An-Najah National University

Faculty of Engineering and Information Technology

Computer Engineering Department

CrunchCraze

Students:

Arees Monastir Nobani Masa Abd Al-Nasser Issa

Project supervisor:

Dr. Emad Natsheh

1 Dedication

We dedicate this work to the families of the martyrs and prisoners first, and to our beloved homeland Palestine. We dedicate it to our families and friends who have never hesitated to provide us with support in all its forms. Finally, we dedicate this work to ourselves as a testimony and proof of our fatigue and perseverance.

2 Acknowledgement

We would like to thank our supervisor Dr. Emad Natsheh and Eng. Abdullah Hinnawi, for their guidance that helped us accomplish this work in the best possible way. We would also like to thank Dr. Raed Al-Qadi for teaching us the basics of embedded systems and Microcontrollers, and Dr. Moneim Al-Masri for helping us whenever you need, and finally we would like to thank Dr. Manar Qamhieh and Dr. Luai Malhis for being there to answer our questions.

We would like to thank our families who supported us with financial and moral support to reach what we have reached. Loving, motivating and patient mothers. Our fathers who suffered to see our progress and success in life, and our friends for being there for us.

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5 Abstract

CrunchCraze is innovative machine designed to pack nuts according to customer preferences, integrating a production line with user friendly control panel. Customers can select their desired weight choosing between two options 150g for 15₪ or 250g for 25₪, and then choose the number of types they want up to 3 if 150g and up to 5 if 250g, they can also select seasoning options like salt, slat and pepper, or none. The machine's significance lies on enhancing customer experience by providing a customizable, efficient, and consistent packing process, thus improving operational efficiency and meeting the demand for convenience in food retail. Key aspects include customization, inventory management with low-supply alerts, and a user interface that guides customers via an LCD screen. The main objectives are to automate nut packaging, offer customization, implement an efficient inventory system, and enhance customer satisfaction. The development process involves requirements analysis, design, implementation, testing, and deployment. While similar vending machines exist, CrunchCraze is unique in its high customization and integrated inventory management system.

6 Introduction

6.1 Problems

Packing nuts process is often manual and time consuming, with large amounts of manpower involved which results to varying quality in products. This has increased the

demand for convenience in tailor-made service options within the food industry, hence need for a machine that can use the details given by the client to pack nuts in a short time. Traditional packaging techniques has lack of the agility and rapidity necessary to keep up with contemporary consumer standards.

6.2 Objectives

The CrunchCraze project aims to develop a smart machine that allows customers to select their desired weight, it'll provide two weight options. Costumers also choose they type of nuts they want. Likewise, the machine provides a seasoning options. It also has a LCD screen to guide customers through the process. Additionally, it includes an inventory management system to alert the admin or owner when supplies are low, ensuring continuous operation.

6.3 Significance of The Work

The significance of CrunchCraze lies in its potential to revolutionize the nuts packaging industry through the provision of a customizable yet efficient solution. Automating the packaging process will go long way solving issues related to manual work as well as inconsistency thus enhancing business efficiency and customer satisfaction. Besides, the inclusion of modern technological adaptations like interactive user friendly control panel alongside real time inventory alerts, brings a new level of convenience and reliability to the market.

6.4 Organization of the report

We have divided this report into six chapters. Chapter 1: Abstract and Introduction, where we discuss the problem, objectives, and significance of the work. Chapter 2: Theoretical Background and Previous Work. Chapter 3: Methodology, which includes an overview of the working design and decisions related to software, hardware, and processing. Chapter 4: Process of Work, where the ASM chart and component designs are incorporated. Chapter 5: Future Work, where enhancements and future ideas are discussed. Chapter 6: Conclusion and Recommendations, which discusses the main results and drawbacks of the project.

7 Theoretical Background and Previous Work

The idea of utilizing vending machines in retailing stores is widely used to provide different items and goods, and it's proved to be an effective way for saving time for both sellers and buyers, and usually it's used in the high demand stores and daily purchases. Despite its widely spread, there are no known such machine in nuts stores. Which make it a new idea and increasing the opportunities of success.

