AN-NAJAH NATIONAL UNIVERSITY
FACULTY OF ENGINEERING
DEPARTMENT OF COMPUTER ENGINEERING

Graduation Project II

Aromatic Light

PREPARED BY:
Reem Abd Al Raheem Hasan
Farah Faisal Ahmad

SUPERVISED BY:
Dr. Emad Natsheh

PRESENTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR BACHELOR'S DEGREE IN COMPUTER ENGINEERING

9 Sep 2025

Acknowledgments

First of all, we would like to thank our supervisor, Dr. Emad Natsheh, for his continuous guidance and valuable feedback during this project. His support and encouragement were essential to the completion of our work. We also extend our thanks to all the faculty members of the Computer Department for the knowledge and skills they have provided us throughout our academic journey. Finally, we are deeply grateful to our families and friends for their patience, motivation, and unwavering belief in us.

Disclaimer

This project has been prepared by Reem Hasan and Farah Faisal as a partial requirement for the Bachelor's degree in the Computer Engineering Department. The content of this report has not been modified or corrected by anyone, as it will be evaluated solely by the professors of An-Najah National University. It should be noted that An-Najah National University holds no responsibility for any statements, results, or conclusions presented in this report.

Contents

List of Figures

Abstract

This project involves an automated unit for producing customized scented candles with the aim of simplifying and speeding up traditional craftsmanship methods. In addition to the increasing demand for decorative and calming candles, the proposed machine provides a practical solution for creating personalized handcrafted candles in an easy and efficient way.

The system enables the user to select the number of molds (up to three at a time), the type of wax (two available options), colors (two color dyes), and scents (two fragrance options). The process begins by melting and blending the chosen wax with the selected color dye until the mixture is smooth and consistent. Afterward, the selected scent is added and mixed again to achieve the desired fragrance intensity. The final mixture is then poured into the molds. To accelerate the cooling and solidification process, a ventilation system is integrated to provide effective airflow around the molds.

Unlike commercial machines designed for large-scale production, this project is tailored for individual users and small-scale businesses. Its customizable automation features allow users to experiment with various combinations of wax, colors, and scents while ensuring consistency and quality. The project provides a modern and flexible solution that supports both hobbyists and entrepreneurs interested in candle-making.

Chapter 1

Introduction

Recently, there has been an increase in home-based handmade works, and candle-making has become one of the most common. From this point, the idea of designing a machine emerged to make the process easier and faster. Such a device will help women create candles with different scents and colors without spending long hours or much effort.

1.1 Problem Statement

The difficulty lies in the traditional way of making candles, which requires melting wax, mixing colors, and adding scents by hand. This method is time-consuming and exhausting, and the results are often inconsistent. The proposed machine solves these problems by saving time, reducing effort, and providing safe and efficient production with better quality and precision.

1.2 Objectives

The main objective of this project is to design and build an automated machine that produces candles by controlling the required quantities and steps without the need for full manual work. This will make the candle-making process faster, safer, and more efficient.
This machine introduces several features as follows:

1. Choosing the number of molds (up to three) for candle production.
2. Selecting the type of wax from two available options.
3. A heating system to melt the wax and keep it at the proper temperature.
4. A mixing system to blend the wax with the chosen colors and fragrances.
5. Color selection system that allows the user to choose either one of two dyes or a mixture of both.

6. Fragrance selection system that provides two scent options.
7. Pouring system to fill the molds with precision.
8. Ventilation system using fans to cool and solidify the candles quickly.

1.3 Scope of Work

1. Control the quantities of wax, dyes, and fragrances according to the user's choice.
2. Develop a sequential process that ensures proper heating, mixing, and pouring of materials.
3. Provide an option for color customization: either selecting one dye or combining both.
4. Provide a ventilation stage for cooling the molds after pouring.
5. Test and validate the performance of the system to guarantee quality and safety.
6. Create an interface that allows the user to select the number of molds, type of wax, color, and scent easily.

1.4 Significance

The increasing popularity of home-based candle-making reflects a growing interest in creative and handmade crafts, particularly among women. Traditional candle-making processes are often time-consuming, labor-intensive, and require careful handling of hot wax, which can pose safety risks and limit productivity.

This automated machine provides an innovative solution by allowing users to produce candles with customized colors and fragrances effortlessly. By automating the melting, mixing, and pouring stages, it not only saves time and reduces physical effort but also ensures consistency in the final product.

In addition to improving efficiency and safety, the system empowers women to expand their small-scale businesses and pursue creative experimentation. It supports economic growth by enabling higher production capacity while maintaining quality. Moreover, by minimizing direct contact with hot materials, the machine enhances workplace safety, reducing the likelihood of accidents and long-term strain. This innovation bridges traditional craftsmanship with modern technology, offering a practical and flexible tool for hobbyists and entrepreneurs alike, fostering both personal development and professional opportunities.

1.5 Organization of the report

The report begins with the introduction, which includes the problem statement, project objectives, scope of work, and the significance of the study. This section explains to the reader what the project is and why it was undertaken.

The second chapter discusses the limitations and challenges that we faced during the project, as well as the standards followed and the software tools used for coding and application development. It also highlights relevant previous coursework that helped us complete the project.

The third chapter contains the literature review, covering previous studies, related works, and findings that provide a scientific background and better understanding of the context of the project.

The fourth chapter focuses on the methodology, describing the overall project structure, the components used, the electronic hardware, and a detailed explanation of how the system operates. This chapter gives the reader a clear idea of how the project was implemented and its step-by-step process.

The fifth chapter presents the results and analysis, followed by the final chapter, which includes the conclusion and discussion, summarizing the project, presenting key outcomes, and suggesting potential future improvements or extensions.

Chapter 2

Constraints and Earlier Coursework

2.1 Constraints and limitations

1. Determining the correct ratios of wax, colors, and fragrances using syringes was challenging. The syringes were fixed on a wooden frame, while the wax containers and pumps connected to them were placed on a rotating circular platform to deliver the ingredients accurately into the molds.

2. Ensuring proper insulation of all connections between the syringes, wax containers, and pumps to prevent leaks or electrical short circuits.

3. Finding a temperature sensor capable of accurately detecting high temperatures was difficult, which affected the heating process.

4. Securing the syringes on the fixed wooden frame to prevent vibrations during operation.

5. The heater remained fixed, while the molds moved beneath it to receive the mixture precisely, ensuring proper filling without spillage or disturbance.

2.2 Standards / Codes

- We developed our code using the Arduino IDE, enabling us to control the hardware via the Arduino platform.
- For communication, we utilized MQTT as our protocol, enabling clients to control the device through a specialized mobile application.
- We created the mobile application using the App Inventor platform that providing the ability for the users to control the system remotely.

2.3 Earlier Coursework

- Microprocessor and Microcontroller courses, we gained a knowledge of how to control the hardware components in our project.

- Critical Thinking course, which helped us conduct research on various topics and improved our skills in documentation and report writing.

- Wireless and Networks courses, which played a vital role in understanding communication between nodes, assisting us in connecting the application to our system via ESP and Arduino.

- Electronics course, which provided guidance on different aspects of electronic systems and technologies.

- Self-learning, through YouTube Arduino tutorials and various research papers, which helped us gain practical knowledge and solve implementation challenges.

Chapter 3

Literature Review

In recent years, there has been growing interest in small-scale home-based industries, particularly in creative crafts such as candle-making. This trend reflects the desire for personalized and unique products, as well as the flexibility of working from home, making it especially suitable for women seeking to combine creativity with economic activity.

One of the main challenges in handmade candle production is achieving precision in handling materials while ensuring product quality. The process requires melting wax, blending colors, adding fragrances, and carefully pouring the mixture into molds to produce consistent and attractive candles. Traditional methods are often labor-intensive and time-consuming, and handling hot wax carries safety risks if proper precautions are not taken.

Automation has emerged as an innovative solution to these challenges. Studies on automated systems in home-based industries have shown that technology can reduce manual effort, increase process accuracy, and ensure consistent product quality.in candle-making, automation allows precise control over wax temperature, color and fragrance blending, and accurate pouring into molds, reducing both the time and effort required while enhancing overall productivity.

Furthermore, economic empowerment of women is a significant benefit of such innovations. Increased productivity and product quality enable women to compete in the market, explore new designs, and achieve additional income in a safe and organized manner. Automation not only simplifies the production process but also creates a safer working environment and fosters personal creativity.

In conclusion, although handmade candle production requires significant skill and effort, integrating automated systems provides innovative solutions that enhance safety, improve efficiency, and support creative and sustainable production. This opens new economic and creative opportunities for users.

Chapter 4

Methodology

4.1 System Structure

4.1.1 External structure of Candel making machine

The external structure of the candle making machine was designed mainly from wood, to facilitate cutting, drilling, and fixing the different components used in the project.On the top, there is a rotating circular platform that holds two wax containers together with the pipes for color and fragrance. These components rotate in sequence until they reach the heating section, where the wax is melted and mixed with the additives. Finally, the melted wax is poured into the molds placed at the end of the machine. Figure 4.1 illustrates the SolidWorks design of the project, showing all dimensions and how the frame and mechanisms are arranged.

