



AN-NAJAH NATIONAL UNIVERSITY

FACULTY OF ENGINEERING & INFORMATION TECHNOLOGY

DEPARTMENT OF COMPUTER ENGINEERING

GRADUATION PROJECT II



Authors:

Lama Qawareeq 12028355

Wafaa Hamed 12010800

Supervisor:

Dr. Samer Al-Arandi

**Submitted in partial fulfillment of the requirements for
the Bachelor degree in Computer Engineering**

June, 2025

Dedication

Thanks to God first. Without His grace, we would not have reached this stage of success in our educational journey.

To the one who delivered the message and reached the nation, our Master Muhammad, may God bless him and grant him peace. To the one who taught us success and patience... To the one who taught us to give without waiting.

To those who taught us and endured hardships to reach where we are. To those whose prayers were the secret of our success. To all our family members, friends, and companions.

To everyone who enlightened our path with knowledge and knowledge.

Here is this humble work.

Acknowledgment

We extend our sincere thanks and gratitude to our project supervisor, Dr. Samer Mayaleh, whose support and careful guidance were instrumental.

We would also like to thank all the professors in the Computer Engineering Department for all the knowledge and wisdom they provided us during our years of study, which enabled us to complete this project.

We should also express our gratitude to our family and friends for their continued encouragement.

To everyone who played a role, however small, in the completion of this work, we say: Thank you from the bottom of our hearts.

Contents

Dedication	2
Acknowledgment	3
Disclaimer	6
Abstract	7
1 Introduction	8
1.1 Statement of the problem	8
1.2 Objectives	8
1.3 Importance of the work	9
1.4 Organization of the Report	9
2 Constraints, Standards, and earlier course work	10
2.1 Limitations and Challenges	10
2.1.1 Weak Infrastructure for the Work Environment	10
2.1.2 High temperature inside the workshop	10
2.1.3 insufficient mechanical knowledge	10
2.1.4 Time delay and schedule pressure	10
2.1.5 Cost	10
2.2 Standards	11
2.3 Earlier Coursework	11
3 Literature Review	12
4 Methodology	13
4.1 Choosing the Idea	13
4.2 System Structure	13
4.3 Hardware components	15
Step 1: Choose drink type	17
Step 2: Choose Nescafé type	17
Step 3: Choose sugar preference	17
Step 4: Choose cup size	17
4.3.8.2 Motor Drivers	21
H-Bridge Driver 4.21	21
5A Motor Driver	21
.....	22

4.3.9 Relays	22
4.3.10 Mini Water Pump (DC Diaphragm Pump).....	22
5 Result and Conclusion	25
5.0.1 Result.....	25
5.0.2 Conclusion	25
6 Discussion and challenges we encountered and their solution:	27
6.0.1 Discussion:.....	27
6.0.2 Challenges We Encountered and Their Solutions:.....	27
7 Future Work.....	28
Bibliography	29

Disclaimer

This report was prepared by Lama Qawareeq and Wafaa Hamed as part of the graduation requirements for a Bachelor's degree in Computer Engineering at the Faculty of Engineering, An-Najah National University.

This report has not been edited or proofread except for linguistic and spelling corrections. It may contain some linguistic or content errors.

The opinions expressed in this report, as well as the findings and recommendations, represent the views of the project organizers alone. An-Najah National University assumes no responsibility for any use of it for purposes other than its intended purpose.

Abstract

This project presents the design and implementation of a smart, automated hot beverage machine capable of preparing a variety of drinks, including coffee, Nescafé, espresso, latte, and cappuccino. The machine allows users to customize their beverages by selecting sugar levels, liquid type (water, milk, or both), and cup size via a keypad or a mobile application. It features an integrated LCD screen for interactive guidance and supports admin-level modifications to drink names and ingredients. The system combines mechanical, electronic, and software components, using Arduino Mega, ESP32, stepper motors, temperature sensors, relays, and pumps. Challenges such as mechanical design constraints, time pressure, and electrical safety were addressed through iterative testing and expert consultation. The final prototype operates reliably and provides a convenient, user-friendly interface for beverage preparation. This project lays the foundation for future enhancements, including smart scheduling, integrated payment systems, and personalized user experiences.

1 Introduction

1.1 Statement of the problem

With the growing demand for hot beverages such as coffee, Nescafé (regular, espresso, latte), and cappuccino, these beverages are still often prepared manually, which takes time and effort. Furthermore, relying on traditional preparation methods can lead to variations in ingredient ratios, taste, and quality.

This project aims to speed up the preparation process of these beverages, and easily, you can place orders via mobile phone.

1.2 Objectives

Design and implementation of a smart, multi-function machine to prepare a variety of hot beverages, such as coffee, Nescafé, latte, espresso, and cappuccino.

