AN-NAJAH NATIONAL UNIVERSITY
FACULTY OF ENGINEERING & INFORMATION TECHNOLOGY DEPARTMENT OF COMPUTER ENGINEERING

GRADUATION PROJECT II

POP IT UP

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Disclaimer

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Abstract

In recent years, there has been a growing demand for automated food machines that combine convenience, efficiency, and hygiene while providing an engaging user experience. Our project, **Pop It Up**, introduces an innovative popcorn-making machine designed to automate the entire process of producing freshly made popcorn with minimal human intervention.

The system integrates multiple stages, including automated cup dispensing, precise oil and seed measurement, controlled heating and mixing, customizable flavor dispensing, and an automatic cleaning stage using an air piston to ensure cleanliness and prepare the pot for the next batch. Each stage is controlled by motors, sensors, and relays, ensuring high accuracy, speed, and safety throughout operation.

This machine not only simplifies popcorn preparation but also enhances the user experience by offering different flavors and portion sizes while maintaining hygiene between cycles. With its user-friendly interface and reliable hardware design, **Pop It Up** provides a modern, efficient, and hygienic solution for snack preparation in cinemas, events, and public spaces. Ultimately, the project demonstrates how automation and mechatronics can transform traditional food-making processes, delivering consistency, convenience, and quality to users.

Chapter1

Introduction

Popcorn is one of the most popular and widely consumed snacks around the

world, especially in cinemas, events, and entertainment venues. Traditional methods of preparing popcorn often require manual effort, close supervision, and lack the ability to provide customization in flavors or serving sizes. With the growing demand for automation and convenience in food preparation, there is a clear need for a modern solution that makes the process faster, safer, and more efficient.

Our project, ***Pop It Up***, focuses on designing and developing an automated popcorn-making machine that combines mechanical, electrical, and control systems to prepare fresh popcorn with minimal human intervention. The machine integrates key stages such as automated cup dispensing, precise measurement of oil and seeds, controlled heating for popping, and the addition of various flavors. By incorporating motors, sensors, and user-friendly controls, the system ensures accuracy, consistency, and an enhanced user experience. Ultimately, this project aims to highlight the role of automation and mechatronics in improving traditional food production methods, offering a solution that is not only practical and efficient but also adaptable to different user preferences.

1.1 Problem Statement

The main problem stems from the lack of automation and customization in conventional popcorn-making methods. Users are often limited by manual preparation, which requires time, effort, and provides little flexibility in flavor or portion options. The objective of this initiative is to address this challenge by introducing an automated popcorn-making machine that enables users to prepare fresh popcorn efficiently while selecting from a variety of flavors and portion sizes. This innovation leverages modern technology to enhance accuracy, convenience, and the overall user experience.

1.2 Objectives

Our project's main goal is to develop an automated popcorn-making 0machine that streamlines the process of preparing fresh popcorn, reducing the reliance on manual methods and offering users a convenient and customizable experience. -following functionalities:

- Automatically dispense cups before the popcorn is served.
- Measure and dispense precise amounts of oil and seeds to ensure consistency.
- Control the heating process to pop the corn safely and efficiently.

• Allow users to select and add different flavors to personalize their popcorn.
• Provide options for different portion sizes, giving flexibility to meet user preferences.

• Implement an automatic cleaning stage using an air piston to keep the cooking pot clean after each cycle.

1.3 Scope of Work

The project's scope encompasses designing, developing, and implementing an automated popcorn-making machine to streamline the preparation, flavoring, and serving of popcorn. The system will comprise hardware components such as motors, relays, sensors, a heating element, and a user interface (keypad and display), along with software to manage operations and user interactions. The scope of work includes the following key areas:
• Integrating a cup dispenser mechanism to automatically place cups in the production line.
• Dispensing precise amounts of oil and corn seeds into the heating chamber.
• Heating and popping the seeds with controlled temperature and timing.
• Spraying flavors onto the popcorn according to user preferences and automatically cleaning the cooking pot using an air piston to remove any remaining residues.
• Implementing a control system that manages all stages of operation, ensuring efficiency, safety, and accuracy.

