



**An-Najah National University**  
**Faculty of Engineering and Information Technology**  
**Department of Computer Engineering**

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# **M a n q u s h t i**

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# **Disclaimer**

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# Table of Contents

|        |  |    |
|--------|--|----|
| 1.     | Acknowledgment.....  | 6  |
| 2.     | Abstract.....  | 7  |
| 3.     | Introduction.....  | 8  |
| 3.1.   | Background.....  | 8  |
| 4.     | Constraints, Standards, and Earlier Coursework.....        | 9  |
| 4.1.   | Constraints.....   | 9  |
| 4.1.1. | Belt Design and Tensioning:.....                           | 9  |
| 4.1.2. | Dough Type:.....   | 9  |
| 4.1.3. | Piston and Dough Handling:.....                            | 9  |
| 4.1.4. | Oven Heat Distribution:.....                               | 9  |
| 4.1.5. | Electrical Load Management:.....                           | 10 |
| 4.1.6. | Space Requirements:.....                                   | 10 |
| 4.2.   | Standards  |    |
|        | Electrical Standards and Safety Measures We Followed:..... | 10 |
| 4.2.1. | Wire Selection:.....                                       | 10 |
| 4.2.2. | Relays and Contactors:.....                                | 10 |
| 4.2.3. | Heater Safety:.....  | 10 |
| 4.2.4. | Cutting Blade Safety:.....                                 | 10 |
| 4.2.5. | Oven Insulation:.....                                      | 11 |
| 4.3.   | Earlier Coursework.....                                    | 11 |
| 5.     | Literature Review.....                                     | 12 |
| 5.1.   | Traditional Methods of Manqusheh Production.....           | 12 |
| 5.2.   | Automation in Food Production.....                         | 12 |
| 5.3.   | Inspiration from Auto Pizza Project.....                   | 12 |
| 6.     | Methodology.....   | 13 |
| 6.1.   | Hardware parts.....  | 13 |
| 6.2.   | Description.....   | 15 |
| 6.3.   | App.....   | 29 |
| 7.     | Results and Discussion.....                                | 30 |
| 8.     | Conclusion and Recommendations.....                        | 31 |
| 9.     | Future Work.....   | 32 |
| 10.    | References.....  | 33 |

# Table of Figures

| <b>Figure No.</b>      | <b>Title</b>                                  | <b>Page No.</b> |
|------------------------|---|-----------------|
| <b>Figure 6.2.1</b>    | Manqushti System                              | 12              |
| <b>Figure 6.2.2</b>    | Arduino Mega 2560                             | 14              |
| <b>Figure 6.2.3</b>    | 12V 30A Switching Power Supply                | 16              |
| <b>Figure 6.2.4</b>    | Power Supply Computer                         | 16              |
| <b>Figure 6.2.5</b>    | Rocker Switch                                 | 17              |
| <b>Figure 6.2.6</b>    | The Laser Module and LDR                      | 17              |
| <b>Figure 6.2.7</b>    | 8-Channel and 2-Channel Relays                | 18              |
| <b>Figure 6.2.8</b>    | 2x1 Keypad                                    | 19              |
| <b>Figure 6.2.9</b>    | Tiny RTC I2C Module                           | 19              |
| <b>Figure 6.2.10</b>   | Cutter Dough Machine                          | 20              |
| <b>Figure 6.2.10.1</b> | DC Motor: Windshield Wiper Motor              | 20              |
| <b>Figure 6.2.10.2</b> | Pneumatic Piston for the Dough Cutter Machine | 21              |
| <b>Figure 6.2.10.3</b> | Capacitive Proximity Sensor PNP               | 21              |
| <b>Figure 6.2.10.4</b> | Ultrasonic                                    | 22              |
| <b>Figure 6.2.11</b>   | Circular Machine                              | 22              |
| <b>Figure 6.2.11.1</b> | Car Window Motor                              | 23              |
| <b>Figure 6.2.12</b>   | Press Dough Machine                           | 23              |
| <b>Figure 6.2.12.1</b> | Heating Coil                                  | 24              |
| <b>Figure 6.2.12.2</b> | DS18B20 Temperature Sensor                    | 24              |
| <b>Figure 6.2.13</b>   | SaltCheese Dispenser Machine                  | 25              |
| <b>Figure 6.2.13.1</b> | Stepper Motor Nema 23 and Driver TB6600       | 25              |

|                        |   |    |
|------------------------|---|----|
| <b>Figure 6.2.13.2</b> | The IR Sensor   | 26 |
| <b>Figure 6.2.14</b>   | Oven Chamber  | 26 |
| <b>Figure 6.2.14.1</b> | Contactator   | 27 |
| <b>Figure 6.2.14.2</b> | Thermocouple Temperature Sensor<br>Module MAX6675                     | 27 |
| <b>Figure 6.2.15</b>   | Advanced Stepper Motor Nema 23 and<br>Driver TB6600 for Conveyor Belt | 28 |
| <b>Figure 6.2.16</b>   | Stepper Motor Nema 23 for Conveyor<br>Belt                            | 28 |
| <b>Figure 6.2.17</b>   | ESP32   | 29 |
| <b>Figure 6.2.18</b>   | user-side application   | 29 |
| <b>Figure 6.2.19</b>   | admin-side application  | 29 |
| <b>Figure 6.2.19.1</b> | admin-side application  | 29 |
| <b>Figure 6.2.20</b>   | Results   | 30 |

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We cannot forget our friends, whose constant support and uplifting messages kept us going through the toughest days. Their encouragement and friendship have played a vital role in our success.

