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Faculty of Engineering & Information Technology

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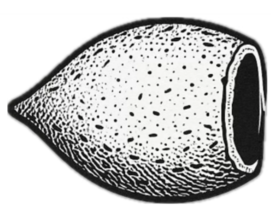
Hardware Graduation Project



Kibbe Maker

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Acknowledgment

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Disclaimer statement

This report was written by students from the Computer Engineering Department – Faculty of Engineering and Information Technology – An-Najah National University. It contains their experience in the hardware project, and the formatting style required by the university was followed in preparing this report.

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Abstract

It takes a lot of time, effort, and accuracy on the part of both mothers and restaurant owners to prepare kibbeh. We therefore made the decision to automate the kibbehmaking process so that it could be prepared in huge quantities quickly. The project depends on an electronic control unit to accurately control the amount of filling and regulate movements, as well as an integrated mechanical system to guarantee uniform size and shape. It is appropriate for both domestic and commercial use since it also considers safety, hygienic practices, and user-friendliness. With the flexibility to customize the kibbeh and filling size to the user's requirements, the main objectives are to increase production efficiency, decrease material waste, and guarantee high quality in the finished product. The project relies on a methodology of sending the order via an LCD screen to determine the number of kibbeh balls required, and then the user uses the keybad buttons to indicate the quantity of kibbeh balls required. After that, the dough is pressed by pistons using a hydraulic press set to the proper pressure. The filling is then pressed inside the kibbeh ball and shaped into the proper shape. Additionally, the shaping process is carried out and the arrival of the kibbeh ball is detected using lasers and LDR.

The production line is driven by a DC motor, and the necessary quantity is confirmed by a counting sensor. The project idea was requested in the markets and has never been implemented before.

Chapter 1. Introduction

1.1 General background

In many cultures, particularly in Arabic cuisine, kibbeh is a traditional and well-liked meal. Because of the meticulous shaping and stuffing procedure, it takes a lot of time and effort to prepare. Conventional techniques rely on manual labor, which can lead to size and shape irregularities and be time-consuming, especially when making big amounts at home or in restaurants. Seeking intelligent technologies that streamline cooking procedures and improve efficiency has become crucial as a result of technological advancements and our growing reliance on automated solutions in daily life. This is where our project's concept came from: creating and deploying an automated kibbeh-making machine that provides a useful, contemporary way to save time and effort while preserving accuracy and quality in output.

1.2 Objectives of the work.

This project's primary goal is to create and deploy an automated device that can shape and prepare kibbeh in an efficient and reliable manner. The purpose of this research was to overcome the issues with conventional kibbeh-making processes, including their time consumption, size and shape inconsistencies, and the substantial physical labor involved in the manual process. Our project's goals are to decrease manual labor, guarantee consistency in the finished product's size and shape, save time—particularly when making big quantities—and enhance food safety and hygiene by reducing hand contact during manufacturing. The project also aims to give home cooks and small food businesses a workable way to improve their manufacturing process by providing a clever and efficient substitute that boosts output while maintaining the traditional characteristics of kibbeh.

1.3 Significance or importance of your work

Our project is significant because it provides a creative solution that keeps up with technical developments and enhances the conventional way of making kibbeh, a dish that is highly sought-after in both local and Arab markets. Manual kibbeh production confronts various obstacles, such as time consumption, uneven quality, and significant physical effort, which impair competitiveness—especially with the increased demand for ready-to-eat and fast-prepared food products. By increasing production efficiency, guaranteeing consistent quality, and lowering the expenses related to manual labor, automating the kibbeh-making process adds economic and commercial value to the project. Additionally, this technology supports small and medium-sized food enterprises and satisfies the growing market demand for smart tools that improve consumers' lives, enhancing the traditional food and pastry industry's prospects of success and sustainability.

1.4 Organization of the report

The issue of making kibbeh by hand was examined in this study, particularly in domestic contexts and small-scale endeavors that encounter difficulties with time, effort, and variable quality. Finding an automated system that streamlines the production process without sacrificing the dish's customary excellence was the main goal. The difficulties of creating kibbehs by hand, including irregularities in size and shape, a lot of physical labor, and limited output, were first discussed. The goals of the project and the useful answers it provides were then examined. The design approaches, tools, and techniques used to implement the automated kibbeh-making machine are included in the study. Together with an explanation of the experimental findings, a pertinent literature review is also included.The value of the suggested approach in achieving high-quality, hygienic, and efficient kibbeh production while reducing manual involvement is finally emphasized in the conclusion.