8 Methodology

8.1 Overview

For the CrunchCraze project, the methodology focuses on the design, development, and implementation of the nut packaging machine. Following this, an Algorithmic State Machine (ASM) is designed to control the machine, specifying the necessary components such as Arduinos and motors. Using C/C++ and the Arduino IDE, the ASM-based control system is programmed and integrated into the machine. Finally, thorough testing is conducted to ensure that the machine functions as intended, providing customers with a seamless and efficient nut packaging experience.

8.2 Constraints

One major constraint faced during the development of CrunchCraze was the budget limitation, which affected the choice of materials and components. Additionally, the size of the machine was designed to be compact and suitable for small retail environments, which requires careful planning and optimization of space.

The time-scale is another constrain, since this is a graduation project with limited time to add more functionalities.

8.3 Hardware Components:

Power Supply

Power supply is an electrical device that provides an electrical load with electric power. Its primary purpose is to transform electric current from source to proper load voltage, current, and frequency; hence sometimes they are called electric power converters.

We used it to supply enough voltage and current with different values for components.

Figure 1: power supply

Arduino Mega 2560

Arduino Mega is a flexible development board that supports various input/output (I/O) functions that are impressive in nature. It contains 54 digital I/O pins in all, with 15 of them functioning as PWM outputs thereby making it possible to establish a connection between it and vast types of devices as well as sensors. Moreover, it possesses 16 analog inputs which can be used to provide accurate measurements of analog signals. Additionally, the board has 4 built-in UARTs (hardware serial ports) which can be used concurrently.

We used two Arduinos Mega one of main control the other one to move motors and read ultrasonic, both connected via TX, RX.

Figure 2: Arduino Mega

Stepper shengZan Mechatronios

We used a stepper motor which is responsible for circling the cans and stops on the selected one.

Another stepper motor used to flip the nuts after being mixed to fill the containing unit.

Figure 3: ShengZan stepper motor

HY DIV268N Stepper Driver

The HY-DIV268N is a widely used stepper motor driver module. It is designed to drive bipolar stepper motors with a maximum current capacity of up to 5A. This module supports various micro-stepping modes (full-step, half-step, etc.) and offers step and direction control inputs for precise motor control.

Used it to drive main stepper motor and stepper motor that flips the griddle.

Figure 4: Driver

LDR + Laser

The LDR Sensor Module is used to detect the presence of light / measuring the intensity of light. The module's output goes high when light is present and low when it is absent. The sensitivity of the light detection can be adjusted using a potentiometer.

With cutting the laser the LDR reads low numbers and this is how to know where the stepper should stop

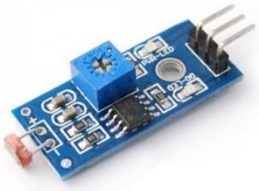


Figure 5: LDR

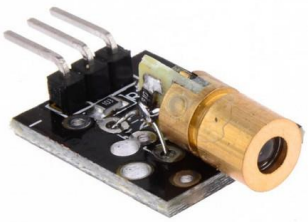


Figure 6: Laser

Read Switch

Raed switch is a sensor used as a reference point for the stepper to go back to.

Figure 7: Read Switch Sensor

LCD with I2C

LCD screen with I2C connected to guide customers through the process.

Figure 8: LCD with I2C

Stepper Nema 17

The NEMA 17 stepper motor is extensively utilized in robotics, 3D printers, and automation systems. Featuring a standardized 1.7-inch frame size and a 1.8-degree step angle, it delivers precise positioning and control. These motors are available in various configurations, including different holding torque ratings and wiring options. Renowned for their compatibility, reliability, and versatility, NEMA 17 motors are a popular choice for numerous applications.

Used it to fill the required nuts and to move the belt to get the nuts containing unit out.

Figure 9: Nema Stepper

Driver A4988

Stepper motor driver (A4988) is a micro stepping driver with built-in translator for operation, this driver has a maximum output capacity of 35V and -/+2A.it can operate bipolar stepper motor in full, half and quarter.

Used it to driver steppers.