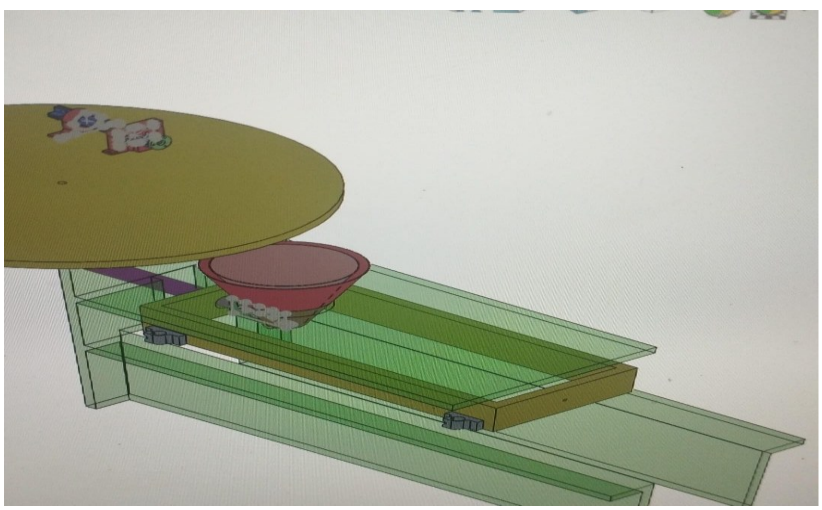

Figure 4.1: Machine frame design.

And after designing the frame,we made it to wood frame on a carpentry as shown in figure 4.2

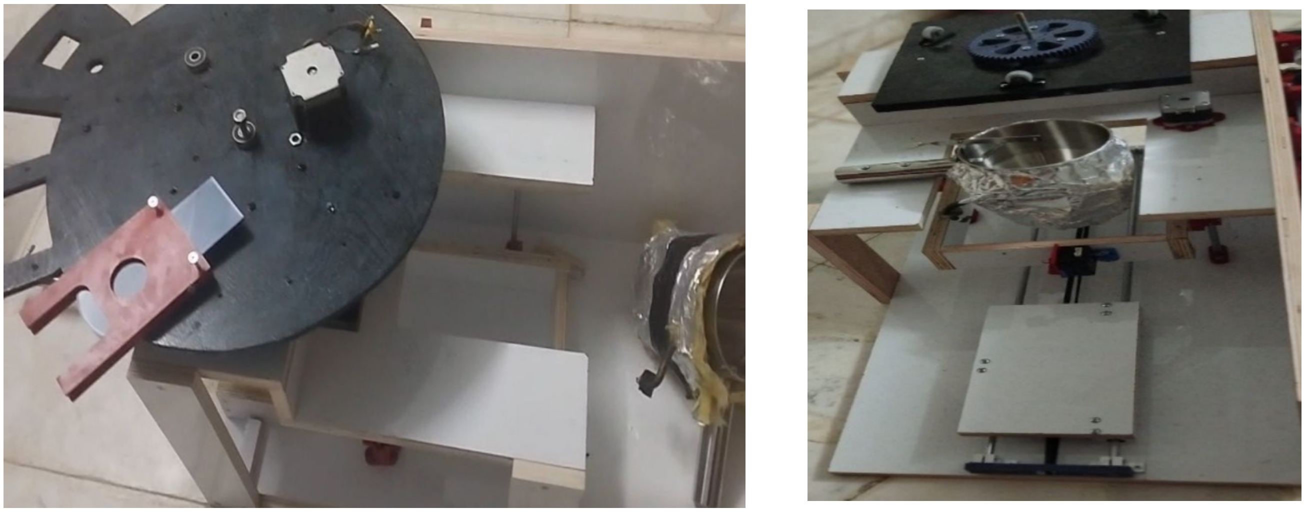

Figure 4.2: Machine frame

4.1.2 Control system

The candle-making machine is equipped with an electronic control unit that enables the user to fully customize the production process. The first step is to select the number of molds (1, 2, or 3), with each mold capable of holding approximately 86 grams of solid wax. Based on this selection, the system automatically determines the total amount of wax required for melting.

Next, the operator can enrich the candles with additives. Two types of colors and two types of fragrances are available. The user can choose the desired proportion of each additive, with the option to create color mixtures for more variety. These selections are precisely dispensed at the right stage of the process using syringes.

All operations are controlled through a keypad connected to an LCD screen. The screen provides clear, step-by-step instructions, guiding the user until the machine successfully completes the requested batch of candles.

Figure 4.3: control system

4.1.3 Wax Container Positioning and Dispensing Control

In this stage, the motor rotates the rotary disk until the magnet fixed on the disk passes in front of the Hall Effect sensor. At this point, the system detects the Home Position and sets it as the main reference for movement. After determining this position, the controller calculates the required number of steps for the stepper motor to move any selected wax container directly under the heater. Once the container is in place, the servo is activated to control the amount of wax released, which varies depending on the number of selected molds.

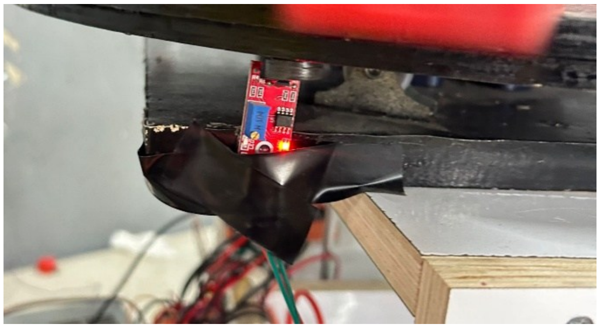

Figure 4.4: Wax Container Positioning

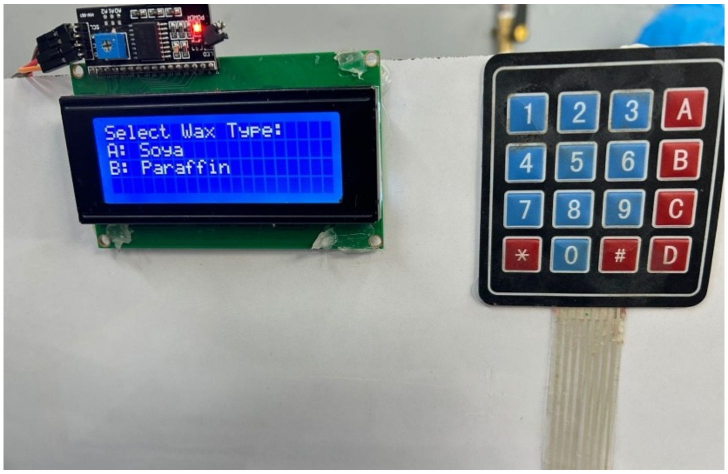

Figure 4.5: Wax Container Positioning

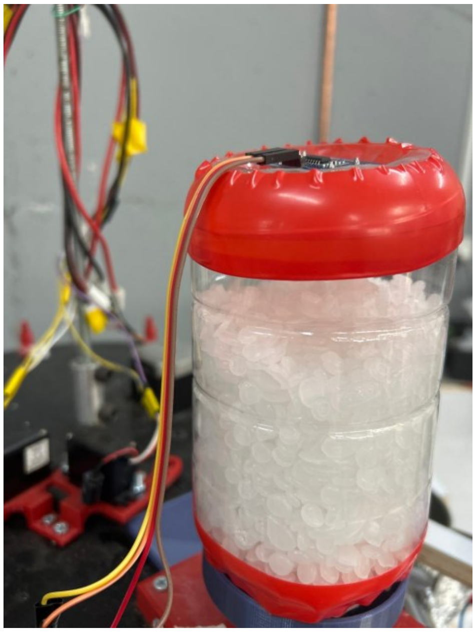

Figure 4.6: Wax Container Positioning

4.1.4 Wax Heating and Temperature Control

In this stage, the wax is heated until it fully melts and becomes a liquid ready for pouring into the molds. The temperature is precisely controlled using a thermal sensor, so that if it reaches 200°C, the system automatically turns off the heater to prevent the wax from burning or being damaged. Once the temperature drops, the system turns the heater back on to continue heating. This on/off cycling continues automatically for 15 minutes to maintain the wax in a proper liquid state without exceeding the maximum temperature.

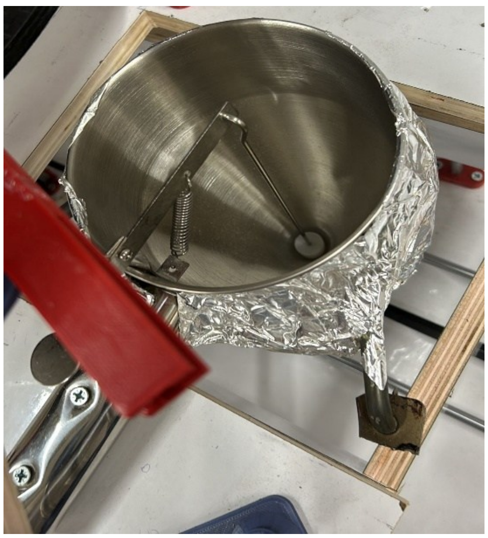

Figure 4.7: Wax Heating

Figure 4.8: Wax Heating

4.1.5 Adding colors

In this stage, the rotary disk moves to the position of the selected color and stops under the heater. Then, the color is dispensed at a predetermined ratio to ensure the desired color is achieved in the wax.