Lastly, this work is dedicated to the resilient people of Gaza. We proudly pay tribute to the families enduring hardship and to the martyrs who gave their lives for a noble cause. The strength and willpower of the people of Gaza continue to inspire and motivate us every day.

# Abstract

The Manqushti system revolutionizes the production of traditional Middle Eastern flatbreads, specifically Manqusheh with Nablus Cheese, by implementing a fully automated process. This innovation improves efficiency and accuracy in bakery operations while maintaining the authentic taste of this beloved dish.

The system automates every step of the process—from dough preparation, through cheese topping selection, to the final baking. By reducing manual labor and optimizing the workflow, it addresses the growing demand for faster food production without compromising quality.

Unlike typical bakery automation systems that focus on general bread production, the Manqushti system is uniquely designed to cater to the specific needs of making Manqusheh with Nablus Cheese. Key automated tasks include forming dough balls, rolling the dough, adding cheese toppings, and baking, allowing bakers to operate more efficiently and ensuring the final product meets high standards of freshness and perfection.

# Introduction

Manqusheh with Nablus cheese is a cherished Middle Eastern dish that has long been part of the region's culinary tradition. However, making this dish traditionally is a labor-intensive process that involves various steps such as dough preparation, topping application, and baking. This project introduces the Manqushti system, an innovative automated solution aimed at streamlining the production of manqusheh, making it faster, more consistent, and less dependent on manual labor. By automating key tasks, the system ensures efficiency and maintains the authentic taste of the dish while addressing challenges faced by bakeries in terms of production speed and labor costs.

## Background

Manqusheh, particularly with Nablus cheese, has been a staple for generations. The traditional process of making this dish involves skillful dough preparation and the precise distribution of toppings to ensure a perfect result. While this method has stood the test of time, it can be labor-intensive and time-consuming, especially in larger-scale production environments such as bakeries that need to meet high demand.

As the demand for traditional Middle Eastern foods increases, bakeries face the challenge of maintaining quality while also improving production efficiency. Manual methods of preparing manqusheh often result in inconsistencies in size, topping distribution, and cooking time. Furthermore, these processes heavily rely on skilled labor, making it difficult to scale production or reduce operational costs. To address these challenges, automation has emerged as a promising solution in many industries, including bakeries. However, most existing bakery automation systems focus on bread production and are not tailored to the unique requirements of making manqusheh. The Manqushti system was specifically designed to overcome these challenges by automating key stages of the manqusheh-making process. This system automates tasks such as dough ball formation, dough rolling, cheese topping application, and baking, enabling bakeries to produce high-quality manqusheh at a faster rate while maintaining its authentic taste and texture.

By introducing automation to the production process, the Manqushti system reduces the reliance on manual labor, enhances production speed, and ensures consistent quality. This innovation not only meets the demand for faster food production but also preserves the traditional flavors that make manqusheh a beloved dish in Middle Eastern culture.

# Constraints, Standards, and Earlier Coursework

## Constraints

We would like to note that the production line was adapted from a pizza production project. This gave us an existing production line to work with, but it came with challenges that needed to be addressed:

### **Belt Design and Tensioning:**

- The production line initially had separate stages, which posed issues with consistency and flow. To solve this, we covered the stages with a full cloth belt.
- The tensioners were replaced with a motor capable of withstanding more pressure, as the movement became heavier due to the modifications.
- A belt that could withstand heat and had a soft texture was selected to prevent sticking during the process.

### **Dough Type:**

- We experimented with multiple types of dough until we arrived at the correct type that maintained the desired texture and consistency throughout the automated process.
- logistical challenges.

### **Piston and Dough Handling:**

- The use of a piston introduced challenges related to airflow and dough handling. Ensuring that the dough did not stick required careful selection of materials and adjustments to the system.
- Dough, being a complex material, was difficult to detect using traditional sensors. After testing several options, we implemented an industrial oven sensor capable of accurately detecting the dough.

### **Oven Heat Distribution:**

- There were issues with the oven's heat distribution. The initial setup resulted in uneven baking, where the top and bottom of the manqusheh were not cooked evenly.

- Adjustments were made to ensure better heat distribution, allowing for consistent and uniform baking of the manqusheh.

#### **Electrical Load Management:**

- The system's components, particularly the oven, drew high amounts of current, which caused the university's security systems to shut down. To address this, we utilized a contactor and a visible Nescos to manage the electrical load effectively.

#### **Space Requirements:**

- The size of the project necessitated a spacious location to accommodate the production line. Finding a suitable space posed

## **Standards**

### **Electrical Standards and Safety Measures We Followed:**

#### **Wire Selection:**

- We used 2.5mm<sup>2</sup> wires for the oven to ensure proper current flow and avoid overheating.

#### **Relays and Contactors:**

- Relays were placed in protective boxes because they operate at 220 volts, ensuring safety.
- Contactors were used to reduce the electrical load and protect the system from power surges.

#### **Heater Safety:**

- The heater's wires were insulated with cold silicone or thermal insulators to prevent exposure.
- The heating elements were covered with a non-conductive material to ensure safety.

#### **Cutting Blade Safety:**

- The blade is mounted on a secure holder, leaving only the tip exposed for functionality.

- Additional protective layers surround it on the sides, creating a box-like structure for safety during operation.

#### **Oven Insulation:**

- The oven is insulated with thermal-grade materials to retain heat efficiently and improve safety.

#### **User-Friendly Design:**

- The user interface is designed with simplicity in mind to make operation easier.
- There are two buttons for intuitive use, ensuring that anyone can operate the system without confusion.