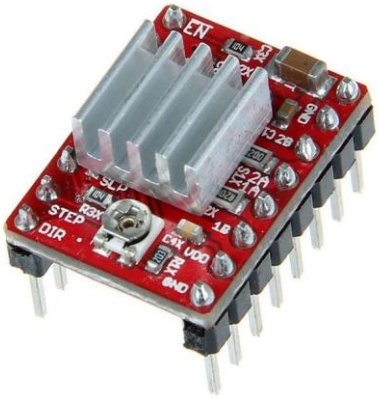


Figure 10: A4988 Driver

Ultrasonic

The high-sensitivity ultrasonic range sensor has been designed to be compatible with Arduino boards. It runs on a supply voltage of DC 5V and draws current up to 15mA. Receiving range varies from 2cm up to 4m while its acceptance angle equals 15°.

Used it knew nuts level to know when to refill them.

Figure 11: Ultrasonic

Capacitor 100µF

Used with driver a4988.

Figure 12: Capacitor

DC Motor

A DC motor is a kind of electric motor that uses direct current electricity, and then changes it into mechanical energy by magnetic force interaction due to the current

conduction in coils. They are simple to use and very efficient, so they have found wide use. For example, they are employed in such household gadgets as cooler, automotive or washing machines among other areas where automation is needed.

Used two one to mix nuts and the other connected with belt to move boxes down to fill them.

Figure 13: DC Motor

Relay

A relay is an electrically operated switch connected to dc motors.

Figure 14: Relay

H-bridge

Connected to stepper motor, used to control motor speed and rotation direction.

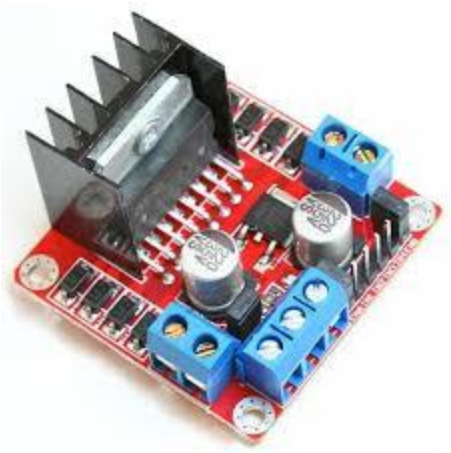


Figure 15: H bridge

Keypad 4*4

keypad is an input device consisting of buttons arranged in a grid or matrix layout, each representing a specific character, number, or command. It is often used for various electronic instruments and systems for entering data or making choices.

Used for customer to choose what they want.

*Figure 16: Keypad 4*4*

RFID

Radio frequency identification refers to a wireless system comprised of two components: tags and readers [1]. Arduino boards can be used with RFID modules for building systems which read and operate on RFID tags.

We use it as simulation for payment.

Figure 17: RFID

ESP32

Esp32 is a chip that provides Bluetooth connectivity in embedded devices.

We used it to send messages to the admin that the can is almost empty and needs a refill.

