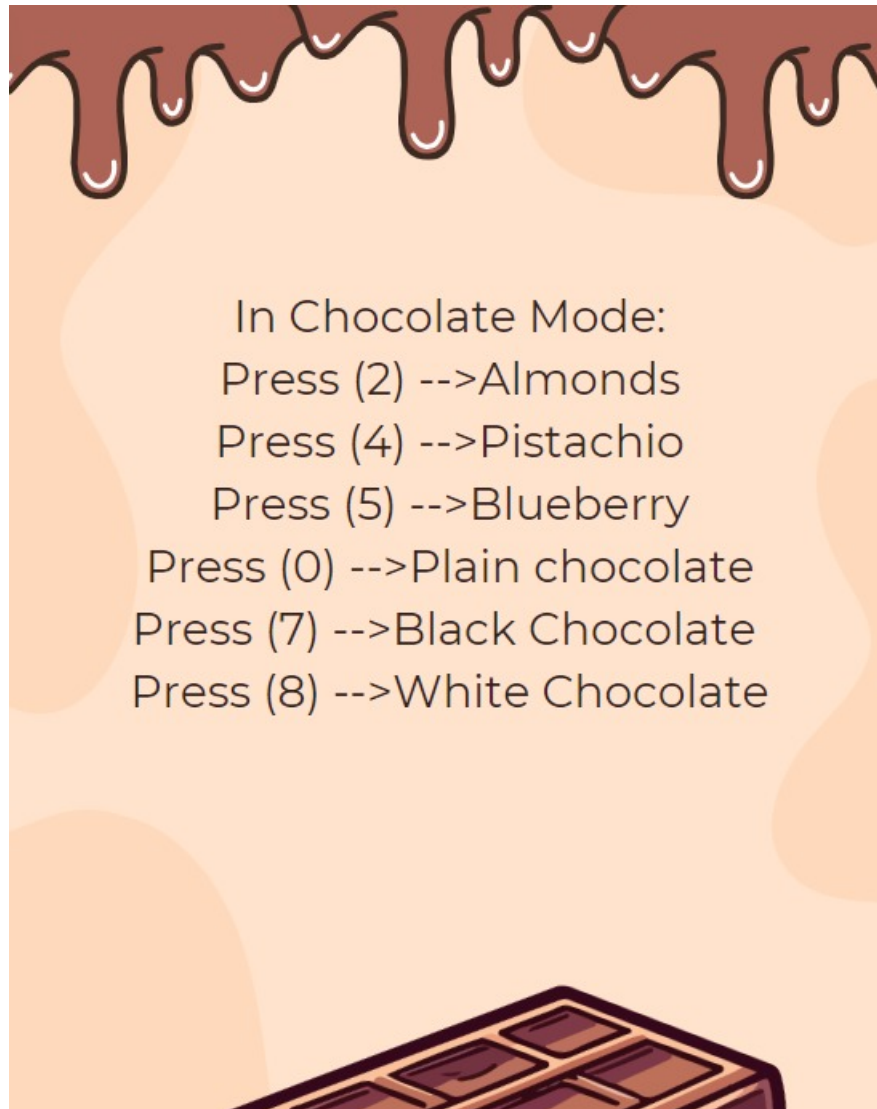


Figure 4.29: Chocolate mode

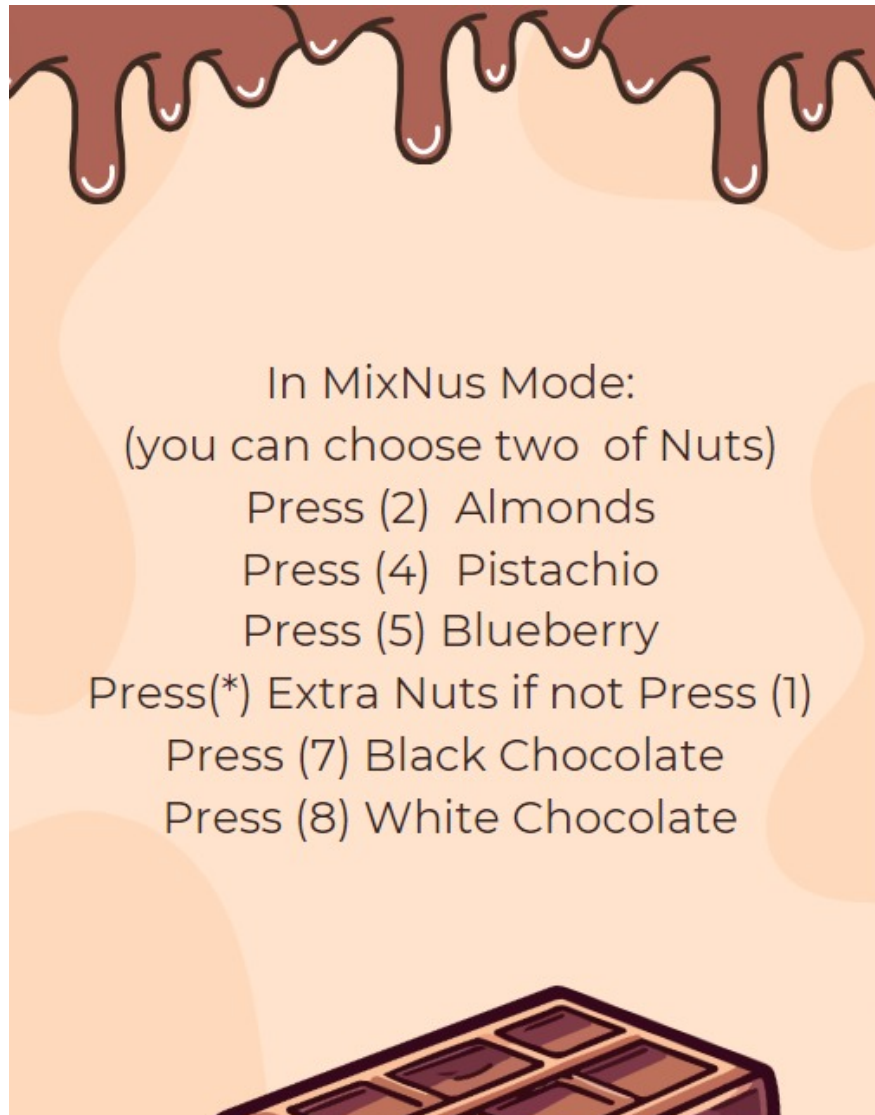


Figure 4.30: Mix mode

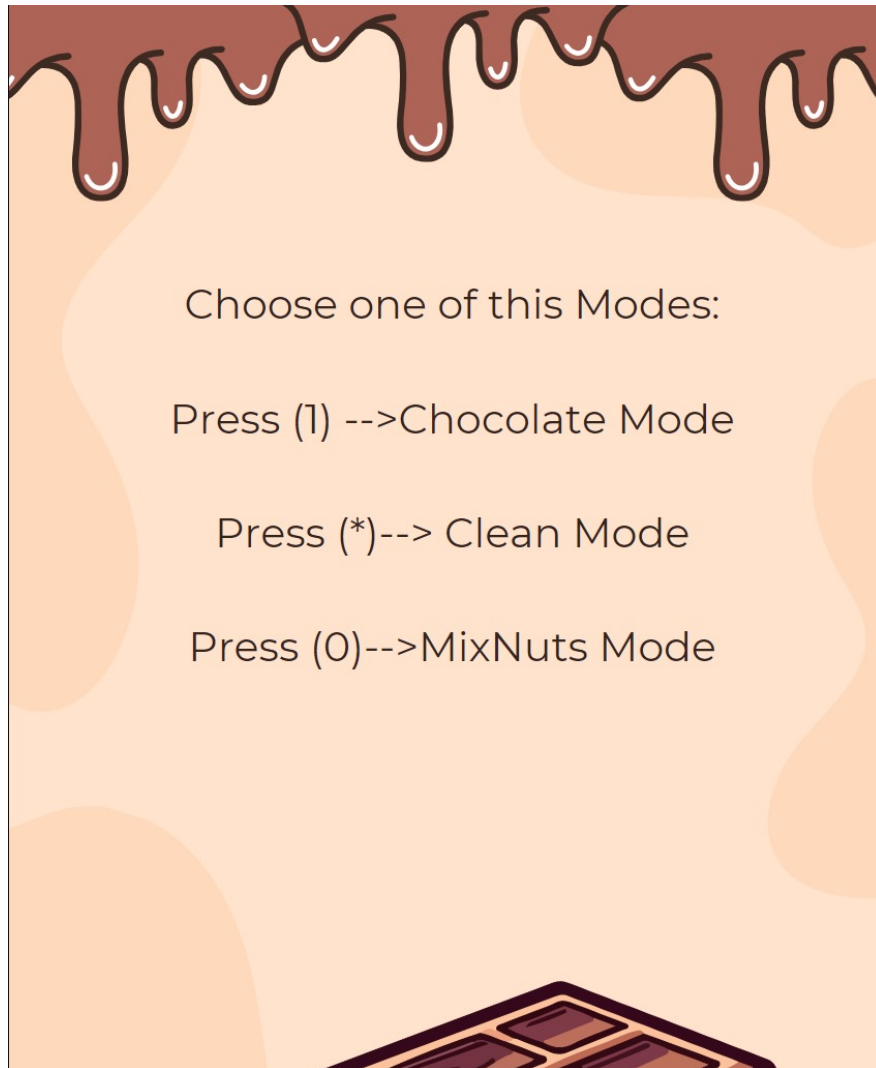


Figure 4.31: Modes

4.2.3 Download templates

We use conveyor Belt1 components to download templates until reach to conveyor Belt2 then run it and turn off first conveyor Belt1 .



Figure 4.32: Download templates

4.2.4 Add Nuts on template

In this part the conveyor Belt2 move templates untill it reaches the user's choice ,then if LDR detect the templates the conveyor Belt2 stop untill the process of LDR finish.