## **Earlier Coursework**

During this project, we relied on several key courses that played a vital role in expanding our knowledge and ensuring the project's success:

- **Microcontrollers & Lab:**  
This course was fundamental in understanding hardware implementation, serial communication, and programming Arduino to handle controller logic. It also provided practical experience with sensors and hardware components.
- **Electrical Circuits:**  
It guided us in selecting the right resistors and sensors, ensuring proper integration of the hardware components.
- **Computer Networks:**  
We gained insights into serial communication techniques, which were crucial for achieving system portability and improving efficiency.
- **Critical Thinking & Research:**  
This course sharpened our ability to research effectively and document our work comprehensively.
- **Self-Learning:**  
By exploring free online resources, we were able to overcome challenges and deepen our understanding of complex topics.

# Literature Review

The literature Review for the Manqushti system explores various aspects of bakery automation, traditionally food production challenges, and technological advancements relevant to the project's goals.

## **Traditional Methods of Manqusheh Production**

Traditional Manqusheh with Nablus Cheese production involves several labor-intensive steps, including dough preparation, topping application, and baking. Studies such as [Hungry Paprikas, 2023] emphasize the cultural significance of preserving the authentic taste and texture of Manqusheh while meeting modern production demands. Despite its popularity, traditional methods often lead to inconsistencies in quality, especially in high-demand settings like bakeries.

## **Automation in Food Production**

consistency, and scalability. Research by [Deskera, 2023] highlights how automated systems in bakery operations reduce manual labor while maintaining product quality. Common applications of automation include dough mixing, shaping, and baking, as demonstrated in systems for bread production.

However, studies [Smith, 2020] indicate that existing systems primarily cater to generic bread production, with limited focus on the intricate requirements of traditional foods like Manqusheh. The need for automation tailored to regional and cultural dishes remains a gap in the field.

## **Inspiration from Auto Pizza Project**

The Manqushti system draws inspiration from the "Auto Pizza" project, developed by Shahd Bilal Hamza and Fana Abdul Rahim Yamk under the supervision of Dr. Loai Malhis, and presented on August 28, 2023, as part of the Computer Engineering Department's graduation projects. The "Auto Pizza" project demonstrated the potential of integrating automation into food preparation processes, focusing on pizza production. This project serves as a foundation for exploring automation tailored to traditional foods like Manqusheh, offering insights into hardware implementation, system integration, and optimization for specific culinary requirements. The Manqushti system builds upon this framework, adapting and expanding its scope to address the unique characteristics of Manqusheh production, such as dough preparation, precise topping distribution, and cultural authenticity.

# Methodology

## External design



Figure 6.2.1: Manqushti System

## Hardware parts

### Microcontroller

- Arduino Mega 2560

### Motors and Drivers

- DC Motors
- Stepper Motor Nema 23 + TB6600 Driver (3.5A)
- Advanced Feature Stepper Motor Nema 23 + TB6600 Driver (5A)

## **Sensors**

- Capacitive Proximity Sensor PNP
- Ultrasonic Sensor
- IR Sensor
- Laser Module and LDR Module
- DS18B20 Temperature Sensor
- Thermocouple Temperature Sensor Module MAX6675

## **Actuators**

- Pneumatic Piston + Pneumatic Solenoid Valve 220V

## **Power Supplies and Switching**

- Power Supply (Computer)
- 12V 30A Switching Power Supply
- Relay 8 Channel + Relay 2 Channel
- Contactor
- Rocker Switch

## **Input Devices**

- 2x1 Keypad

## **Other Components**

- Connecting Wires
- Resistors
- Heating Coil
- Tiny RTC I2C Module

## Description

In this section, we will discuss each component and explain how it is used in our machine

### Arduino Mega 2560



Figure 6.2.2: Arduino Mega 2560

The heart of the Manqushti System is the Arduino Mega, which is in charge of all the interactions between subsystems. It attends to every machine, operates stepper motors, receives and processes keypad inputs – to select the quantity of Manqusheh, computes the entire system operation time, and gathers sensor values in order to control and monitor the machine's health status. Besides, it also connects to ESP32, which helps in connecting our system with smart devices and networks to make them work easily with it. The Arduino Mega has several benefits as well, such as user-friendliness in the Arduino IDE, which ensures their availability for novices and skilled developers. It has a sufficient number of pins, and that is why it is perfect for controlling a variety of devices. It can also provide reliable communication to external devices, and with 256 KB flash memory, it can manage various sophisticated tasks and data processing simultaneously. Therefore, the Arduino Mega is a critical component for the administration and integration of different parts of the Manqushti System.

## 12V 30A switching power supply



Figure 6.2.3: 12V 30A switching power supply

The inclusion of a 12V 30A switching power supply significantly contributed to the successful operation of our project. This type of power supply, also known as a switched-mode power supply (SMPS), proved indispensable due to its ability to provide various voltage levels and substantial power output. Switching power supplies offer a remarkable advantage in terms of efficiency when compared to linear power supplies. Their operation involves rapidly switching the input voltage on and off at a high frequency, with output voltage regulation achieved through control circuitry. This design approach results in higher efficiency and allows for more compact and lightweight power supply designs, which were essential for driving the eight stepper motors and other project components.

## Power supply computer



Figure 6.2.4: Power supply computer

In our project, we used a computer power supply to give different parts and modules steady, dependable power. Its dependability and capacity to supply adequate power across several voltage rails are the reasons we used it.

## Rocker switch



Figure 6.2.5: Rocker switch

The project included a rocker switch that could be used as an emergency button, enabling the administrator to quickly turn the entire system on or off. Enhancing safety and control procedures, this functionality is especially important when working with parts like the oven that run at high voltages of 220V.

