An-Najah National University

Faculty of Engineering & Information Technology

Computer Engineering Departmentg

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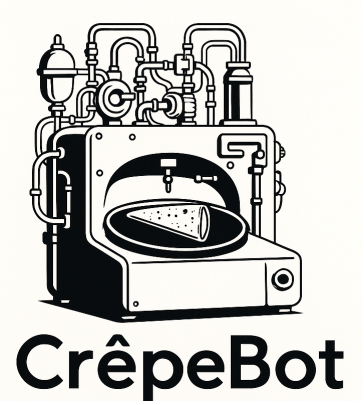
Graduation Project 2 - Hardware



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Acknowledgment

In the name of Allah, the Most Gracious, the Most Merciful

All praise is due to Allah, who taught man what he did not know, and guided us through every step of our journey. Peace and blessings be upon our Prophet Muhammad, the teacher of mankind, and upon his family and companions.

We extend our deepest gratitude and heartfelt appreciation to our supervisor, Dr. Anas Toma, whose guidance, patience, and generous insights were essential in shaping this project. His dedication, encouragement, and constructive criticism have left a profound impact on both our academic and personal growth.

To our beloved parents, your unwavering faith in us, constant prayers, and unconditional love have been the strongest source of strength and motivation. You were our silent supporters in every sleepless night, every moment of doubt, and every small success. This work is a reflection of your sacrifices.

To our families, who have surrounded us with care, and to our friends, who have offered support in countless ways—thank you. Your encouragement, kindness, and presence have made this path lighter and more meaningful.

Above all, we are humbled by the grace of Allah that has carried us through challenges, enlightened our minds, and brought this endeavor to completion.

Abstract

This project presents a fully automated crepe maker that operates without human intervention, except for choosing the initial settings.

The user selects the type of chocolate (white or milk chocolate) and the preferred filling (small candies or chocolate chips) using a keypad and an LCD panel or using a phone application, after which the machine operates autonomously.

All mechanical components are driven by motors controlled via Arduino, running a pre-programmed code.

The process begins by loading a precise amount of crepe mixture, usually by a servo motor, and combining it with an appropriate amount of milk.

The mixture is then mixed by an automatic mixer and poured onto a circular metal plate that will rotate by a stepper motor and there is gas to heat it, which will be connected to a relay to disconnect and connect the electricity at the appropriate time.

A metal piece, usually powered by a DC motor, is rotated to distribute the mixture evenly and define its edges.

Once the crepe is fully cooked, the metal plate moves to the second stage, where the selected chocolate is distributed.

A servo motor and DC motor will be used for this stage, followed by the selected filling.

Finally, the board moves to the third stage with the stepper motor installed in the base of the chassis, where the crepe is presented.

Mostly these selected pieces in addition to other pieces that we will choose according to experience and work, in addition to the Arduino Mega piece and the power supply to supply some motors with the necessary electricity and in addition to the driver for the motors that will need.

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Disclaimer

This report was produced by students from the Computer Engineering Department at An-Najah National University. Although great care was taken to ensure accuracy, there may still be some grammatical or content errors. An-Najah National University disclaims responsibility for any inaccuracies and is not liable for any unintended uses of this report beyond its intended purpose.

Chapter 1

Introduction

1.1 Background

With the rapid development of technology and smart automation in recent years, the idea of our project CrêpeBot was born to align with modern trends in food preparation. It aims to simplify and speed up the process of making crêpes while maintaining quality and precision. Preparing crêpes manually can be time-consuming and requires attention to detail in spreading the batter, heating, and decoration. CrêpeBot is a smart, automated crêpe-making machine controlled by an Arduino Mega. It uses motors for plate rotation and spreading, and it includes pumps designed to dispense different types of chocolate—white, milk, or a mix—directly onto the crêpe. The machine is intended to reduce manual effort while providing an enjoyable and customizable crêpe-making experience.

1.2 Objectives

The main goal of CrêpeBot is to automate the process of making crêpes in a simple, low-cost, and efficient way. It is designed to be accessible for home use or small food businesses. Specific objectives include: Automating the pouring and spreading of crêpe batter onto a hot plate. Pumping selected types of chocolate—white, milk, or a mix—onto the crêpe surface. Adding decorative toppings such as candy, chocolate chips, or a mix, using a rotating decoration system. This decoration mechanism is driven by a DC motor located at the center of a plus-shaped (+) structure. The motor rotates four straight arms extending outward, each equipped with a topping outlet at its end. As the structure spins, toppings are released and distributed evenly across the surface of the stationary crêpe from above. Ensuring smooth and visually appealing decoration by precisely controlling the motor speed and the activation of topping pumps. This approach enables consistent, hands-free crêpe decoration with a unique mechanical design and minimal complexity.

