Smart Oven with Temperature Control

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ABSTRACT

The main aim of this project is to develop a smart oven system that has the capability to control the temperature and duration of cooking automatically according to the size and weight of the food. In this proposed system, a microcontroller NodeMCU ESP8266 was used as core component of the system. All data will be controlled based on the programming code written in Arduino IDE. The Graphical user interface was developed using MIT app inventor. This will allow the user to control the oven system using a smartphone or tablet through Wi-Fi. The proposed system was implemented to enhance the existing system. This was archived by using a food probe sensor to get the internal temperature of the food and by integrating the system with IOT. The performance of the developed system is evaluated by testing the weight of the food using loadcell, ambient temperature of the oven, cooking duration of different weights of chicken part, Cooking Duration of different weights, and doneness level for beef, Food probe sensor to be tested with different power supply, and IOT platform latency. The proposed system has 95% accuracy in terms of monitoring the temperature of the oven, while the existing system is only 89%. The proposed system was also able to estimate the duration for cooking depending on the weight of food inserted to the oven. The whole chicken was estimated to take 45 minutes where the weight of the whole chicken is 1kg. On the other hand, the thighs which has 100 grams was estimated to have 25 minutes. The estimating time was estimated by knowing the weight of the food. Further enhancement can be made to the system one of these recommendations is to involve image processing technique to the system.

Keywords: Temperature, Oven, Microcontroller, NodeMCU ESP8266, Food Probe Sensor.

1. Introduction

Recent developments, with innovative materials and processes being developed in engineering, offer the opportunity to create a large variety of functional devices. Nowadays, the way people interact with the equipment, devices, and appliances are changing due to digital technology, learning algorithms and sensors. Moreover, wireless technologies have helped to grow in smart applications like monitoring and controlling home devices such as an electric oven. An oven can be defined as a kitchen device that developed and created to do the bakes as well as heat for plenty types of foods also the oven is the most common appliance used for cooking such as roasting and baking. The oven designs had many changes from clearly mechanical to fully automated which can decide which temperature required according to the food inserting.

Additionally, the commercially available domestic ovens allow the user to adjust temperature and time as per the instructions instructed by the instructors therefore, the user must estimate the required temperature and the duration of cooking. This process for adjusting the temperature can be wrong therefore, the temperature of the final food could be very hot or still cold. Also, some people have a loss of autonomy caused by deficits, making it difficult to perform daily tasks, such as cooking using the oven. Moreover, most people check the doneness of the chicken as well as the meat by seeing if it is firm while it is pressed, or by checking the color of the chicken. This operation for checking the doneness of the food can be incorrect. However, the most accurate process for checking the doneness of the chicken or meat is to check the actual temperature of the chicken. A smart oven has been introduced to help people who suffer from a loss of autonomy to perform important daily tasks such as cooking using an oven. A smart oven is an automated oven that has the capability to control and monitor the temperature as well as the duration of cooking for different types of food [2].

2. Literature Review

Researchers (Anuradha & Bhushan, 2019) have approached a research to improve and enhance the oven system. The researchers were observed that there are some recommendations should be considered such as the system should be more user friendly, and the system should be developed to give more return on investment.

The block diagram of the proposed system shown below, the circuit was designed to control all the necessary parameters. This circuit consists of microcontroller, Graphical Liquid Crystal Display unit (GLCD), relay with time, temperature control and other supporting components. The relay circuit was designed to be connected to the microcontroller and interfaced with the oven. This relay triggers the timer circuit of the oven. After that relay given to the timer for the oven system, and the temperature of the oven pre-set at 180. The system was able to show the ingredients of the recipe once the user selects the recipe. Moreover, the computer program is developed in embedded C language which is the required hex file for ATmega16 microcontroller. Some future work can be implemented in which the system can be improved and enhanced. This development can be obtained by using food sensor which can give the internal temperature of the food hence the user can know if the food is mature or not. Also, by using the food sensor a lot of people who have less knowledge about cooking will benefit [3].

Yusuf & Ekrem (2016) have proposed a research to control the temperature of the oven using a PID controller. The PID controller was used since it gives better performance compared with P and PI controller. In addition, the PID was used since it has more stability compared with other controller. The result of the system was found, and it was noticed that the ZINGLER-NICHOLS method is good in stability and the system response of the system were satisfied, where, the settling time of the system was only a few seconds. Lastly, there are many other techniques developed after ZINGLER-NICHOLS method for controlling the temperature which provide better performance such as fuzzy-logic controller which can include a lot of conditions in order to control the temperature of the oven system. Also, another drawback of the system is that the PID control is not able to determine the temperature of the food inside the oven correctly [5].