Figure 18: ESP32

Application interface

Figure 19: Application

9 Process of work

9.1 ASM chart

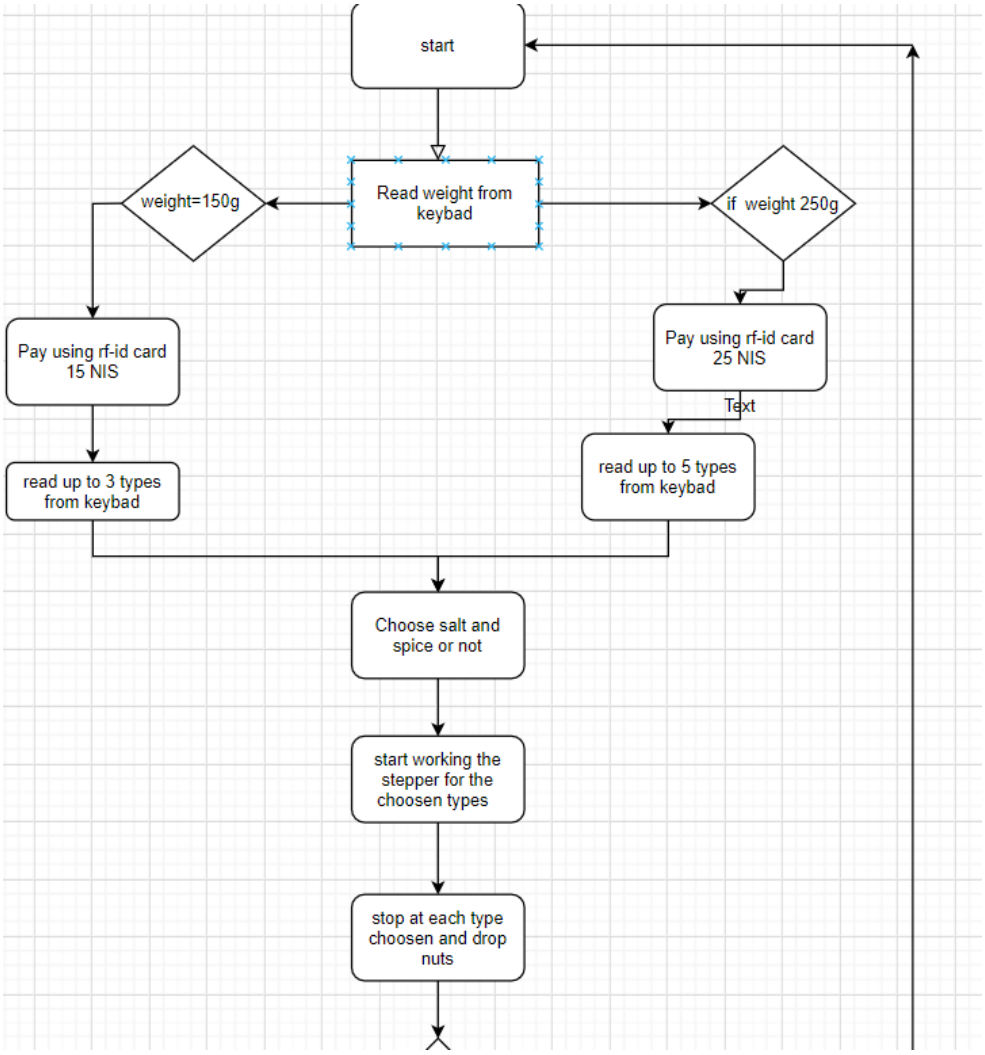
First, we defined the criteria that should apply to this machine. Then, we defined how it works and interacts with the user. Based on that and on ASM, we defined the necessary control parts.

When the machine powered, the circling the cans Then the user should input what weight would to choose 150g or 250g, if the user chose 150g he should pay 15 NIS using card (simulation) then choose up to 3 types nuts, and he can choose adding salt or salt and spice or never adding both.

If the user chooses 250g he should pay 25 NIS using card (simulation) then choose up to 5 types nuts, and he can choose adding salt or salt and spice or never adding both.

After choosing the nuts chose start dropping to tray and mixing together for 10 seconds

While mixing the belts start moving and moves nuts container, if the nuts container reaches to the center under the funnel, the tray flip over the nuts into funnel and from funnel to nuts container, then the nuts container goes out to the user.


start
Read weight from keybad
weight=150g
if weight 250g
Pay using rf-id card 15 NIS
Pay using rf-id card 25 NIS
Text
read up to 3 types from keybad
read up to 5 types from keybad
Choose salt and spice or not
start working the stepper for the choosen types
stop at each type choosen and drop nuts