1.3 Significance of the Work

The importance of CrêpeBot lies in its ability to reduce manual labor, ensure consistency, and bring creativity into food preparation. As life becomes faster and more demanding, automation in kitchen tools is becoming essential. CrêpeBot makes crêpe preparation easier for individuals who want to enjoy fresh crêpes without needing professional skills. Furthermore, the machine supports food businesses and home users by saving time and reducing food waste due to its precise control of ingredients. Its simplicity and low cost also make it an ideal project for educational, experimental, or commercial purposes. It introduces a step toward smart kitchen solutions where customization and automation meet.

1.4 Organization of the Report

This report is split into six major chapters:

- **Chapter 1 – Introduction:** Outlines the project's background, objectives, relevance, and overall reason for developing the CrepeBot system.
- **Chapter 2 – Theoretical Background and Previous Work:** Examines existing crepe-making machines and identifies the automation gap that this project seeks to fill.
- **Chapter 3 – Constraints and Earlier Coursework:** Discusses the difficulties faced during implementation, specifically mechanical constraints, and how preceding courses aided development.
- **Chapter 4 – Methodology:** Outlines the hardware components, system architecture, and thorough design of each crepe-making phase.
- **Chapter 5 – Results and Discussion:** Analyzes the implementation outcomes, assesses system performance, and tackles issues that arose.
- **Chapter 6 – Conclusion and Future Work:** Summarizes the project's successes and makes recommendations for future improvement and development.

This organization enables a logical flow from concept to execution, helping readers comprehend the project's motivation, development, outcomes, and future potential.

Chapter 2

Theoretical Background and Previous Work

Although many crepe-making machines are commercially available, most of them rely heavily on human intervention during the preparation process. For instance, machines listed on platforms like Amazon typically only provide heating plates to cook the crepe batter, but do not offer automated mixing, pouring, or decoration features [1]. Similarly, listings on eBay show that the majority of these machines are designed to perform only one step in the process: cooking the crepe [2].

Even in restaurants and commercial setups, more advanced machines may be capable of baking multiple crepes simultaneously. However, these machines still depend on human labor for essential steps such as batter preparation, pouring, filling, and decoration [3] [4].

Unlike these existing solutions, our project is not merely a crepe cooking machine, but rather an integrated, automated system that handles the full process: mixing ingredients, pouring the batter, cooking, and even decorating the final product. This makes our proposed system significantly more advanced and autonomous compared to most of the available options on the market.

Figure 2.1: CrepeBot

Chapter 3

Constraints & Earlier Coursework

3.1 Constraints

3.1.1 Absence of mechanical expertise

One of the challenges we faced in the project was controlling the movement of the pan using the natural weight connected to a Nema 23 stepper motor.
The motor was intended to rotate the pan by approximately one-third of a turn; however, due to the pan's weight, it sometimes moved slightly more than one-third of a turn, and other times less than expected.
To address this issue, we stopped the pan's movement and adjusted the stepper motor's torque to prevent any excessive motion.
Additionally, we used a servo motor acting as a gate to precisely control the movement. This approach allowed us to fine-tune the rotation according to an appropriate value, relying primarily on the servo motor to ensure accurate and stable motion.
Furthermore, we encountered another issue related to heating the pan. Each time the pan was heated, it would warp and tilt slightly downward. As a result, when pouring the mixture, the desired circular shape was not formed properly; instead, the mixture would slide toward the edges.
To solve this, we added supports around the heating area, which caused the pan to warp inward rather than outward, achieving the intended shape for optimal mixture distribution.

3.2 Earlier course work

3.2.1 Micro-controllers and PIC

Through these materials, we gained the essential knowledge needed to work with Arduino, including how to program and control it effectively.
We learned how to write code using its development environment and understood the basics of serial communication (TX, RX), including how to send and receive data.

This foundational knowledge served as the starting point for implementing our project. These skills enabled us to connect microcontrollers with various components such as motors and sensors, and also to make real-time adjustments during operation.
As we progressed, we developed a practical understanding of how hardware and software interact, which allowed us to build a more efficient and reliable project.

3.2.2 critical thinking course

The Critical Thinking course helped us develop essential skills in writing and organizing technical reports using Overleaf. It also improved our research abilities, such as finding reliable sources and analyzing information logically, which supported us in both the theoretical and practical parts of our project.

