Ministry of Education and Scientific Research
Elmergib University
Faculty of Engineering Al-khoms
Department of Electrical and Computer Engineering
Elmergib Journal of Electrical and Electronic Engineering

وزارة التعليم العالي والبحث العلمي
جامعة المرقب
كلية الهندسة الخمس
قسم الهندسة الكهربائية والحاسوب
مجلة المرقب للهندسة الكهربائية والالكترونية

Volume 2, Issue 3, --- 2023

ISSN: 2959-0450

Design and simulation of Automatic Pasta Cooking Machine

Najmi Wafi[1], Ausama Ahmed[2], Mftah BinHasan[3], Moad Kahal[4]

[1]nawafi@elmergib.edu.ly, Elmergib University, Libya
[2]ahamed@elmergib.edu.ly, Elmergib University, Libya
[3]mbinhasan@elmergib.edu.ly, Elmergib University, Libya
[4]moad.kahal@gmail.com, General Electric Company of Libya, Libya

Abstract- The cost of living in most countries is going up with time, which causes people to work harder for longer period of times to meet their needs. This made doing their everyday tasks like laundry and preparing daily meals harder as the free time is shorter. Healthy living requires doing a number of tasks, such as cleaning the house, cooking the meals exercising, entertainment …etc., all of this should be done in the free time. Some people do not know how to cook, while others do not have the time and sometimes, may not have the mood to cook. That causes people to rely on buying food or eating unhealthy and bad quality food like sandwiches and fast food. A good solution for the food problem is designing a robot or an automatic machine that can cook a good food with no, or limited, supervision. Having such a robot, also allows doing other tasks. In this paper, an Arduino powered pasta machine is proposed and simulated. The user puts the ingredients in the machine, then the machine starts cooking immediately or after a specified period of time. It is designed with the a focus on utilizing locally available parts. The simulation was carried out using Proteus Design Suite.

Keywords – Cooking machine, Proteus, Pasta, Arduino.

I. INTRODUCTION

Autonomous cooking machines are gaining traction in the realm of culinary technology, offering convenience and precision in meal preparation. These machines, equipped with sensors, actuators, and control systems, can automate various cooking tasks, ranging from measuring ingredients, stirring and mixing to cooking to desired doneness. These machines enable users to enjoy pasta without dedicating extensive time and effort. This paper delves into the design and implementation of a pasta cooking machine with minimal user intervention. Pasta, a staple food in many cultures worldwide.

There is a number of cooking machines in the literature, in a paper titled "A Novel Automatic Cooking Robot for Chinese Dishes", the authors presented a robot to cook Chinese dishes named AI cooking robot (AIC) [1]. The robot is divided into four parts: the work mechanism, the stir-fry and dispersing mechanism, the feeding mechanism, and the mechanism of leaving the material in the middle mechanism. The robot uses a mechanism to adjust the temperature called the fire control system. While in the paper presented by Moyeenudin, et al. a focus on prototyping a food processor that works without physical presence using WIFI application is presented [2]. A Dosa, an Indian food, making machine is designed using an Arduino Uno. It takes the size of the Dosa as an input and pours a specific amount of batter on a hot pan for the cooking [3]. For a similar type of food, an Appam cooking machine utilizes motors, valves, microcontrollers, and sensors to automate the pouring, spreading, and removal of cooked food from the pan [4]. A soup machine is suggested by Bekerici, where it uses a Programmable Logic Controller (PLC) to serve soup and bread to the user [5]. Arduino is the heart of most cooking machines, where it was used in a rice cooking machine [6], and in a simple cooking machine with IOT ability [7].

Submitted 24 Dec. 2022; Final Version Received 17 Aug. 2023; Accepted 23 Mar. 2023; Published Online in 09 Dec. 2023

II. Framework of the Designed System

To make the basic design of the system clear and easy to understand, this section is divided into three parts: a block diagram, a flowchart, and a simulation model.

A. Block Diagram of the System

The main components of the proposed automatic pasta cooking machine and their relationship are illustrated in Figure 1. The system consists of 19 components, with an Arduino Mega board serving as the core controller. The state of the machine and the cooking process settings are monitored by an LCD screen and buttons. Other components connected to the Arduino Mega board include: motors through L293D H-bridge for adding ingredients and moving the lid of the pot; buzzer for bringing attention to the process; water pump, and water level sensor along with their control circuits to control the water level in the pot; ultrasonic sensor and oil pump and its circuit to control the amount of oil; heater and its circuit to control the temperature with the use of LM35 temperature sensor.