Chapter 2. Theoretical Background and Previous Work

2.1 Theoretical Background

2.1.1 Keypad and LCD Systems for Human-Machine Interaction

Human-machine interaction is essential to the effective functioning of automated systems. Users can enter precise commands or quantities, such the amount of kibbeh pieces they want, straight into the machine by using a keypad. After that, an LCD screen shows this input, allowing for real-time verification and feedback. Both home and small business customers will benefit from an easy control experience because to these components' simplification of the user interface and reduction of operational complexity.

2.1.2 Food Automation Using Pneumatic Systems

Pneumatics—more especially, compressed air-powered pistons, or "pistons"—is one of the project's primary technologies. Both the filling and the kibbeh dough are under pressure in this arrangement thanks to pneumatic pistons. The human pressing method is replaced by this automatic compression, which guarantees uniform and effective shape of the kibbeh pieces. Because of its clean operation, speed, and controllability, pneumatics are utilized extensively in food processing.

2.1.3 A Mechanism for Automated Cutting

The kibbeh needs to be sliced and divided into various pieces after it has been filled and shaped. A piston-based cutting system with sensor guidance is used to accomplish this. The piston starts to make a precise cut when the stuffed and formed kibbeh reaches a predetermined sensor. This improves product quality and cuts down on waste by guaranteeing that every kibbeh piece is consistent in size and shape.

2.1.4 Mechanism of Conveyor and Serving Plate

Each piece of kibbeh is transported to a serving plate by a track or mechanical path once it has been cut. To preserve the kibbeh's structural integrity, the system makes sure it is handled gently. The plate automatically turns to receive the next piece after it has been dropped upon it. The plate can gather several kibbeh pieces in succession thanks to this rotation, which guarantees that the pieces are arranged neatly and avoid overlapping.

2.1.5 Integration of Mobile Applications

The system incorporates a mobile application that enables users to remotely start or stop the kibbeh-making process, improving user comfort and updating the control interface. The increasing trend of incorporating Internet of Things (IoT) technologies into kitchen equipment is seen in this. By offering remote control, monitoring, and the ability to modify parameters like quantity or timing of preparation, the mobile interface offers value.

2.2 Previous Work

Significant progress has been made in the area of automated food preparation in recent years, especially in the food industry sectors that need precise portioning, shape, and less human interaction to maintain efficiency and hygiene. The planned automated kibbeh-making machine is similar to a number of other proposals and systems:

2.2.1 Commercial Kibbeh-Making Machines

There are commercial kibbeh-making machines on the market, including models made by Shenghui and ANKO. These devices automate the shaping process through pressing mechanisms. However, the majority of them are not appropriate for home kitchens or small food enterprises because they are expensive, need professional operation and maintenance, and are made for large-scale industrial use.

2.2.2 Arduino-Based Automated Food Projects

Microcontrollers like Arduino have been used in a number of student and research projects to automate processes like filling, shaping, and cutting dough for items like cookies or stuffed pastries. Similar to the kibbeh machine project, these systems frequently use pneumatic pistons for pressing and sensors to determine the position of the dough.

2.2.3 Mobile App-Controlled Devices

Mobile application control is becoming more and more common in modern automation projects. Bluetooth or Wi-Fi apps are used to remotely start or configure the device. The rise of smart kitchens and the Internet of Things (IoT) in relation to cooking automation is reflected in this trend.

2.2.4 Pneumatic Shaping Techniques

Pneumatic technologies have been demonstrated to provide precise, reliable shaping and filling in chocolate and pastry equipment in industrial settings. Research demonstrates that, in contrast to conventional mechanical systems, air pressure-based extrusion can enhance filling distribution.