## The Laser Module and LDR

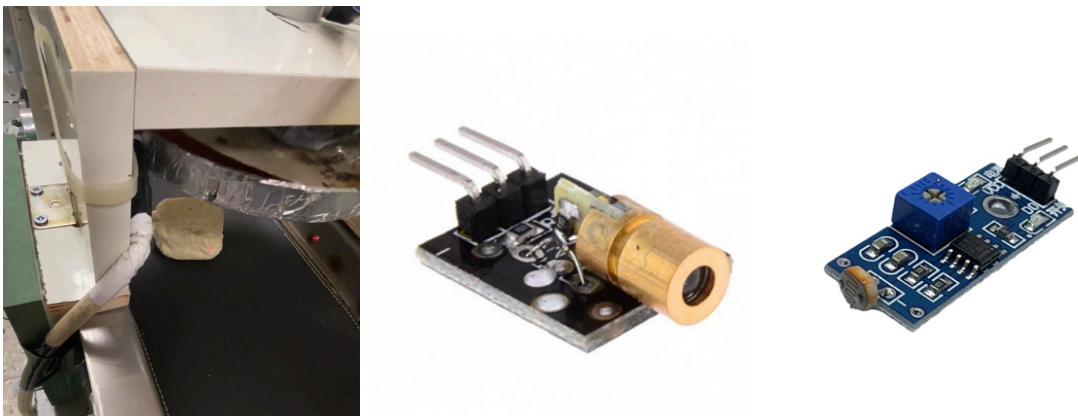


Figure 6.2.6: The Laser Module and LDR

The Laser Module and LDR (Light Dependent Resistor) Module work together to detect the dough. When the dough passes through the laser beam, the LDR reads the value, signaling the press machine to activate. We use this system to detect the presence of dough.

## 8-Channel and 2-Channel Relays

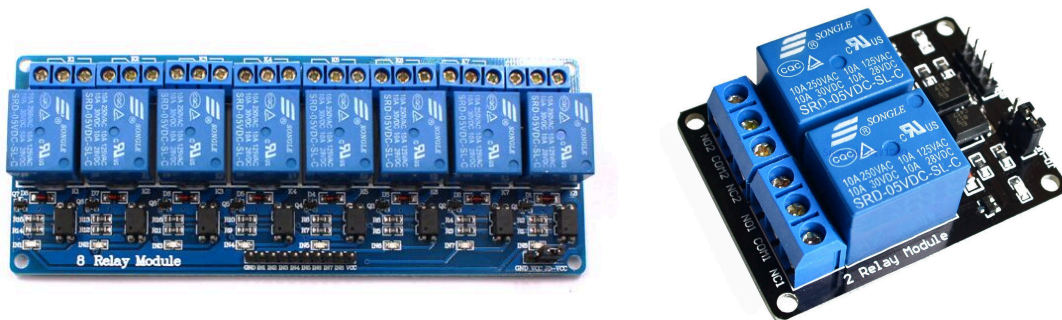


Figure 6.2.7: 8-Channel and 2-Channel Relays

The project incorporated an 8-channel relay module and a 2-channel relay module to efficiently manage various operational stages, highlighting the critical role of relays in automation and control systems. Relays are indispensable for isolating and controlling high-power circuits using low-power signals, ensuring both safety and operational efficiency. The 8-channel relay module was employed to control the first stage, which included the DC motor and piston, the second stage with an additional DC motor, and the third stage involving coil heating and the piston. This module was instrumental in coordinating multiple components and overseeing the majority of the project's processes. In contrast, the 2-channel relay module was dedicated to regulating the oven, ensuring precise and efficient control. By integrating relays into the system, the project achieved reliable switching, electrical isolation, and effective management of high-current loads, all of which were essential for seamless, safe, and robust operation.

## 2x1 Keypad

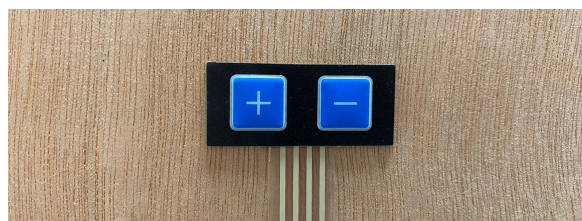


Figure 6.2.8: 2x1 Keypad

We use a 2x1 keypad to allow the user to select the desired number of Manqusha. Pressing the '+' button indicates the user wants one Manqusha, while pressing the '-' button indicates they want two. The keypad is easy to use, durable, and cost-effective, making it an ideal input method for user interaction. Additionally, it is compact and reliable, allowing for efficient in the system.

## Tiny RTC I2C Module

We use the Tiny RTC I2C Module in our system to calculate the real-time duration the system takes to prepare and deliver a Manqusha to the user, whether they order one or two. This module provides accurate real-time tracking, enabling precise measurement of operation times and enhancing system reliability.

