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

Graduation Project II

Za'ter Master

Prepared by:
Aya Ba'ara
Sewar Aslan

Supervised by:
Dr. Luai Malhis

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Disclaimer

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Abstract

Za'ter is a traditional Palestinian dish, and despite its age, no Palestinian breakfast is complete without it. The process of making Za'ter is long and challenging, requiring a lot of manual effort. It involves moving Za'ter from one stage to another, sifting, milling, and mixing ingredients all by hand. Our project aims to simplify the management of Za'ter preparation, making the process more efficient and less labor-intensive. We plan to create an automated system that controls various stages of Za'ter production, using an Arduino board connected to different components such as motors and others. The process involves grinding the Za'ter until we achieve the right consistency. Once we reach that stage, we carefully add ingredients like sesame, sumaq, and salt in the specified amounts to ensure the perfect blend of flavors. After adding these ingredients, we mix everything thoroughly until the mixture is homogeneous, Finally, we present the Za'ter in an attractive form, ready for customers to enjoy, This attention to detail throughout the process is essential for delivering a perfect product

Chapter 1

Introduction

For Palestinians, za'ter is more than just a dish; it means so much to our heritage, our identity, and our resilience. For generations, Palestinians have grown, cooked, and consumed za'ter as a means of holding onto the culture, embracing heritage, and preserving life, which is being threatened. Importantly, za'ter is a great part of Palestinian cuisine-the land produced and the traditions that are used in the dishes.
The Za'ter Machine: a project in support of easy za'ter production. Making za'ter traditionally involves multiple stages of laborious job processes, from grinding the herbs and sifting to mixing the elements. With our machine, all these complicated steps are rolled into just one single streamlined procedure. Its purpose is to let people who cook do this faster and with less effort. This would save not only time and effort but also ensure that this cultural practice of making za'ter continued unabated in modern times.

1.1 Problem Statement

This process of making za'tar—a traditional staple within Palestinian cuisine—is highly laborious and time-consuming. It is multistep, ranging from harvesting, grinding, sifting, and mixing to get the final product, solely manual, hence multiplying the laboriousness and unproductiveness of the activity.
Further, the lifestyle of today's world makes it more difficult for people to invest their time and energy in this customary culture by the day. There is urgency in providing such a solution that would ease the whole preparation of za'ter to make it easy, fast, less of a burden, and yet culturally relevant.

1.2 Objectives

Our main objective is to design an automated za'ter-making machine to prepare za'ter effectively, thereby reducing the continuous need for human assistance. The following features are to be incorporated into this smart za'ter machine:

1. Automate the Za'ter Production.
2. Raise and lower the cover of the grinding machine and grind the Za'ter.
3. Sifting Za'ter and getting rid of the waste.
4. Add appropriate amounts of sesame, sumaq, and salt.
5. Mixing the ingredients to get the final product.

1.3 Significance

This Za'ater-making machine is unique for many reasons; firstly, for being one that bridges tradition and technology. It uses the same idea of traditional Palestinian heritage, softening the process of making Za'ater and making it less laborious. Because of this modernization, a substantial reduction in labor time and cost is seen by both household and commercial Za'ater producers. In streamlining the process, this machine greatly increases accessibility and promotes continuity with these practices within a modern framework.

1.4 Organization of the report

The report first of all gives an introduction to the problem statement, objectives of the project, the scope of work, and its significance.
The second chapter sets out the limitations and constraints that forced us during work on the project, also the standards we used the programs we used in coding and application, and finally earlier coursework.
The next chapter, In, takes the literature review. The work and results that are relevant will be included in that chapter.
Then, the methodology chapter follows, which gives deep information on the project, its structure, the components used in building it, the electronic hardware, and in particular talking about how this system works.
The results and analysis go to the fifth chapter, while the conclusion and discussion go to the conclusion and summarize the project, with the future work that can be done on the project.

Chapter 2

Constraints and Earlier Coursework

2.1 Constraints and limitations

1. The main problem was Finding the appropriate structure for each stage to complete its work perfectly.
2. The nature of the ingredients used to make Za'ter is difficult to deal with, for example: sumaq is so thick.
3. Determine the appropriate time to finish grinding the entire amount of Za'ter and the time needed to sift it.
4. The number of motors used is very large, causing high cost.

2.2 Standards / Codes

- For the development of the code, we used the environment of Arduino IDE, which allowed us to directly control the hardware by using the functionalities provided in the Arduino platform.
- We used the MQTT protocol for communication so that the client can control this device remotely using a mobile application.
- The mobile application was created using the App Inventor platform, providing users with the ability to control the system from a distance.

2.3 Earlier Coursework

- The Critical Thinking course taught us how to research effectively, which helped a lot with documenting our work and writing reports.

- Micro-processor and Micro-controller and there Labs courses gave us hands-on experience with controlling the hardware components in our project and knowing how to deal with the components' data sheets.
- The Wireless and Networks courses played a key role in helping us understand how to connect different devices, which we applied by linking the mobile app to our system using an ESP module with Arduino.
- The Electronics and Digital Circuits courses provided a strong foundation in electronic systems, which was vital for our project. Along the way, we also relied on self-learning through YouTube Arduino tutorials and independent research to deepen our understanding.

Chapter 3

Literature Review

One of the most popular of these traditional spice mixtures in all of Palestinian cuisine is called Za'tar, made of a mixture of wild thyme, sumaq, sesame seeds, among others. Because it is so crucial an element of both Palestinian culture and cuisine alike, families traditionally make za'tar by hand: they pick wild thyme from hillsides, dry it out, and then combine it with spices in a manner passed down through the family for generations, a process as much about preserving tradition as it is about producing food. In rural areas, preparing za'ter is often directly associated with the agricultural cycle, reflecting the strong connection between the land and the people in general. The preparation of za'ter is basically by far associated with the agricultural cycle, particularly in rural areas where this quasi-symbiotic relation between people and land has always been significant. [Abufarha, 2013].

While za'ter is a crucial part of Palestinian life, little attention has been paid to easing its production. Most research looks at agricultural and cultural aspects, but with the growth in demand for Palestinian products, it is high time ways are found to make za'ter more efficiently without losing its traditional value. Such a machine for making za'ter will help this demand be met and simplify the whole process from harvesting to grinding and mixing, while retaining that taste and quality in it.