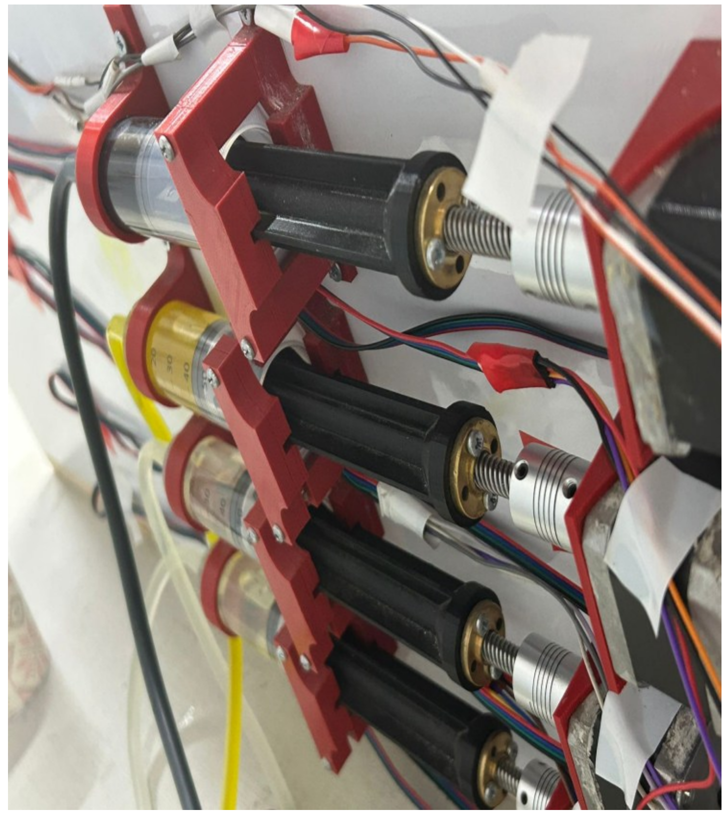

Figure 4.9: Adding colors

4.1.6 Mixing Stage

After adding the colors, the rotary disk moves until the mixer is positioned under the heater. The elevated mixer then lowers into the heater and stirs the wax with the color for 10 seconds to ensure a homogeneous mixture. After mixing, the mixer is raised back to its original position.

Figure 4.10: Mixing down

Figure 4.11: Mixing up

4.1.7 Adding smell

In this stage, the rotary disk moves to the position of the selected fragrance and stops under the heater. Then, the fragrance is dispensed at a predetermined ratio to ensure the desired scent is achieved in the wax. The wax temperature is kept relatively low to prevent the fragrance from evaporating and to maintain its quality.

Figure 4.12: Adding smell

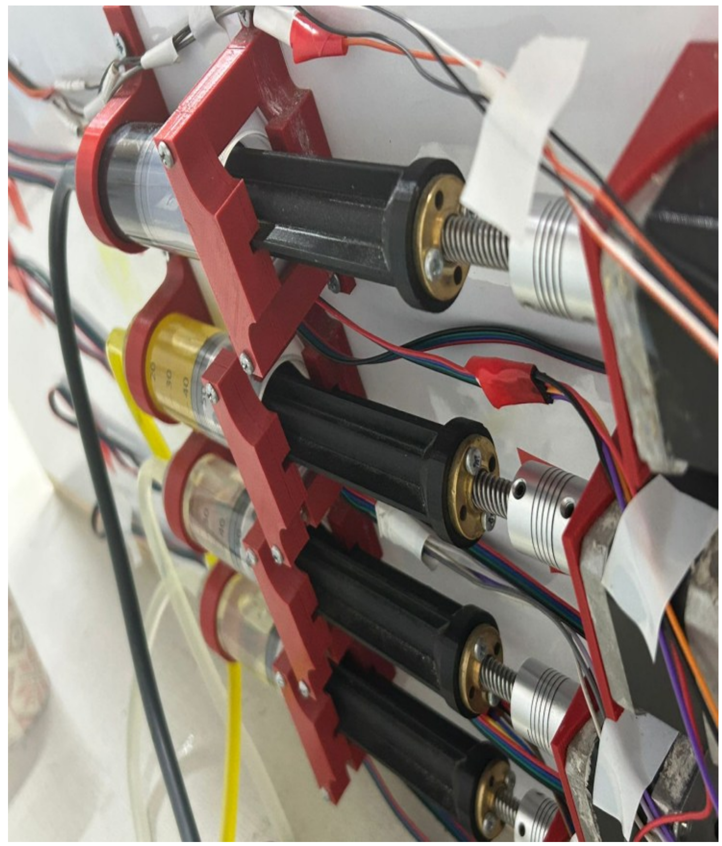

Figure 4.13: Adding smell

4.1.8 mixing smell

After adding the fragrance, the rotary disk moves until the mixer is positioned under the heater. The elevated mixer then lowers into the heater and stirs the wax with the fragrance for 5 seconds to ensure a uniform mixture. After mixing, the mixer is raised back to its original position.

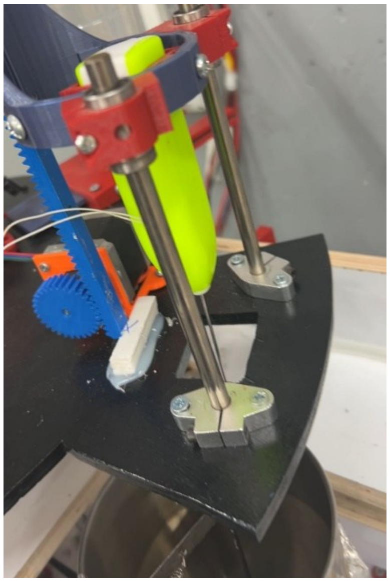

Figure 4.14: Mixture casting process

Figure 4.15: Mixture casting process

4.1.9 Mold Positioning Stage

In this stage, the molds move linearly until they are positioned under the heater. Each mold stops automatically when the laser beam is interrupted on the LDR sensor, ensuring precise placement before pouring the wax.

Figure 4.16: molds in the production line

4.1.10 Pouring & Cooling Stage

After the mold reaches the position under the heater, the stepper motor connected to the heater cover moves upward to open the heater and start the pouring process. Once the wax is poured into the mold, the cover moves back down to close the heater. If there are multiple molds, this process is repeated for each mold to ensure accurate and safe wax pouring. After pouring is complete, the fan is activated, and the molds move back until they reach the fan for cooling.