Enabling the user to customize the beverage by choosing whether or not to add sugar as desired.

Providing intelligent control of the liquid source (water, milk, or a combination of both) according to the selected beverage type.

Supports the ability to select the desired cup size and automatically adjusts the amount of ingredients.

The system is programmed so that every 15 revolutions of the component motor correspond to the emptying of the entire container. To ensure no sudden stop during beverage preparation, the system monitors the number of revolutions of each motor.

Upon reaching revolution number 14 (i.e., one revolution before the quantity is finished), an automatic alert is displayed on the LCD screen indicating that the powder type used is about to run out. The alert is customized to the beverage type.

The project provides two control interfaces: a keypad and a wireless smartphone app.

Integrates an LCD screen for interactive instructions during the preparation process.

Supports replacing drink names via the app: This feature is available to admins only, as the new drink name will be displayed on the LCD and in the app instead of the previous drink.

The machine is designed in a medium size for use in homes or offices.

1.3 Importance of the work

This project contributes to providing a smart and economical solution for preparing hot drinks quickly and accurately, especially in places that require self-service, such as offices or small kiosks. It also offers a convenient user experience by integrating the device with a mobile application.

1.4 Organization of the Report

This report is structured to provide a clear and comprehensive explanation of the project. It begins with Chapter 1: Introduction, which outlines the problem statement, objectives, scope of work, and the significance of the project.

Following this, Chapter 2: Constraints, Standards, challenges, and earlier course work, along with related coursework that informed the development process.

Chapter 3: Literature Review presents an analysis of previous works and studies, highlighting gaps in the existing solutions and providing the foundation for this project's approach.

Next, Chapter 4: Design and Implementation focuses on the technical aspects, detailing the design methodologies, tools, and technologies used to realize the project.

To ensure reliability and functionality, Chapter 5: Testing and Evaluation elaborates on the testing procedures, evaluation metrics, and results achieved.

Finally, Chapter 6: Conclusion and Future Work summarizes the outcomes of the project and offers suggestions for further development and potential extensions.

The report concludes with a comprehensive References section, listing all sources cited.

2 Constraints, Standards, and earlier course work

2.1 Limitations and Challenges

2.1.1 Weak Infrastructure for the Work Environment

We faced a significant delay in commencing practical implementation of the project due to the unpreparedness of the workshop. Preparing the necessary tables, equipment, and tools took a long time, forcing us to constantly move between tables and manually transport project components, which impacted the speed of completion.

2.1.2 High temperature inside the workshop

The workshop environment was not conducive to work, with inadequate ventilation or cooling systems, creating an uncomfortable work environment, especially during long hours. This directly impacted our concentration and reduced our performance throughout the various phases of the project.

2.1.3 insufficient mechanical knowledge

The biggest hurdles we faced were mechanical. For example, when operating the NEMA 23 motor responsible for rotating the piece of wood, we initially connected it via an H-bridge, but it proved unable to provide the necessary torque. We had to replace it with a 5-amp driver. Furthermore, some of the other motors didn't perform as efficiently as expected, necessitating a design review to understand their torque and power requirements.

2.1.4 Time delay and schedule pressure

Due to delays in setting up the workshop, transportation difficulties, and military checkpoints that hindered access to the university, we faced extreme time pressure to complete the project. This forced the team to intensify work hours and work long hours to complete tasks on time.

2.1.5 Cost

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

2.2 Standards

The control system was developed using the Arduino IDE in C++, which provides ready-made libraries for various sensors and motors.

We developed a mobile application using CSS/HTML to enable users to submit requests remotely.

Safety standards were adhered to in the electrical wiring and electronic circuits, and protective devices such as insulation and plastic enclosures were provided to avoid potential hazards during operation

2.3 Earlier Coursework

The Microcontroller utilizing PIC controllers course which provided 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. All of these fundamental abilities enabled us to build our project.

The Circuit and Electronics courses gave 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 helped 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.

3 Literature Review

Hot beverage machines have become an integral part of modern life, especially in public spaces such as offices, universities, hospitals, and transportation hubs. These machines offer convenience, consistency, and speed in preparing drinks such as coffee, tea, and hot chocolate. With the increasing demand for automation and smart systems, hot drink dispensers have evolved to include more advanced features, such as touch interfaces, programmable selections, and automatic ingredient mixing.

The global market for vending machines, including those dedicated to hot beverages, is growing rapidly. According to recent studies, the market is expected to surpass USD 30 billion by 2027, driven by the need for time-saving solutions and enhanced user experience [1]. This reflects the rising trend toward intelligent systems that combine mechanical, electrical, and software engineering to serve daily needs efficiently.

