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Sweets Assembly

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Abstract

This project is important for several reasons. Firstly, it addresses the need for efficient and automated candy cans production, saving time and effort in the process of filling it.

It also improves the cleanliness of the candy products as it reduces human handling, minimizing contamination risks. Moreover, the project eliminates the need for manual labor in the candy filling and packaging process, contributing to labor cost savings.

Overall, it enhances candy production efficiency and quality while reducing operational costs. In our view, key aspects for this project include full automation using stepper motors and a conveyor belt, ensuring precise candy filling through RFID quality control, enabling user interaction and monitoring via mobile app connectivity through ESP, and prioritizing safety to prevent accidents and product contamination, given the involvement of machinery and food products.

The project's primary objectives are automation in candy can production, enhancing efficiency, maintaining quality control, and enabling remote control and monitoring through a mobile app. This includes designing an automated production line, reducing manual labor, ensuring precise candy measurement, and allowing remote access for efficient operation.

The methodology involves four main stages: design and planning, hardware implementation, software development, and testing and optimization. Design and planning encompass layout design and component selection. Hardware implementation focuses on assembling the necessary components, while software development creates control software and a mobile app. Testing and optimization ensure project goals are met, and user documentation and training cover operation and maintenance.

Chapter 1

Introduction

Contents

1.1 General background

Sweets Assembly is a transformative project in the candy manufacturing industry that automates the entire production line, eliminating the need for human labor. Through innovative technologies, it ensures enhanced efficiency, cleanliness, and safety, setting new standards for cost-effectiveness and quality in confectionery production.

1.2 Objectives

Fully automate the candy can production process, which aims to enhance overall efficiency. The project is designed to streamline the manufacturing workflow, significantly reducing the time and resources traditionally required.

Additionally, it eliminates the need for human labor, thereby minimizing the risk of contamination and errors. This automation is expected to lead to a safer, more consistent product, meeting the high standards of quality and hygiene demanded by consumers and regulatory bodies.

Our project seeks to create a flexible system that can adapt to various production demands without compromising quality. The use of sophisticated monitoring and control technology is intended to provide a seamless operation, with the ability to quickly adjust to market changes and consumer preferences.

1.3 Significance or importance of your work.

This project lies in its pioneering approach to candy can production. It revolutionizes the process by introducing complete automation, which not only streamlines production but also significantly diminishes the requirement for manual labor. This transition to an automated system ensures a reduction in operational costs and enhances product cleanliness by minimizing human contact, thereby reducing contamination risks. Consequently, the project stands as a substantial advancement in the confectionery industry, promising to deliver high-quality products with improved efficiency and safety.

1.4 Organization of the report

Our report is carefully crafted to guide you through the "Sweets Assembly" automation project, starting with an Introduction that presents the need for innovation in candy production, and defining our Objectives for improved production outcomes.

We then describe the Technological Framework, outlining the automation technologies at the heart of our project, and detail the Implementation and Safety Measures that ensure product quality and safety.

In the concluding sections, we analyze the Results and System Efficiency, discussing the impact on the industry, and our Conclusions and Future Work summarize our achievements and suggest directions for future innovation.

The report ends with References that acknowledge the foundational research that informed our project. Join us on this journey as we explore the integration of automation technology in traditional candy production, charting a new course for the industry.

Chapter 2

Theoretical Background

Contents

2.1 Efficient and Automated Candy Production

Traditional candy production involves manual labor, which is time-consuming and labor-intensive. The project aims to automate the production process using stepper motors and a conveyor belt, streamlining the workflow and significantly reducing the time and effort required for candy manufacturing.

2.2 Cleanliness, Contamination Risk Reduction and Labor Cost Savings

Human handling in candy production can introduce contamination risks. By minimizing manual intervention, the project enhances the cleanliness of candy products. This is crucial in meeting hygiene standards and ensuring the quality of the final product.The elimination of manual labor in candy filling and packaging contributes to significant cost savings. Automation not only increases efficiency but also reduces dependency on human resources, leading to economic benefits for the candy production process.

2.3 User Interaction and Monitoring via Mobile App

The integration of mobile app connectivity through ESP facilitates user interaction and real-time monitoring. This feature allows for remote control, enabling operators to manage the production process efficiently, monitor performance, and address any issues promptly.

Chapter 3

Methodology

Contents

3.1 Introduction

This chapter outlines the methodology adopted for the design and implementation of the Sweet Assembly hardware project. The methodology encompasses adherence to engineering standards, consideration of design constraints, the design process followed, tools and technologies utilized, and project management strategies employed to ensure successful project completion.

3.2 Standards and Specifications (Codes)

We managed to follow Engineering standards in Sweet Assembly project, going with Agile Method with weekly meetings and discussion about each of the features, Starting with the machine mechanics ending by the factory testing and modifying, we built the machine step by step, each step as a feature.