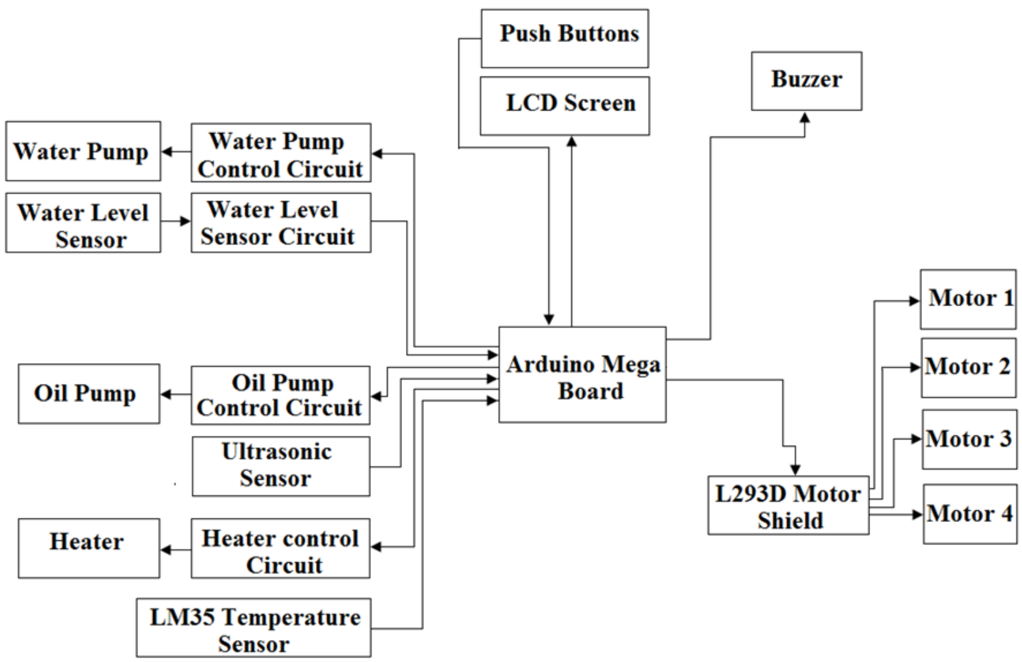

***Figure** 1: General block diagram of the system*

B. System Flow Chart

The system flow chart is shown in Figure 2. The heater will be turned on after setting the cooking process parameters. The Operation of adding the ingredients to the cooking pot begins when the water and oil have been added using a screw feeder mechanism. The operation of adding the ingredients in the food containers takes its place if "time to add food container ingredient?" was yes. The heater will turn OFF when the cooking is done, otherwise the operation will return back through a feedback path (" cooking is done?" to "need to add water?"). The cooking operation ends after the buzzer buzzes and a sentence "cooking is done" is displayed on the LCD screen.

C. Simulation Model of the System

The overall system, shown in Figure 3, is simulated and developed using Proteus professional software which is very renowned, flexible and easy to use and gives accurate results [8]. Note that the simulated system has mostly the same elements that are shown in Figure1 with a few exceptions. An AC lamp is used instead of cooking heater, (ON, OFF) switches are used instead of

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water lever sensor and DC motors are used to represent the water and oil pumps. These elements were used because the Proteus software does not contain the replaced elements in its library.