From a technical perspective, hot drink machines integrate multiple systems: heating elements for water, precise pumps for dispensing liquids, and rotating or linear mechanisms for moving cups and ingredients. Microcontrollers such as Arduino and ESP32 are often used to manage user input, control the motors, and handle timing between stages [2]. These controllers are cost-effective and provide sufficient processing power for such embedded applications.

Moreover, the preparation of beverages like coffee, cappuccino, or latte requires accurate proportions of ingredients such as water, milk, and powder. Automating this process demands not only mechanical precision but also a thoughtful software design that allows the user to customize drink size or type. In several existing works, such as smart vending prototypes or IoT-based kitchen appliances, researchers have focused on enhancing user interaction by integrating keypads, LCDs, and even mobile apps [3].

In our project, we designed and built a smart hot beverage dispenser that allows the user to choose from various drinks—such as regular coffee, Nescafé, espresso, latte, or cappuccino—through a keypad interface. The user can also select the cup size (half or full), and the machine prepares the drink automatically by mixing predefined amounts of ingredients. This system combines mechanical rotation for cup positioning, multiple ingredient containers, and automated control for valves and pumps.

4 Methodology

The system structure, hardware components, overall system design, and mobile application will be presented in detail in this chapter.

4.1 Choosing the Idea

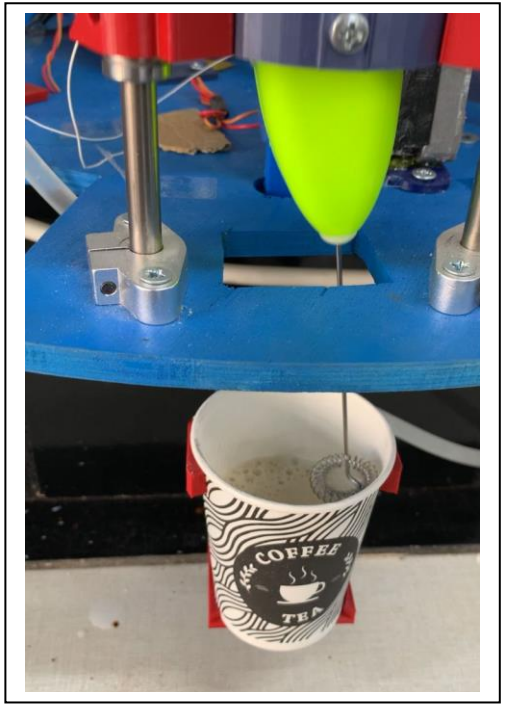
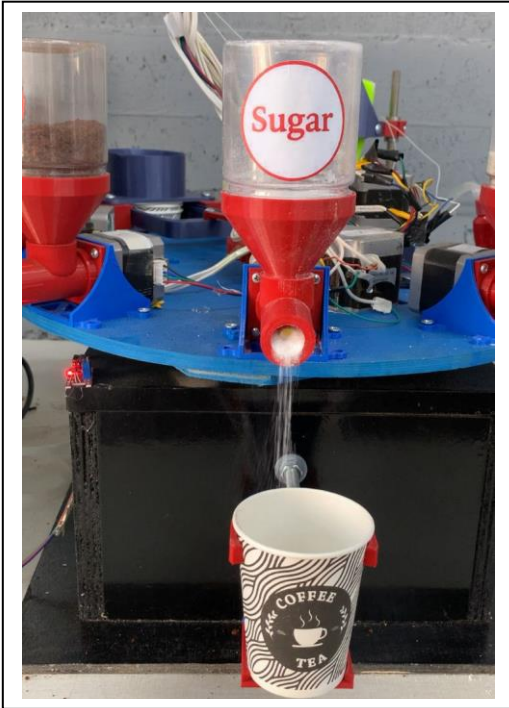
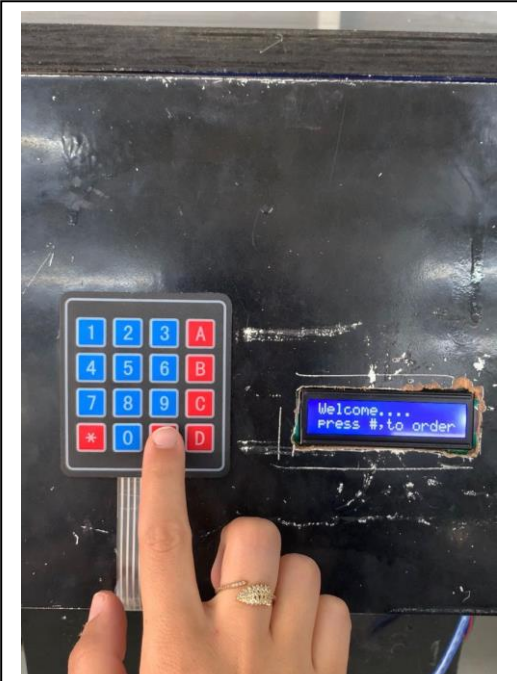
The idea for our project was inspired by our love for hot beverages and frequent visits to coffee shops. Seeing the high demand, we were motivated to design and build our own automated drink machine—one that reflects our creativity and provides a simple, enjoyable user experience.