3.3 Constraints

Economic and budget constraints:

Budget constraints may affect the size of the project and the tools used in it, as the size of the machine depends on the number of products used, and thus an increase in the electronic components used such as motors and others, and this all leads to an increase in the cost.

Time constraints:

We completed this project in the summer semester, as the time is less than the regular semester, so we faced some difficulties and pressure due to the limited time, in addition to that we are implementing a project like this for the first time, and therefore we needed to learn and search for electronic components and how to connect and deal with them, in addition to the time for experimentation and assembly And all this takes time.

Project compilation limitations (Power):

Due to the variations in hardware components within the project and their diverse power consumption profiles, there was an initial disparity in power consumption. This led to challenges in aggregating power, particularly because the utilized components operated across multiple energy thresholds. This endeavor marked our inaugural experience in constructing such a apparatus, involving concurrent management of these distinct power requirements. To illustrate, certain components necessitated a 12-volt supply, including motors, printer, and interior lighting. Conversely, some elements operated on a 5-volt, such as the screen and scanner, while others functioned on 3.3 volts, exemplified by the ESP, door lock and mp3 components. Consequently, during the assembly phase, we employed a versatile power supply capable of delivering assorted voltage outputs.

Components Availability:

The intention was to design spiral wires with dimensions and sizes that are appropriate for the intended products. However, these specific 9 spirals were not commercially available. Consequently, we took it upon ourselves to manufacture these spirals, a process that consumed a considerable amount of time due to the necessity for a meticulous approach. This precision was vital in ensuring the smooth operation of the purchasing process and minimizing the occurrence of errors.

3.4 Tools and Technologies

Arduino Mega

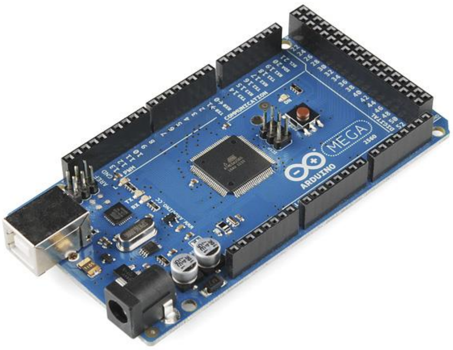


Figure 3.1: Arduino Mega.

In our project, we have chosen an Arduino Mega 2560, a microcontroller board from the Arduino family. It has more functionalities than the original Arduino board and makes use of the ATmega2560 chip. It features numerous communication interfaces like UART, SPI, and I2C, 54 digital I/O ports, 16 analog inputs, and may be powered by USB or an external source. It is frequently utilized in tasks like robotics and automation that call for more I/O connections and memory. We used the digital ports for writing and reading on some of the components, and we also used the serial ports to communicate with other components such as the ESP, i.e. we used 3 serial connections We used SCL and SDA pins to connect the LCD driver, and the rest of the parts were connected to the digital ports.

NEMA 17 stepper motor

Figure 3.2: NEMA 17 stepper motor.

We used stepper motors to drop the candy from the candy cans in which they will be filled in the cups, because of it's precise control we made it rotate specific steps to drop a certain amount of candy, and we connected the motor with L298N-Dual-H-bridge-Motor-Driver to be controlled by Arduino. We have used 3 steppers because we have 3 candy cans one stepper for each.

NEMA 23 stepper motor

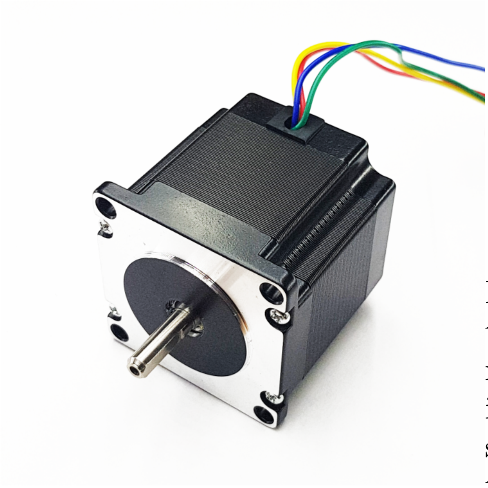


Figure 3.3: NEMA 23 stepper motor.

Nema 23 is a standard frame size for stepper motors, commonly used in various automation and robotics applications. It has a 57x57mm (2.3x2.3 inch) faceplate, making it suitable for medium-sized projects. Nema 23 motors offer precise control and are known for their reliability and versatility.In our project it's used for moving the conveyor belt it needs more torque than Neam 17 stepper motor.