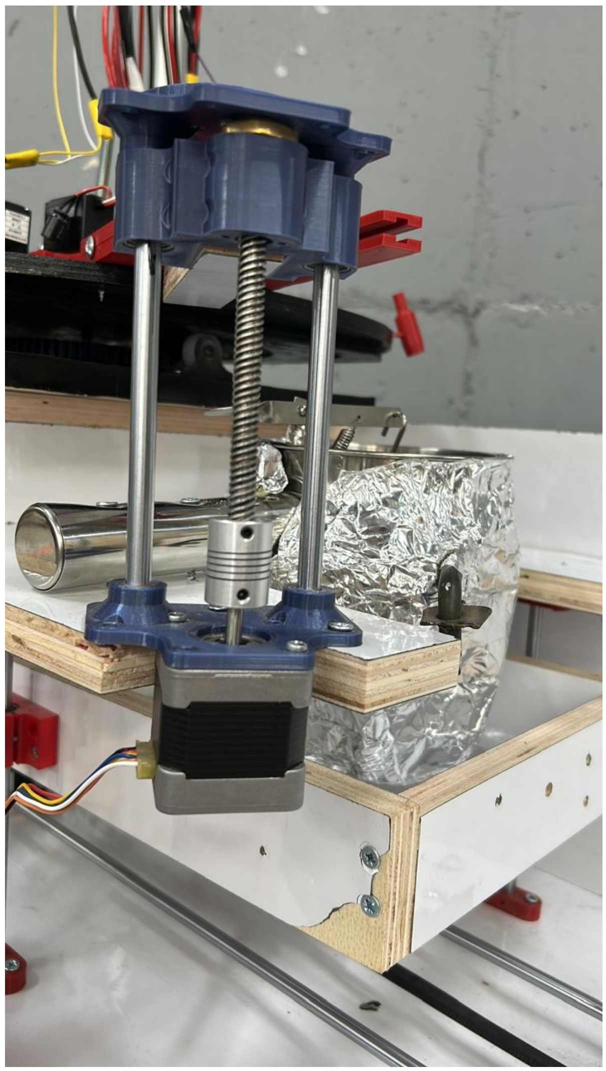

Figure 4.17: stepper moves upward to open

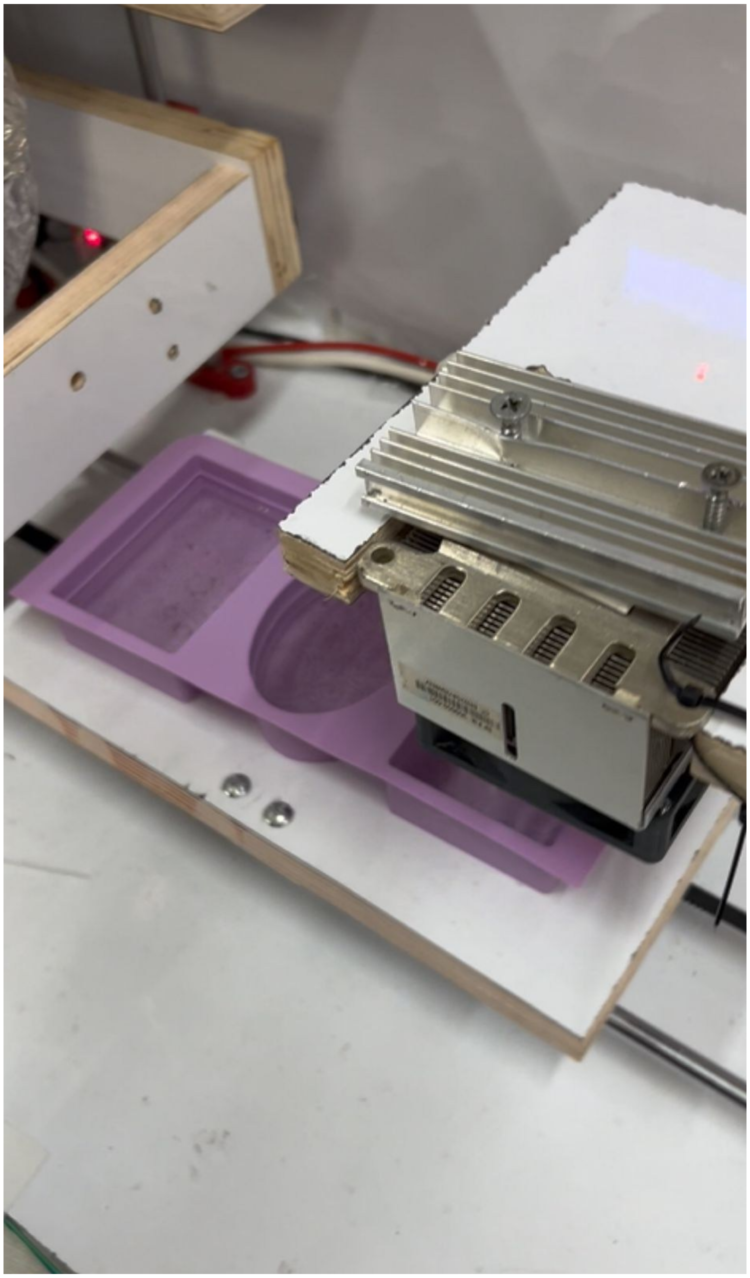

Figure 4.18: Ventilation system

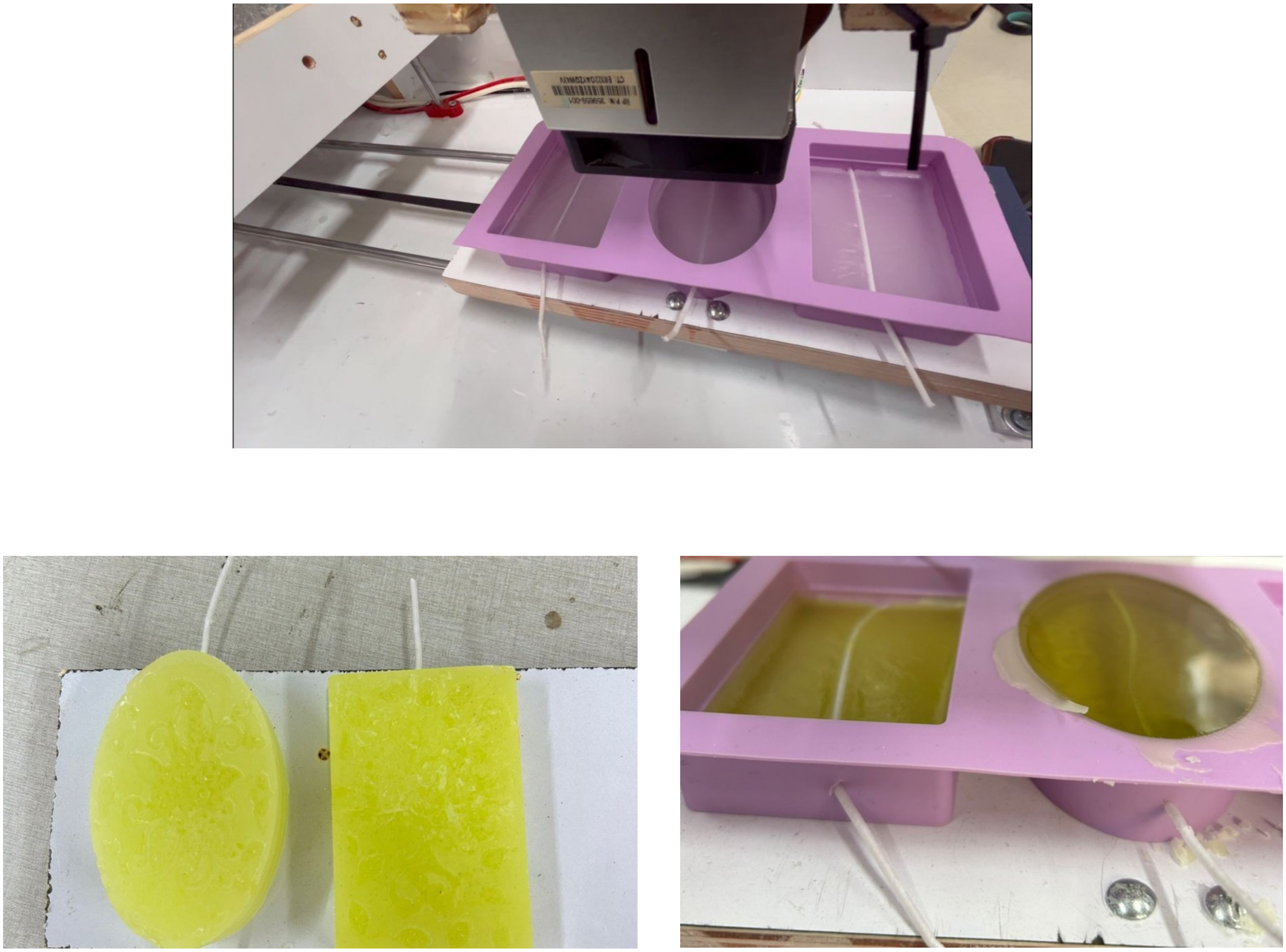

Figure 4.19: Ventilation system

4.2 Hardware components

4.2.1 Arduino MEGA

The Arduino Mega 2560 is a microcontroller board based on the ATmega2560. 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. It also provides 256 KB of flash memory, 8 KB of SRAM, and 4 KB of EEPROM, allowing it to store larger and more complex programs. With its multiple I/O pins and communication ports, the Mega 2560 is ideal for projects involving robotics, automation, or multi-sensor systems. It is fully compatible with the Arduino IDE, making programming and testing straightforward for both beginners and advanced users.

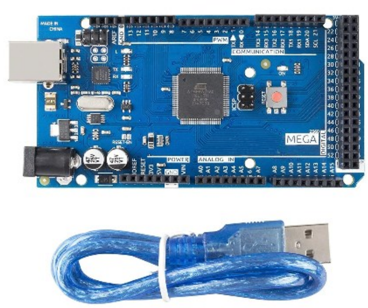

Figure 4.20: Arduino MEGA.

4.2.2 ESP8266 NodeMCU

The ESP8266 NodeMCU is a cost-effective microcontroller board that comes with built-in Wi-Fi capabilities, making it ideal for IoT applications. Based on the ESP8266's Wi-Fi chip, it enables easy wireless connectivity to the Internet or local networks. The board features 11 GPIO pins that can be used to connect sensors, motors, and other external devices, along with PWM support for spe- cific applications. It also includes a micro-USB port for device power and code upload, which can be done through popular programming environments such as the Arduino IDE or Lua. Thanks to its built-in flash memory, the NodeMCU can store necessary programs and data. The combination of Wi-Fi support, ease of programming, and compatibility with a wide range of IoT applications makes the ESP8266 NodeMCU a popular choice for connecting devices to the Internet.[**?**]

Figure 4.21: ESP8266 NodeMCU

4.2.3 Computer Power Supply

A Power Supply Unit (PSU) is an essential component in a computer that delivers the electrical energy required for the system to operate. It takes the high-voltage AC power from the wall outlet and converts it into low-voltage DC power, which is safe and usable by the computer's hardware. Different voltage outputs, typically 3.3V, 5V, and 12V, are supplied to support components such as the CPU, motherboard, graphics card, and storage devices.

The PSU is rated by its wattage capacity, which indicates how much total power it can provide to the system. It is equipped with multiple connectors to match different hardware requirements. Modern PSUs often carry the 80 PLUS certification, showing that they are energy-efficient, and most are fitted with cooling fans to prevent overheating. To protect the system, PSUs also integrate several safety mechanisms, including over-current, over-voltage, and short-circuit protection, ensuring reliable performance and reducing the risk of hardware damage.

Figure 4.22: Power Supply

4.2.4 MAX6675

The MAX6675 is a digital thermocouple-to-digital converter used to measure high temperatures. It interfaces with a K-type thermocouple to accurately read temperature values, making it suitable for monitoring the temperature inside heaters. The sensor provides digital output via SPI communication, which can be easily read by microcontrollers like Arduino for precise temperature control and monitoring.

Figure 4.23: MAX6675 Temperature Sensor

4.2.5 Laser Module

We used a Laser Module, which is a small device that emits a focused red light beam. Lasers in general produce a coherent, monochromatic, and highly directional beam of light. In our project, the laser projects a steady red beam onto the LDR sensor, and when the laser beam is blocked from reaching the sensor, it indicates that the mold has come to a complete stop in its position under the heater.