Chapter 3. Methodology

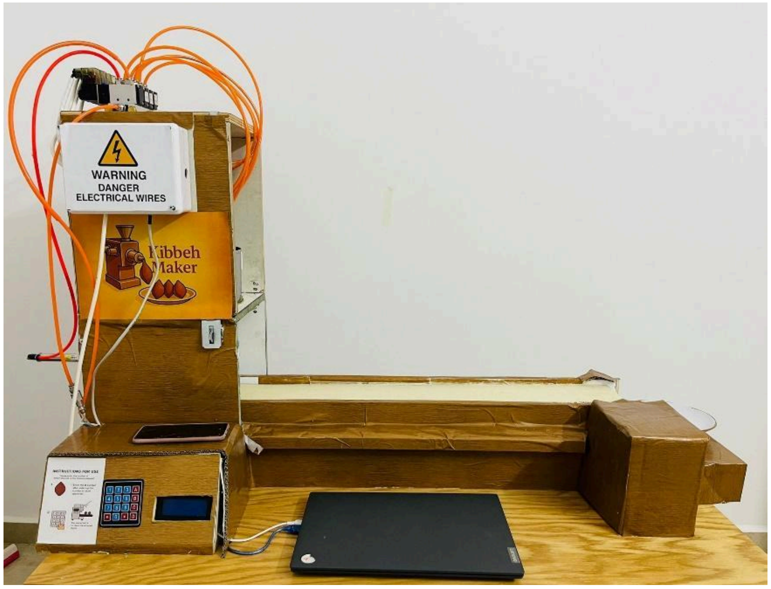

Figure 1: Kibbeh Maker

Without any human involvement, the kibbeh-making machine was set to run automatically and generate the necessary quantity of kibbeh balls. The procedure is broken down into four primary steps, each of which is essential to guaranteeing the system's automation, consistency, and effectiveness. These phases are:

3.1 Kibbeh maker stages :

3.1.1 Dough and Filling Pressing Stage:

To preserve food safety and quality and to stop corrosion over time, a stainless steel mold was utilized. The dough is held in the outer cone of the mold, which is made up of two nested conical shapes, while the filling is contained in the inner cone.

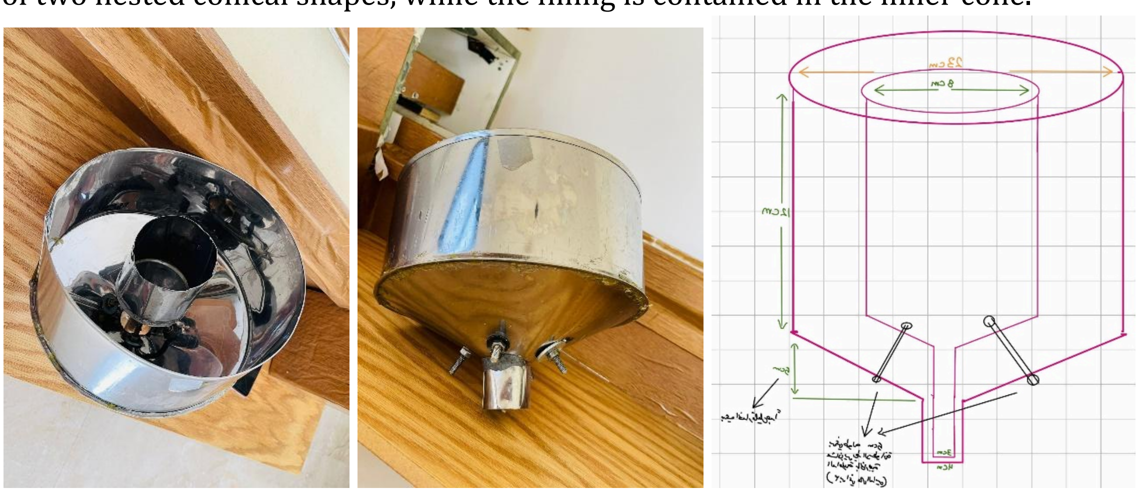

Figure 2: a stainless steel mold

Initially, the process begins by inputting the desired number of kibbeh pieces through either the keypad or the mobile application.

Figure 3:The stage of entering the number of kibbeh balls

The dough is pressed using a wooden cover that is attached to two pistons, and the filling is pressed using a different cover that is connected to one piston.