Indeed, considering other producing foodstuffs industries, such as olive oil production in Mediterranean countries, we realize that technology can make traditional food production faster and more consistent without sacrificing quality.[Foxhall, 2008] Similarly, by using the same ideas with za'ter, small-scale producers could match the increases in demand so that this treasured spice blend continues to be made with care.

Food technology research also demonstrates that the scalable development of machines for both small farms and larger operations can bring prosperity to local communities.[Hameed et al., 2018] A machine that would make za'ter is part of such a community's success insofar as it hastens production without compromising the cultural preservation of za'ter.

While much of the literature on za'ter focuses on its cultural and agricultural value, the innovation in its manufacture increasingly appears to be a rising need. Such a machine that manufactures za'ter could bridge the gap between honoring tradition and embracing modern needs by improving za'ter production efficiency while sustaining its rich heritage. Further exploration of the technology and its likely impacts on local communities shall be the key towards making this vision true.

Chapter 4

Methodology

4.1 machine Structure

4.1.1 machine Body

Figure 4.1: machine design.

4.1.2 Grinding Stage

The grinding stage will consist of a dc car motor connected to a rope and a pulley, which allows the cover to open and close easily. Also, it will contain two switches that stop the car motor while raising and lowering, including a relay to turn on the mill. Finally, a NEMA23 motor flips the container over to let the ground thyme fall into the next stage.

Figure 4.2: Grinding Stage

4.1.3 Sifting Stage

The sifting stage consists of a 50 cm diameter sieve fixed on 4 springs to which the thyme reaches after grinding, then it is screened by a very fast DC motor with a weight fixed at its end to add vibration. Under the sieve there is a belt that moves right and left by a strong NEMA motor to transfer the materials to the next stages.

Figure 4.3: The pulley

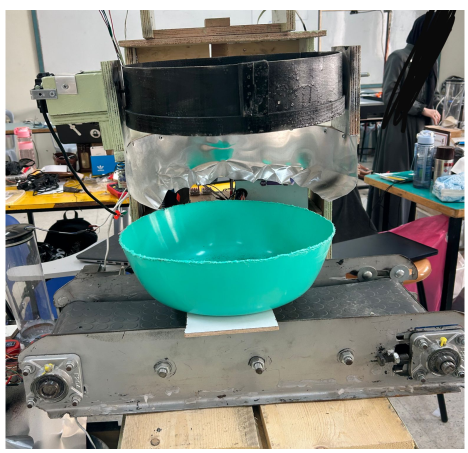

Figure 4.4: Sifting Stage1

Figure 4.5: Sifting Stage2

Figure 4.6: DC Motor with the weight

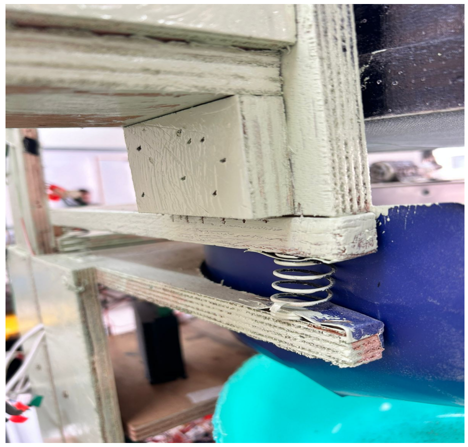

Figure 4.7: Spring

4.1.4 Adding Ingredients Stage

At this stage, the ingredients of sesame, sumaq and salt are added. This stage consists of a plastic box in which the sesame is placed and two funnels made of soft iron to suit the nature of sumaq and salt. At the end of these boxes, there is an opening that is opened and closed using a cover and a servo motor. At the top of the all boxes, an ultrasonic is installed to ensure that the boxes are filled with ingredients.

Figure 4.8: Adding Stage

Figure 4.9: The Iron funnel

4.1.5 Mixing Stage

The mixing stage consists of a huge funnel with a small cylinder at the end, inside which a mixer rotates by means of a motor. The mixer was specially made to mix the materials well. At the end of the cylinder there is a small gate with a servo motor attached to open the gate after the mixing process is complete and the final result is delivered to the box.

Figure 4.10: Mixing Stage

Figure 4.11: The Funnel

Figure 4.12: The Mixer

4.2 Hardware components

4.2.1 Arduino MEGA

The MEGA 2560 is designed for more complex projects. With 54 digital I/O pins, 16 analog inputs and a larger space for your sketch The Arduino Mega 2560 is a microcontroller board based on the ATmega2560[1]. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller.We used it for the large number of inputs/outputs it has that we needed to get this project done. We basically connected most of the components on it like ESP32 , all the Motors (stepper ,Dc and servo) and drivers,ultra sonic sensor switches.[Arduino, 2024a]

Figure 4.13: Arduino MEGA.

4.2.2 ESP 32-microcontroller

The ESP32 is a versatile and widely-used microcontroller and Wi-Fi/Bluetooth system-on-chip (SoC) produced by Espressif Systems.
A SoC, is essentially an integrated circuit that takes a single platform and integrates an entire electronic system onto it, for an specific application. Contrary to a simple microcontroller (like Atmega324p Arduino Uno), that offers several general usage peripherals instead of a specific set of tools for one application.
we used it to send commands between App inventor mobile application and the Arduino created.[Arduino, 2024b]

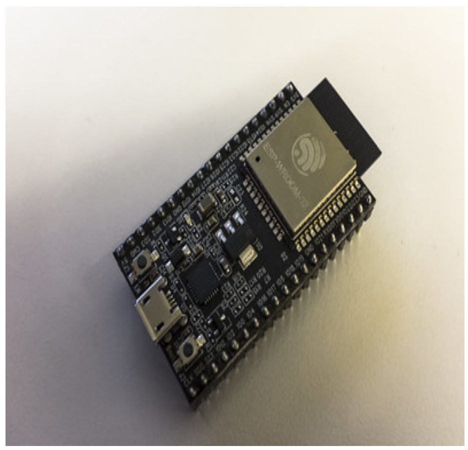

Figure 4.14: esp32-microcontroller

4.2.3 Computer Power Supply

The desktop computer power supply converts the alternating current (AC) from a wall socket of mains electricity to a low-voltage direct current (DC) we used it to get 12 and 5 volt.