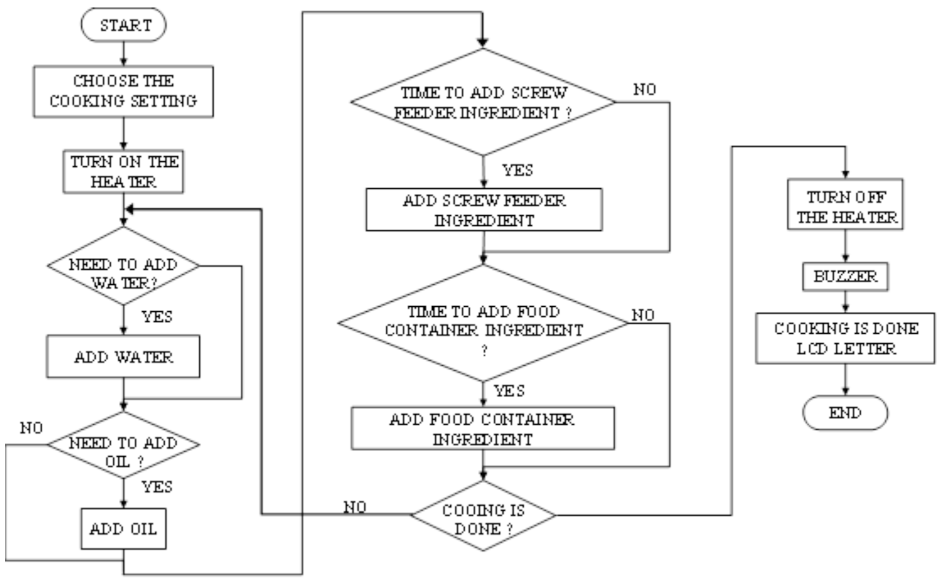

***Figure** 2: Flow chart of the system operation*

Using an ultrasonic sensor over the pot to measure the water level is not a good idea as it will be exposed to steam and high heat from the pot which will highly damage the sensor. 32 switches are used instead, see Figure 3, to simulate the water level in the pot. They are used to connect the power probe to the 32 signal probes, since the water level can be determined by defining how many signal probes connected to the power probes through the switches, see Figure 4. The signal probes can't be connected directly to the Arduino board; Because, the signal coming out of them is weak due to the water resistance not compatible with the Adriano logic levels and they require a lot of I/O pins.

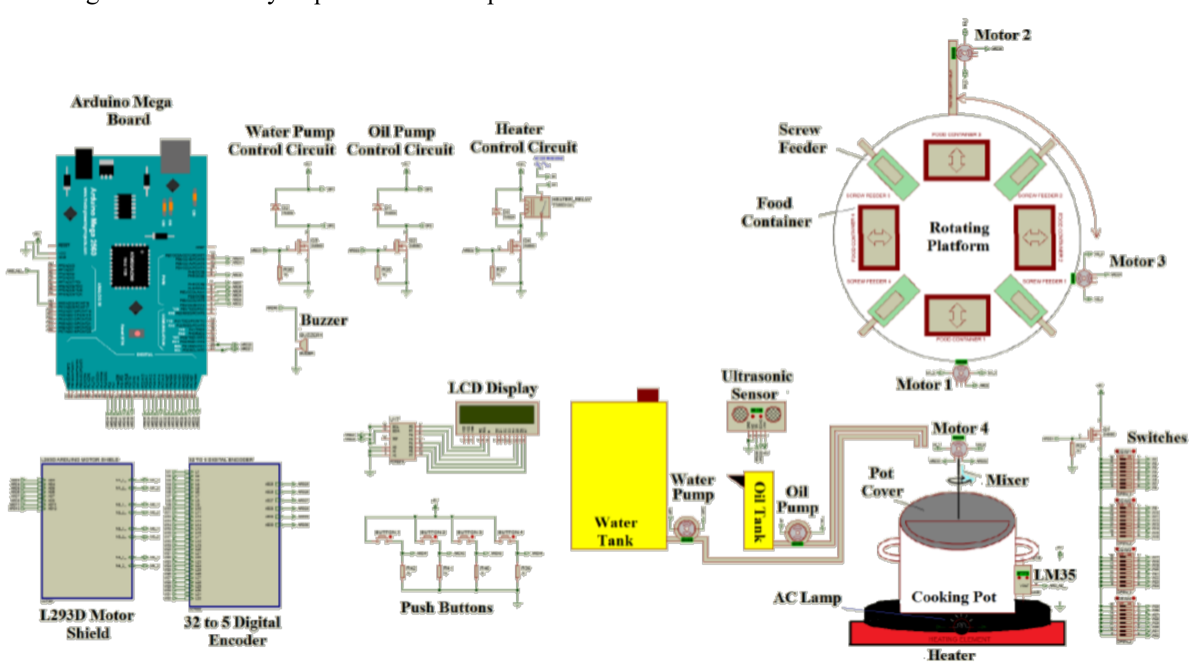

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Figure 3: System simulation using Proteus software

For that, an electronic circuit shown in Figure 5 is used. The first stage of the circuit is ULN2003 Darlington transistor matrix ICs . It is used to amplify the signal coming out of the probes and makes it compatible with the TTL levels. The second stage of the circuit is 32 to 5 priority encoder which is used to encode the 32 wires coming out of the ULN2003 ICs to 5-bit binary number. This will reduce the number of pins needed to connect the water level sensor to the Arduino board.