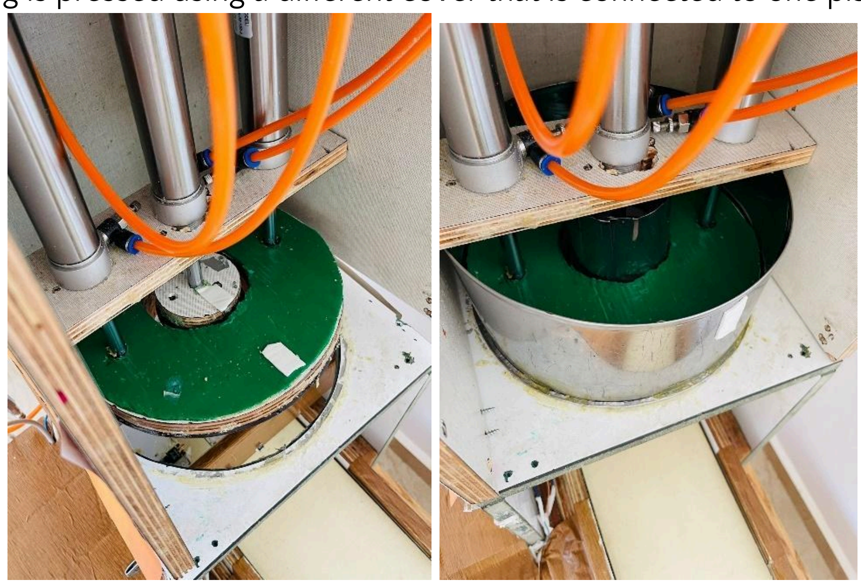

Figure 4: A wooden cover connected to a pneumatic piston.

The filling piston injects the stuffing into the middle of the hollow dough cylinder after the dough pistons compress and extrude the dough into a hollow cylindrical shape using air pressure.

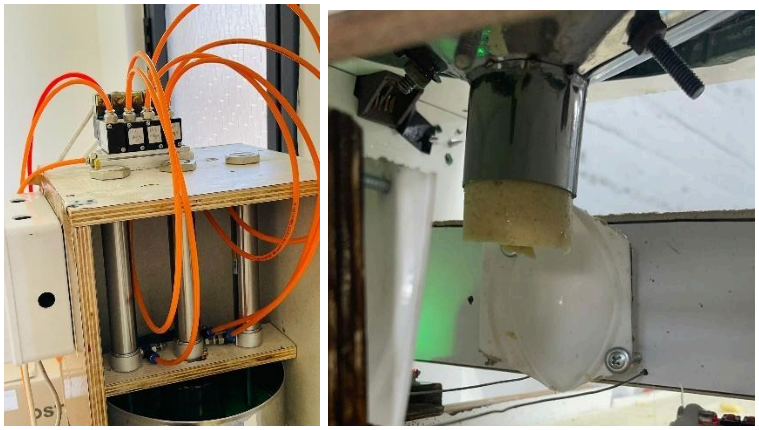

Figure 5: Dough pressing stage

Components Used in This Stage:

- The selector : the first part employed in this step, regulates the pistons' activity by uniformly supplying them with air. This guarantees that the dough and the filling move in unison and are properly pressed.

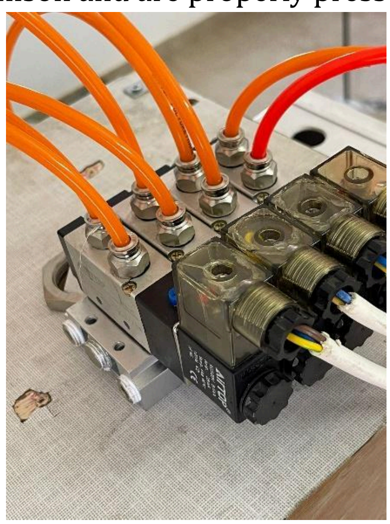

Figure 6:Selector

- The relay : connected to the selector controls its operation by supplying and switching the current on.