4.2 System Structure

The outer design of the project is shown in Figure 4.1.

Before starting the preparation process, the user interacts with the machine through a keypad interface to choose the desired drink type (e.g., coffee, Nescafé, or cappuccino), sugar preference (with or without sugar), and cup size (half or full). Once the selection is confirmed, the machine automatically begins the preparation, which is divided into three main stages:

- **Stage 1: Cup Dispensing**
The cup dispensing mechanism is designed using 3D printing technology. Cups are securely held in a vertical stack, and a NEMA 17 stepper motor controls the release system. Upon rotation, the motor allows a single cup to drop accurately into its designated position in the preparation area. The mechanism then returns to its original state to block additional cups, ensuring precise, one-by-one dispensing.
- **Stage 2: Ingredient Dispensing**
Once the cup is in place, the machine uses motors to release the desired powder (e.g., coffee, Nescafé, or cappuccino mix). The user selects the drink type and cup size using a keypad interface.
- **Stage 3: Liquid Dispensing**
At this stage, temperature sensors first check the internal temperature of the system. If the temperature is below 40°C, the heating elements are automatically activated to raise it to the desired level.
Once the desired temperature is reached, water or milk is added to the cup, where the powder is already present.
- **Stage 4: Blending**
After adding the liquid, the contents in the cup are thoroughly blended by a mechanical mixer to produce a smooth, well-prepared beverage.



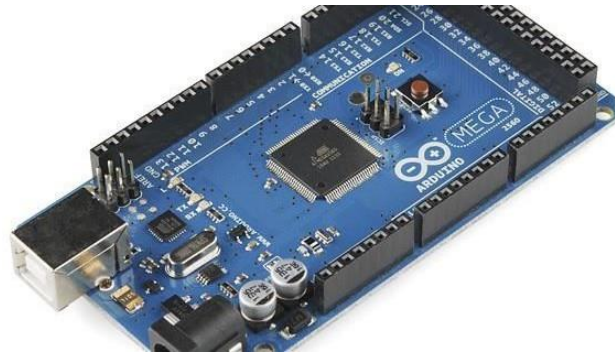
4.3 Hardware components

4.3.1 Microcontrollers

Arduino Mega 2560

The Arduino Mega 2560 is a microcontroller board based on the ATmega2560 [4]. 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.



4.3.2 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 [5]. We used it in our project to connect it with the mobile application that we have created. 4.10.

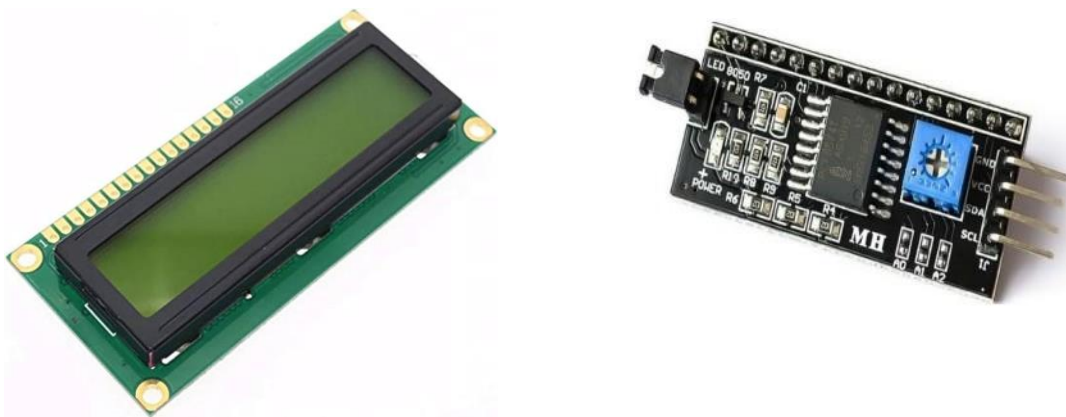


4.3.3 LCD and I2C

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.[6].

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.



4.3.4 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 4x4 keypad typically consists of 8 pins, 4 for the rows and 4 for the columns. These pins can go to any digital Arduino pin.