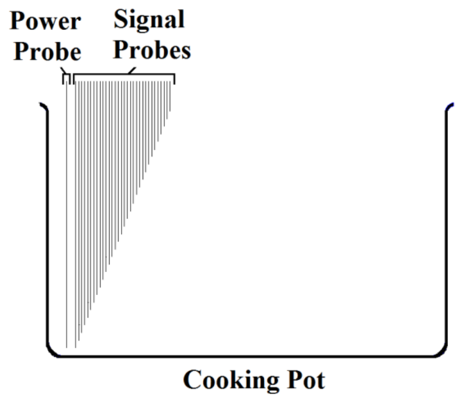

Figure 4: Water level sensor probes

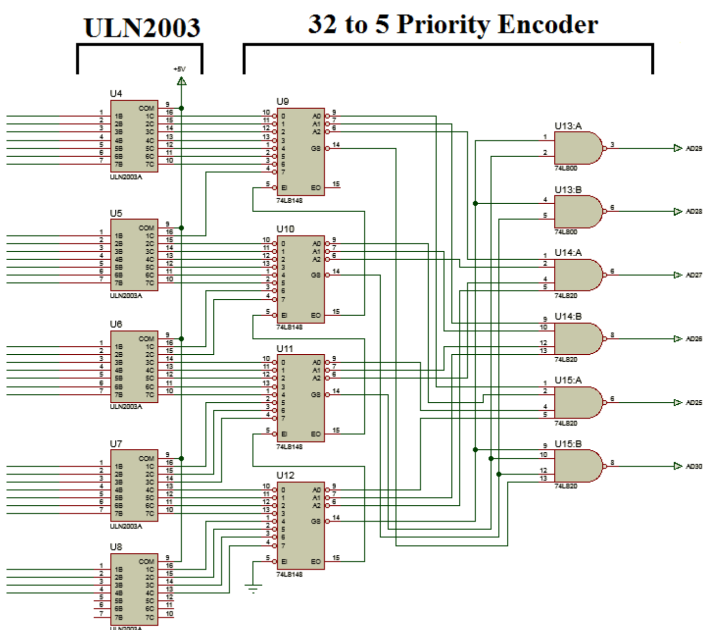

Figure 5: Water level sensor circuit

III. System Description

The system operation according to Figure 2, starts with a WELCOME message sown on the LCD screen, see Figure 6. Then a user can use four buttons to select suitable cooking settings, see Figure 6, upper part. The four buttons are used for dual purpose; the first purpose is for adjusting the time, where two buttons are used to incrementing and decrementing the hours/minutes selected by button 3 and the fourth is for confirming the setting of the time. The user selects the cooking time for the meat and the pasta and the time for the start of the cooking. The second purpose of the buttons is used to select the appropriate quantity of

Submitted 24 Dec. 2022; Final Version Received 17 Aug. 2023; Accepted 23 Mar. 2023; Published Online in 09 Dec. 2023

the ingredients, by going through the cooking options, which are setting the quantity of the pepper, salt, turmeric, tomato paste, potato, meat and pasta, see Figure 6, subfigures 1 to 15.