Figure 7 : Relay

- The pistons: They work to press the dough and the filling. 3صورة البستونات

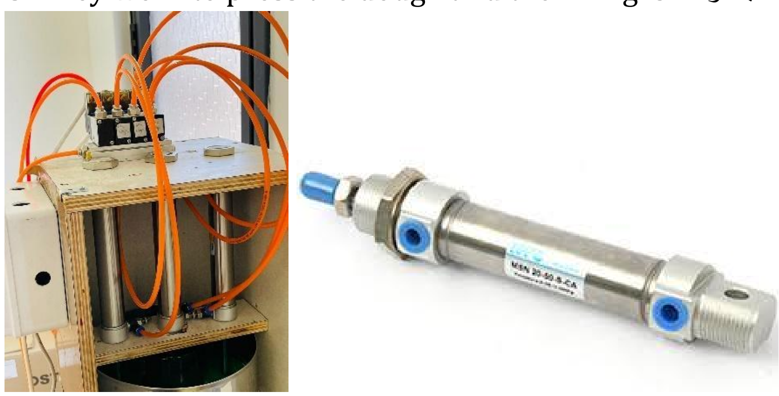

Figure 8:Pistons

3.1.2 Kibbeh Cutting Stage:

In this step, we detected the arrival of a kibbeh ball at the proper length using a laser and an LDR, as seen in Figure 9. At the same time, the laser counts the kibbeh balls passing by. As illustrated in Figure 10, a pneumatic piston fitted with half of the kibbeh forming mold is actuated upon detection, while the other half of the mold is placed across from it. The kibbeh ball is sliced by the piston's intense pressure and released onto the conveyor belt in the appropriate shape.

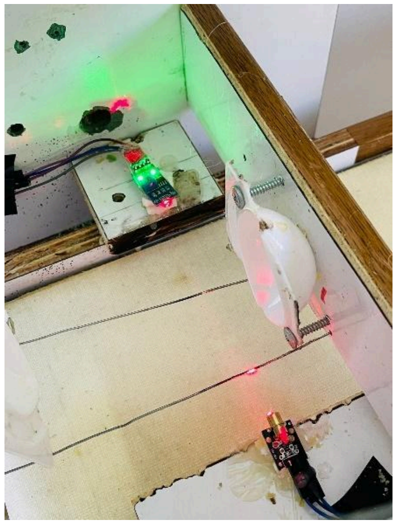

Figure 9:Laser and LDR

Figure 10 : Cutting piston

3.1.3 Kibbeh Transfer Stage:

The kibbeh ball is moved from the cutting stage to the plate assembly stage via a conveyor path driven by a DC motor.

Figure 11:Kibbeh Transfer Stage

3.1.4 Kibbeh Arrangement Stage:

At this point, the kibbeh ball is detected at the end of the conveyor path using an LDR sensor and a laser. The plate, which is attached to a stepper motor, turns by one-third of a turn when the ball is detected on it, making room for the subsequent kibbeh ball.

Figure 12:Kibbeh arrangement stage on the plate

3.2 Standards and Tools :

We used the **Arduino IDE** as the integrated development environment to write the code for controlling the hardware components through the Arduino platform. Additionally, we used **MIT App Inventor** to create a mobile application that communicates with the system wirelessly.

3.3 Controller Part

3.3.1 Arduino Mega:

To manage the machine's operations, we employed the Arduino Mega board. The user can utilize the mobile application or a keypad to enter the desired quantity of kibbeh balls. The kibbeh production phases are then started and managed in accordance with the orders sent by the Arduino.

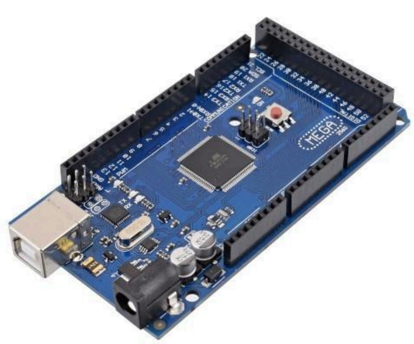

Figure 13:arduino mega

3.3.2 ESP with Mobile Application:

A mobile application allows for remote control of the system. Using MIT App Inventor, we created the mobile application, which we then linked to the Arduino Mega via the esp wroom 32 WiFi module to provide wireless machine control.