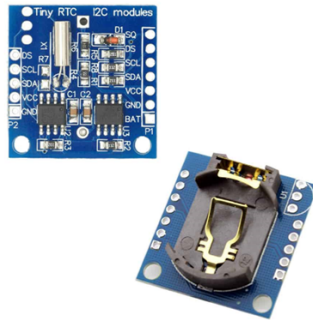


Figure 6.2.9: Tiny RTC I2C Module

## First-stage

### Cutter dough machine

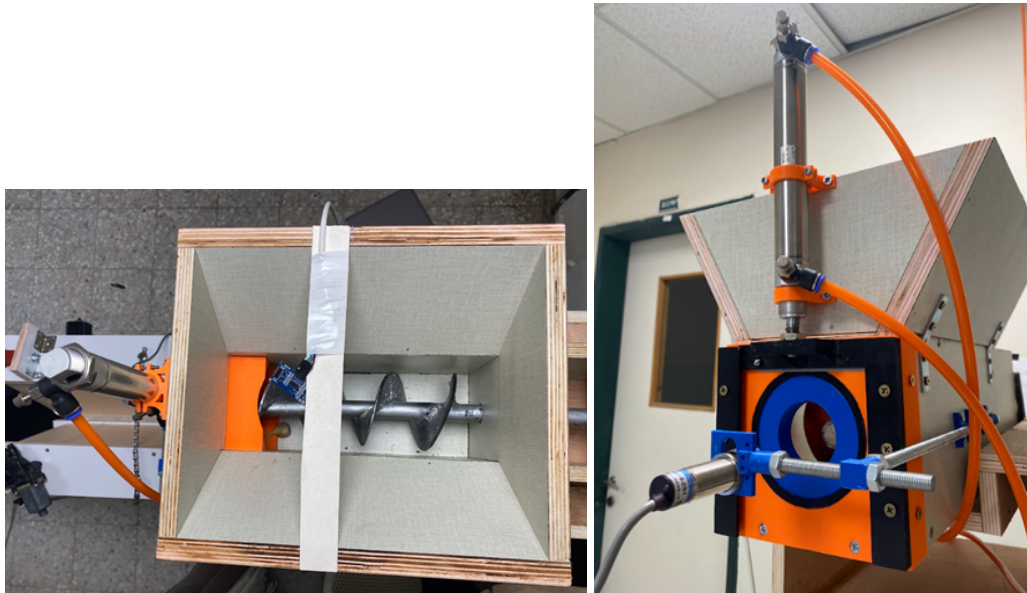


Figure 6.2.10: Cutter dough machine

## Components

### DC motor

We use a DC motor, specifically a Windshield Wiper Motor, in the first-stage dough cutter machine. The motor is connected to a screw mechanism that pushes the dough to prepare it for cutting. We chose the Windshield Wiper Motor because it provides strong torque, which is necessary to apply enough force to push the dough effectively.

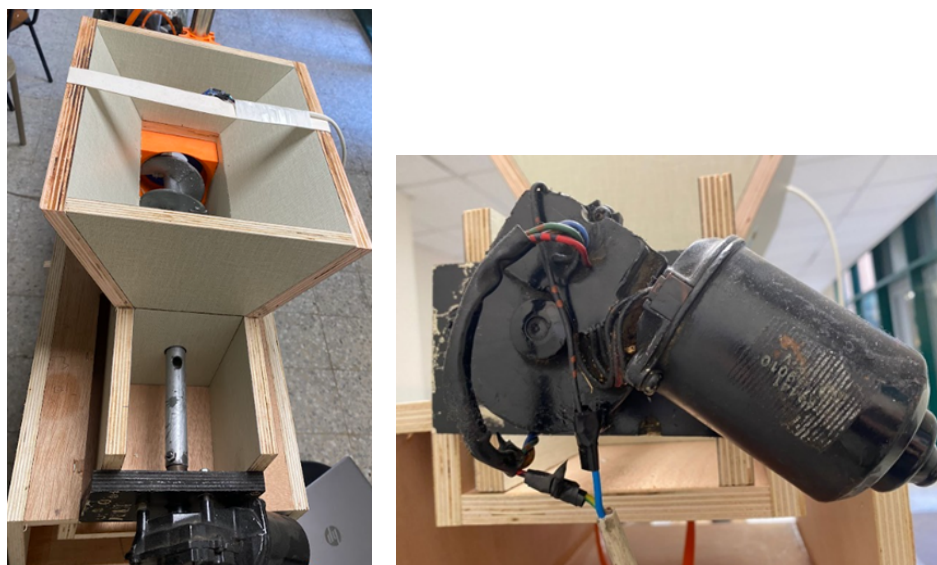


Figure 6.2.10.1: DC motor: Windshield Wiper Motor

## **Pneumatic Piston + Pneumatic Solenoid Valve 220V**

We employ pneumatic pistons of larger diameters to gain more surface area to exert greater force when connected to pneumatic systems. The 125 mm diameter piston has been designed to serve an optimal balance of force and is perfect for strenuous tasks such as pressing or cutting dough that requires significant force. Additionally, A 220V pneumatic solenoid valve is used with each piston to control the flow of compressed air that powers it.

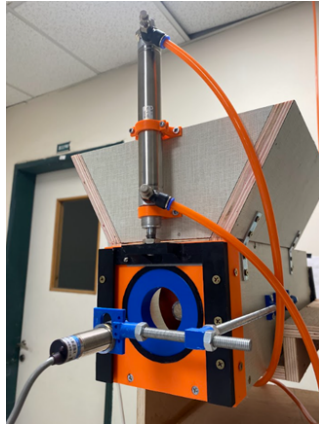


Figure 6.2.10.2: Pneumatic piston for the dough cutter machine

## **Capacitive Proximity Sensor PNP**

The Capacitive Proximity Sensor PNP is a specialized type of industrial sensor that has the capability to recognize certain materials. In our case, it is used for sensing the dough while it comes out of the machine nozzle. This particular sensor has been used in our case since it is very accurate and works efficiently in detecting the dough.

How It Works:

The circuitry of the sensor is designed to detect changes in capacitance. When dough is present, it enters the electric field of the sensor. This disturbance of the field causes the capacitance to increase which is subsequently detected by the sensor and distinguishes the dough.