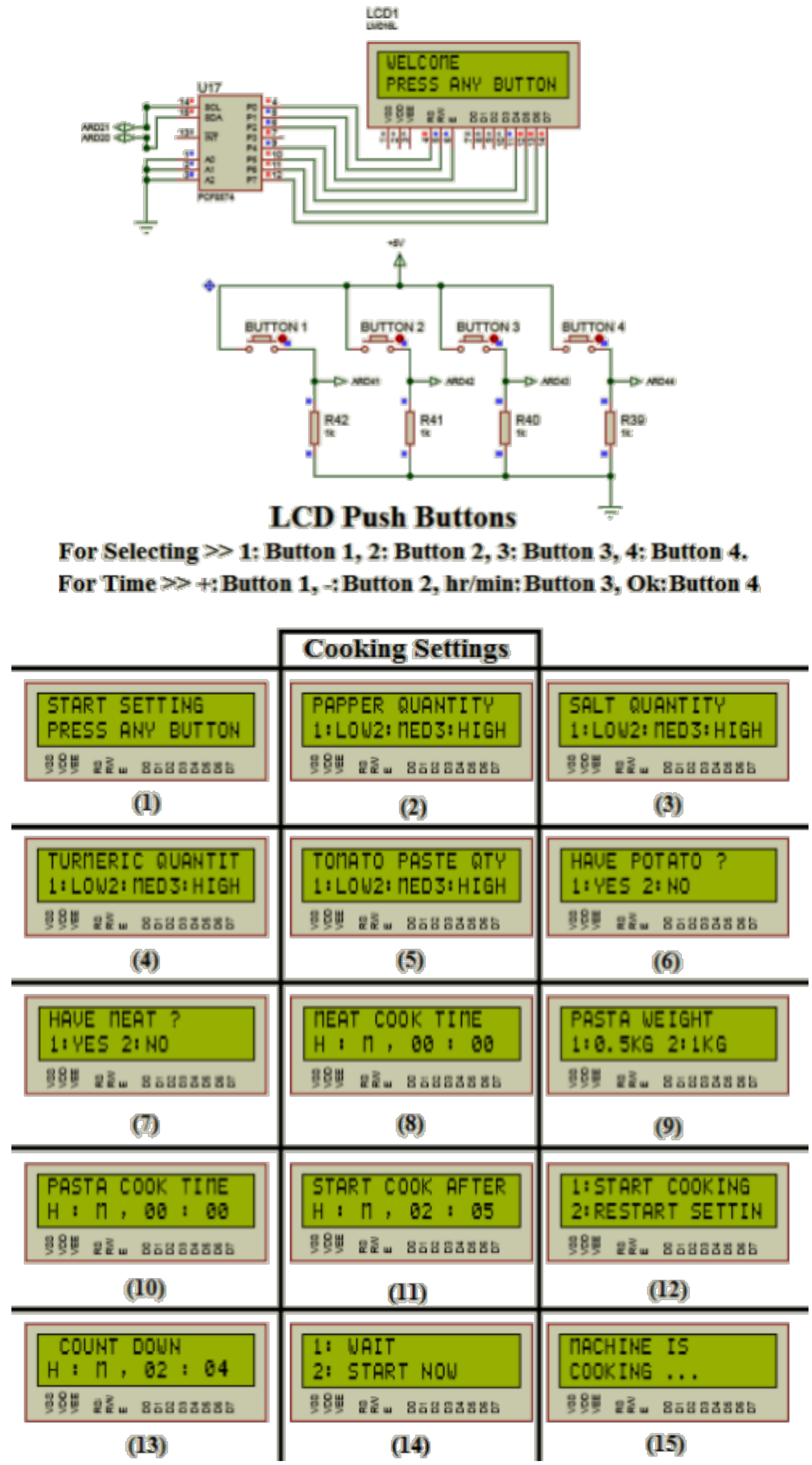

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***Figure** 6: Upper shows buttons and LCD connection, Bottom, shows WELCOME message and the cooking settings*

Then the proposed machine will start cooking through turning ON the heater by switching ON the MOSFET connected to the heater control circuit using Arduino as shown in Figure 7. The temperature of the cooking pot is measured using LM35 temperature sensor so that each ingredient can be added at the proper temperature.

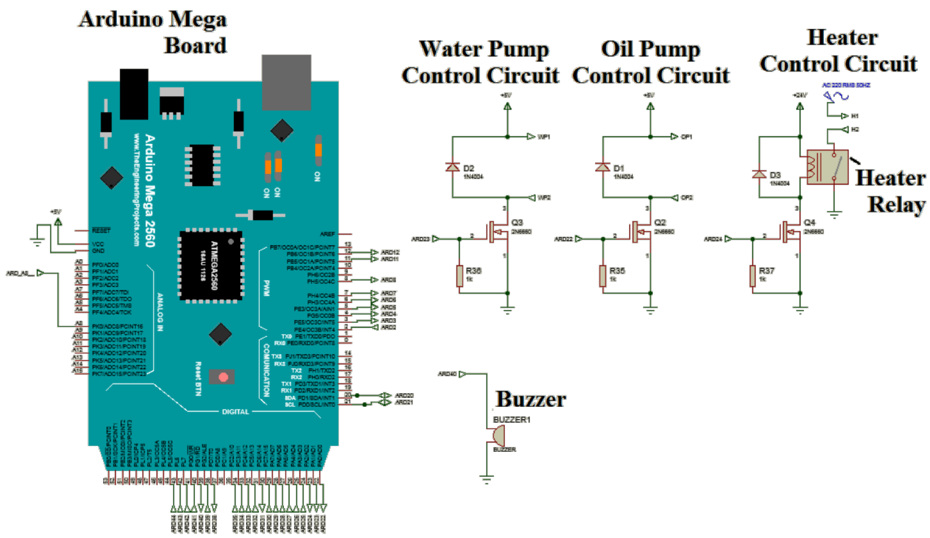

***Figure** 7:Arduino Mega, Buzzer, and pumps and heater control circuit.*

When the system needs to add water, the Arduino will check the water level using the water level sensor. If the water level is low, the Arduino will switch on the MOSFET connected to the water pump control circuit, as shown in Figure 7.