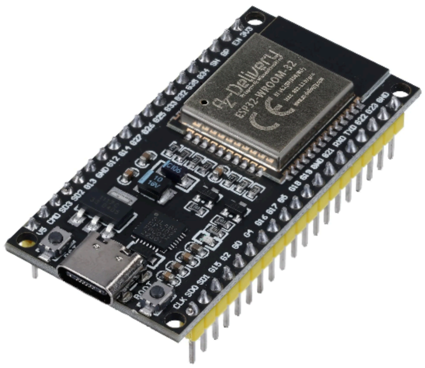

Figure 14:esp wroom 32

Application interfaces:

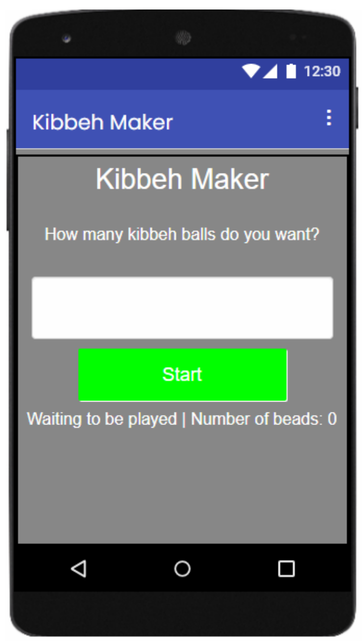

Figure 15:The mobile application

The mobile application features a user interface consisting of an input box to enter the desired number of kibbeh balls, a start button to send the start command to the machine, and a label that displays the current stage of operation.

3.4 Earlier coursework

3.4.1 A course on critical thinking

This course gives us research skills and teaches us how to utilize Overleaf to write quality reports.

3.4.2 PICs and microcontrollers

These resources helped us learn how to work with and operate the Arduino. We also learnt about the serial (TX, RX) and how to send and receive it, as well as how to utilize the program to write programs. With this knowledge, we were prepared to begin the project.

3.4.3 Our usage of the ESP-32

to connect our application to the system via WiFi was made easier by the Networking and Communications courses.

3.4.4 Self-education

We have improved ourselves by searching it on Google Scholar and YouTube.

3.5 Constraints

1. Practical Issues: One of the biggest problems we encountered was that the laser sensor was providing inaccurate readings because of the workspace's lighting. The sensor's accuracy was impacted by this interference, which also delayed the process's following step.

2. Technical Difficulties: We had a lot of trouble figuring out the ideal dough and filling mold form that would work with our machine design. We looked at a number of local vendors and experts, but were unable to locate a suitable stainless steel mold. The primary cause of the problem was the necessary material (stainless steel) and the requirement for a specialized forming equipment in order to precisely shape it. We had to order the mold from a far-off place, which caused significant delays. Road conditions and the high cost of transportation caused the order to be further delayed.

3. Lack of Mechanical Experience: In the cutting process, we experimented with several types of motors to achieve a fast and precise cut. However, most of the attempts failed due to inappropriate motor speeds. These trials consumed a significant amount of time until we finally arrived at a workable solution.

4. Cost-Related Problems: Throughout the experimentation stages, we squandered a lot of dollars. Because of the high temperature in the workstation, the dough would go bad in a matter of days. The dough's consistency would gradually deteriorate, even on the same day, rendering it unsuitable for trustworthy testing and influencing the anticipated outcomes.Results and Analysis

Chapter 4. Results and Analysis

Data was gathered during the kibbeh-making machine's development and testing stages in order to assess production efficiency, precision, and dependability. The results are used to confirm that each subsystem operates as intended and show how the machine behaves under different operating situations.

4.1 Cutting Accuracy

An LDR and laser sensor configuration was used to track the cutting process. Under controlled illumination circumstances, the laser was able to detect the presence of the kibbeh ball with an accuracy of 94%. Three out of twenty trials had false triggers in uneven illumination conditions. Later, a shade cover was added to lower this inaccuracy to less than 5%.

4.2 Conveyor Performance

Under constant load, the DC motor-driven conveyor system successfully moved kibbeh balls from the cutting area to the plate 100% of the time. 2.5 seconds was the average transfer time per unit.

4.3 Plate Rotation and Placement Accuracy

Even spacing between kibbeh balls was ensured by the stepper motor moving the plate, which completed one-third spins with a positional accuracy of $\pm 1.5°$. Only two of the 60 tested cycles had a minor misalignment, which had no effect on the overall operation.