1.4 Significance

This popcorn-making machine stands out for multiple reasons. It modernizes the traditional process of preparing popcorn by automating the steps of dispensing, heating, and flavoring, allowing users to enjoy freshly made popcorn with greater ease and precision. By merging the simplicity of snack preparation with advanced technology, the machine bridges the gap between manual methods and modern convenience.
Automating various aspects of popcorn production not only saves time and effort but also makes the process accessible to a broader audience, including individuals with little to no experience in food preparation. This innovation fosters customization and enhances user satisfaction by offering options for different flavors and portion sizes.

Moreover, the system's ability to control ingredient quantities and spraying flavors ensures consistency, safety, and reduced material waste, which is beneficial in both personal and commercial settings. By combining traditional snack preparation with automation, this machine elevates the user experience, making popcorn production more efficient, cost-effective, and enjoyable.

1.5 Organization of the report

The report begins with an introduction that outlines the problem statement, project objectives, scope of work, and significance.
The second chapter discusses the limitations and constraints faced during the development of the project, along with the standards applied, the programming tools used, and references to related coursework.
The third chapter provides a literature review, presenting relevant studies, previous works, and their outcomes.
The fourth chapter focuses on the methodology, describing the system's overall design, its structural layout, electronic hardware components, and explaining in detail how the popcorn machine operates.
The fifth chapter highlights the results and analysis obtained from testing the system, followed by the conclusion and discussion chapter, which provides a project summary and suggestions for potential future improvements.

Chapter2

2.1 Constraints and Earlier Coursework

• One of the main challenges we faced was with the A4988 driver used in the cup dispenser. Initially, it did not function properly, and the motor performance was unstable. This issue was solved by adding a capacitor to stabilize the driver, which significantly improved its operation.
• Another problem occurred with the power supply. At first, we attempted to take power from multiple wires, but this setup did not provide stable voltage to the Arduino and caused malfunctioning. The issue was resolved by using a single wire connected properly through a connector, which ensured stable and reliable power delivery.

• We also faced a limitation in terms of working time inside the university workshop, as it closed at 3:30 p.m. This restricted the hours available for testing and assembling, making it difficult to progress at the desired pace.

2.2 Standards / Codes

- Our code was created using the Arduino IDE, allowing us to manage the hardware through the Arduino platform.

2.3 Earlier Coursework

- During our Microprocessor and Microcontroller courses, we acquired the skills to manage hardware components in our projects.

- The critical thinking course aids us in researching various topics, enhancing documentation, and improving report writing skills.

- Learning independently through Arduino courses on YouTube ,Google and various research studies

- Courses on wireless networks have been crucial in comprehending communication among nodes. This knowledge is essential for linking applications to our system, especially when connecting with Arduino using ESP.

- A course on electronics that covers a wide range of electronic systems and technologies.

Chapter3

Literature Review

Popcorn preparation has traditionally relied on manual methods, which are time-consuming and offer little customization. Modern automation in food systems, such as industrial popcorn lines, ensures precision, speed, and consistency. Inspired by these systems, ***Pop It Up*** integrates motors, sensors, a heating unit, and flavor sprayers into a compact machine controlled by a microcontroller. This approach modernizes snack preparation, making it more efficient, customizable, and user-friendly.

Chapter 4

Methodology

4.1 System Structure 4.1.1 Machine Body

Fig. 4.1: Popcorn Machine Body 1

4.1.2 Cup Dispenser Stage

The **Cup Dispenser Stage** is the first stage in the ***Pop It Up*** system. Its main role is to automatically release a single cup into position so that the popcorn can be served inside it.

In this design, the mechanism relies mainly on a **stepper motor** connected to the cup holder. When the motor rotates at a defined angle, one cup is released from the stack, while the remaining cups stay in place. The accuracy of dispensing depends on the motor's programmed movement rather than additional sensors or limit switches.