The Arduino uses an ultrasonic distance sensor to measure the oil level in the tank. When the system needs to add oil, the Arduino turns on the oil pump, as shown in Figure 8-a. This is done by switching on the MOSFET connected to the oil pump control circuit, which is shown in Figure 7. The oil pump turns off when the oil level in the tank decreases to the desired level, as shown in Figure 8-b. Using a timer instead of water and oil sensors would be an open-loop control system. However, this approach is not recommended because the performance of the pump motors can vary depending on temperature conditions due to the heater.

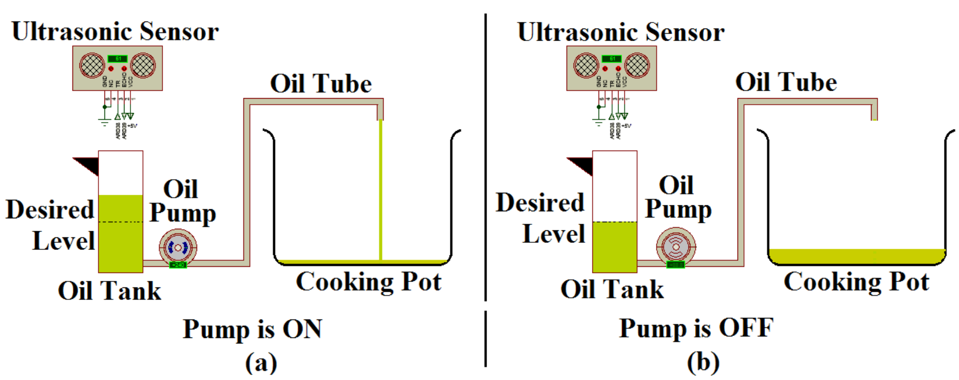

***Figure** 8: (a) pumping oil . (b) desired level reached.*

When the system needs to add one of the screw feeder ingredients, such as pepper, turmeric, salt, or tomato paste, to the cooking pot, the Arduino will drive the DC motors using the L293D motor shield. Motor 3, as shown in Figure 9, will be used to rotate the platform to place the needed screw feeder in front of motor 1.

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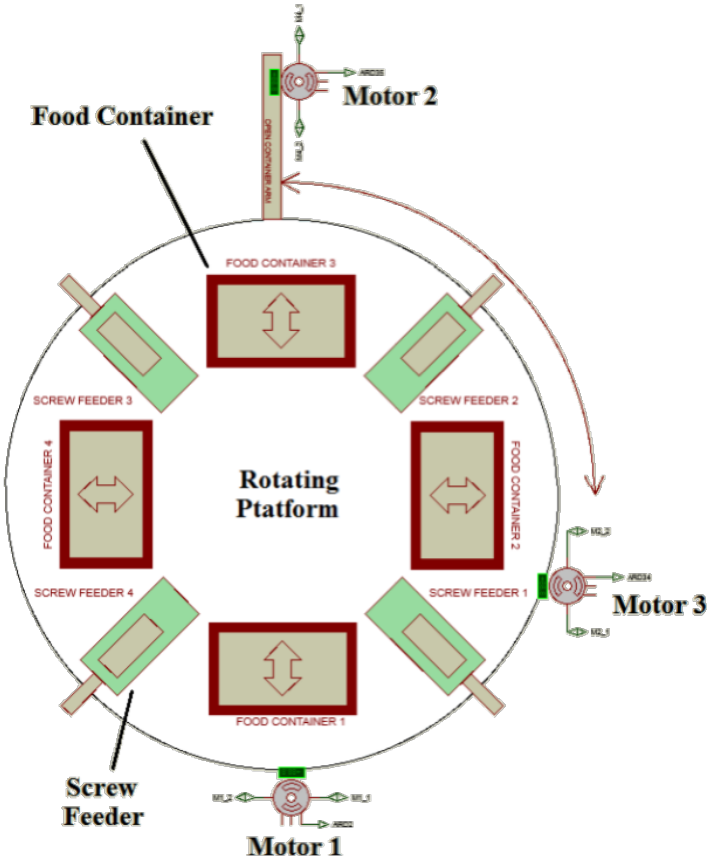

Figure 9: Rotation of the platform

Motor 4 opens the pot cover by rotating it halfway. The pot cover consists of two circular metal pieces stacked on top of each other, as shown in Figure 10. To open or close the pot cover, motor 4 rotates the upper piece by half a rotation. A one-way bearing connects the motor to the upper piece, allowing the motor to move the cover only when rotating clockwise.