Chapter 4

Methodology

4.1 Hardware Components Used in the Project

4.1.1 Keypad and LCD Display

Used by the user to select the desired crepe toppings and chocolate type. The keypad provides input options, while the LCD displays available selections and feedback throughout the process.

Figure 4.1: Keypad and LCD Display

4.1.2 Powder Dispensing System (Container, Servo Motor, and DC Motor)

This system consists of a container that holds ready-made crepe powder. The container has a bottom opening sealed with a lid, which is controlled by a servo motor. This motor opens the lid for a specific duration to release a measured amount of powder

into the blender. Inside the container, a DC motor is mounted and equipped with blades that rotate through the powder. This stirring action prevents the powder from clumping or accumulating at the edges, ensuring a consistent and smooth flow when dispensing.

Figure 4.2: Powder Dispensing System

4.1.3 Water Tank and Pump

A separate water container is connected to a pump, which delivers a specific amount of water into the blender. This ensures the correct powder-to-water ratio during mixing.

Figure 4.3: Water Tank and Pump

4.1.4 Blender (Mixing Unit)

The blender is responsible for mixing the powder and water. It performs an initial mix, then waits for the hot plate to heat up, and mixes again before sending the mixture to the cooking surface. This two-phase mixing ensures the texture is smooth and consistent.

Figure 4.4: Mixing Unit

4.1.5 Heating Plate (Circular Gas-Powered Hot Plate)

A circular metal plate is heated using an electronic gas burner. It serves as the cooking surface where the crepe mixture is poured and cooked evenly. The system waits for a few seconds after ignition to ensure proper heating before pouring.

Figure 4.5: Heating Plate

4.1.6 Pump and Solenoid Valve (Mixture Dispensing System)

Once the mixture is ready, a pump draws it from the blender and sends it through a solenoid valve. The valve opens for a calculated duration to pour a precise amount of the mixture onto the heated plate, allowing it to spread in a circular shape and cook properly.

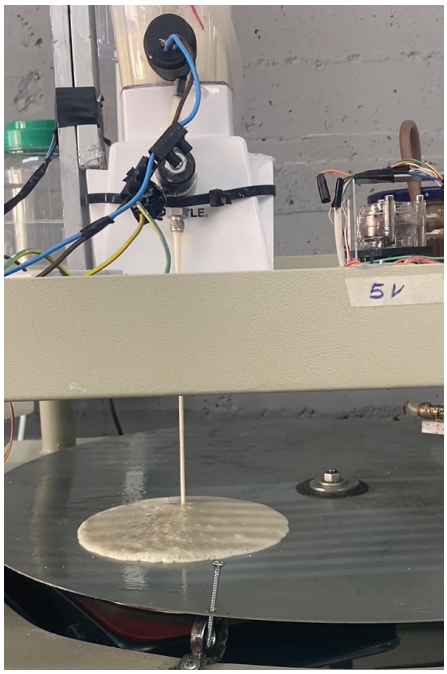

Figure 4.6: Mixture Dispensing System

4.1.7 Nema 23 Stepper Motor and Driver (Crepe Rolling Mechanism)

After the crepe is cooked, the hot plate is rotated by a Nema 23 stepper motor connected to a driver. The motor is programmed to turn the plate exactly one-third of a

full rotation. However, due to thermal expansion and the weight of the structure, there is a tendency for the metal plate to slip slightly forward beyond the intended stop point. To address this issue, a screw is fixed onto the rotating plate. When this screw strikes a stationary stopper—positioned directly in front of the servo-controlled gate—it triggers the servo motor to briefly open the gate upward, allowing the screw to pass through. This mechanism ensures the plate only continues rotating after precise alignment is confirmed, effectively preventing any over-travel and maintaining accurate positioning for the next cycle.

Figure 4.7: Servo motor 1

Figure 4.8: Servo motor 2

Figure 4.9: stepper motor and driver

4.2 Topping Dispensing Mechanism

4.2.1 Stage One: Chocolate Dispensing via Rotating Arm

The topping system is built around a metallic structure shaped like a "+" symbol, driven by a 12V DC motor capable of rotating in both clockwise and counterclockwise direc-

tions. This bidirectional movement is enabled using two relays to reverse polarity and thus motor direction.
At the ends of the arm are two liquid chocolate dispensers:

- One pump for regular (brown) chocolate.
- One pump for white chocolate.

Each pump is driven by a stepper motor with a dedicated driver to ensure controlled and precise extrusion. Based on the user's selection—brown chocolate, white chocolate, or a mix of both—the corresponding pumps are activated while the arm spins to ensure even and artistic coverage of the crepe.
After completing the distribution, the DC motor rotates the arm back to its original position to avoid wire tangling or chocolate tubing complications.