This simple yet effective approach ensures that only one cup is dropped each time the process is initiated, reducing manual effort and making the machine more efficient and user-friendly.

Fig. 4.2: Cup Dispenser Mechanism

4.1.3 Slider

The **Slider Stage** is a critical part of the *Pop It Up* system. Its main function is to **move the cup** between different positions during the popcorn-making process.
After the **Cup Dispenser Stage** drops a cup, the slider—driven by a **stepper motor**—transports the cup to the popping area, where popcorn is dispensed into it. Once the cup is filled with popcorn, the slider continues its movement to the **flavor spraying area**, where selected flavors are added.
This stage allows the machine to handle multiple processes automatically without human intervention, ensuring smooth transitions between stages. The use of a stepper motor provides precise control over cup positioning, guaranteeing that the cup is always correctly aligned under the popcorn outlet and the flavor sprayers.
By integrating the Slider Stage, the system increases automation, efficiency, and accuracy in the serving process.

Fig. 4.3: Slider Stage 1

4.1.4 Cooking Stage (Pot & Piston Mechanism)

The **Cooking Stage** is the core of the *Pop It Up* system, responsible for preparing the popcorn. At the beginning of this stage, the **air piston** keeps the pot lifted in its upper position. While in this position, a **servo motor** opens a small gate to dispense the corn seeds into the pot, and an **oil pump** injects the required amount of oil.

After the ingredients are loaded, the **heating element** is activated through a relay, and the **stirring mechanism** begins to rotate. While the pot remains in its raised position, the seeds and oil are mixed and heated until the popcorn is fully cooked.

Once the preset cooking time is complete, the **air piston lowers the pot**, allowing the popcorn to be released through an outlet into the waiting cup positioned by the **Slider Stage**.

By coordinating the operation of the **servo motor, oil pump, relays, and air piston**, the Cooking Stage ensures precise ingredient handling, reliable heating, and smooth dispensing of popcorn.

Fig. 4.4: Cooking Pot & Piston System

Fig. 4.4: Oil Pump

Fig. 4.4: popcorn bowl

4.1.5 Flavor Spraying Stage

The **Flavor Spraying Stage** is responsible for adding the final touch to the popcorn by dispensing one of three available flavors: **salt, spicy, or cheese**. Each flavor container is equipped with a **stepper motor** mechanism that controls the spraying process. The user selects the desired flavor through the system's interface, and the corresponding stepper motor activates to release the flavor evenly onto the popcorn.

By using stepper motors, the system ensures **precise control** over the amount of flavor applied, preventing waste and ensuring consistency in taste. The separation of the three spraying mechanisms also minimizes the risk of cross-contamination, maintaining the purity of each flavor. This stage enhances the overall user experience by introducing personalization, allowing each customer to enjoy popcorn prepared exactly to their taste preference.

Fig. 4.5: Flavor Spraying

4.1.6 Cleaning Stage (Air Piston System)

The Cleaning Stage ensures the cooking pot remains clean and ready for the next batch of popcorn. After the popcorn is dispensed into the cup, an **air piston** is activated to blow high-pressure air toward the pot. This process removes any remaining popcorn kernels, oil residues, or seasoning particles stuck inside or around the pot.

The piston is connected to the system through a relay,which controls the airflow timing automatically. By directing a burst of air at the pot, the cleaning process is quick and efficient,
reducing downtime and maintaining hygiene standards.

Process Flow:

1-After the popcorn is dispensed, the system waits for a few seconds.
2-The relay activates the air piston.
3-The air piston pushes a strong stream of air directly toward the pot to remove debris.
4-Once the cleaning cycle is complete, the piston turns off automatically.

Main Components Used:

Air Piston: Provides a strong, controlled air stream for cleaning.
Relay Module: Controls the activation and deactivation of the piston.
Air Duct / Nozzle: Directs airflow precisely toward the cooking pot.