Figure 4.24: Laser Module

4.2.6 Hall Effect sensor

The Hall Effect sensor is a device that detects the presence of a magnetic field. When a magnet passes near the sensor, it produces a change in voltage that can be read by the microcontroller. In our project, we used the Hall Effect sensor to determine the starting point of the rotating disc. A magnet is attached to the disc, and when it passes in front of the sensor, it sends a signal to the microcontroller indicating that the disc has reached the reference or home position, ensuring precise alignment before any subsequent movement.

Figure 4.25: Hall Effect sensor

4.2.7 NEMA23 stepper motor

A stepper motor is an electric motor that moves in precise steps according to electrical signals sent to it, allowing accurate control of position and speed without the need for external sensors in most applications. It can hold its position precisely when stopped and can move heavy loads with high precision.in our project, we used a NEMA23 stepper motor to rotate the platform that holds the wax containers, fragrances, color syringes, and the mixer, providing the necessary power and accuracy to move these heavy components reliably and repeatably during operation.

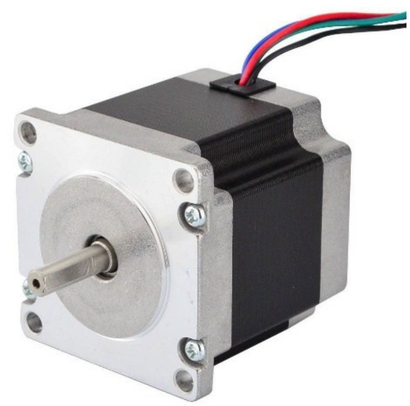

Figure 4.26: NEMA23 stepper motor

4.2.8 LDR Sensor

The LDR sensor, also known as a photoresistor, is a passive electronic component that changes its electrical resistance depending on the amount of light it receives. Its resistance drops when exposed to light and rises in darkness. In our project, the LDR was utilized to sense the presence of the mold; when the light to the sensor is blocked, it indicates that the mold is precisely positioned under the heater.

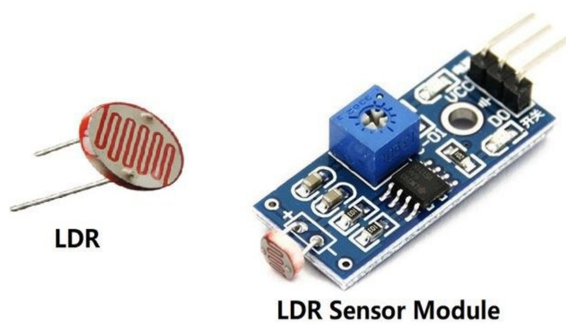

Figure 4.27: LDR Sensor

4.2.9 NEMA 17 Stepper Motor

The NEMA17 stepper motor is widely used due to its compact size and high torque output, making it ideal for applications that require precise and controlled movements. It completes a full rotation in 200 steps, giving each step an exact angle of 1.8 degrees, which allows for highly accurate positioning.

Each coil can handle up to 3.5 A, and the motor can operate with a voltage range of 3 to 12 V. This makes it perfect for tasks that need precision, such as moving molds, opening and closing the heater to pour wax into the molds, and controlling syringes containing colors and fragrances to ensure accurate placement of materials.In short, the NEMA17 motor combines compactness, precision, and sufficient torque, making it suitable for a wide range of mechanical systems that require reliable and repeatable motion control.

Figure 4.28: Stepper Motor

4.2.10 SG37BL-A DC Brushless Gear Motor

The DC motor converts electrical energy into rotational motion.

In our project, we used it to operate the mixer for blending the wax inside the heater.

Figure 4.29: DC Motor

4.2.11 TB6600 Stepper Motor Driver

The TB6600 Stepper Motor Driver is a control unit that drives stepper motors by receiving Step and Dir signals from a controller, enabling precise movement. It supports microstepping for smoother and more accurate motion and allows current adjustment to safely drive heavy motors.in our project, we used the TB6600 to control the NEMA23 stepper motor, moving the rotating platform that holds the wax containers, fragrances, color syringes, and the mixer with high precision and power.

Figure 4.30: TB6600 Stepper Motor Driver

4.2.12 Micro Limit Switch

I used micro limit switches to determine the number of steps of the stepper motor controlling the molds and to stop it when reaching the end, ensuring precise control of the mold movement.

Figure 4.31: Limit Switch

4.2.13 A4988 driver Stepper Motor Driver

I used the A4988 stepper motor driver, a complete micro-stepping driver with a built-in voltage converter. It operates between 8 V and 35 V and can supply up to about 1 A per phase, with higher currents achievable if additional cooling is provided. I paired it with a 100 µF capacitor for stable operation.

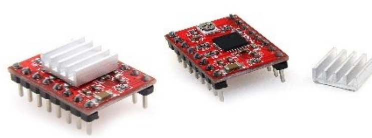

Figure 4.32: A4988 driver Stepper Motor

4.2.14 Relays

A relay is an electrically controlled device that can open or close electrical circuits. In our project, we used relays to control the operation of the heater, the mixer, and the fan, enabling us to turn them on or off safely and efficiently according to the system's requirements.

Figure 4.33: Relay

4.2.15 Stainless Steel Rods

Stainless steel round bars are utilized in the manufacture of structures, appliances, and machinery. We used it to put the heater above it to move on also the belayas.

Figure 4.34: Stainless Steel Rods

4.2.16 4 x 4 Matrix Keypad

The 4 × 4 matrix keypad module is a simple input device consisting of 16 keys arranged in a grid. Each row and column of keys is connected to separate pins, allowing the microcontroller to detect which key is pressed. In our project, we used this keypad as the main control interface of the machine, enabling the user to select the type of wax, the number of molds, the color, the fragrance, and the proportion of each color and fragrance.

Figure 4.35: 4 x 4 Matrix Keypad

4.2.17 Intercom Wires

We used them for wiring and connecting different components together.

Figure 4.36: Intercom Wire

4.2.18 Arduino Wires

To be able to connect the components to the Arduino.

Figure 4.37: Arduino Wires

4.2.19 Servo motor

A servo motor is a type of electric motor that allows precise control of its rotation angle within a limited range, typically between 0° and 180° or more depending on the type. Unlike stepper motors, it can move quickly and stop accurately at the desired angle without the need for an external sensor in most applications, as it usually contains an internal control circuit to maintain the shaft’s precise position.in our project, we used this servo to open and close the dispenser responsible for releasing wax into the molds. The servo precisely controls the movement of the valve or arm that allows the wax to flow or stops it, providing smooth and accurate control over the amount of wax dispensed.

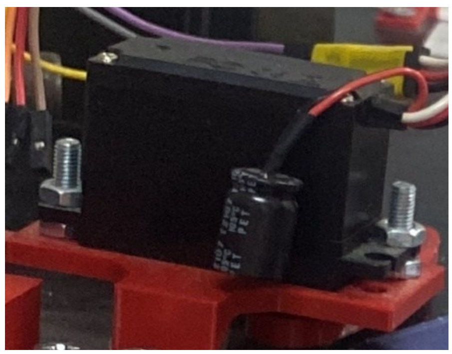

Figure 4.38: Servo motor

4.2.20 20x4 LCD screen

The 20×4 LCD screen is a common display for text and numbers, capable of showing 20 characters per row across 4 rows. It is widely used in electronic projects and devices to present information in a clear and organized manner. In our project, the LCD screen is used to display all the options for making wax, including wax type, color, fragrance, number of molds, and the proportion of each color and fragrance, as well as to show machine statistics and real-time operational status.

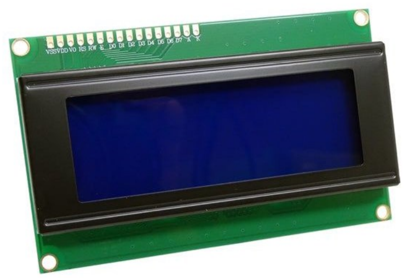

Figure 4.39: LCD Screen

4.2.21 I2C LCD Driver

The I2C LCD Adapter is a module designed to operate an LCD screen using only two data pins instead of multiple pins. It communicates with microcontrollers, such as Arduino, via the I2C protocol. Normally, an LCD requires six or more data pins, which can limit the number of sensors and modules connected at the same time. This adapter reduces the number of pins needed, making the project easier to manage. It also allows multiple I2C-compatible devices to share the same communication line and work simultaneously.

Figure 4.40: I2C LCD Driver

4.2.22 Capacitor

We also used a 100 µF capacitor connected to the A4989 stepper motor driver. The capacitor helps stabilize the power supply and smooth out voltage fluctuations, ensuring reliable operation of the stepper moto.

Figure 4.41: capacitor

4.2.23 Stainless Can with Heater

The stainless can is a heat-resistant container made of stainless steel, designed to withstand high temperatures without corrosion or damage. It is equipped with an electric heater rated at 220V, which provides uniform heating throughout the container.in our project, this component is used to melt the wax safely and efficiently. The stainless steel material ensures durability, easy cleaning, and prevents contamination of the wax, while the 220V heater allows for fast and consistent melting. By maintaining stable heat, the system ensures the wax reaches the desired liquid state for pouring into molds without overheating or burning.