L298N Dual H-Bridge motor driver

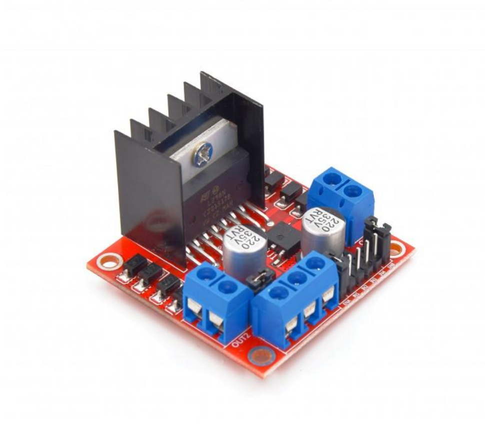


Figure 3.4: L298N Dual H-Bridge.

A motor driver is employed for the purpose of regulating motor rotation. It serves to govern the movement of a stepper motor as well, achieved through the precise administration of current and voltage to the coils in a methodical manner. Moreover, it facilitates command over the motor's rotational direction and speed by meticulously managing the current's passage through the coils. We used a driver for each motor, gave it 12 volts power, and controlled its rotation and speed using the code.

LCD 20X4

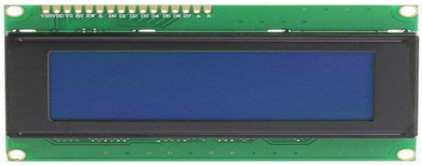


Figure 3.5: LCD 20x4.

It is a tool for visual output and information display. We used it to display writings on it so that the user can easily control the machine. It was controlled by an I2C driver.

LCD Driver module with I2C interface

Figure 3.6: LCD Driver module with I2C interface

A specialized electronic component designed to make it easier to integrate a liquid crystal display (LCD) into electronic systems is an LCD driver module with an I2C interface. 4 wires GND, VCC, SCL, and SDA come out of it. VCC is connected with 5 volts and SCL, SDA from the driver with SCL, SDA from Arduino.

Keypad 4x4

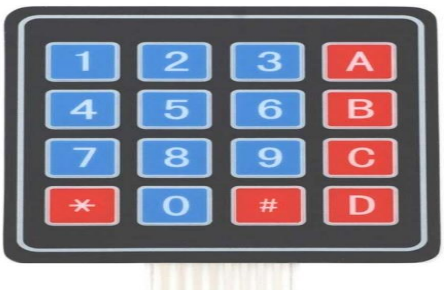


Figure 3.7: Keypad 4x4.

Input device that consists of a grid of 16 buttons arranged in a 4x4 matrix. Each button represents a specific character, number, or command. We used it to enter values on the machine and to control it.

RFID Reader

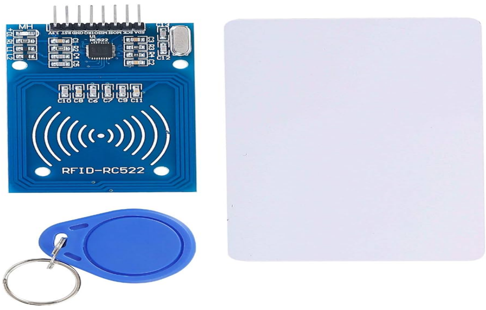


Figure 3.8: RFID Reader.

Is a device designed to communicate with Radio Frequency Identification (RFID), We used it so that the user can use it as a credit card for making payments or for the admin to scan their own card to access their designated privileges. It contains 6 wires, 2 for data (D0, D1), 2 for VCC and GND, and 2 for lighting and sound.

Ultrasonic Sensor

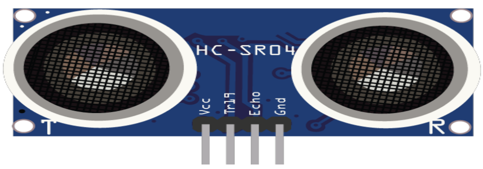


Figure 3.9: Ultrasonic Sensor.

A transducer sends out high-frequency sound waves and calculates how long it takes for the waves to return after hitting an object. The distance between the sensor and the object is then determined using this data. Ultrasonic sensors are often used to measure distance and detect proximity, where we used 4 sensors, the first to measure the distance between the sensor and the cups if it is about 25cm it means no cups left so it sends a notification to mobile app, and the other three sensors are uses the same approach to check if there's no candy left in the cans.

ESP32

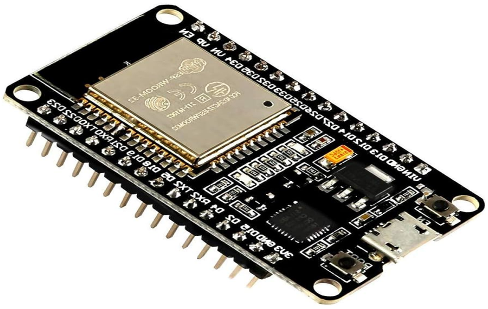


Figure 3.10: ESP32.