4.2 Hardware components

4.2.1 Arduino MEGA

The Arduino Mega 2560 was the basis for controlling our project. The board is based on the ATmega2560 microcontroller and has 54 digital input/output pins, 15 of which can be used as PWM outputs, 16 analog inputs, and 4 UART ports for serial. controlled the **Cup Dispenser Stage**, the **Slider Stage**, the **Cooking Stage** (including relays, oil pump, servo motor, and air piston), and the **Flavor Spraying Stage** (stepper motors for salt, spicy, and cheese flavors). With its high number of I/O pins, the Mega 2560 provided the flexibility required to coordinate multiple motors, pumps, and relays simultaneously. With its high number of I/O pins, the Mega 2560 provided the flexibility required to coordinate multiple motors, pumps, and relays simultaneously.

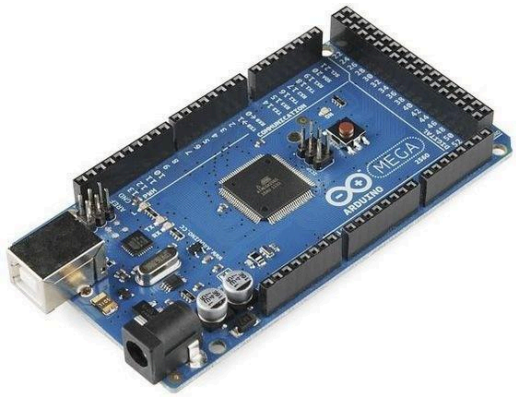

Fig. 4.7: Arduino MEGA Board

4.2.2 Power Supply

The power supply is an electrical device that is characterized by its ability to provide different voltages to operate various electronic components, which enables it to provide each piece with the appropriate power for its needs, whether it needs low or high voltage to ensure its efficient operation.

Fig. 4.8: Power Supply 1

4.2.3 The guide line of Power Supply

4.2.4 H-bridge

We used the L298N in our project to control the cup dispenser stepper, which helped us control their speed and direction precisely while dispensing the cups.
The L298N allows the speed and direction of the motors to be controlled at voltages ranging from 5V to 35V, and handles up to 2A of current per motor, making it ideal for automation and robotics projects.

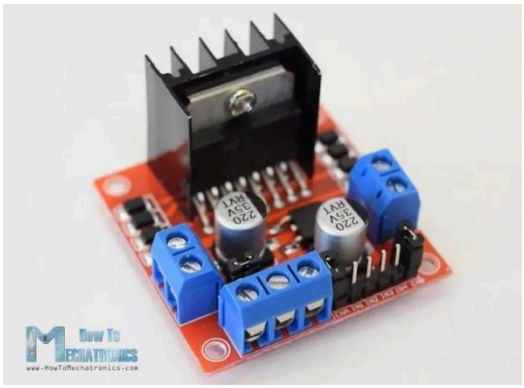

Fig. 4.9: H-Bridge 1

4.2.5 Driver

We used the A4988 to control the stepper motor in the slider stage and flavors stage . This advanced driver makes controlling the stepper motors easy and efficient, as it can handle up to 35V and ±2A current.

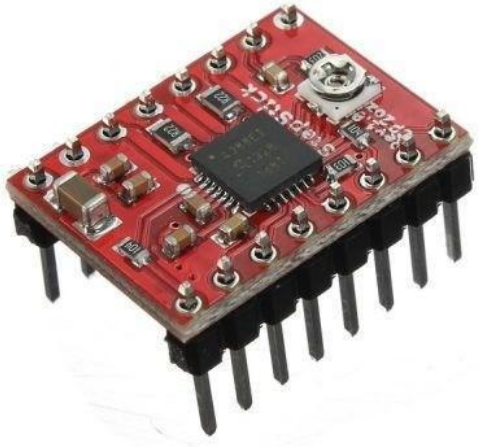

Fig. 4.10: A4988 driver 1

4.2.6 stepper motor

NEMA17 stepper motors are popular because they are both small and powerful. These motors require 200 steps to complete a full cycle, which means each step is accurate to 1.8 degrees. They can handle up to 3.5 amps of current and operate at voltages ranging from 3 to 12 volts. In our project, we used five of these motors: the first one was responsible for controlling the flow of the cups, while the second was used to control the slider, and the last three for controlling flavors .