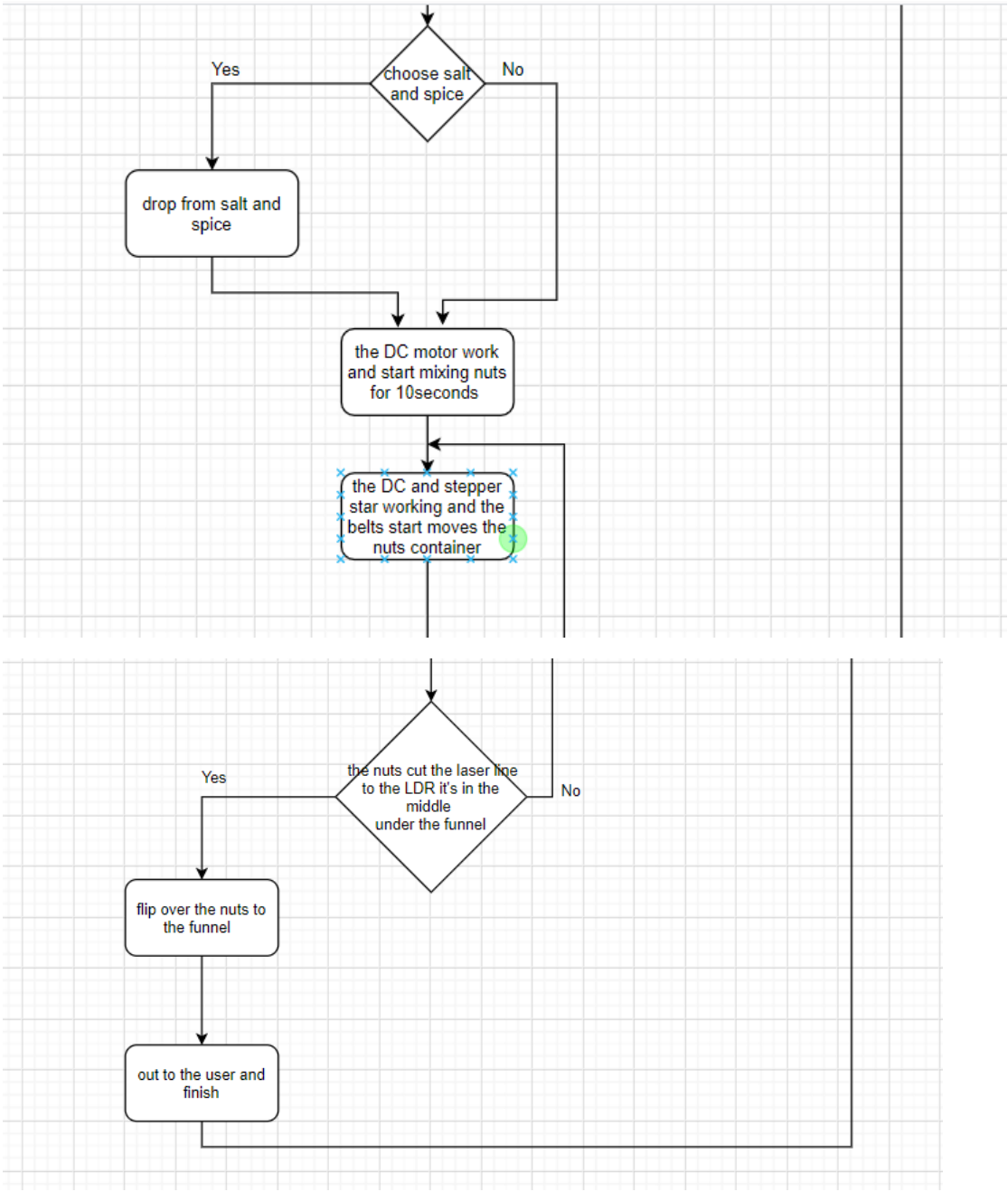


Figure 20: ASM chart

9.2 Controller Design

Figure 21. Cans

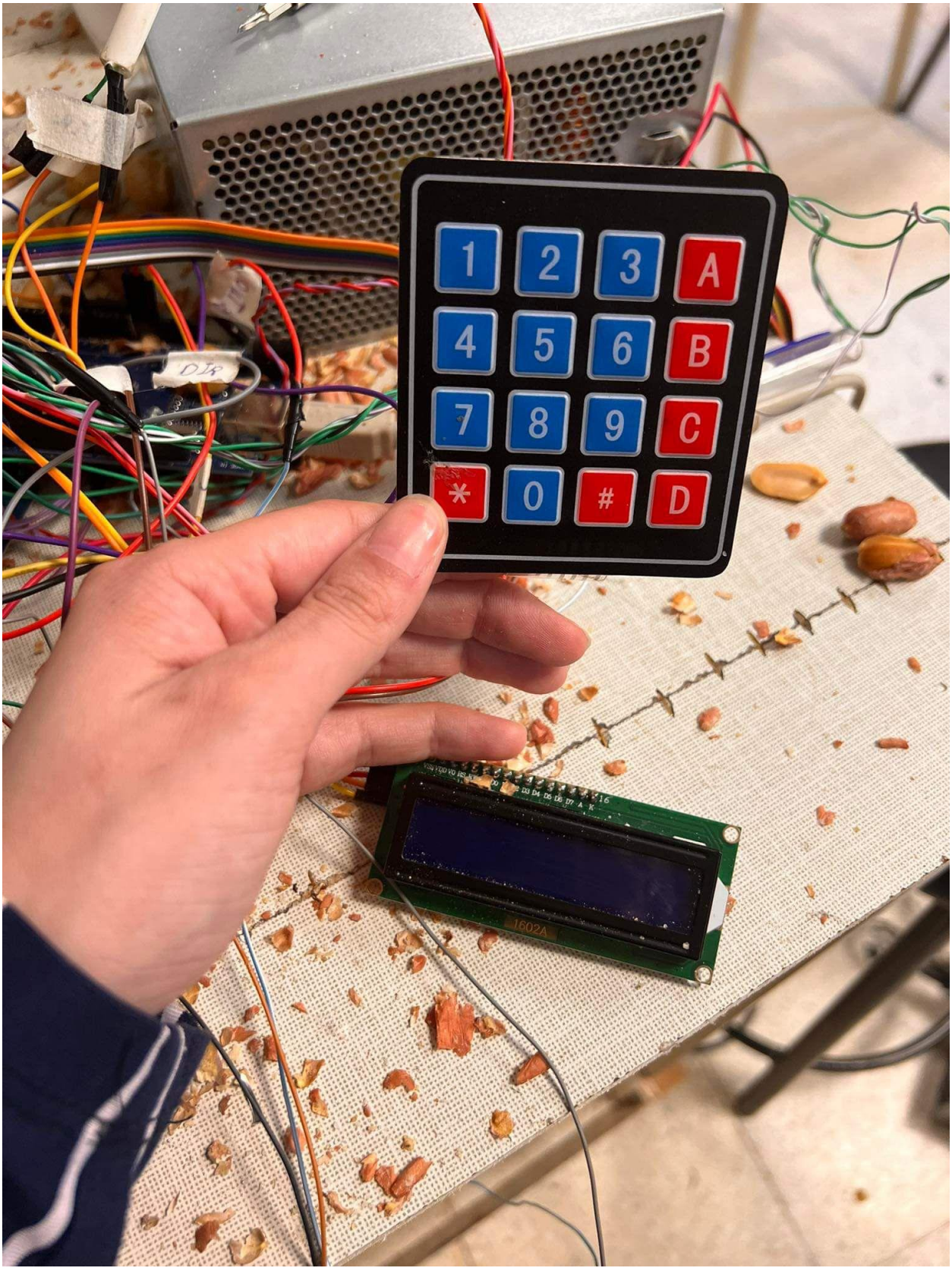


Figure 22. Keypad and lcd

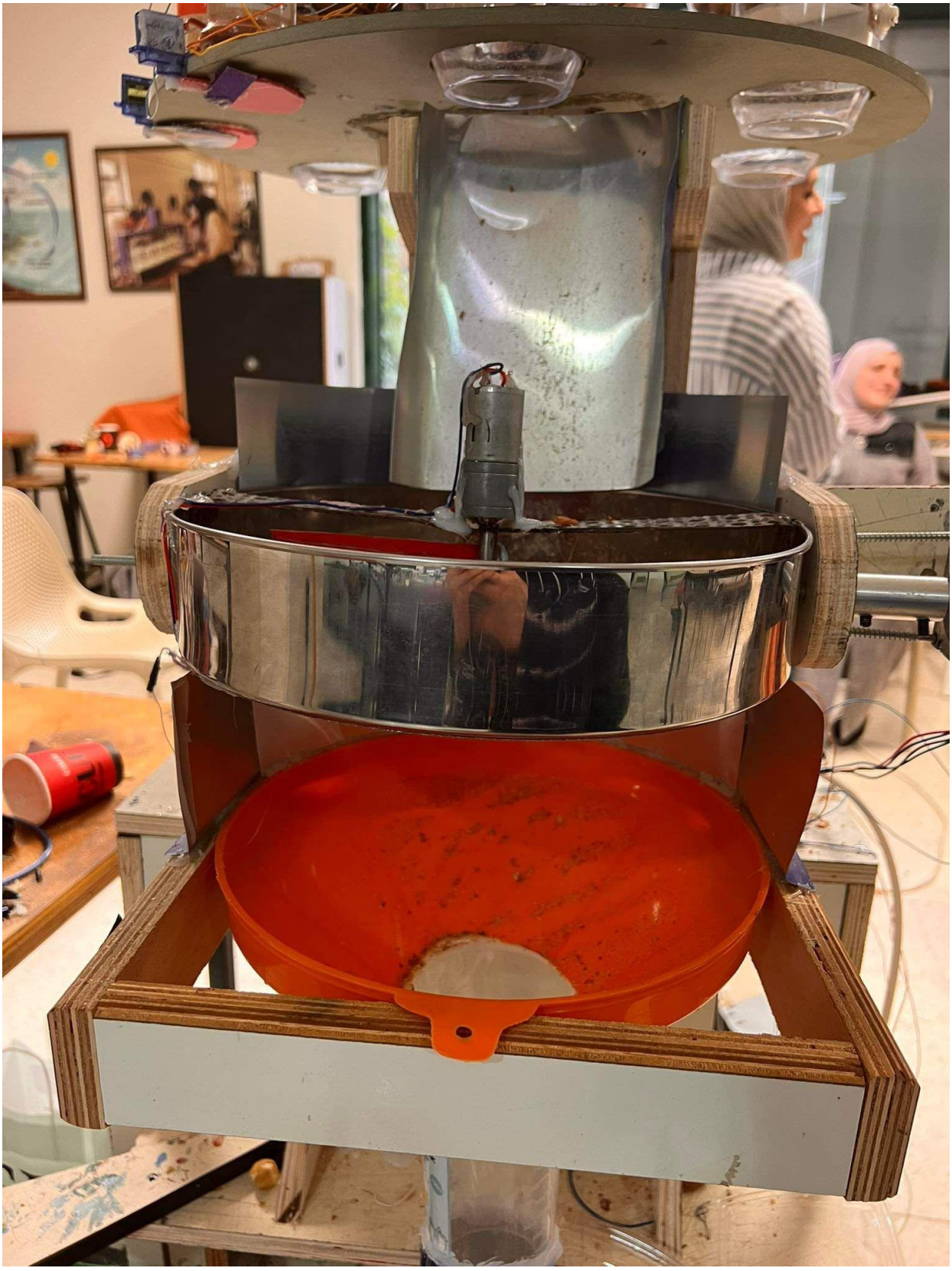


Figure 23. Mixing

Figure 24. Belts

10 Future of work

We aim to continue developing the project to include more types of nuts and different weights to meet the diverse needs of retailers and customers. Additionally, we plan to use a larger container to hold a greater quantity of nuts, reducing the frequency of manual refills. We also intend to incorporate more payment methods, such as coins, to provide greater convenience for users.

11 Conclusions and Recommendation

The project addresses the problem of slow customer service in retail nut stores, which often experience high demand, especially during peak times. This project aims to increase the quality of service by allowing employees to focus more on assisting customers with services that require human intervention. This machine can significantly help retailers save on operational costs by reducing the number of required employees.

If we to redo the work, we would recommend to spend more time on learning more about Arduino, how it works? How to configure it? How to deploy it in more sufficient way? And how to better supply it and other components with power. A basic knowledge of and understanding of all hardware and software is crucial to avoid wasting time and sabotaging hardware units.

12 References:

1- https://www.fda.gov/radiation-emitting-products/electromagnetic-compatibility-emc/radio-frequency-identification-rfid#:~:text=Radio%20Frequency%20Identification%20(RFID)%20refers,back%20from%20the%20RFID%20tag.
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