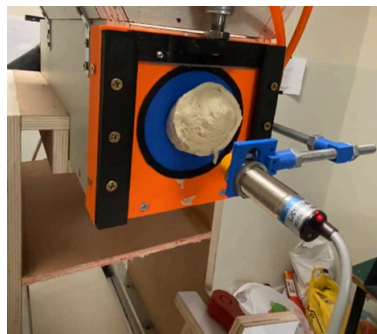


Figure 6.2.10.3: Capacitive Proximity Sensor PNP

## Ultrasonic

The ultrasonic sensor is used to detect the dough level, indicating whether it is full or running low.



Figure 6.2.10.4: Ultrasonic

## Second-stage

### Circular dough machine



Figure 6.2.11: circular machine

## Components

### DC motor

The other type of **DC motor** used is a **car window motor**, which is employed in the second-stage circular machine for making dough balls. This motor is chosen for its power and ability to withstand significant force, which is essential for driving the conveyor belt. The machine uses two conveyor belts moving in opposite directions at an appropriate angle to ensure the dough passes through both belts and forms into a ball shape.

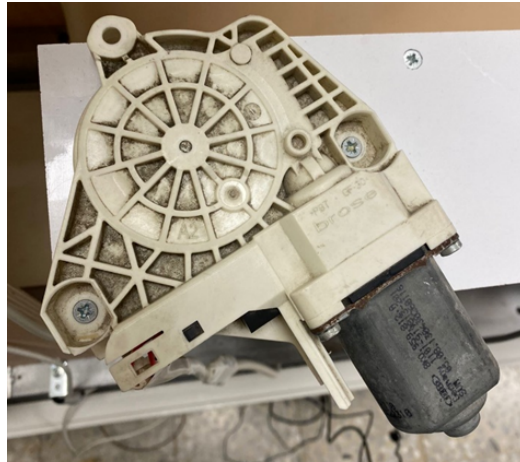


Figure 6.2.11.1: car window motor

## Third-stage

### Press dough machine

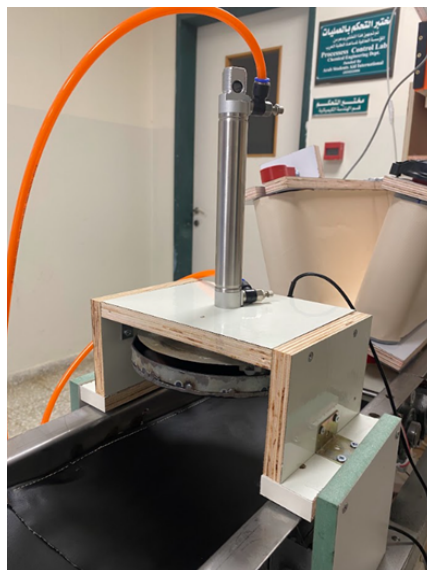


Figure 6.2.12: Press dough machine

## Components

### Pneumatic Piston + Pneumatic Solenoid Valve 220V

### Heating Coils

We use a heater to heat the pressing part of the machine to a specific temperature, preventing the dough from sticking to the press when it is roll out.

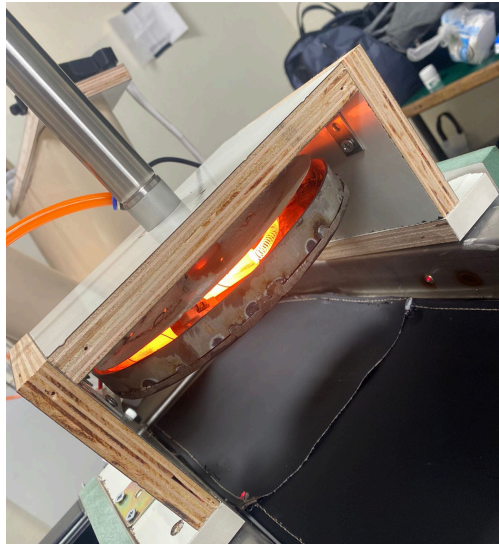


Figure 6.2.12.1: Heating Coil

### DS18B20 Temperature Sensor

Is used to monitor the temperature of the heater, ensuring it stays within the specified range and does not exceed the set limit.