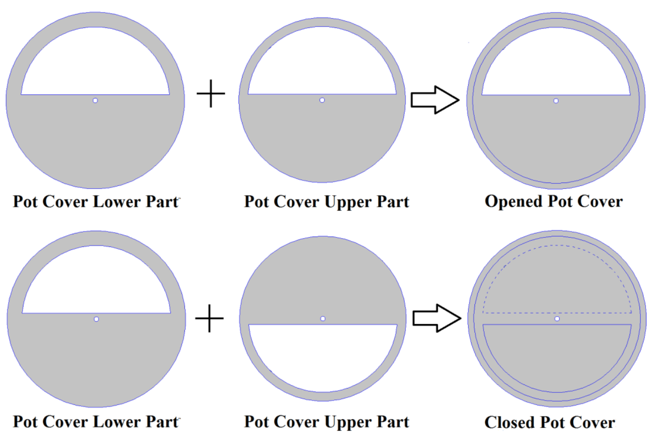

Figure 10: Pot cover parts

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Motor 1, as shown in Figure 11, adds ingredients from the screw feeder to the cooking pot. Motor 4 opens and closes the pot cover whenever an ingredient is to be added. Motor 3 rotates the platform to align it with motor 1.

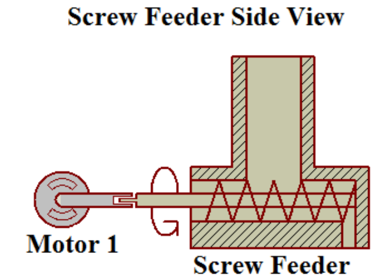

***Figure** 11: Rotating the screw feeder*

When one of the ingredients in a food container (meat, potato, onion, or pasta) needs to be added, motor 3 rotates the platform to align the container with motor 2 arm. Motor 2 then pulls the arm to drop the ingredient into the cooking pot by sliding the bottom of the container out, as shown in Figure 12(a). Finally, motor 2 rotates in the opposite direction to close the container, as shown in Figure 12(b).

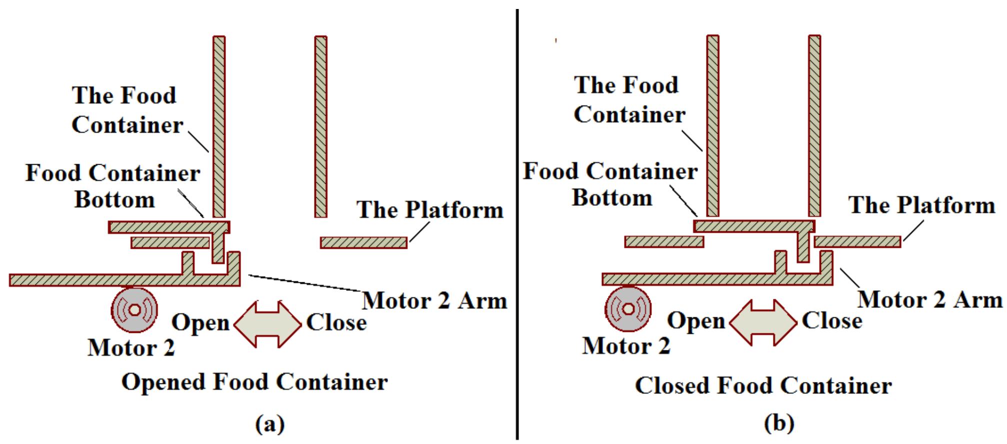

***Figure** 12: (a) open food container. (b) closed food container.*

A mixer is connected to motor 4. Once all ingredients have been added to the cooking pot, motor 4 rotates counterclockwise (the opposite direction of opening and closing the pot cover) to start mixing the ingredients, as shown in Figure 13. This allows the ingredients to be mixed while the pot is covered.

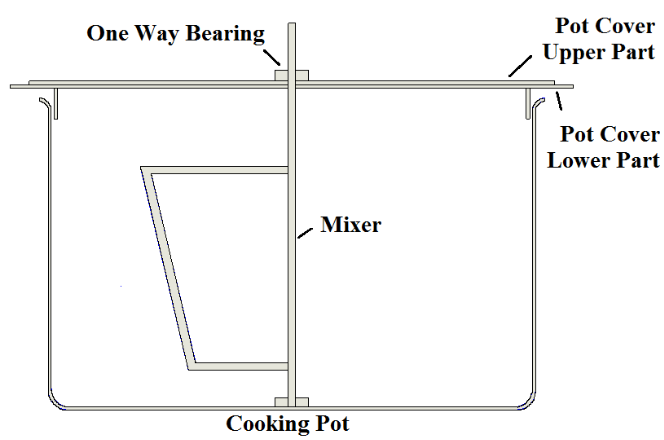

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***Figure** 13: The cooking pot with the mixer and one way bearing.*

When all the operations are performed and the cooking is finished, the buzzer will sound to get the attention of the user while "COOKING IS DONE" text will be presented in the LCD screen.