4.4 Mobile App and Remote Control

In more than 98% of connection attempts, the MIT App Inventor-developed mobile application was able to effectively communicate with the ESP-32 module. Command execution delays were negligible (less than 500 ms) in typical Wi-Fi range scenarios. The start command successfully started the production sequence in real time, and the interface correctly showed the machine's active stage.

Analysis :

The outcomes attest to the kibbeh-making machine's accomplishment of its goals of efficiency, consistency, and automation. All essential subsystems operated within reasonable tolerances, despite the fact that small mistakes were noted because of material or environmental factors. The technology can be scaled up for semi-industrial application and refined further.

Chapter 5. Discussion

In order to decrease human labor, boost production efficiency, and preserve product consistency, the major goal of this project was to automate the kibbeh-making process. It is clear from the results that the project effectively tackled the fundamental problems of forming, filling, cutting, and arranging kibbeh balls with a high degree of automation and precision.

has the ability to automatically make kibbeh balls. By utilizing pressured air-powered pistons for compressing dough and filling, in conjunction with sensors for detecting and cutting, we were able to replicate the manual process more quickly and accurately. The ESP-32's ability to control mobile applications improved user convenience and brought the control interface up to date.

Nevertheless, several restrictions were noted. For example, false triggering was initially caused by environmental lighting interfering with laser-LDR sensing. Early cutting attempts were also inefficient due to mechanical inexperience, as motors were unable to fulfill the necessary speed and strength requirements. Particularly when choosing the right stainless steel mold design and modifying piston timing, these difficulties led to delays and necessitated iterative testing.

Our findings logically show that it is possible to automate a food manufacturing process that has historically involved a large amount of manual work. It follows that other hand-formed foods that need to be filled and shaped could benefit from the use of comparable techniques.

Future advancements could concentrate on the following areas:

Light-proof sensor housings that are enclosed allow for more accurate detection under all lighting conditions.

utilizing feedback control systems to automatically modify air pressure and piston time in response to dough consistency.

Faster motors and multi-track outputs will enable the machine to be scaled for industrial manufacturing.

In summary, even if the project ran into a number of practical difficulties, the finished system effectively showcases a creative approach to food automation, making it a solid contender for more development and possible commercialization.

Chapter 6. Conclusions and Recommendation

This project's primary goal was to develop and put into place a completely automated system that could produce kibbeh balls quickly, hygienically, and consistently with high quality while requiring little human involvement. By combining mechanical, electrical, and software components, the finished system effectively achieved these objectives by simulating the conventional kibbeh-making process through four automated steps: pressing, cutting, conveying, and plating.

The machine's ability to create consistent kibbeh balls through the use of air-powered pistons for dough and filling, laser-LDR sensors for detection, and a stepper motor for systematic plate rotation is evident from the outcomes. Modern remote control was made possible by integration with the ESP-32 and a mobile application, which increased versatility and user-friendliness.

What we discovered:

1.When properly controlled, pneumatic devices can successfully replace manual labor in food preparation.

2. Sensor-based automation presents environmental interference and precision issues that need to be properly controlled.

3.Iterative testing is necessary in mechanical design, particularly when working with unique parts like food-grade molds.

Suggestions for Enhancement:
1.Improve the laser and LDR sensors' shielding mechanism to reduce interference from the environment.
2.Use closed-loop feedback systems to instantly adjust pressure according to dough consistency.
3.Investigate modular designs and substitute materials for simpler part replacement and maintenance.

Future Projects and Unresolved Issues: Future advancement can strive to:
1.Increase the machine's output to an industrial level by utilizing quicker parts and multi-path conveyors.
2.To improve hygiene and cut down on downtime, install automatic cleaning systems.

Among the open issues are:
1.modifying the device to accommodate filled foods other than kibbeh.
2.cutting costs for commercial deployment without sacrificing quality.

In conclusion, this research has established the framework for an intelligent and scalable food automation system designed for traditional cooking. The event made clear how crucial iterative design and interdisciplinary cooperation are to resolving practical engineering issues.

Chapter 7. References

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