We used it in our project to help the user select their preferred drink by pressing specific buttons.

After the LCD displays a **"Welcome"** message, it prompts the user with:

- **"Press # to start"**

When the user presses #, the following options are displayed:

Step 1: Choose drink type

1. Coffee
2. Nescafé
3. Cappuccino

If the user selects 2 (Nescafé), the LCD displays:

Step 2: Choose Nescafé type

7. Classic Nescafé
8. Latte
9. Espresso

Step 3: Choose sugar preference

4. With sugar
 5. Without sugar
1. One spoon of sugar
 2. Two spoons of sugar

Step 4: Choose cup size

8. Half cup
9. Full cup



4.3.5 Computer power supply

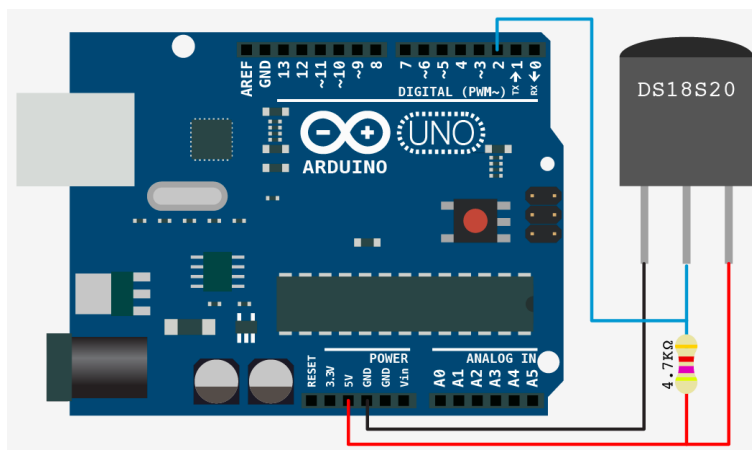
We used an **ISO-450 ATX Computer Power Supply (350W)**, which provides multiple voltage outputs: **12V, 5V, 3.3V, and Ground**. It delivers **32A at 5V** and **16A at 12V**, making it suitable for powering several components in our project.

- We used the **12V output** to power the **motors**.
- The **5V output** was used to supply **sensors and relays**.
- The **3.3V output** was used to power the **ESP32 microcontroller**.



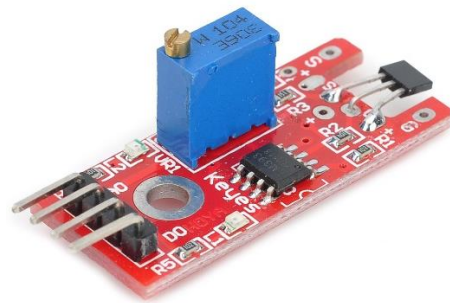
4.3.6 Temperature Sensor (DS18B20)

The DS18B20 is a digital temperature sensor that provides accurate temperature readings with a wide range from -55°C to $+125^{\circ}\text{C}$. It uses the One-Wire communication protocol, allowing multiple sensors to be connected to the same data line. In our project, we used the DS18B20 sensor to monitor the temperature of the liquid in the heating kettle. When the temperature reaches a certain level, the heating process is automatically stopped, ensuring that the liquid is heated properly and safely without overheating.



4.3.7 Hall effect sensor module

The Hall Effect sensor module is used to detect the presence of a magnetic field and convert it into a digital signal. It is a reliable, contactless sensor that responds quickly to changes in magnetic fields. In our project, the Hall Effect sensor was used as a reference point for the rotating disk that carries all the components. Each time the magnet passes in front of the sensor, it generates a signal that helps determine the initial or reset position of the disk, ensuring accurate alignment and control of rotation during operation.



4.3.8 Motors and Drivers

4.3.8.1 Stepper Motors

NEMA 17 Stepper Motor

The NEMA (National Electrical Manufacturers Association) sets standards for various electromechanical components, including stepper motors. These motors are classified by frame size, such as “Size 11,” “Size 23,” and “Size 34.”

The NEMA 17 stepper motor refers to a motor with a standard frame size and a step angle of 1.8 degrees, meaning it takes 200 steps to complete one full revolution.

This motor is a bipolar, four-wire stepper motor. Each of its two coils can handle a maximum current of 3.5 A and supports a voltage range of 3V to 12V.