Figure 4.15: Power Supply

4.2.4 Car Dc Motor

The car wiper motor is a slow but sturdy DC motor capable of bearing weight. We used it to raise and lower the cover using a pulley and rope mechanism.

Figure 4.16: Car Dc Motor

4.2.5 DC Motor

we used 12-volt DC motor capable of operating at 1000 RPM (Power, 2022) used in the sieving stage

Figure 4.17: DC Motor

4.2.6 BTS7960 Motor Driver

The BTS7960 stands as a highly integrated half-bridge module meticulously crafted to cater to the demands of high-current motor control applications. It proudly resides within the NovalithICTM family, housing a p-channel high-side MOSFET and an n-channel low-side MOSFET, together with an integrated driver IC, all compactly packaged as a single unit. used to run the car dc motor and the dc motor

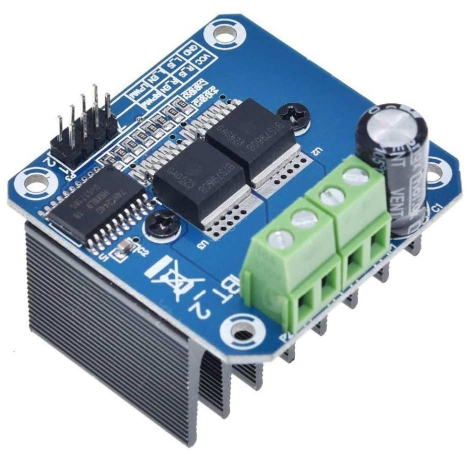

Figure 4.18: BTS7960

4.2.7 Servo Motor

The function of a servo motor is to control the position, speed, and torque of mechanical systems with high precision A servo motor operates by receiving a control signal that represents the desired output position and adjusting its motion accordingly we used it to as gate in order to control the dropping of ingredients

Figure 4.19: Servo Motor

4.2.8 Servo Motor High Torque

This servo features iron gears that can withstand the weight and movement resulting from the mixing stage.

Figure 4.20: Servo Motor High Torque

4.2.9 Nema 23 stepper Motor

NEMA 23 is a stepper motor with a 2.3×2.3 inch (58.4×58.5 mm) faceplate and 1.8° step angle (200 steps/revolution). Each phase draws 2.8 A at 3.2 V, allowing for a holding torque of 19 kg-cm. NEMA 23 Stepper motor is generally used in Printers, CNC machine, Linear actuators and hard drives. used it in flipping ghebal and grinder and in the mixing stage [nem,]

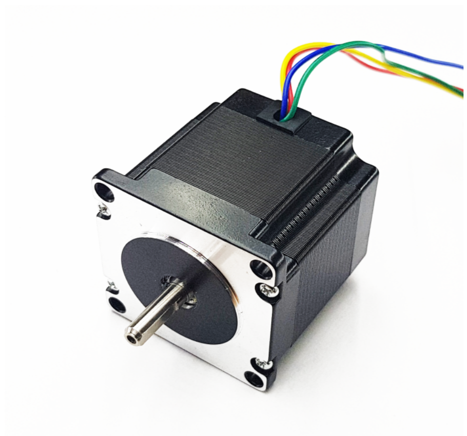

Figure 4.21: Nema 23 stepper Motor

4.2.10 TB6600 Microstep Driver

we went with the TB6600 since it could handle the huge load which was required for our project. Unlike smaller drivers like an H-bridge, it proved much more efficient in handling the load accordingly.

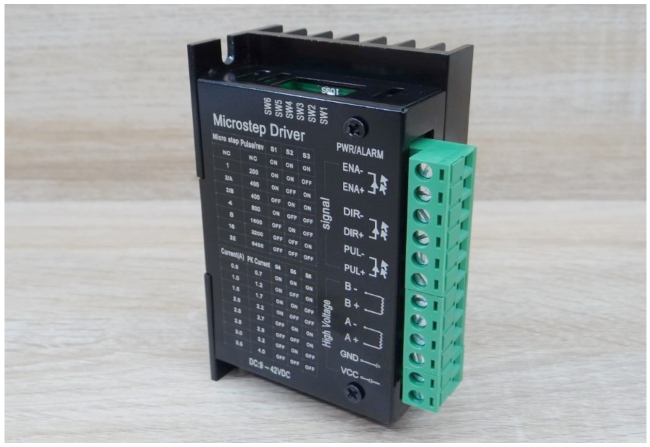

Figure 4.22: TB6600 Microstep Driver

4.2.11 Ultrasonic sensor

Ultrasonic Sensor that use ultrasonic sound waves to measures the distance to an object . We used three of these sensors to measure distance of the ingredient containers to make sure that they are filled

Figure 4.23: Ultrasonic Sensor

4.2.12 Limit Switch

Limit switches provide a straightforward and effective way to prevent a machine's axis from moving beyond its designated limits.We used two switches to control the up and down movement of the cover in the grinding stage when it is pressed the dc motor will stop rotating

Figure 4.24: Limit Switch

4.2.13 Relays

A relay is an electrically operated switch that allows a low-power control signal to control a higher-power circuit. we used one relay to turn the grinder on/off

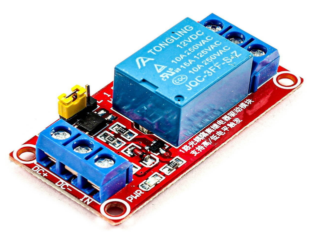

Figure 4.25: Relay

4.2.14 Intercom Wires

used to connect different components together.

Figure 4.26: Intercom Wire

4.2.15 Arduino Wires

To connect ICs to the Arduino.