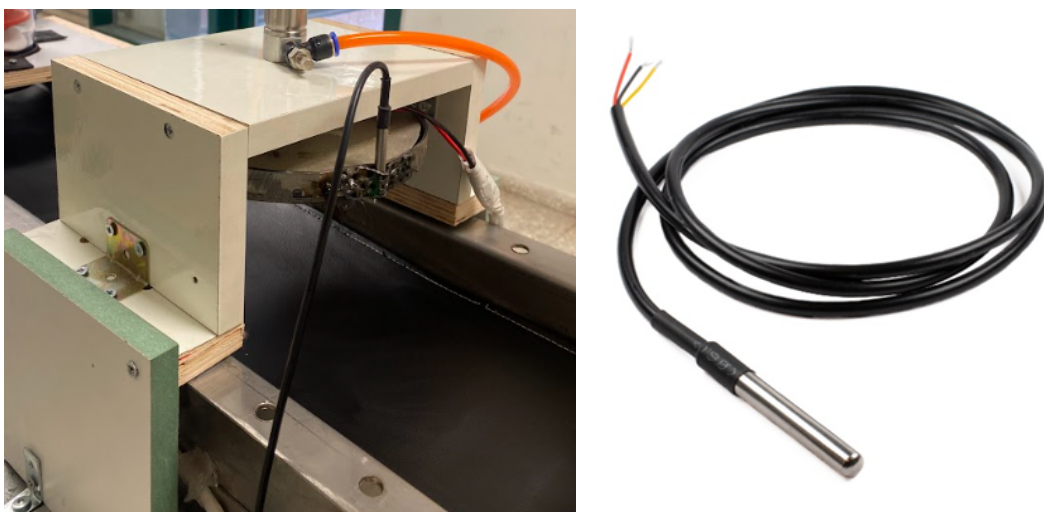


Figure 6.2.12.2: DS18B20 Temperature Sensor

## Fourth-stage

### SaltCheese dispenser machine

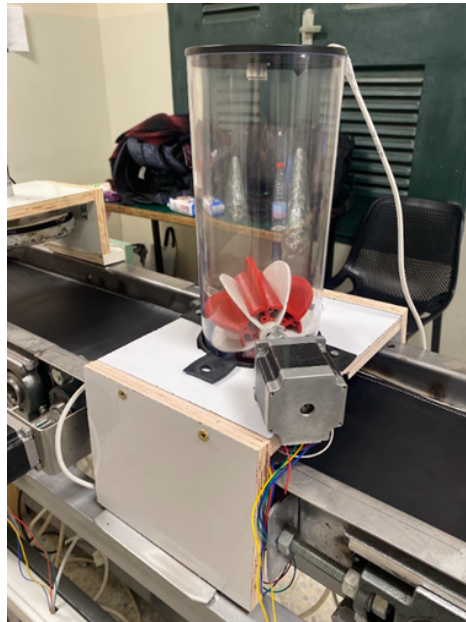


Figure 6.2.13: SaltCheese dispenser machine

## Components

### Ultrasonic

### Stepper motor Nema 23

We use a NEMA 23 stepper motor for multiple purposes, primarily in stage four of the system to dispense salted cheese onto the dough. The cheese is stored in a cylinder, and the motor controls the quantity dispensed by adjusting the number of revolutions. **The TB6600 3.5-amp driver** ensures precise control of these revolutions and effectively regulates the motor's speed.

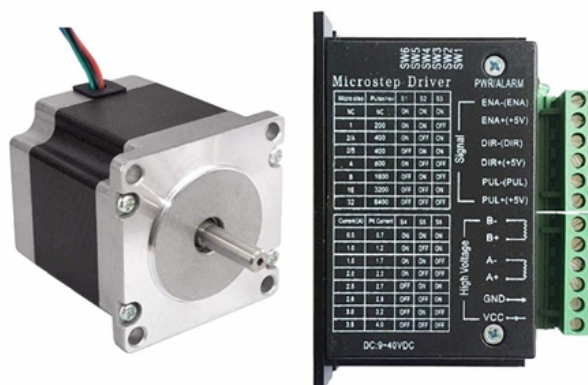


Figure 6.2.13.1: Stepper motor Nema 23 and driver TB6600

## IR Sensor

We use an IR sensor to detect when the dough is positioned under the salted cheese dispenser, allowing the system to add cheese on top. The IR sensor is particularly effective because the conveyor belt is black and the dough is white, making it an easy and reliable way to detect the dough and trigger this action.



Figure 6.2.13.2: The IR Sensor

## Fifth-stage

### Oven Chamber



Figure 6.2.14: Oven chamber

This oven section gets its power from an electric oven with a power rating of 220V used for baking and it has a built-in heat retention and release design. It is obfuscated in a foil wrap which constrains any heat from escaping the chamber

The oven's conveyor system, which is made of hard metal, is able to endure the extreme heat required to adequately bake Manqusha. This combination of attributes guarantees appropriate cooking and holding of the internal temperature for perpetual great outcomes

Considerably, to enhance safety and regulation, a contactor and relay were installed in the system. First, the contactor controls the current high voltage wiring. He uses it to turn on and off the heating elements and conveyor system. The relay was to enable better control and cooperation with the automation of the oven control proper. These modifications were made to enhance the overall dependability, security, and efficiency of the oven



Figure 6.2.14.1: Contactor

### **Thermocouple Temperature Sensor Module MAX6675**

This sensor continuously measures the oven's internal temperature. We use it to monitor the temperature, and if it exceeds the set range, the oven will automatically turn off. We chose this sensor because it can handle high temperatures and is accurate, making it essential for both safety and optimal cooking results. The MAX6675 thermocouple module efficiently converts thermal signals into readable temperature data.



Figure 6.2.14.2: Thermocouple Temperature Sensor Module MAX6675

## Sixth-stage

### Conveyor belt

#### Components

##### Advanced Stepper Motor Nema 23

Additionally, we use a stepper motor to drive the conveyor belt in the oven. An advanced feature stepper motor is also used to operate two separate stages as a single unit, requiring high torque to move them efficiently. To control this motor, we use a **TB6600 5-amp driver**, ensuring precise operation and performance.



Figure 6.2.15: Advanced stepper motor Nema 23 and driver TB6600 for conveyor belt