The ESP32 is a versatile microcontroller developed by Espressif Systems, known for its dual-core processor, built-in Wi-Fi and Bluetooth capabilities, making it ideal for IoT projects. With a rich set of peripherals, low power consumption, and a cost-effective design, the ESP32 has gained popularity for a wide range of applications, from home automation to industrial IoT solutions.

DC Motor

Figure 3.11: DC Motor.

A DC motor with a 300 RPM gear provides controlled and precise rotational motion. The integration of gears allows for speed reduction or torque amplification, making it suitable for applications requiring slower and more powerful output. Commonly used in robotics and automation, this geared DC motor is valued for its versatility and adaptability in various mechanical systems.

Power Supply

Figure 3.12: Power Supply.

A computer power supply converts electrical power from an outlet into usable energy for a computer's components. It typically provides DC voltage outputs to various components. Modern power supplies also incorporate efficiency features and safety mechanisms to ensure stable and reliable operation.

Servo Motor

Figure 3.13: Servo Motor

A servo motor is a rotary actuator that precisely controls the position of its output shaft. It uses feedback from a sensor to maintain the desired position, making it ideal for applications requiring accurate and controlled movement, such as robotics and automation. Servo motors are widely used for their precision, speed, and ease of integration in various electromechanical systems.

Conveyor Belt

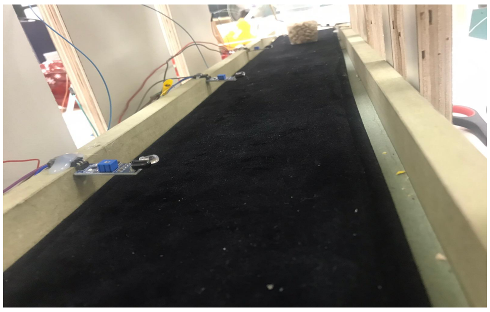


Figure 3.14: Conveyor Belt

A conveyor belt is a continuous loop of flexible material used for the efficient transportation of goods or materials within a facility. It consists of two or more pulleys, powered by an electric motor, that move the belt in a specific direction. Conveyor belts are integral in industries like manufacturing, logistics, and mining for automated material handling.

IR Sensor

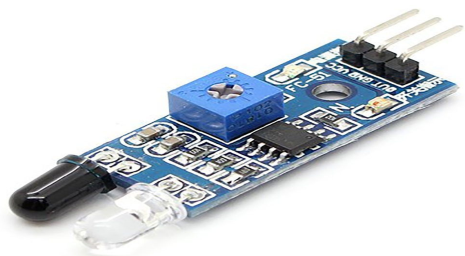


Figure 3.15: IR Sensor.

An IR (Infrared) sensor is a device that detects infrared radiation, often used for proximity sensing, object detection, or temperature measurement. It works by emitting and receiving infrared light, and changes in the received signal indicate the presence or absence of an object or variations in temperature. IR sensors are commonly employed in applications such as automatic faucets, remote controls, and security systems.In our project we used 4 IR sensors 3 are under each candy can that detects the cup so the conveyor stops and the cup start to get filled with candy and the 4th one is used at the final stage which detects the filled cup and therefore the conveyor stops whereas the cup is under the DC motor presser.

3.5 Final Design of The Project

3.5.1 Design Process

As shown in the picture, the final design of the “Sweet Assembly ” project appears, where all the components are shown: the LCD, the KEYPAD, the RFID Reader, the printer, and the ultrasonic, and it also shows the output box and the spiral wire connected to the motor.