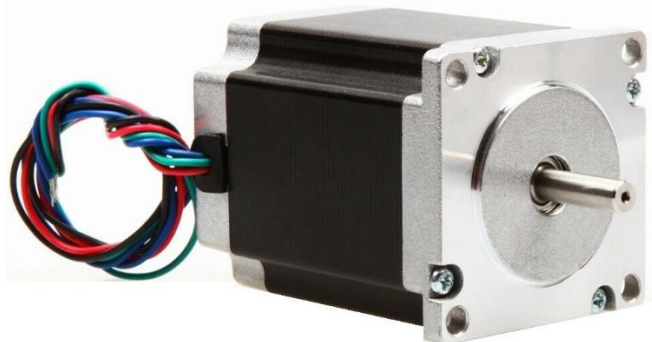
It is capable of rotating in both clockwise and counterclockwise directions, making it suitable for precise position control in a variety of applications.



We used six stepper motors in total throughout the project. Four of them were used in the first stage, “Choosing Components,” to drop the powders (e.g., coffee, sugar, and other ingredients). Each motor was mounted under a container, and by trial and error, we determined the number of steps and rotation cycles needed to drop specific quantities. Another stepper motor was used to lower the cup into the serving position in the second stage. The sixth motor was dedicated to controlling the whisk mechanism — it was responsible for both lowering and raising the whisk as part of the mixing process.

NEMA 23 Stepper Motor

The NEMA 23 is a high-torque stepper motor commonly used in CNC machines and automation systems. It provides precise control of movement, thanks to its high holding torque and accurate step angle, typically 1.8° per step. In our project, we used a NEMA 23 stepper motor to rotate the main disk that carries all the system components. This motor was chosen due to its strength and stability, which are essential for moving the weight of the entire rotating structure smoothly and accurately.

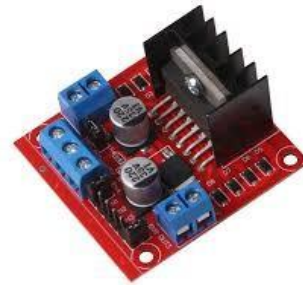


4.3.8.2 Motor Drivers

H-Bridge Driver 4.21

The H-Bridge Driver 4.21 is a commonly used motor driver for controlling low to medium power DC or stepper motors. It allows the direction and speed of a motor to be controlled using standard logic-level signals, and it operates efficiently with 12V power supplies. It is especially suitable for applications that require bidirectional control of motors at low cost.

In our project, we used five H-Bridge drivers to control five NEMA 17 stepper motors. These motors were used for powder dispensing (four containers) and for lowering the cup into position.



5A Motor Driver

The 5A motor driver is a high-current driver module designed to control more powerful stepper motors like the NEMA 23. It supports higher voltage and current levels, provides strong holding torque, and is ideal for heavier mechanical loads and precise motion control.

In our project, we used this driver to operate two motors: one NEMA 23 motor responsible for rotating the main disk that carries the system components, and one stepper motor for lifting and lowering the whisk during the mixing stage.



4.3.9 Relays

A relay is an electronic switch that allows control of high voltage and current devices using a low voltage signal. It is commonly used to activate or deactivate appliances in the same or different electrical networks, making it an essential component for safe and automated control.

In our project, we used two types of relay modules: a **two-channel relay** and a **four-channel relay**. The **two-channel relay** was used to control the operation of the electric kettles by turning them on and off for specific durations during the heating process. The **four-channel relay** was used to manage multiple devices, including the **whisk motor** and **two pumps** responsible for transferring milk or water from the tanks to the cup.

These relays were chosen for their ease of use, as they simply required ON/OFF signals from the microcontroller and offered reliable switching for our electrical components.



4.3.10 Mini Water Pump (DC Diaphragm Pump)

This is a compact **DC diaphragm pump**, commonly used for transferring or dispensing liquids in small-scale projects. It operates on low voltage (typically 3–12V) and is capable of pumping various fluids like water, milk, or other non-corrosive liquids.

In our project, we used **two of these pumps**:

- One pump was used for **dispensing water**.
- The other was used for **dispensing milk**.

These pumps allowed us to control the liquid flow accurately and integrate it seamlessly into the automated beverage-making process.



4.3.11 Wires

Intercom Wires

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



Arduino Wires

We used them to connect the components to the Arduino.