IV. RESULTS

Figures 14 and 15 show the logical representation of the operation time and actuation signal of the first and the second food containers. The actuation signals for containers 3 and 4 are not shown because they are identical to those of container 2, except for the start time. The difference in representation is due to the different locations of the food containers relative to motors 2 and 3. This means that it is better to place the ingredients according to their use in the preparation, usually (onion, meat, potato, and pasta) in food containers (1, 2, 3, and 4), respectively. Following this order minimizes energy consumption and processing time.

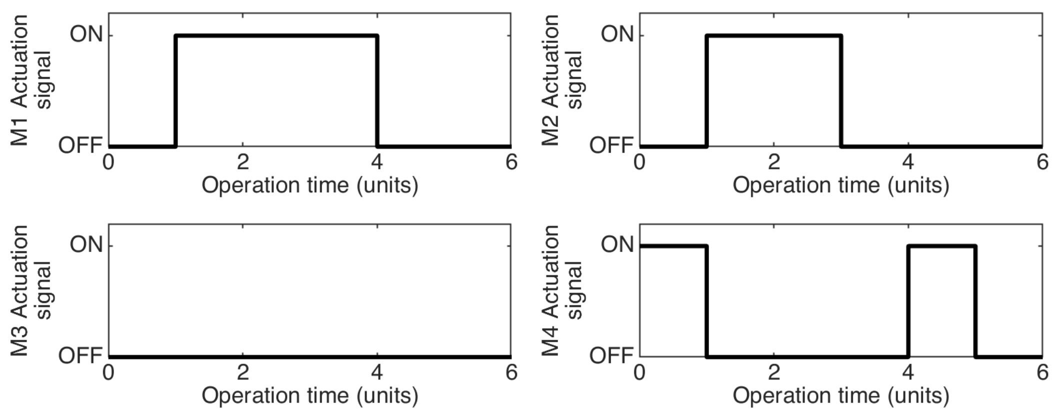

***Figure** 14: Actuation signal for Food container 1, each sub-figure represents the actuation signal for the motors.*

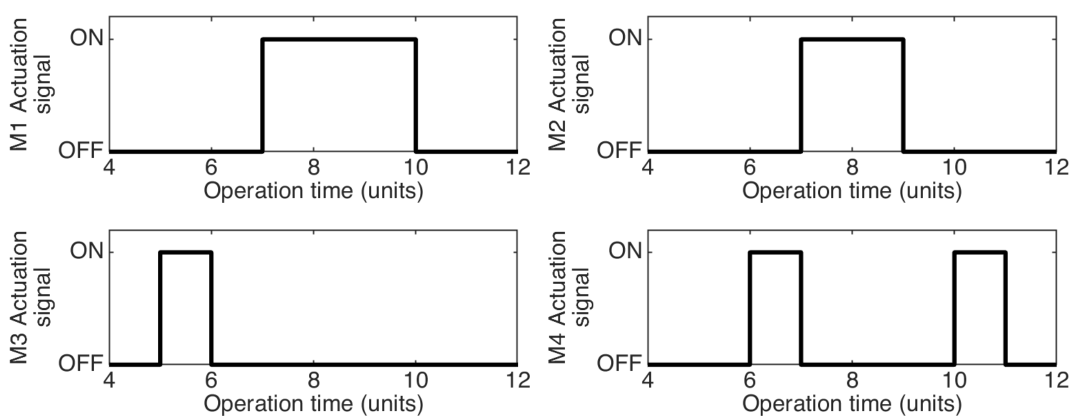

***Figure** 15: Actuation signal for Food container 2, each sub-figure represents the actuation signal for the motors.*

V. CONCLUSION

The proposed pasta cooking machine was simulated using Proteus software. The mechanical structure of the machine is also described. The machine is versatile and can be programmed to cook other foods, such as soup, in addition to pasta. An app can be designed and connected to the machine (by adding Bluetooth or Wi-Fi) to allow users to add different recipes with different cooking times from the app.

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