Figure 4.10: white chocolate


Figure 4.11: milk chocolate

4.2.2 Stage Two: Decorative Toppings – Candy and Chocolate Chips

In the second phase, the decoration toppings are dispensed. Two small containers are mounted at the remaining two ends of the arm:

- One for colorful candy pieces.
- One for chocolate chips.

Each container is equipped with a small hatch controlled by a servo motor. According to the user's preferences—candy, chocolate chips, or both—the DC motor performs one full rotation. During this spin, the corresponding servo(s) are activated up to four times per turn, releasing toppings at equal intervals to form aesthetically pleasing patterns over the crepe.

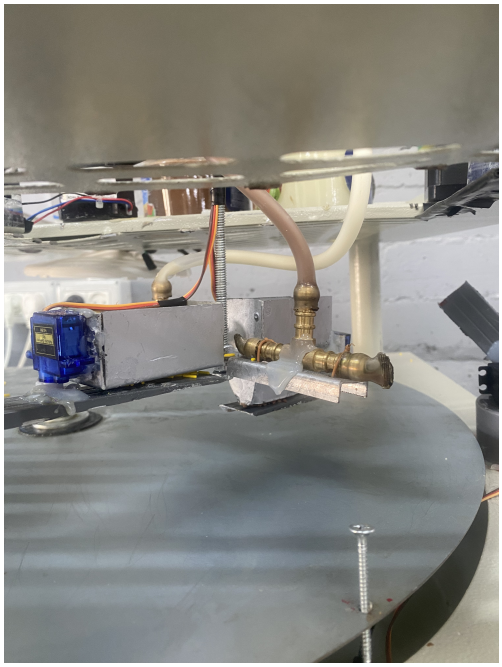

Figure 4.12: Topping Dispensing Mechanism

Figure 4.13: Topping Dispensing Mechanism

4.3 Notification Light

At the final stage of the process, an indicator light installed above the serving area is activated to notify the user that the decorated crepe is ready to be picked up. This light is connected through a relay, allowing it to be programmatically controlled by the system once all previous stages are completed.

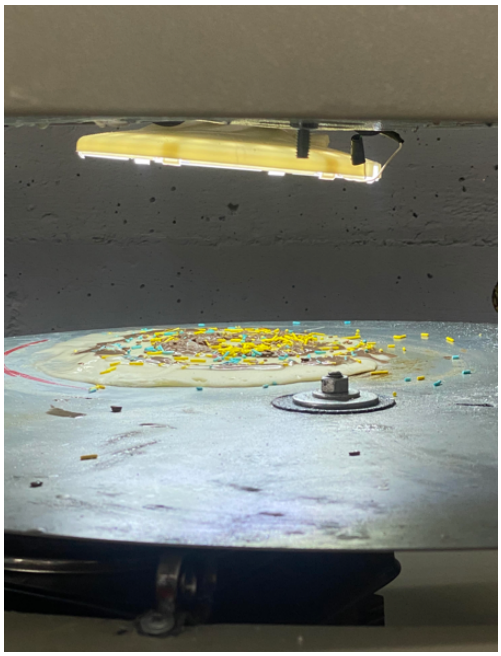

Figure 4.14: Notification Light

4.4 Cleaning Stage

4.4.1 Overview

To maintain hygiene and ensure proper cleaning of the mixing chamber, the system includes an automated cleaning process controlled by multiple hardware components.

4.4.2 Cleaning Procedure

1. A stepper motor moves the cleaning cup to a dedicated position beneath the valve outlet.
2. The solenoid valve and discharge pump are activated (via relays) to release any remaining mixture from the blender into the cleaning cup.
3. A clean water pump draws fresh water into the blender.
4. The relay activates the blender motor to mix the clean water for internal rinsing.
5. The dirty water is then discharged into the cup using the pump and valve again.
6. A servo motor moves the cleaning cup to an external location.
7. Another servo lowers the cup to dispose of the waste water.