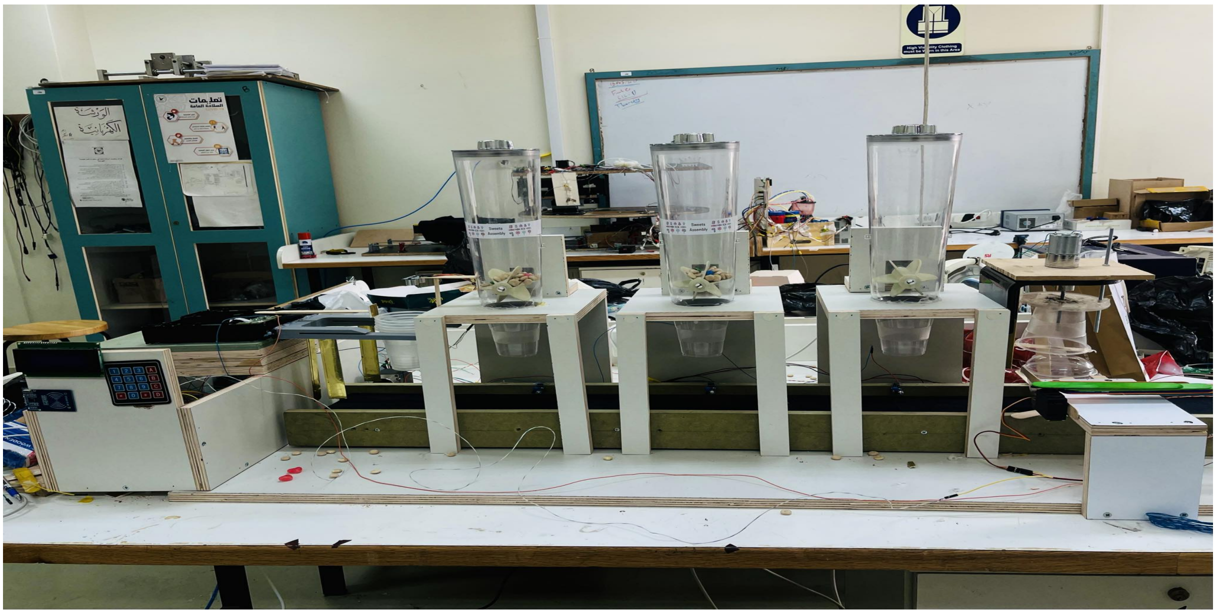


Figure 3.16: Sweet Assembly Final Design.

In the beginning, the user who has the permission to start uses the RFID card to grant access,then the wanted types are selected either by the keypad where you press 1,2 or 3 according to the type and then press A to start or by the mobile application where you also select the wanted types and press start to begin the process where the cup holder drop a cup on the conveyor belt and then the cup starts moving on the belt until it arrives the selected types by passing by an IR sensor which detect the cup so the conveyor belt stops as the cup is under the type can, the candy start dropping by rotating the stepper motor in a certain steps so the amount of candy dropped is specified. Finally filled cup moves to the final stage which is the cover presser that presses the cup with its cover and make it ready to export.

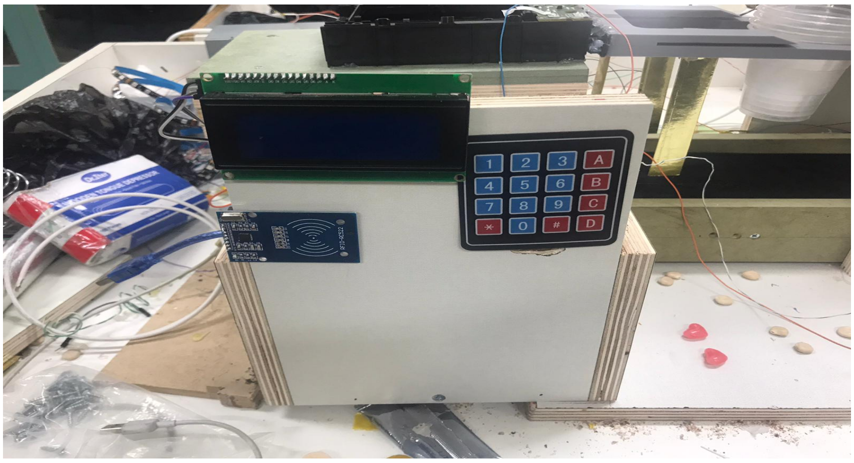


Figure 3.17: First Stage.

This stage as shown above in the figure have the keypad lcd and RFID where the user initiate the process.

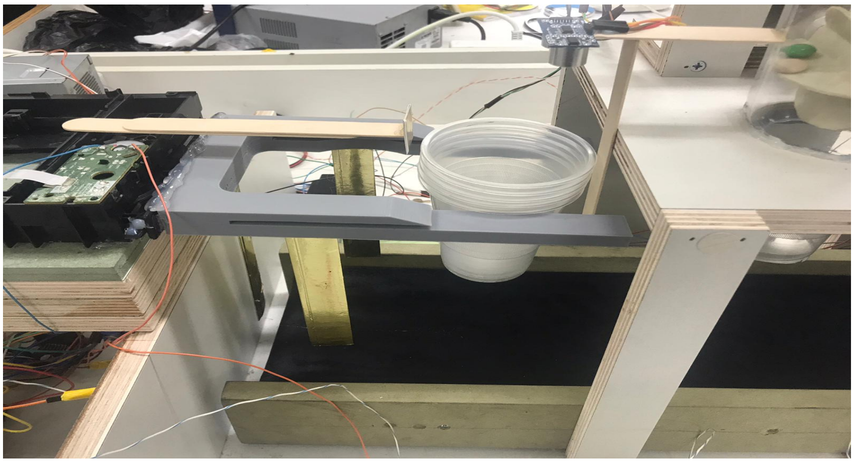
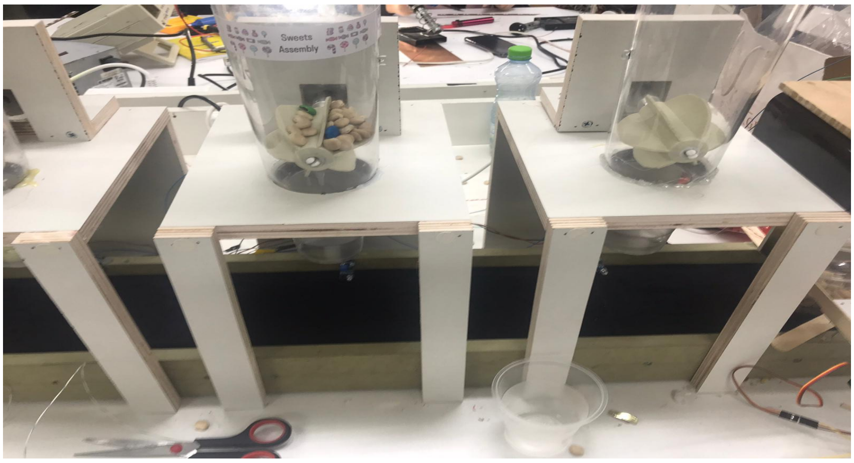