Figure 4.27: Arduino Wires

4.3 Mobile Application

The system connected with an application that enable controlling by the owner of the machine, the application has 4 interfaces as follow:

4.3.1 Start page

Figure 4.28: Start page of application

The page includes The logo and a start button

4.3.2 Control page

Figure 4.29: Cover control

This page has the cover control buttons which are up and down buttons and reminds the user to fill Za'atar to begin the process

4.3.3 Initialization page

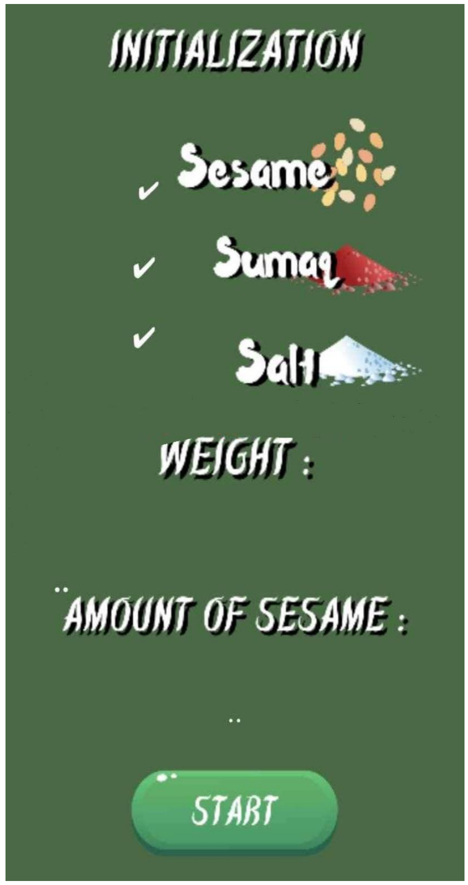

Figure 4.30: Initialization page of application

This page helps the user monitor the status of the ingredients like sesame, sumac, and salt. Detected by an ultrasonic sensor and then sent to the app, the level of these ingredients will indicate when a refill is required inside the containers.

In addition the user can select how much Za'atar has been added: 120g or 60g. For people who like more sesame in Za'atar, there is the possibility of changing the amount of sesame.

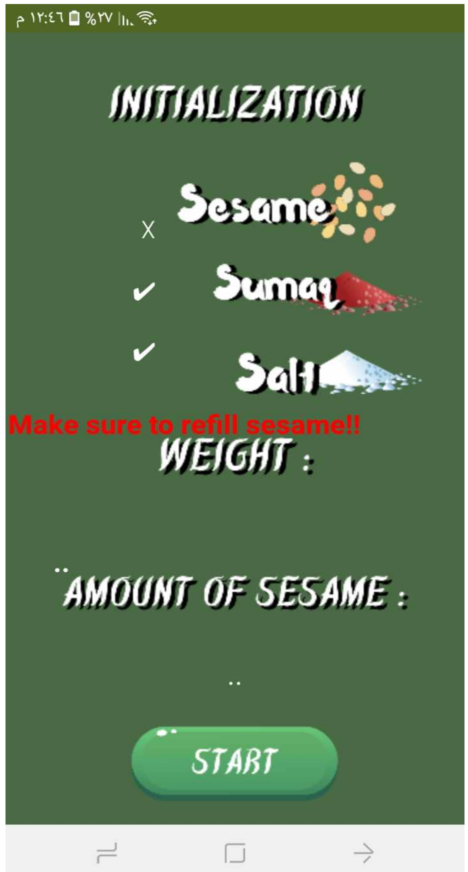

Figure 4.31: refill sesame

when one of the ingredients isn't available you can't start the process until refill the containers and the ultrasonic sensor value update the status to tick

4.3.4 Status page

Figure 4.32: Status page of application

This page shows the user the current stage of the process, with an image indicating the stage. If the stage is "Gharbaleh," a "More Gharbaleh" button will appear, allowing the user to run the DC motor for this stage. Since the duration of Gharbaleh can't be controlled by time, the user controls it visually. When more Gharbaleh is needed, the command can be sent through the app.

4.4 How the system works?

Once the Arduino Mega and ESP32 are powered on, the application is opened, and the ESP32 is connected to the correct WiFi network, the machine is ready. All motors are stopped and waiting for the user to start the process, which proceeds as follows:

4.4.1 Cover Up and Down

Cover Up

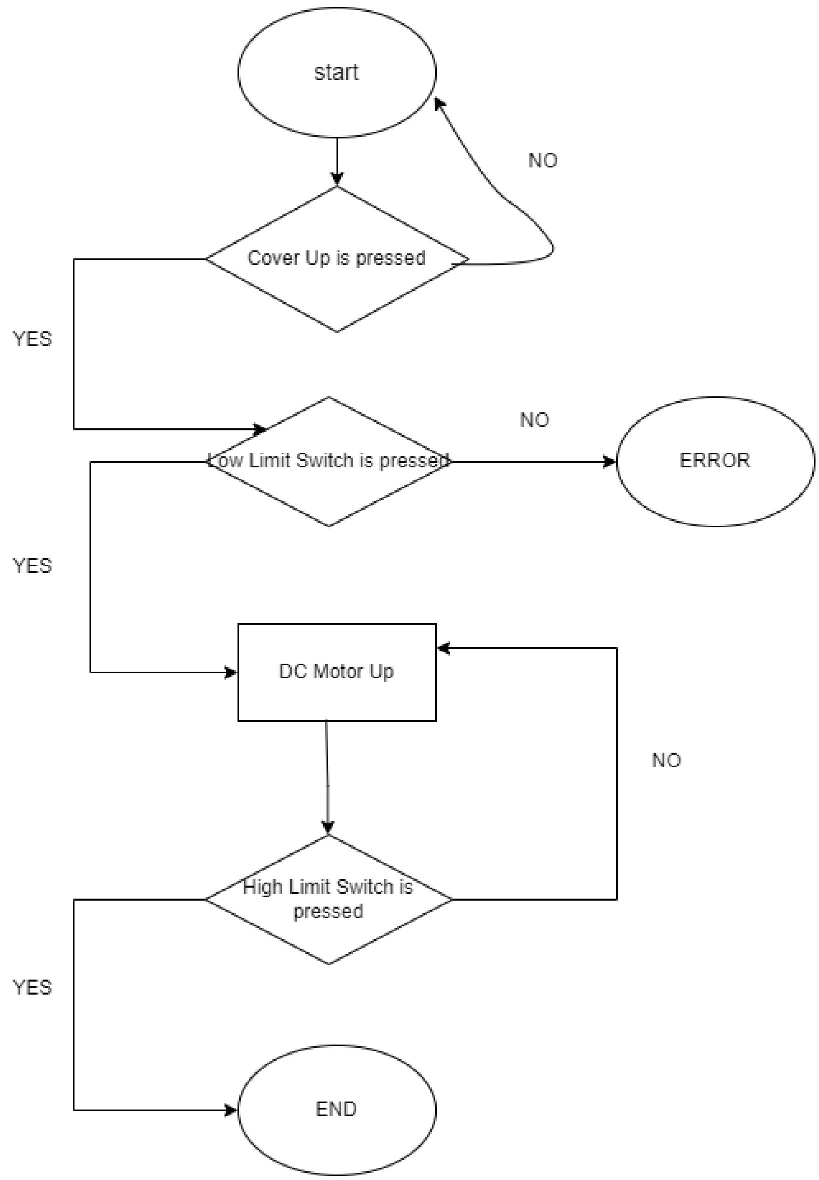

Figure 4.33: Cover Up Flow chart

When the user pressed the Up button the system first check if the cover is closed verifying if the low limit switch is pressed, if the switch isn't pressed then the

cover is already up and error message is displayed
if the Limit switch is pressed then the motor activates and by using rope and pulley the cover will be up allowing the user to add za'tar manually

Cover Down

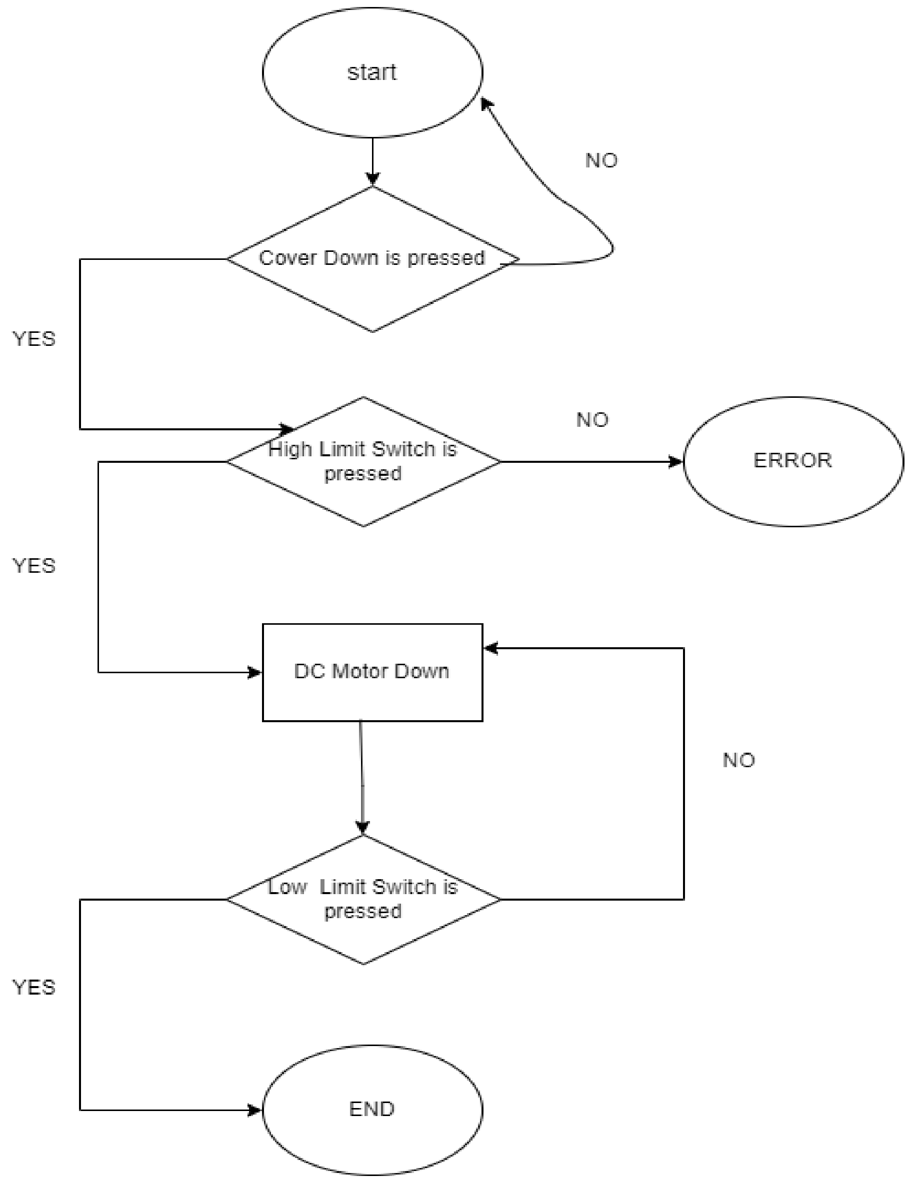

Figure 4.34: Cover Down Flow chart

the cover down is very similar to the up process first the system check if the cover is up by verifying if the high limit switch is pressed, if the switch isn't pressed then the cover is already down and error message is displayed
if the Limit switch is pressed then the motor activates and by using rope and pulley the cover will be down to let the grinding begin