Fig. 4.11: Stepper Nema 17 1

4.2.7 Servo

We used servo motor to precisely control the release of popcorn from the cooking pot. The servo operates a small gate mechanism located at the bottom of the pot.

Fig. 4.12: Servo motor 1

4.2.8 Relay

We used an **8-channel relay module** to control the main electrical components of the popcorn machine, including the **oil pump, air piston, heating element, stirring motor, and lamp**.

Fig. 4.13: Relay 8 channel 1

4.2.9 LDR

An LDR, or photoresistor, changes its action based on the intensity of light:

its resistance decreases when exposed to light and increases in the dark. In our project, we used the LDR as part of a detection mechanism for the **Slider Stage**. When the slider reached the designated position under the cooking pot, the LDR detected a change in light (from the laser beam) and signaled the Arduino to stop the motor.

Fig. 4.14: LDR 1

4.2.10 Laser

Lasers are small devices that emit a narrow, precise beam of light, making them ideal for applications that require precision such as measuring and alignment. In our project, we used a laser to send a beam toward the LDR. When the beam cuts off, we know the bottle has reached its intended location.

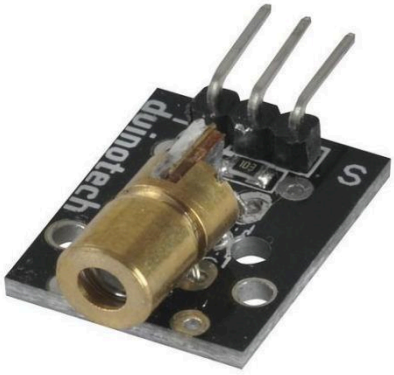

Fig. 4.15: Laser Sensor

4.2.11 Limit switch

Limit switches help detect whether an object is present or absent, and were originally designed to define how far something can travel, giving them their name. In our project, we used these switches to precisely control the stepper motor during the slider stage. They ensured the motor stopped exactly where needed .

Fig. 4.16: Limit Switch 1

4.2.12 Pump

The 12V 3.7A High Pressure Water Pump is a powerful and reliable pump, designed to handle high pressure tasks. We used it in our project to mix the perfume effectively, ensuring smooth liquid flow and even mixing of the perfume.

Fig. 4.17: Pump 1

4.2.13 Capacitor

The 100uF 25V capacitor helps stabilize voltage in electronic circuits and reduces oscillations. We used it with the A4988 module to ensure smoother performance and fewer problems in operation.

Fig. 4.18: Capacitor

4.2.14 Wires

Intercom Wires Used for connecting various components together.

Fig. 4.19: Wire 1

4.2.15 Arduino Wires

Arduino Wires Essential for linking components to the Arduino board for control and communication.

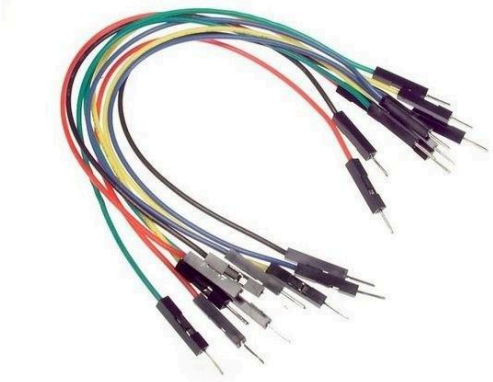

Fig. 4.20: Arduino wire 1

4.2.16 Speaker Wires

Speaker Wires We used speaker wires to connect the different parts, they are strong and can handle higher voltages than what was previously done for our needs.