Figure 3.18: Cup Holder.

Here is where the cups drop to the conveyor belt to get ready be filled.

Figure 3.19: Conveyor Belt.

The most important part in our project is this part (conveyor belt) it's connected with a stepper motor called Nema 23 it moves the belt in constant speed and stops under the right can depending on the IR sensor.



Here where candy is stored and dropped from to the cup.

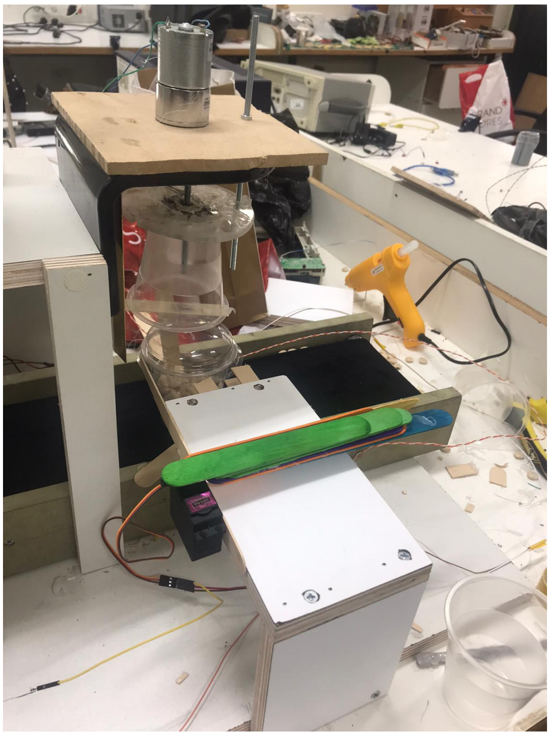


Figure 3.20: Closing Stage.

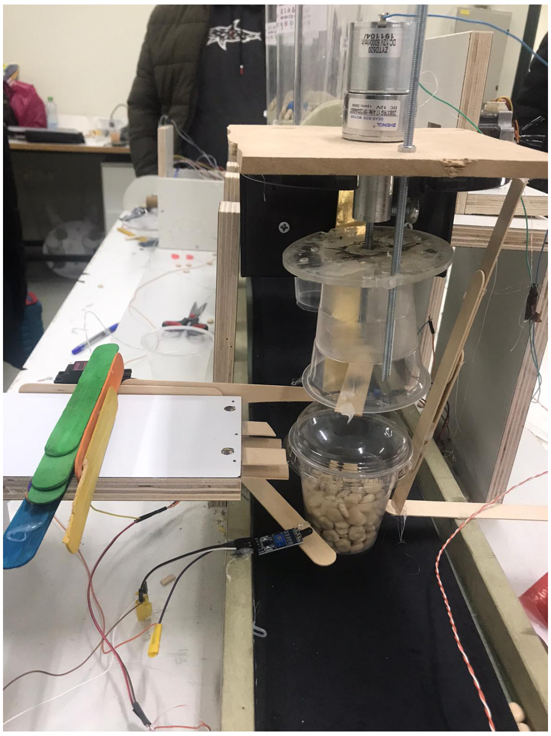


Figure 3.21: Closing Stage.

The final stage where the candy cup gets covered but moving the cover onto the top of the cup using servo motor and then it get pressed by the the DC motor in the top side of the stage.

3.5.2 Mobile Application

The mobile application interface with the ESP32 microcontroller through Bluetooth connectivity.