Figure 4.42: Stainless Can with Heater

4.2.24 Fan with Heatsink and Cooler

A fan with a heatsink and cooler is a cooling system designed to remove heat efficiently from hot surfaces or materials. The heatsink, usually made of aluminum or copper, absorbs and spreads heat away from the source, while the fan blows air over it to accelerate the cooling process. Combined together, they form a cooler that maintains lower temperatures and prevents overheating.in our project, we will use this system to cool the wax after it has been poured into the molds. The heatsink ensures even heat distribution, while the fan speeds up the cooling, allowing the wax to solidify faster and more uniformly. This improves the efficiency of the production process and ensures the wax is ready for use in a shorter time.

Figure 4.43: fan with a heatsink and cooler

4.2.25 3d printer

In this project, several components were fabricated using 3D printing. These include the base gears, the syringe holder with its extension, the circular body holder of the syringe, and the linear guide with a through-hole. The design also incorporates the top and base of the wax dispenser, along with the slider and its can. Additionally, stepper motor holders and servo holders were printed, as well as a motor holder with power nut housing. The set is completed with a side belt and multiple nozzles.

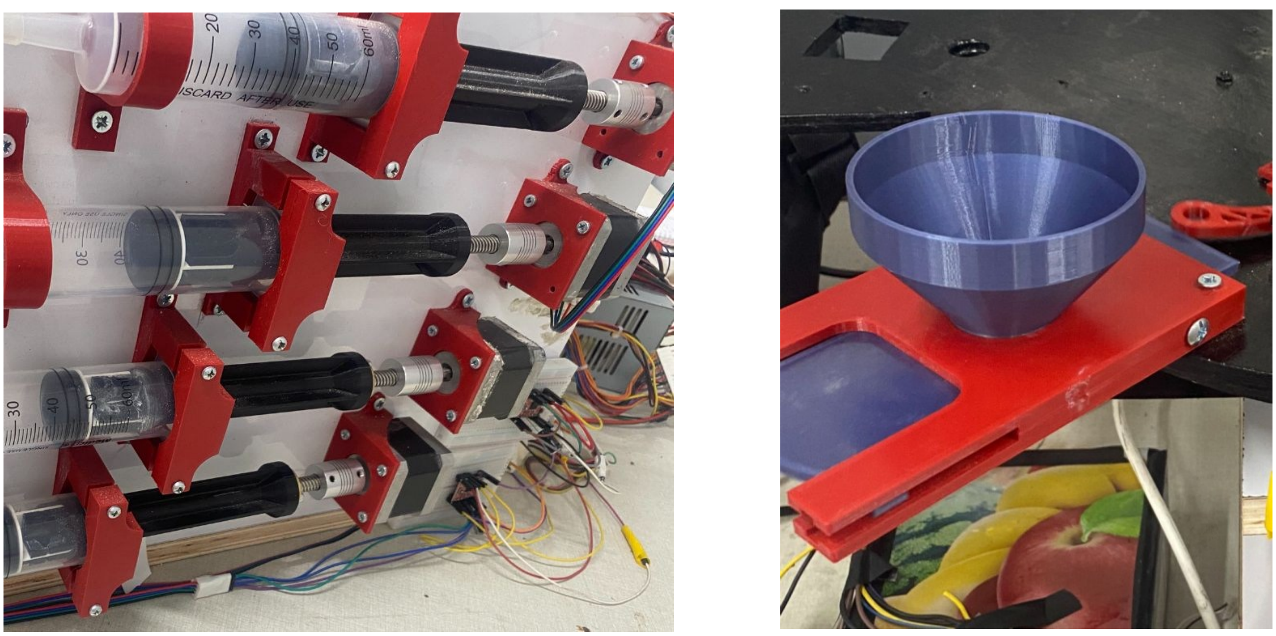

Figure 4.44: 3d printer

4.3 Mobile Application

The system works hand in hand with an application that enables remote control by the owner. This application is built on seven simple yet powerful interfaces, as follows:

4.3.1 Start page

Figure 4.45: Start page of application

From this page, the user can either make an order or access machine statistics with a single click.

4.3.2 Make an order page

Figure 4.46: Make an order page of application

This page lets the admin start by selecting the number of molds (one, two, or three). After that, the user chooses the type of wax (Soy or Paraffin). Once the wax type is confirmed, the system navigates to the next page for color selection.

4.3.3 Choosing colour page-GRB

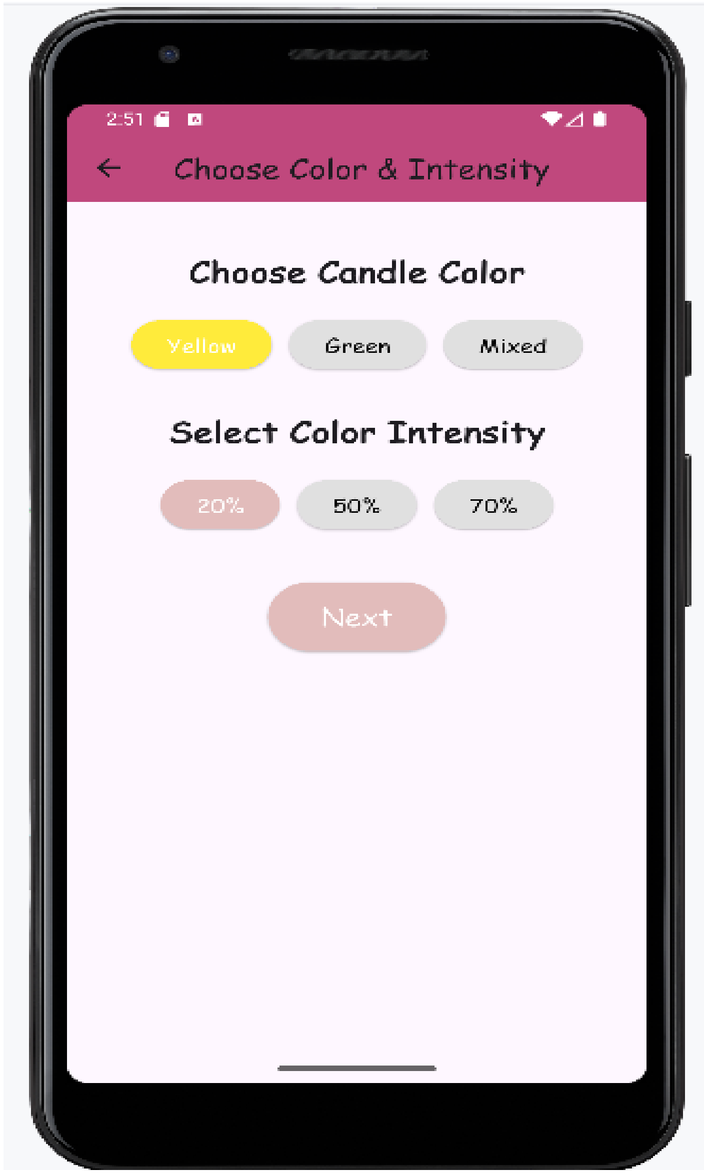

Figure 4.47: Choosing colour page-GRB of application

This page allows the owner to select the color for the candle. The RGB system is used, and the owner can choose one of the two colors or a mix of both. The desired color ratio can also be specified: 20%, 50%, or 70%.

4.3.4 Determining the smell page

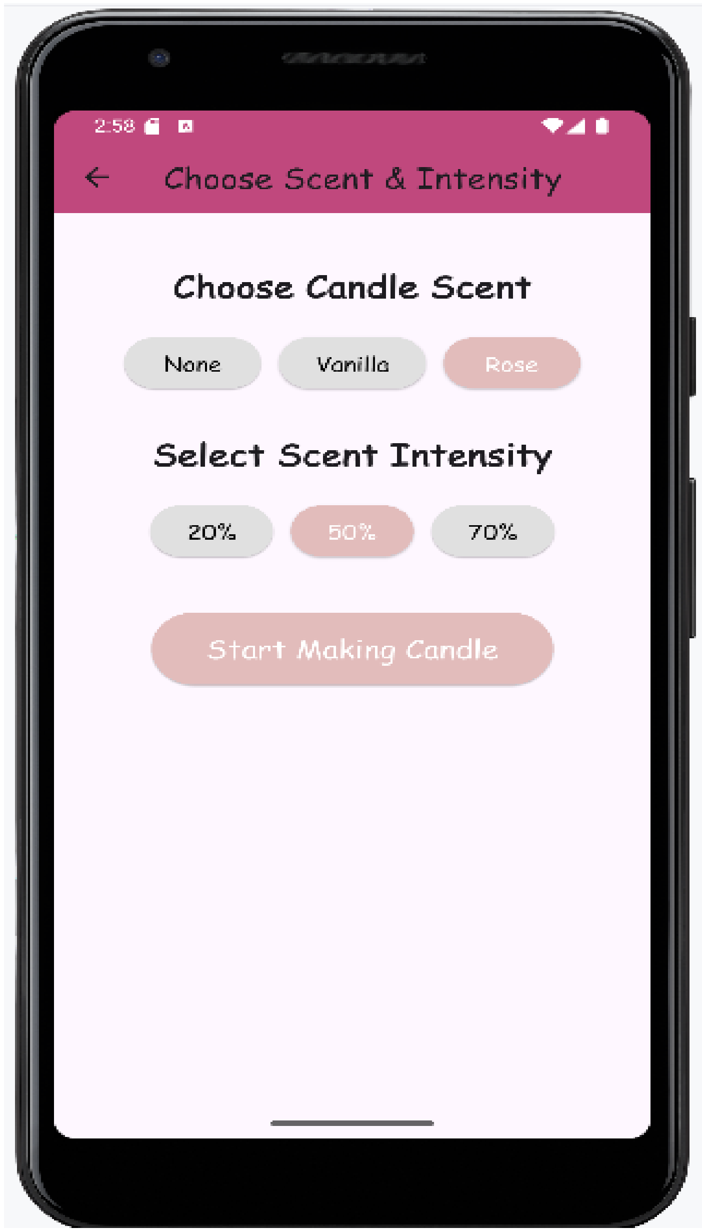

Figure 4.48: Determining the smell page

On this page, the admin decides whether to add a scent to the candle or leave it unscented. If a scent is chosen, the intensity can be set to 20%, 50%, or 70%. Pressing the ‘Start Making Candle’ button will then begin the final production step.