Figure 4.33: selected nuts

4.2.5 mix and download chocolate

In this part if LDR4 is detect the templates the process of chocolate will start ,we do mixing 6-8 minute ,then the stepper motor are open to do access of chocolate to download then rotate anothor direction to do closed ,then we repated this part untill the template is fill of chocolate .



Figure 4.34: Chocolate process

4.2.6 cooling of chocolate

We cool the chocolate until it solidifies using paltier and fan



Figure 4.35: cooling chocolate

4.3 Flow Chart

Our flowchart provides you with the fundamental steps in the basic operation of the "choco palette" machine.

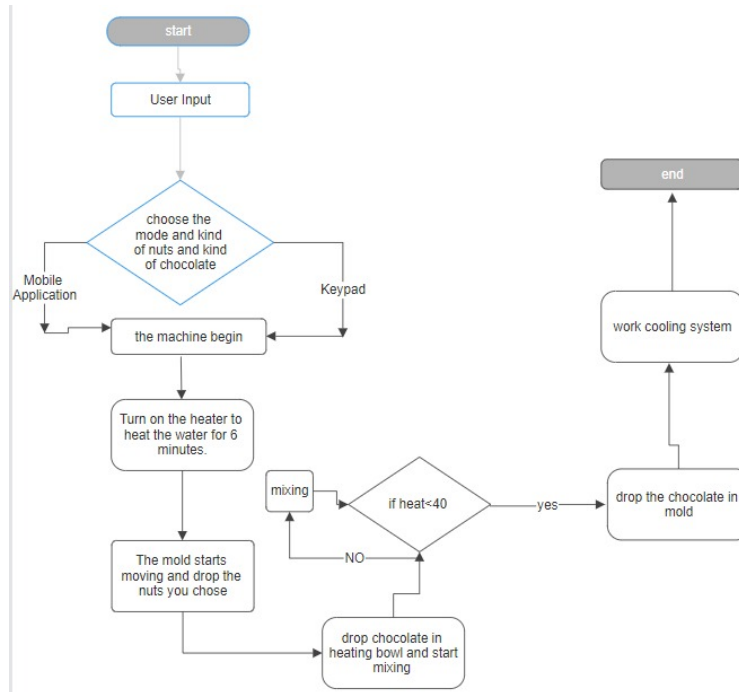


Figure 4.36: Flow Chart

Chapter 5

Results and Discussion

5.1 In Automation:

We were able to accomplish our main objective, which was to show that more than 95 of the chocolate-making process can be automated. Additionally, we wanted customers to be astounded by the final chocolate-making process' accuracy and elegance.

5.2 Resources:

Because raw chocolate is so sensitive, we have encountered a lot of issues with it. The first was when we bought chocolate and traveled to the university in an extremely hot environment. This caused the chocolate to melt repeatedly, rendering it unusable in addition to being expensive. Furthermore, the chocolate also spoiled after being heated for about a minute.

5.3 Motion:

One of our main concerns was movement. When Chocolate moves out of place, it causes difficulty for her son-in-law, and when Dawnload Templete is not in the center of the convey belt, it causes issues. To ensure smooth and effective operation, this required a great deal of mechanical expertise and time.

5.4 Bowl for Heating

It was difficult to find a suitable chocolate melting vessel that could be opened and closed with ease without the need for pricey valves in order to pour the chocolate. We came up with a practical and affordable solution by altering a simple jar to create an automatic opening and

shutting mechanism akin to a linear actuator. In addition, we struggled to build an outer vessel to contain the water surrounding the original vessel to construct a water bath.

5.5 Final Results

The final result was a great success, meeting all our goals and running smoothly in almost every test we conducted.

Chapter 6

Conclusion and Future Work

6.1 Conclusion

6.1.1 Summary

We developed a chocolate production line where users can customize by adding nuts. One of the biggest challenges we faced was handling the chocolate itself because it's so sensitive and can be easily affected during the process. The project might require some adjustments that we were unable to make because of time constraints, lack of expertise, or other factors, but the most crucial thing is that we finished a business project that has a lot of room for improvement and is, hopefully, a step in the right direction. We would love it if someone completed the project and added a small amount of it as a future computer engineering project. Our long-term vision for this project is that it is the first project for a series of projects that add and improve it.

6.2 Improvements

Some design improvements are needed to make it smaller and cover some parts that are not necessary for the user to see.

6.3 Future Work

6.3.1 Add choices of colors

I want to create colored chocolates and add a variety of color options to the system.

6.3.2 More Choices of mold

I want to create chocolate molds in various shapes to offer more variety.

6.3.3 Make it faster

Make the system faster by making a number of molds go on the production line at the same time, for example, when the first mold arrives at the step of casting chocolate, the second mold is in the heating process, and so on.

To do this we must bring a larger production line and make the distances equal between each step and the other.

6.4 Outcome

We've created a smart automated production system that runs smoothly, giving chocolate makers more time and convenience when working with molds and nuts. It adjusts the ingredients perfectly, with no waste or loss, and also makes the process safer for everyone involved

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