Developed utilizing the App Inventor platform, this application features a user-friendly interface that enables smooth interaction with the ESP32 for a variety of control tasks.

The main role of the app is to offer a straightforward method for users to send Bluetooth commands to the ESP32, thereby allowing them

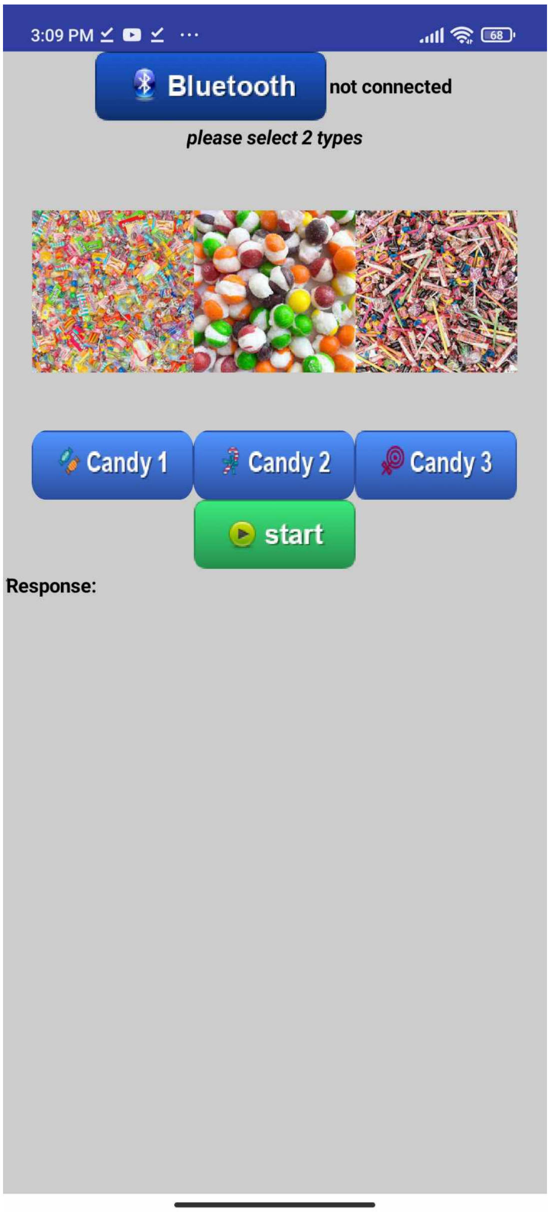


Figure 3.22: Mobile Application.

The privileged user connects to the ESP32 via Bluetooth by pressing the button at the top of the app.

Figure 3.23: List of Bluetooth Devices.

After the user establish the connection the user have to choose two types of candy and then press start to initiate the process.

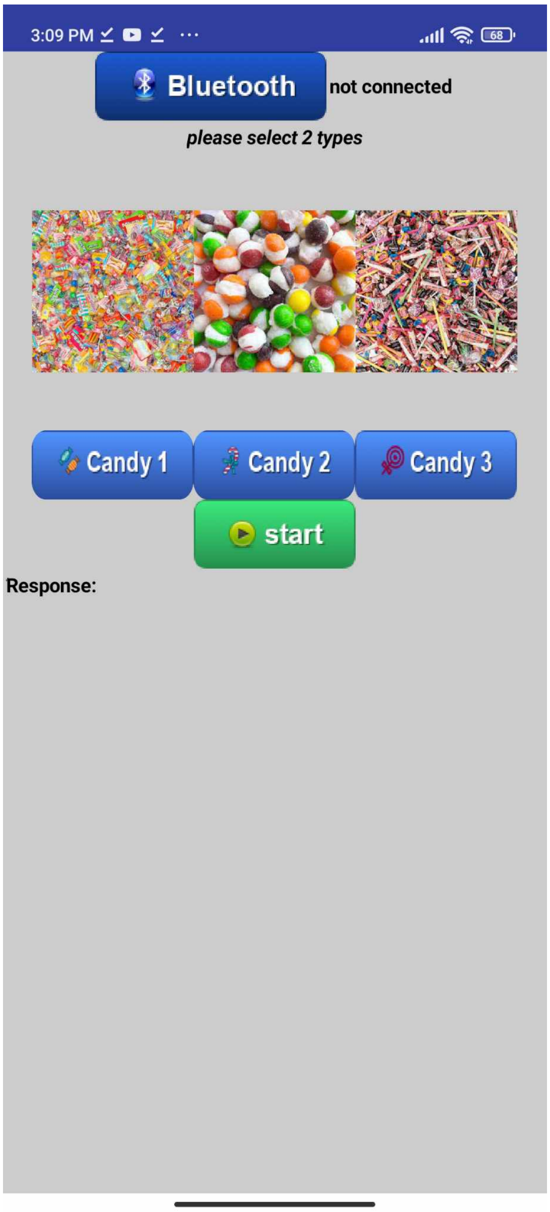


Figure 3.24: Mobile Application.