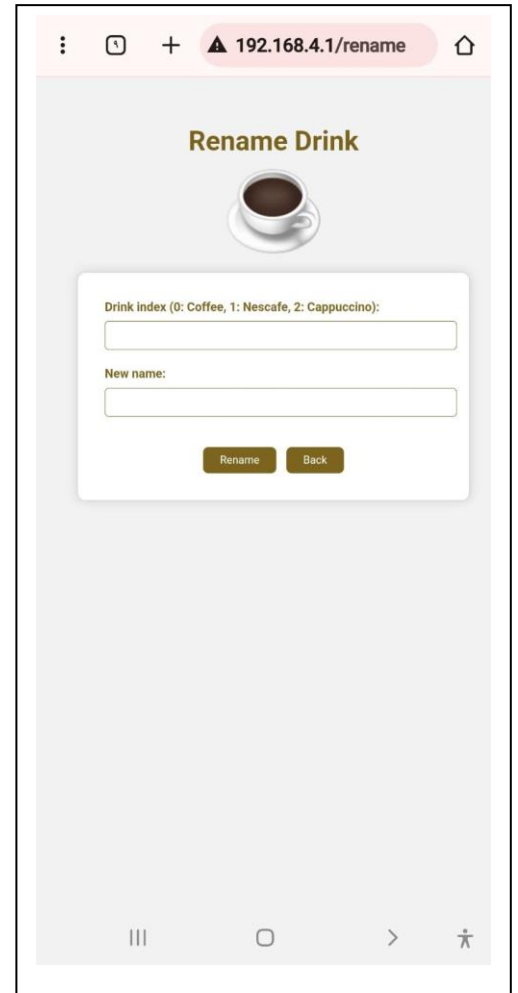
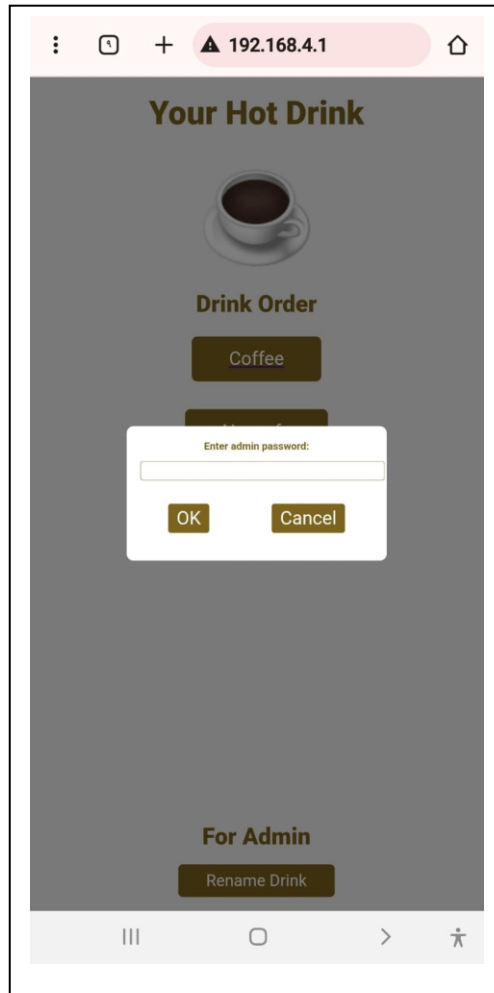
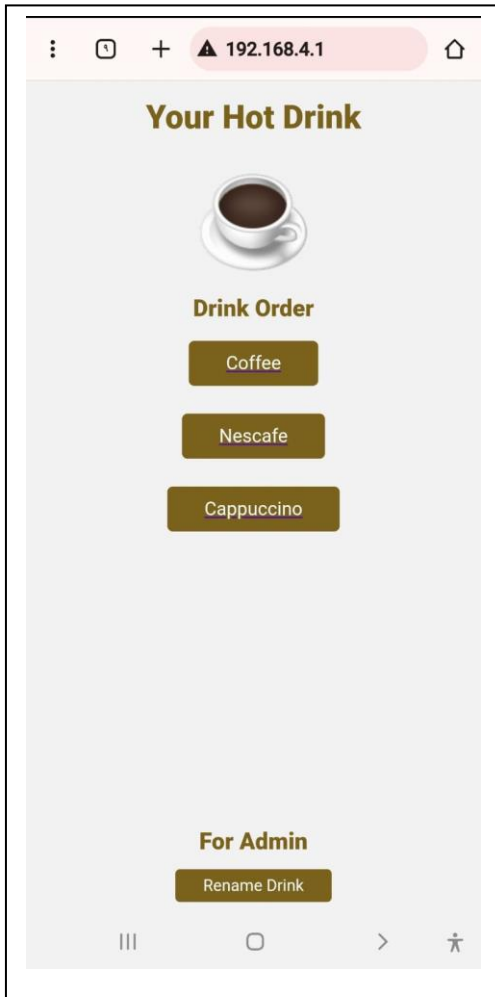


4.4 Web Pages

In addition to the mechanical structure, we developed a web page interface that allows users to select their desired drink with a single click, making the process smoother and more interactive.

We also implemented an admin control system that enables the administrator to modify the ingredients used in drink preparation. For example, coffee can be replaced with another item such as sahlab, and this change is automatically reflected in both the web application and the machine's LCD screen.