4.3.5 Starting process page

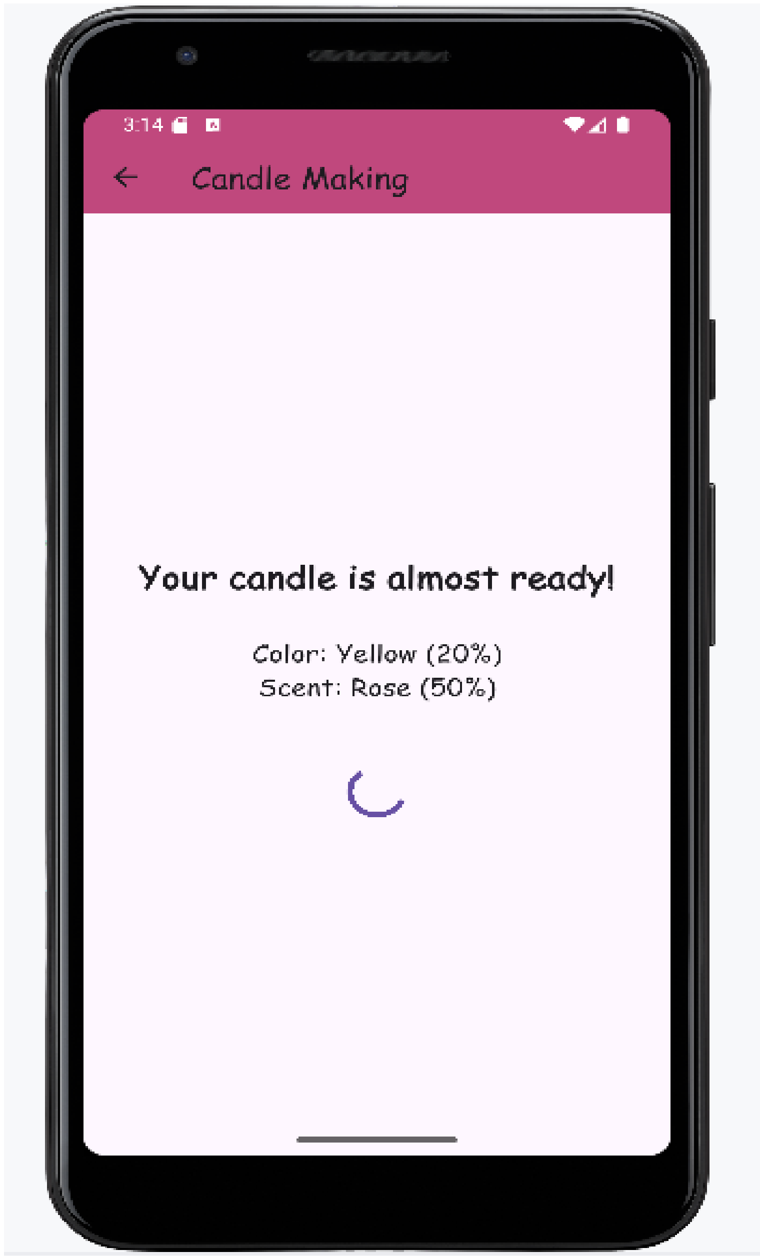

Figure 4.49: Candle Ready Overview

Here's a summary of your candle choices — everything is set, and your candle is almost ready!

4.3.6 Machine statistics page

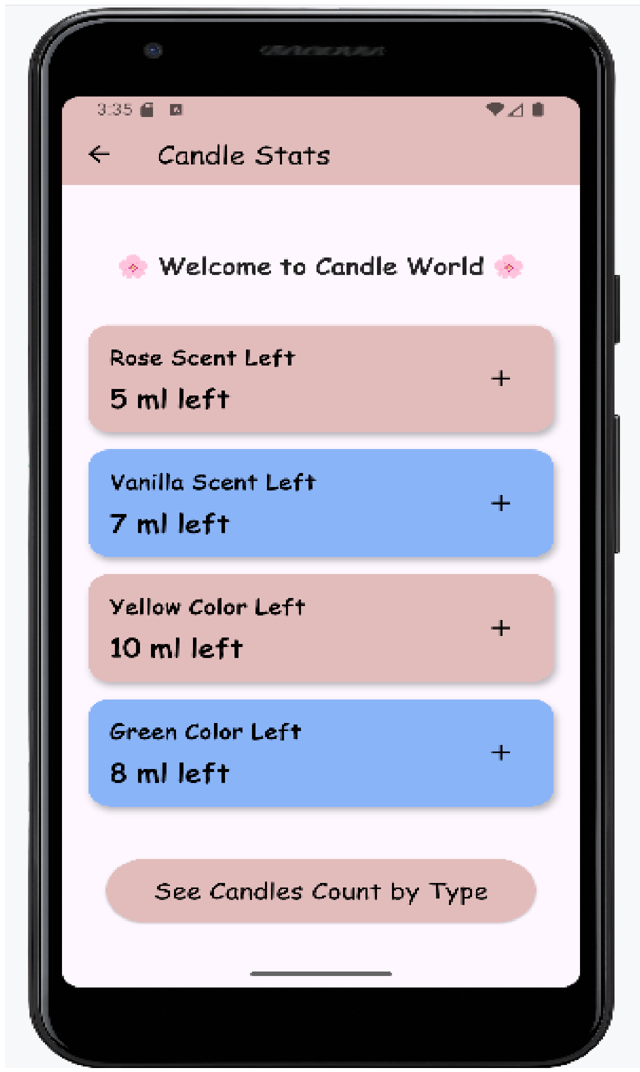

Figure 4.50: Machine statistics of application

This page shows the remaining amounts of each ingredient — the first and second colors, and the first and second scents. Extra supplies can be added if needed. The 'Candle Count' option lets you see how many candles have been produced so far.

4.3.7 Candel count for the machine

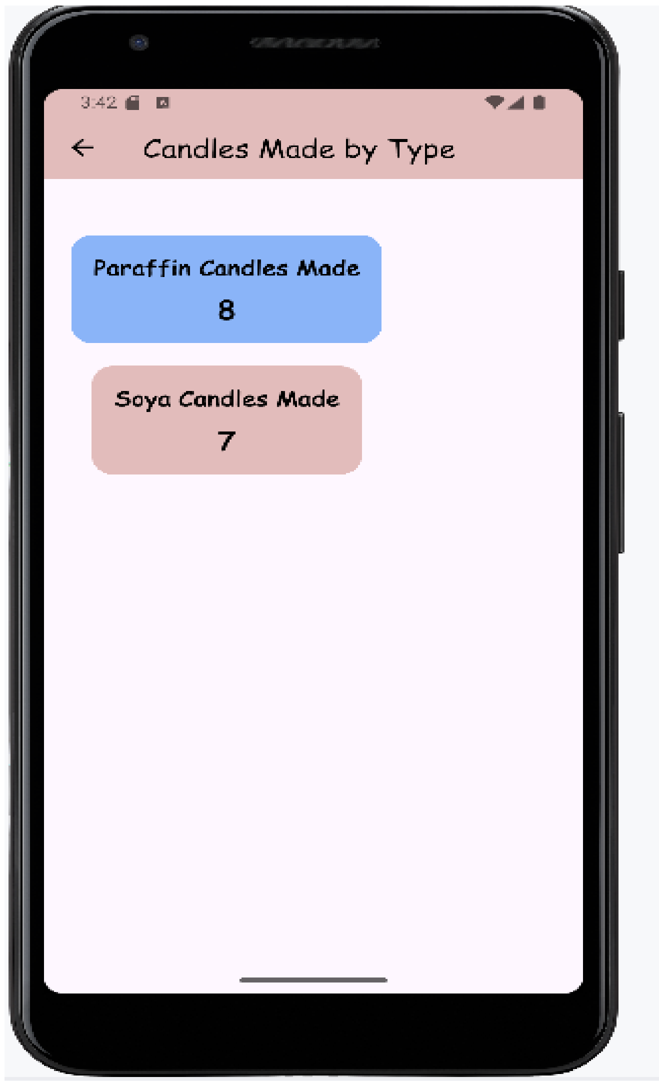

Figure 4.51: Status page of application

This page displays the number of candles produced, separated by type: how many Paraffin candles and how many Soy candles have been made.