Chapter 4

Conclusion

Contents

This project represents a significant stride in the automation of candy can production. It successfully integrates advanced technologies such as stepper motors and RFID for quality control, culminating in a highly efficient and cost-effective production process.

The development phase encompassed thorough planning, design, implementation, and testing, ensuring the system's reliability and safety.

The inclusion of a user-friendly mobile application further enhances the system's accessibility and interaction.

Overall, this project not only elevates the standards of candy manufacturing but also serves as a model for incorporating technological advancements in industrial processes, striking a balance between operational efficiency, product quality, and safety.

4.1 Results and Analysis

The results of the candy can production project demonstrate a successful integration of RFID technology for access control, and a dual-input system (keypad and mobile application) for operation.

The process begins with cup placement on a conveyor belt, progressing through precise candy dispensing via stepper motor rotation.

The efficiency of the system is evident in its ability to specify candy amount accurately.

The final stage, involving a cover presser, ensures the product is ready for export. The analysis reveals a seamless operation, highlighting the project's contribution to innovative manufacturing practices.

4.1.1 Smart Features and Convenience Enhancement

The smart features and convenience enhancements in this candy can production project are evident through its automation and user-friendly interfaces.

The use of RFID for access control and a dual-input system (keypad and mobile application) for selecting candy types showcases the project's commitment to efficiency and ease of use.

The automated process, from cup placement to candy dispensing and packaging, minimizes manual labor and reduces contamination risks, aligning with the project's goals of improving cleanliness and operational efficiency.

The integration of technologies like stepper motors, conveyor belts, and IR sensors ensures precise candy filling and handling. Additionally, the mobile app connectivity through ESP allows for remote monitoring and control, further enhancing user interaction and operational efficiency.

This project not only automates candy can production but also focuses on user convenience and safety, setting a new standard in industrial process automation.

4.1.2 Mechanism and Security Features

The mechanism and security features of the candy can production project are multifaceted. The process begins with RFID-enabled access control, ensuring that only authorized personnel can initiate the production cycle. This enhances security and operational control.

Users then select the candy types either through a keypad or a mobile application, which communicates with the system via Bluetooth.

The use of IR sensors to detect cup placement and the precise operation of stepper motors for candy dispensing showcase the project's focus on accuracy and efficiency.

These mechanisms not only streamline the production process but also minimize the risk of contamination and errors. The inclusion of a cover presser in the final stage further ensures product integrity, readying it for export.

Overall, the project combines advanced technological solutions with stringent security measures to optimize candy can production while prioritizing safety and quality control. so focuses on user convenience and safety, setting a new standard in industrial process automation.

4.1.3 Mobile Application Features

The mobile application in our project is a pivotal feature, enhancing both operational efficiency and user experience.

It offers a user-friendly interface for selecting candy types, facilitating ease of use and streamlining the production process.

This application, developed with sophisticated software, allows users to remotely control and monitor the production line.

Its integration with the system through Bluetooth technology enables seamless communication with the ESP32 microcontroller.

This advanced app not only simplifies the selection and start of the production process but also aligns with the project's goal of reducing manual labor and ensuring precise candy measurement, thereby contributing to overall operational efficiency and quality control in the candy can production.

Chapter 5

Discussion

The analysis delves into the intricacies of a state-of-the-art candy can production system, emphasizing its advanced design and multifunctionality. Notable features such as RFID access control and the dual-input system are underscored for their contribution to security and user experience.

Attention is given to the deployment of conveyor belts and IR sensors, pivotal in managing the candy dispensing process with accuracy.

Further scrutiny is applied to the precision offered by stepper motors, along with the versatility afforded by the integration of a mobile application for overseeing operations remotely.

Central to the evaluation is the system's role in augmenting production efficiency, diminishing the need for manual intervention, and enhancing the quality and safety of the product—mirroring the overarching objectives of

Chapter 6

Conclusions and Future Work

In concluding, this project effectively addresses the need for efficient and automated candy can production. By integrating technologies like RFID, stepper motors, and a user-friendly mobile application, it significantly reduces manual labor and contamination risks, thereby enhancing production quality and operational efficiency.

The seamless combination of hardware implementation, software development, and thorough testing establishes a new standard in candy manufacturing.

For future work, potential areas of focus could include further optimization of the system for energy efficiency, expanding the variety of candy types that can be processed, and integrating more advanced data analytics for real-time quality monitoring. Enhancements to the cup cover mechanism could also be explored.

Additionally, exploring the integration of AI for predictive maintenance and further enhancing the user interface of the mobile app could yield substantial benefits in operational efficiency and user experience.

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