4.4.2 Start the process in general

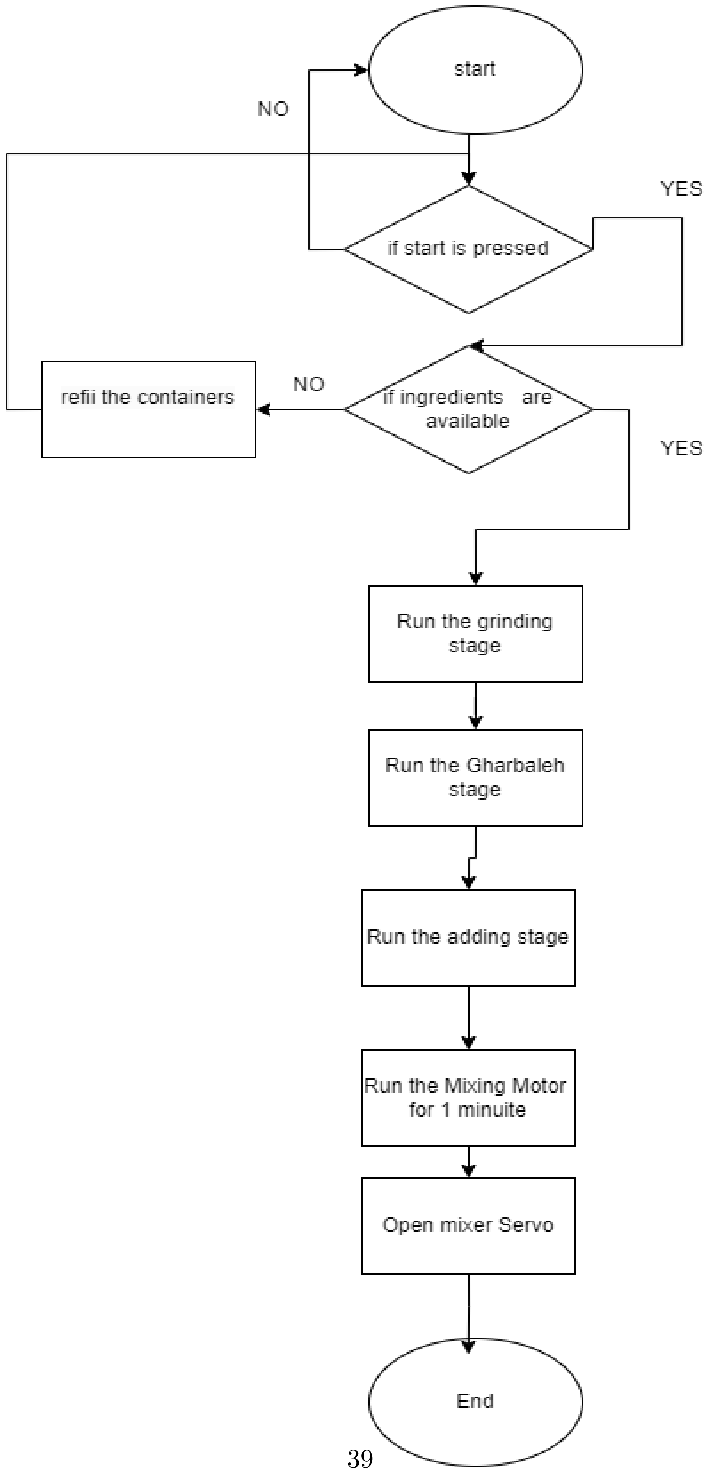

Figure 4.35: Start the process in general Flow chart

The system will start the process only if the start button is pressed and the ingredients are available will be discussed how to check
First the grinding stage is running then the sieving , adding ingredients and finally the Mixing stage .

4.4.3 Checking ingredients

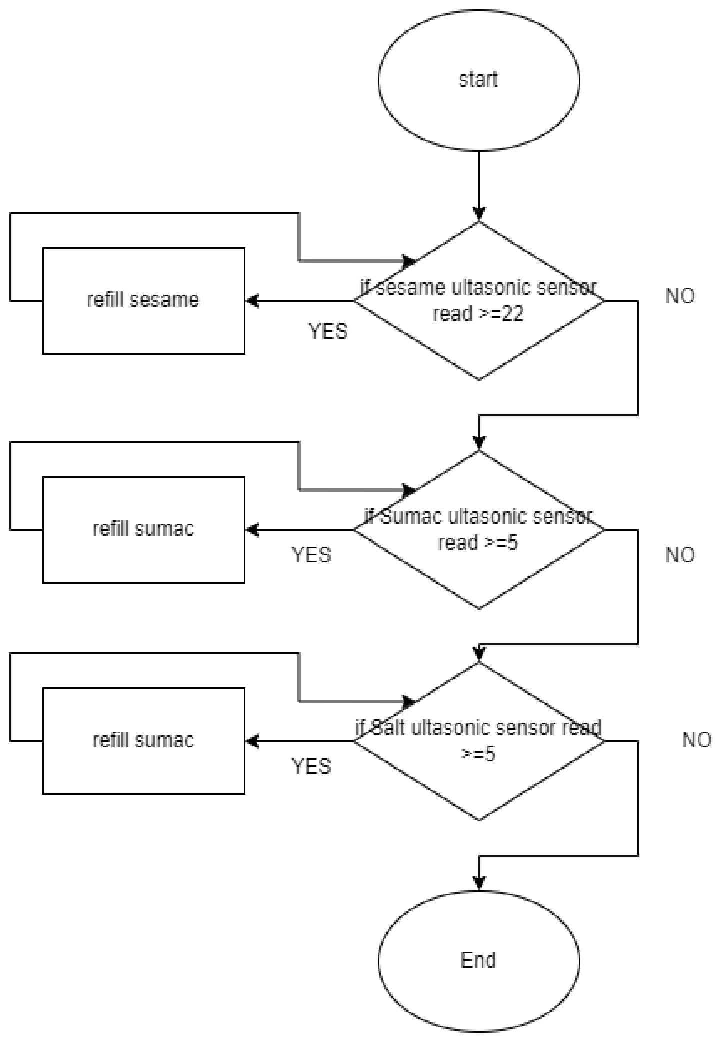

Figure 4.36: Checking ingredients Flow chart

The ultrasonic readings for empty containers are 22 for sesame, 5 for sumac, and 5 for salt. This means the ingredients are available if the ultrasonic readings are below these values so we check this value and compare it.