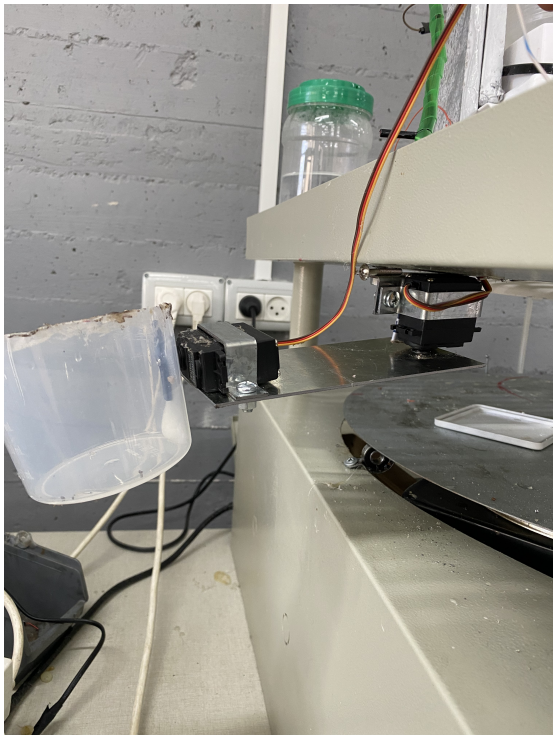

Figure 4.15: Cleaning Stage

Table 4.1: Hardware Components Overview

Component	Description	Purpose
Stepper Motor	Precise rotation motor	Moves the hot plate and operates the chocolate pressing mechanism.
Servo Motor	Angular position motor	Used in the cleaning phase for cup handling and for pausing the hot plate.
DC Motor	Continuous rotation motor	Moves the entire crepe powder into the mixer before blending and rotates the '+' shaped decoration arm for chocolate and candy toppings.
Relays	Electronic switches	Control ON/OFF for most components including the mixer, pumps, valves, DC motors, and gas heater.
Solenoid Valve	Flow controller	Acts like a faucet to open or close the flow of the mixture or cleaning water as needed.
Water Pumps	Liquid transport pumps	One pump draws clean water for cleaning; the other pumps out the blended crepe mixture from the mixer.
Indicator Light	Visual feedback	Signals to the user that the crepe is ready to be served; controlled via a relay.

Chapter 5

Results and Discussion

The final **CrepeBot** implementation demonstrated the viability of automating the crepe preparation process, from batter mixing to topping and serving. Through recurrent testing and changes, many findings were noticed across different modules:

Batter Preparation and Pouring: A servo and DC motor powered the powder dispensing mechanism, which guaranteed a consistent flow and mixing of powder and water. However, due to the pan's weight and thermal expansion, rotation irregularities were initially detected. This was handled by adjusting the torque of the stepper motor and using a stopper-screw mechanism to ensure alignment accuracy.

Heating and Shape Control: Heating the metal plate induced some warping, resulting in uneven crepe shapes. Adding structural supports effectively diverted the warping inward, resulting in better batter distribution and a more circular crepe.

Toppings and Decoration: The dual-stage topping mechanism effectively distributed both chocolate and decorative elements. The revolving +-shaped arm, powered by a DC motor and supplemented by pumps and servos, ensured even topping distribution. Motor direction control and return-to-origin logic reduced tube tangles and increased stability.

Cleaning Automation: The automated cleaning cycle provided encouraging results. It used pumps, valves, and servo-controlled cup movement to follow a timed sequence of water intake, mixing, discharge, and waste disposal, reducing manual work and improving cleanliness greatly.

User Interface and Notification: The LCD and keypad allowed users to select their preferences intuitively. The notification light clearly indicated process completion, enhancing the overall user experience.

Despite some challenges, the system proved robust and reliable, with all modules operating harmoniously under Arduino Mega control—demonstrating the practicality of food automation in small-scale applications.

Chapter 6

Conclusion and Future Work

This project presents **CrepeBot**, an affordable and fully automated crepe-making machine designed to reduce manual labor while maintaining precision and hygiene. From ingredient mixing and heating to topping and cleaning, all operations were handled automatically using Arduino-controlled components and mechanical systems.

The system met its key objectives:

- Automated the core stages of crepe production.
- Provided a customizable experience via user input.
- Ensured consistent product quality and visual appeal.

Future Work and Recommendations

To improve and expand **CrepeBot**, the following enhancements are proposed:

- Improve batter pouring accuracy using liquid level sensors to ensure even distribution without overflow or shortage.
- Add a touchscreen interface to replace the keypad and LCD, enhancing user interaction and customization.
- Develop a mobile application for remote control, order tracking, and real-time notifications.
- Support a wider range of fillings and flavors by adding interchangeable modules or cartridges for ingredients.
- Enhance decoration styles with programmable nozzles and multiple rotation patterns.
- Reduce preparation time by using faster heating elements and optimizing pump timing.
- Improve energy efficiency by utilizing sensor-based systems to activate components only when needed.

With these improvements, **CrepeBot** can evolve from a prototype to a commercial-ready product suitable for cafés, kiosks, or smart kitchens.

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Appendix