Fig 4.21: Speaker Wires 1

4.2.17 LCD

The 16x4 LCD is a practical display based on the HD44780 controller and comes with a backlight, allowing the display of 4 lines with 16 characters per line. LCDs usually consume many Arduino pins and require complex connections, but using the I2C interface, we only need 4 pins to operate it, which saves a lot of space. In our project, we used this display to **facilitate**

the selection of popcorn flavors (salt, spicy, or cheese) through the keypad. The LCD also shows clear step-by-step messages about the **production process**, such as when the cup is dispensed, seeds and oil are added, cooking is in progress, and flavors are being sprayed. This makes it easier for the user to monitor and follow each stage of the popcorn preparation

Fig 4.22: LCD

4.2.18 Keypad

In our project, we used a keyboard to facilitate entering the proportions of the perfumes and to control the entire popcorn-making process and to facilitate user interaction with the system. The keypad is connected directly to the Arduino, allowing the user to make selections such as choosing the desired **flavor** (salt, spicy, or cheese), starting the cooking process.

Fig 4.23: KeyPad

4.2.19 Air Piston

The air piston is used to generate a powerful burst of air aimed at the cooking pot for cleaning purposes. It is controlled through a relay, ensuring the process is automatic and activated only after the popcorn is dispensed.

Chapter 5

Results and Discussion

In this project, we developed an integrated popcorn production system that combines automation with traditional popcorn-making techniques to deliver an efficient, hygienic, reliable, and user-friendly process. The system successfully automated all key stages: **cup dispensing, seed and oil loading, cooking, flavor spraying, cleaning, and serving**.

During operation, the process begins with the **Cup Dispenser Stage**, which releases a cup, and the **Slider Stage**, which moves the cup into position. The **servo motor** then releases the corn seeds, while the **oil pump** injects the required amount of oil into the cooking pot. With the **air piston raised**, the heating element and stirrer, both controlled by relays, work together to cook and mix the popcorn within a predefined time.

Once cooking is complete, the **air piston lowers the pot**, allowing the popcorn to be dispensed directly into the cup. The slider then moves the filled cup to the **Flavor Spraying Stage**, where one of the three available flavors — salt, spicy, or cheese — is selected and evenly applied using stepper motor–driven sprayers.

After the flavoring process, the **Cleaning Stage** is automatically activated. In this stage, the air piston blows a powerful stream of air toward the cooking pot to remove any leftover popcorn kernels, oil residue, or seasoning particles. This ensures the system remains clean and ready for the next production cycle, maintaining hygiene and preventing cross-contamination between different batches.

The results demonstrated that the system can consistently produce high-quality popcorn while **minimizing human effort** and ensuring hygienic operation. Each stage functioned smoothly and in synchronization, guaranteeing accurate ingredient handling, proper timing, reliable flavor application, and effective cleaning. This confirms that the integration of mechanical design, electronics, and control software provides a **complete and practical solution** for automated popcorn production.

Chapter 6

Conclusion and Future work

6.1 Conclusion

Our automated popcorn machine shows how technology can improve traditional snack preparation. By automating cup dispensing, seed and oil loading, cooking, and flavor spraying, the system reduces manual effort and ensures consistent results. This project simplifies the popcorn-making process and opens the door ,for future improvements, such as adding more flavors or different cup sizes.

6.2 Future work

Cup Size Selection
Add options for selecting different cup sizes (small, medium, large) to provide more flexibility for users.

Expand Flavor Range
Upgrade the system to include more flavors beyond salt, spicy, and cheese, giving users more variety and personalization.

Automatic Cleaning Process
Enhance the cleaning mechanism by making it adjustable for different levels of cleaning intensity based on residue amount.

Touch-Screen Interface
Replace the keypad and LCD with a modern touch-screen interface to improve usability and provide a more interactive experience.

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