4.4.4 Grinding stage

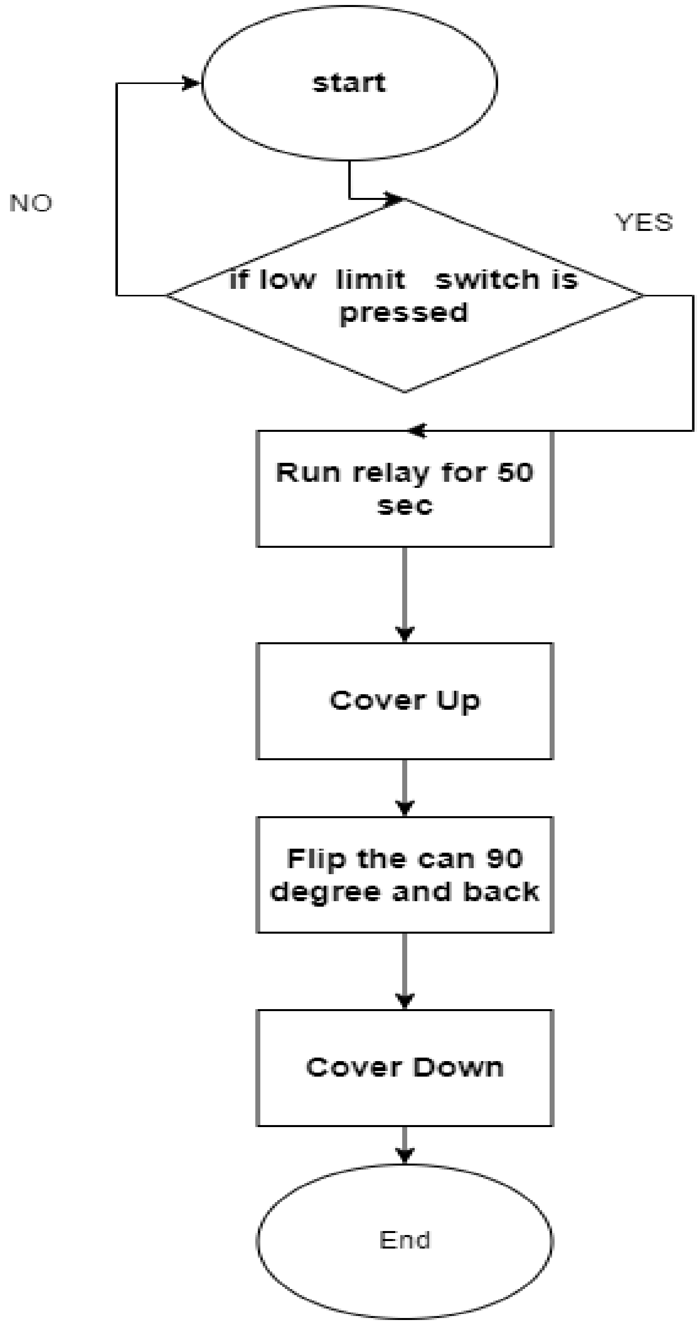

Figure 4.37: Grinding stage Flow chart

The grinding stage begins with a safety check to ensure that the cover is securely down by monitoring the limit switch. Once this is confirmed, the relay is activated for 50 seconds to ensure the za'atar is thoroughly ground. After the grinding is complete, the cover goes up until the high limit switch is pressed and then the stepper motor rotate 90 degree that ensure that za'atar is moved to the second stage. and Finally the cover will lower again, and stage 2 start .

4.4.5 Gharbaleh or sieving stage

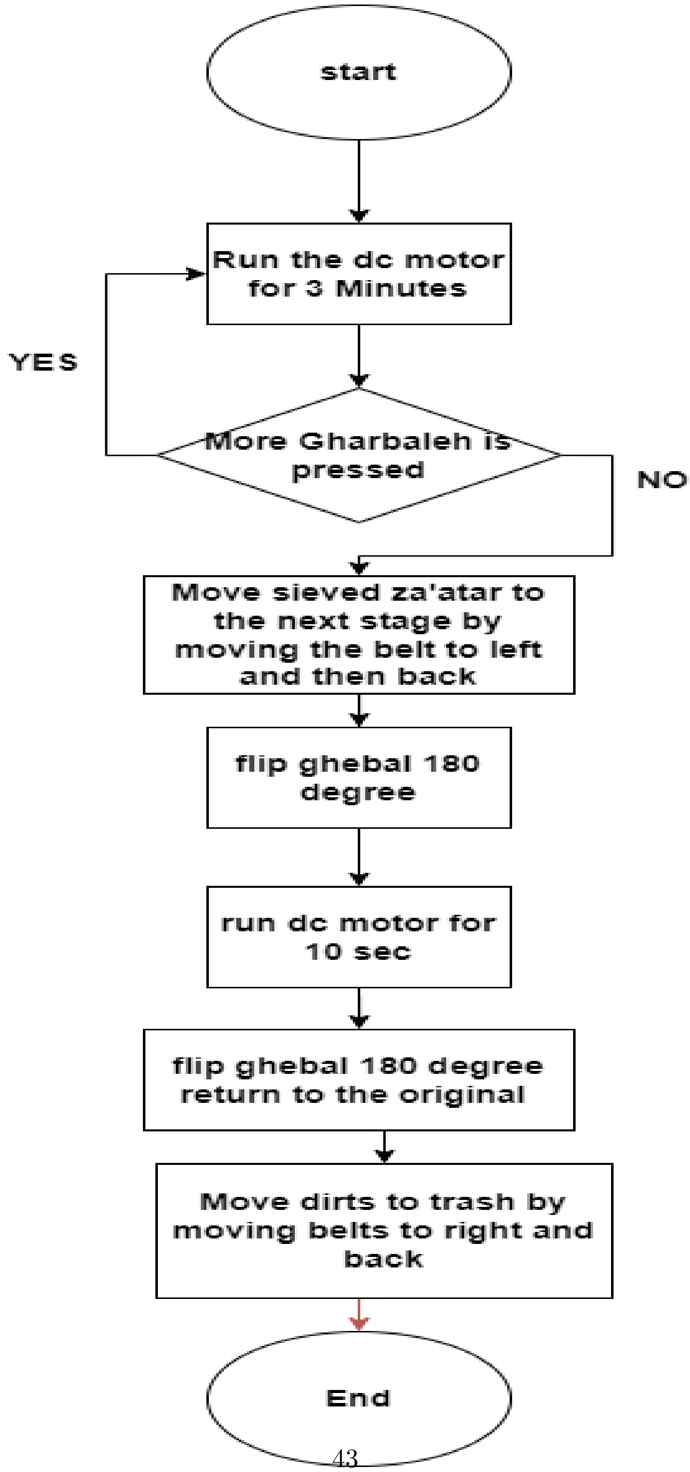

Figure 4.38: Gharbaleh stage Flow chart

The "Gharbaleh" stage begins by running the DC motor for 3 minutes. This duration is necessary because the stage's completion cannot be assessed except visually. The user can request additional "Gharbaleh" as needed. After this, the sieved Za'atar is transferred to the mixing stage by moving the belt, which is controlled by the stepper motor connected to it. To remove any dirt, the "Gharbaleh" is flipped 180 degrees using the stepper motor, and the dirt is then directed to the trash by moving the belt to the right.