4.4 How the system works?

When the Arduino Mega and ESP8266 are powered on and successfully connected to the Wi-Fi network, the system becomes ready for operation. At this point, all components remain in an idle state, waiting for the user to make a selection from the application. The candle-making workflow is carried out in a structured sequence of phases as described below:

4.4.1 Start the system (Wax Positioning, Heating, Coloring, Mixing, Pouring, Cooling)

When the user chooses the start option from the application, the system begins by positioning the wax container. The wax is then heated until it reaches the required temperature. Afterward, colors are added and mixed thoroughly to ensure uniformity. Once the mixture is prepared, fragrance is introduced and blended. Finally, the mold is positioned, the wax is poured, and the cooling phase starts until the candle is ready.

4.4.2 Ingredient Selection and Preparation

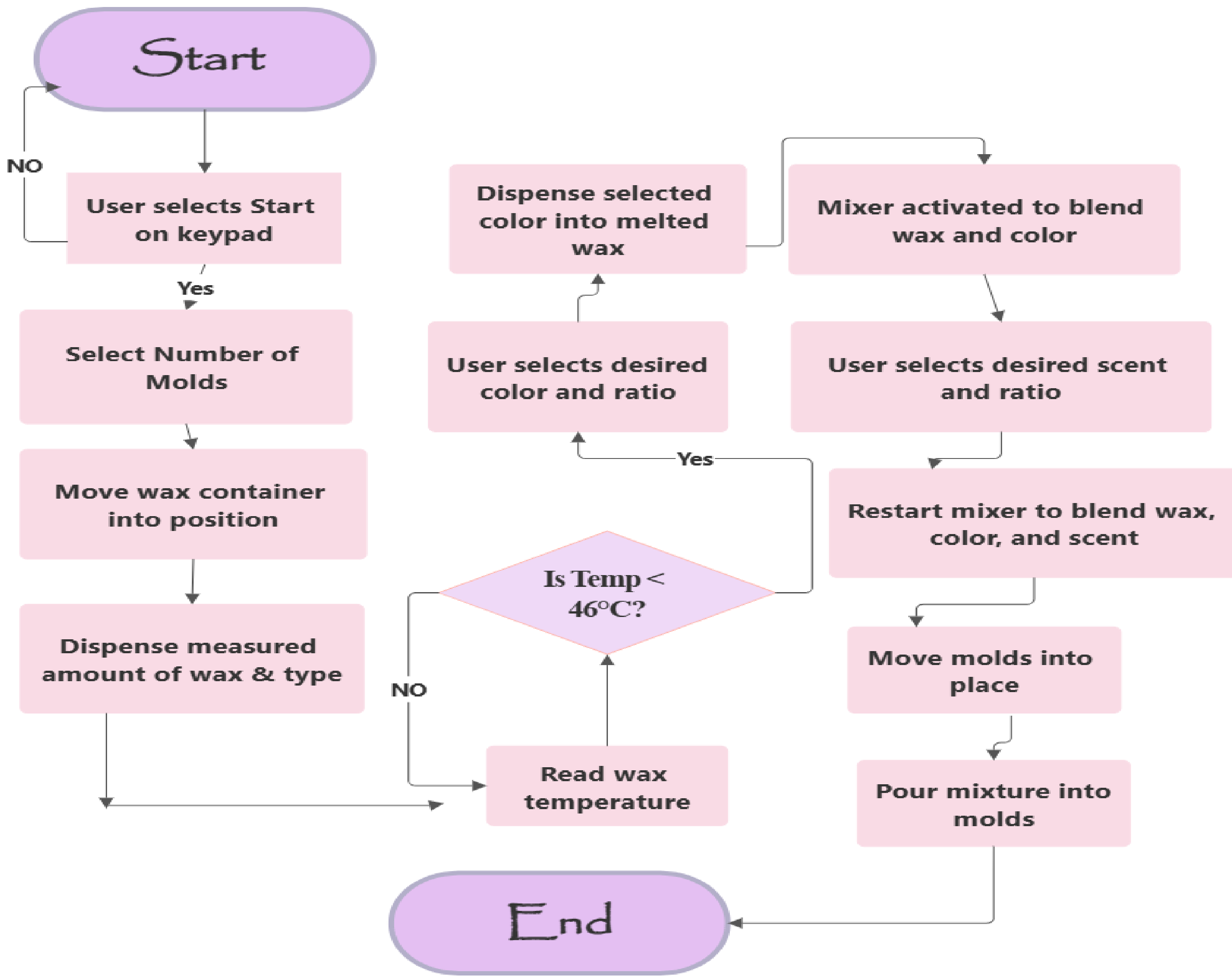

Figure 4.52: Making order Flow chart

- Start

- User Input on Keypad
- Move wax container into position.
- Dispense measured amount of wax into heating chamber.
- Read wax temperature.
- Is Temp < 46°C ?

- User selects desired color and ratio (20%, 50%, 70%).
- Dispense selected color into melted wax.
- Mixer activated to blend wax and color.
- Sensors check homogeneity.
- Select fragrance (Scent A or Scent B).
- User chooses ratio (20%, 50%, 70%).
- Dispense fragrance into mixture.
- Restart mixer to blend wax, color, and scent.
- Sensors ensure uniform mixture.
- Move molds into place.
- Pour mixture into molds.
- Activate ventilation system for cooling.
- Wait until candles solidify.
- End – Candle Ready

Chapter 5

Results and Discussion

In this section, we dive into the journey of the candle-making machine, revealing how it transformed the traditional candle-making process into something faster, safer, and full of creative possibilities. From the very beginning, our goal was to make the process more enjoyable and less exhausting, and with each trial of the machine, we discovered impressive results in terms of time, effort, and quality.
The first noticeable benefit was the significant saving of time and effort. Traditionally, candle-making required careful attention to every step: melting the wax, mixing it, controlling the temperature, pouring into molds, and monitoring the cooling process. A small mistake could ruin the entire candle, and completing a batch could take several hours. With the machine, most of these steps are automated with high precision, making the workflow smoother, reducing physical strain, and significantly enhancing safety, as users are no longer exposed to burns or spills.
Another key advantage is the ability to increase production without extra effort. Small producers or home-based makers can produce more candles to meet higher demand while maintaining consistent quality in every batch. Each candle retains the same smooth finish, aesthetic appeal, and fragrance, helping build customer trust and encouraging repeat purchases.
Finally, safety has become a real priority. Users no longer handle hot wax directly for long periods, protecting their health and significantly reducing potential risks, especially for those working from home without professional safety equipment.
In summary, the machine has not only saved time and effort but also transformed candle-making into an enjoyable, safe, and creative process, producing high-quality candles consistently and giving small producers a clear competitive edge and an opportunity to stand out in the market.

5.1 Safety Improvements

Safety was one of the top priorities in developing the candle-making machine. Traditional candle production often involves handling hot wax directly, stirring it manually, and pouring it into molds, which can expose the user to burns or accidents. With the integration of automated heating, mixing, and pouring systems, the need for direct contact with hot materials has been largely eliminated.

This improvement makes the process much safer, especially for small-scale producers or individuals working from home who may not have access to professional safety equipment. By reducing the risk of burns and repetitive strain from manual work, the system not only protects the user's health but also ensures a more reliable and controlled process.

5.2 Customization Capabilities

Our candle-making system provides several customization options that make every product unique. Users can select between two base colors and even blend them to form new shades. In addition, the system offers a choice between two fragrances, which can be used individually to create distinctive scents.

Beyond colors and fragrances, the molds used in production come in decorative shapes such as a patterned rectangle or an ornate oval, giving the candles a refined and artisanal look. These features add creativity and personalization to the process, allowing the candles to stand out in the market and appeal to customers seeking more than mass-produced products.

5.3 Consistency in Production

In candle production, uniformity is everything—a slight change in wax ratio, temperature, or pouring speed can completely alter the final look and quality of the candle. With our system, these variables are no longer left to chance. The automated process ensures that each candle, whether scented or colored, maintains the same smooth finish, burn quality, and durability.

This level of consistency doesn't just simplify production; it also creates trust with customers who expect the same experience every time they purchase a candle. For small businesses, this reliability can transform first-time buyers into loyal customers and give the brand a professional edge in the competitive candle market.

5.4 Reduction in Labor

The candle-making machine takes over tasks that would normally require constant effort from the user. Processes such as mixing, monitoring the temperature, and pouring the wax are fully automated, which greatly reduces the need for physical involvement.

This automation not only saves time but also lessens the strain of manual work, especially for individuals who balance many responsibilities. By reducing the physical burden, the system helps preserve the user's energy and health, while making the candle-making process smoother, more convenient, and enjoyable.

5.5 User Interface and Control

To make the system practical and accessible, we developed a mobile application that allows users to manage the candle-making process with just a few taps on their smartphone. Through the app, the user can choose the number of candles to produce, select the desired colors, and add fragrances according to preference.

The interface is designed with simplicity in mind, so even non-technical users can operate it without difficulty. In addition, the app fits seamlessly into the fast-paced lifestyle of modern users by offering remote control and monitoring of the production cycle. This makes the system not only efficient but also highly flexible, allowing customization and control at every step of the candle-making process.

5.6 Challenges and Limitations

While developing the system, we discovered that candle making is not as simple as melting and pouring wax. One of the main hurdles was balancing the proportions of wax, fragrance, and color to achieve consistent quality. Another difficulty came from controlling the melting and cooling temperatures, since even small fluctuations could affect the smoothness and finish of the candles. At times, we had to intervene manually to correct imperfections, which highlighted how sensitive the process is and how much precision is required to reach professional results.

5.7 Future work

The machine will be enhanced to automatically place the wick into the chosen mold before pouring the wax, eliminating the need for pre-wicked molds.