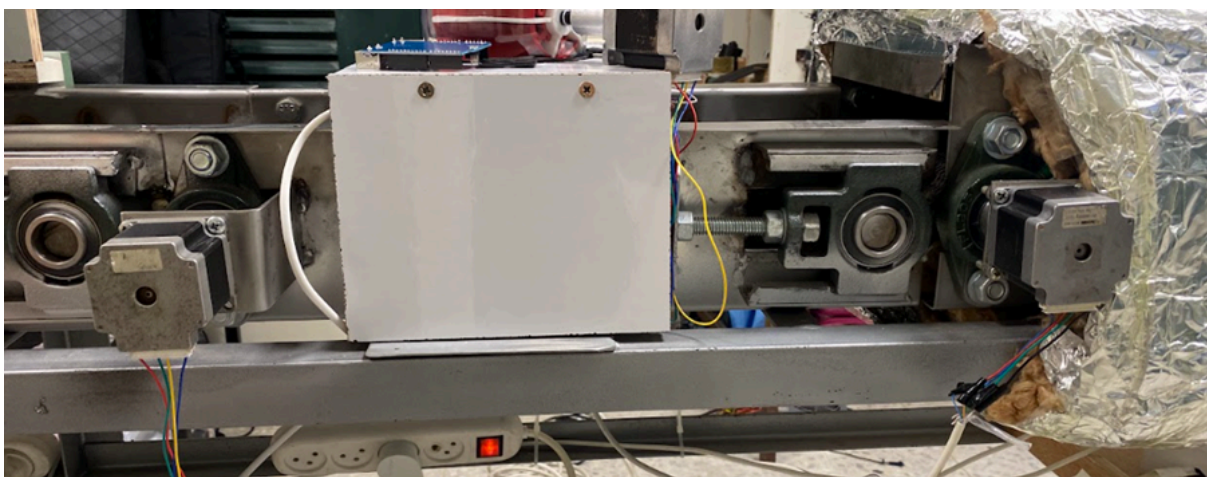


Figure 6.2.16: Stepper motor Nema 23 for conveyor belt

# App

We developed an application using App Inventor to send data to the ESP32. The ESP32 receives this data from the application based on the user's selected quantity of Manqousha. This data is then transmitted to the Arduino via the TX and RX interface. Upon receiving the data, the cutter machine begins cutting the dough according to the specified quantity.

Additionally, we developed an admin-side application to manage and control each machine individually. This application allows for handling maintenance or other specific scenarios, monitoring sensor values to ensure proper operation, and being prepared for unexpected situations.

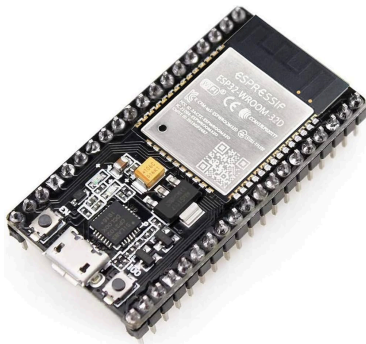


Figure 6.2.17: ESP32



Figure 6.2.18: user-side application



Figure 6.2.19.1: admin-side application

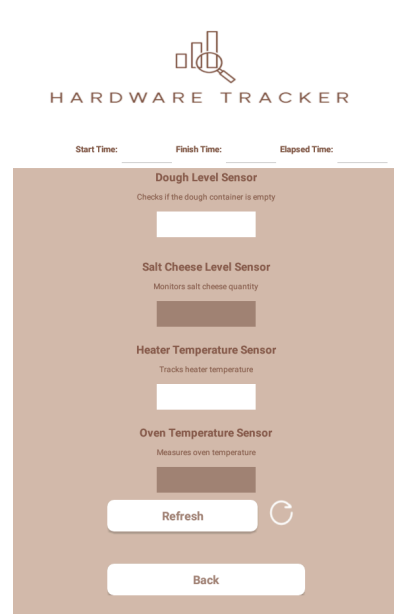


Figure 6.2.19.2: admin-side application

## Results and Discussion



Figure 6.2.20: Results

The Manqushti system effectively automates the production of Manqusheh with Nablus Cheese, addressing key challenges such as efficiency, consistency, and product quality. Its innovative design ensures the seamless integration of multiple automated processes, including dough ball formation, rolling, cheese topping application, and baking. By leveraging advanced components such as the Arduino Mega 2560, stepper motors, capacitive sensors, and a Tiny RTC module, the system achieves precise control and timing at each stage. Challenges related to dough handling, oven heat distribution, and electrical load management were addressed through careful material selection, system calibration, and enhanced safety measures. Testing demonstrated significant improvements in production speed and consistency compared to traditional methods, with uniform heat distribution ensuring even baking and consistent product quality. The system's modular design and user-friendly interface make it adaptable to various bakery scales, highlighting its potential as a reliable solution for modernizing traditional Middle Eastern flatbread production while preserving its authentic taste and cultural significance.

## **Conclusion and Recommendations**

The Manqushti system represents a significant advancement in the automation of traditional Manqusheh production, incorporating Nablus Cheese while enhancing both efficiency and consistency, all while maintaining the authentic taste and texture of the dish. By integrating components such as stepper motors, pneumatic pistons, sensors, and temperature control systems, the production process is optimized, minimizing manual labor and addressing common challenges faced by bakeries. Although the system has demonstrated considerable success, there is room for improvement, particularly in enhancing sensor accuracy for dough detection and exploring more advanced heat distribution techniques in the oven. Furthermore, broadening the system's adaptability to accommodate various types of traditional Middle Eastern flatbreads could expand its market potential. As bakeries continue to seek innovative solutions to meet growing demand while ensuring product quality, the Manqushti system provides a compelling model for future automation in the food production industry.

## **Future Work**

Future work for the Manqushti system includes several enhancements to further optimize its performance and expand its capabilities. First, implementing parallel processing could improve the system's efficiency by allowing multiple tasks, such as ingredient preparation and oven management, to occur simultaneously. Second, integrating a dough kneading machine would automate the labor-intensive dough preparation process, ensuring consistency in texture and quality. Third, expanding the ingredient choices, such as offering different types of cheeses or toppings, could attract a wider customer base and diversify the product offerings. Finally, utilizing RTC memory to store data during power sleep mode would allow the system to resume operations seamlessly after power interruptions, preserving progress and reducing downtime. These improvements will help refine the system, enhancing its reliability and versatility in the competitive food production market.

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