4.4.6 Adding ingredients stage

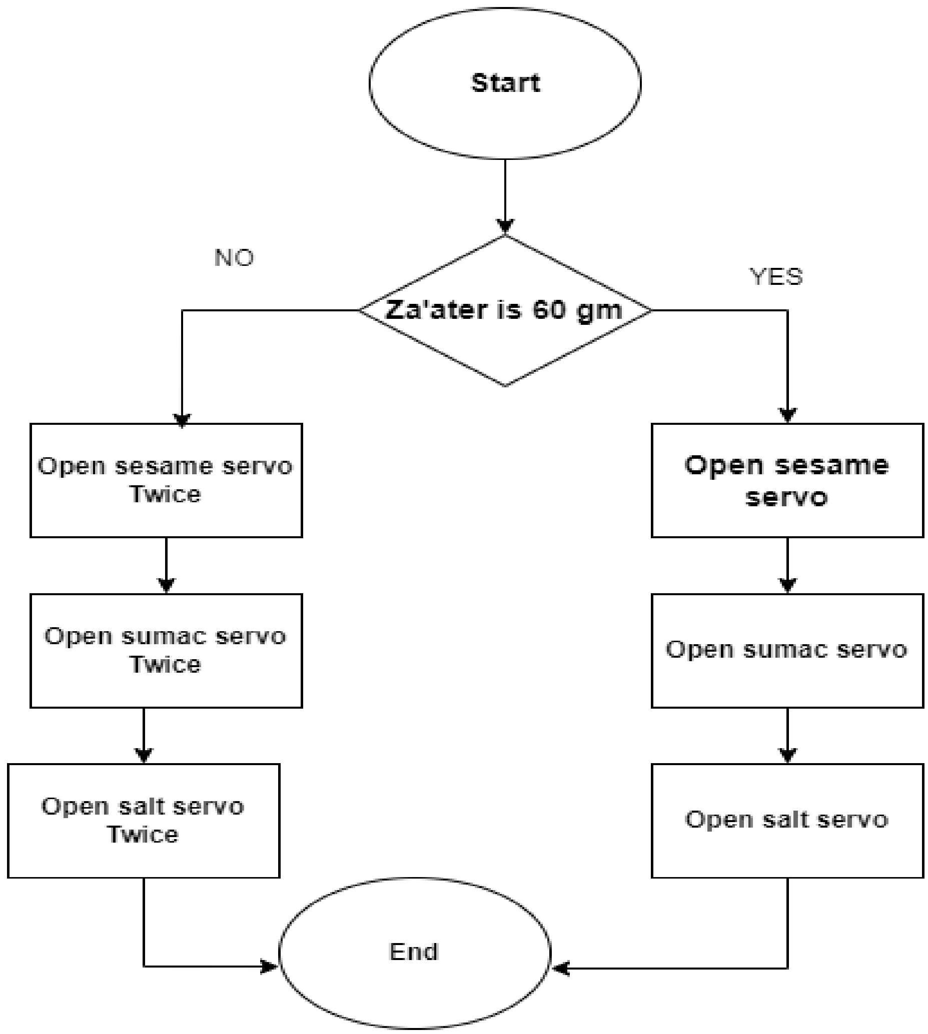

Figure 4.39: Adding ingredients stage Flow chart

For 60 gm of Za'atar we need 80 gm of sesame , 20 gm of sumac and 12 gm of salt this is achieved by controlling the servo motor for each container, adjusting the servo's angle, and setting a delay before closing.If the Za'atar quantity is 120 grams, we need to call each function twice to obtain the required amount.

Chapter 5

Results and Discussion

We have successfully created an automation system for making za'atar, transforming it from raw leaves to a ready-to-eat product for breakfast. We are pleased with the outcome, having carried out the project as we initially desired.

Here are some problems we faced and how we solved them:

For the grinding stage, we tried to build the grinder from scratch, so we built it using a pot and Ferber (an abrasive metal cutting disc), but because of the light weight of the za'ater and the speed of Ferber it spread all over the room, so we bought a ready-made grinder.

Figure 5.1: Grinder from scratch

For the seiving stage, the design for this stage was a bit challenging. We tried many things and finally adopted the seive with springs around and a fast DC motor, which succeeded in the seiving process. to flip the seive and get rid of the leftover moved from the Nema17 motor to the Nema23 motor because it can't flip it

For the cans that contain the salt and samac, we moved from plastic cans to soft iron so that they don't clump. And for Sesme, we moved from the NEMA 17 to the servo motor because it collects around the motor and prevents it from moving smoothly.

Figure 5.2: Final output

Figure 5.3: Final output 2

Chapter 6

Conclusion and Future work

6.1 Conclusion

Based on Arduino and various motors, the Za'atar Master model is an example of how one machine could potentially automate every aspect of za'atar making. It efficiently grinds and sieves, adds the ingredients, along with mixing them all together taking lesser time and effort. It also provides with enhanced convenience, safety and efficiency. The system is being described as an example of automation within a backdrop where more machines are likely to be deployed at large in kitchen due its dependence on the advantages that come with applying digital technology during daily tasks, opening up opportunities for other elements of za'atar processing.

6.2 Future work

- Implement autofill mechanisms for ingredients such as za'atar, sumac, salt, and sesame.
- Enable the option to scale the production size and select any weight for the final product.
- use weight sensors to handle ingredient measurements more accurately, replacing timing-based methods.
- Develop a wrapping system to improve the efficiency of the production .

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