This system offers high flexibility in customizing drinks and updating ingredients without the need to manually modify the source code, making it practical and easy to expand.



5 Result and Conclusion

5.0.1 Result

After completing the design, programming, and assembly phases, the project team was able to implement a smart hot beverage machine that operates efficiently according to pre-defined specifications. The machine is capable of preparing a range of beverages, such as coffee, Nescafe, latte, espresso, and cappuccino, with the ability to select the amount of sugar. The appropriate liquid type (water, milk, or a combination of both) is determined by the beverage type. Of course, determining the ratio of powder and(liquid in the case of a water/milk mixture) also depends on the beverage type and cup size. But In the case of cappuccino, we left it up to the user to choose the liquid source they want: milk or water.

We also achieved:

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

A continuous display was provided to the user on an LCD screen to guide them through the preparation process, which improved ease of use and interaction

For admin: The ability to easily change the flavor type through the app, such as replacing coffee with hot chocolate.

Automatically adjusting the proportions of ingredients based on the cup size selected by the user.

Send notification to LCD when components are about to expire

Despite the challenges, the project has proven effective as a prototype with potential for future development

5.0.2 Conclusion

The machine succeeded in achieving its primary objectives despite time constraints, mechanical design issues, and technical difficulties related to identifying the necessary parts and how to connect them correctly. Despite all these challenges, we were able to build a machine that combines mechanical design, programming, and smartphone connectivity.

This project represents a first step toward developing smart home devices that efficiently and comfortably meet users' daily needs, and can be considered a foundation for developing more advanced and professional versions in the future, whether for personal or commercial use.

6 Discussion and challenges we encountered and their solution:

6.0.1 Discussion:

In this project, we integrated mechanical systems with programming and electronics to automate the preparation of hot beverages. This interdisciplinary combination enhanced our practical understanding of how to link theoretical concepts with real-world applications, especially in areas such as motor control, ingredient management, structural design, and embedded systems. This experience provided a valuable opportunity to consolidate our academic knowledge through the implementation of a comprehensive practical project.

6.0.2 Challenges We Encountered and Their Solutions:

Powder Dispensing Issues:

Initially, we attempted to use a servo motor beneath the ingredient container to open the lid and allow the powder to drop directly. However, we faced difficulties because some types of powder did not fall easily and required shaking or vibration to flow completely. Therefore, we designed specialized parts using 3D printing to ensure precise and controlled movement that facilitates efficient powder dispensing.

Cup Dispensing Mechanism Design:

Since the 3D-printed parts are custom-made according to the specific cup size, it was not feasible to design a stable mechanism that supports multiple cup sizes. Therefore, we chose to work with only one cup size that exactly fits the machine's dimensions, which simplified the overall design and assembly.

Lack of Experience in Similar Projects:

Being our first experience with a project of this nature, it required extra time to understand how to select and assemble the appropriate components, experimenting with different options until we found optimal solutions for each implementation stage.

Electrical Safety Risks:

The heating system operated on a 220V electrical supply, posing safety risks during assembly and testing. To mitigate these risks, we consulted with Engineer Abdullah, who assisted us in handling this part safely, while we strictly adhered to all necessary safety precautions to protect the team and the project.

7 Future Work

- **Smart Scheduling:** The machine can be programmed to operate automatically at different preset times on various days of the week, adapting to the user's routine and preferences for optimal convenience.
- **Integrated Payment System:** Adding a secure payment method (e.g., contactless card or mobile payment) to allow users to purchase drinks easily and securely without manual intervention.
- **Customizable Music Playback:** Allow users to select their preferred music or playlists to be played during the beverage preparation process, enhancing the overall user experience and making the wait more enjoyable.

Bibliography

- [1] “Global Vending Machines: Strategic Business Report 2022–2027,” ResearchAndMarkets, 2022.
- [2] S. Author et al., “IoT Based Voice Controlled Drink Dispenser System,” IJIREISS, 2024.
- [3] A. Author et al., “Internet of Things Based Smart Vending Machine using Digital Payment System,” ResearchGate, 2021.
- [4] Arduino, “Arduino Mega 2560 Rev3,” Arduino Official Website. [Online]. Available: <https://store.arduino.cc/products/arduino-mega-2560-rev3>. [Accessed: 14-Jun-2025].
- [5] Roberto Ierusalimsky, "Programming in Lua," 4th ed., Lua.org, 2016. [Online]. Available: <https://www.lua.org/pil/>
- [6] Circuit Basics, “How to Set Up an LCD Display with Arduino,” [Online]. Available: <https://www.circuitbasics.com/how-to-set-up-an-lcd-display-on-an-arduino-using-an-i2c-lcd-backpack/> [Accessed: 14-Jun-2025].