Researchers (Atilla, Sulaiman & Fırat, 2016) have proposed a research to improve the efficiency of control the temperature inside the isolated box. The research was focused on developing of temperature control system for tension-compression testing machine. There were some components used to develop the system which are isolated box, dry resistance, thermocouple, air fan, ARDUINO microcontroller, computer, and voltage regulator. The researchers were developed the heat system where the source of the heat in the system was the dry resistance which can give a power of 2.5W. The inner temperature of the isolated box was adjusted by regulating the voltage of the dry resistance. Besides, the thermocouple type-K was used to measure the temperature inside the isolated box. After that the temperature which already measured by the thermocouple was transferred to the computer via a USB cable. However, by helping of the software defined, the controller was able to produce the needed input. The system was developed successfully, and the result of the system was satisfactory. The performance of the proposed system was obtained in the MATLAB and the reference input temperature was controlled by manipulating with the input signal. The system was used a thermocouple K-type which can only measure the surface of the product. This considered as one of the limitations of the system where a thermocouple KM28 with probe can be used to measure the internal temperature of the product [1].

Researchers (Rina et al., 2016) has proposed a system that involves development for both hardware and software. The proposed system was developed an effective TudungSaji which able to maintain the food warm and to protect the food from any pests. The smart TudungSaji uses an Arduino microcontroller as the brain of the system, and to introduce an automated function and job. The components used in the system are temperature sensor LM35, and limit switch which works as input of the system, Atmega microcontroller for data interpretation, and two bulbs as the output of the system. The proposed system starts once the food was inserted or placed in the TudungSaji, then the bulbs will start turn on automatically. The LM35 sensor detects the temperature, once the temperature below 60℃, then the bulbs will turn on. On the other hand, the bulbs will automatically turn off when the temperature reaches above 60℃. The bulbs that were used have 240 V, and 100W bulb as a heating element. The system can be improved by replacing bulbs with thermistor coil, where this coil can introduce more heat energy because of the material of the coil as in the oven system. The result of the system was divided into two part which are simulation, and the result that found when the system implemented. The result of the system was satisfied where the temperature was controlled according the actual temperature, and the system was operated as expected. The proposed system has some drawbacks and limitations. LM35 temperature sensor can only detect a range of temperature from -40 ℃ to 110 ℃ . Therefore, the LM35 can be replaced by K-type thermocouple which can detect a range from -200℃ to 1350℃. This can enhance the detection of the temperature of the oven system. Temperature control system is a vital application that used in most modern homes [4].

3. Methodology

This section explains the overall flowchart of the whole system. The modified flowchart can be shown in Figure 1&2. The system starts once the microcontroller got power via adapter. The system starts to read the limit switch status. This status indicates if the door of the oven is close or open. The system will alert the user to close the door of the oven.

Then, the load cell will be located under a metal plate of the oven. This will be added to measure the weight of the processed food. After the system had measured the weight for the inserted food, the food thermistor sensor will be located at the side of the oven. This will be inserted inside the food where; it can be able to obtain the internal temperature of the food. Then, these values will be transferred to the cloud through Wi-fi and then the GUI will take these data to be displayed in the GUI.

After that the user will have to choose between chicken or beef. Each selection has its own choices. The user can select the part of chicken or the doneness level of the beef. After the selection was made, the oven system will start to operate in which the relay switch will energy the hot plate element of the oven.

Additionally, the system will decide the power level and the total heating time according to weight of the food, the selected doneness level if the beef was chosen, and the chicken parts if the chicken was selected to be cooked. Once the selection was made, the relay switch will activate the hot plate element and the temperature sensor "K-type thermocouple sensor" will start to measure and monitor the temperature of the system, where once the temperature of the oven exceeds the set temperature, the relay is energized and it switches off the hot plate element of the oven.

On the other hand, if the temperature of the oven drops, the relay switch will be energized, and it will switch on the hot plate of the oven. While this is going on, the system will continuously check the internal food temperature and once the desired internal temperature reaches and the duration is finished, then the relay will switch off the hotplate element. Also, the user will be alerted through GUI. This indicates that the cooking process is done. This system was developed to enhance the cooking method in which the estimating time will be assigned based on the selection made by the user and weight of the food.

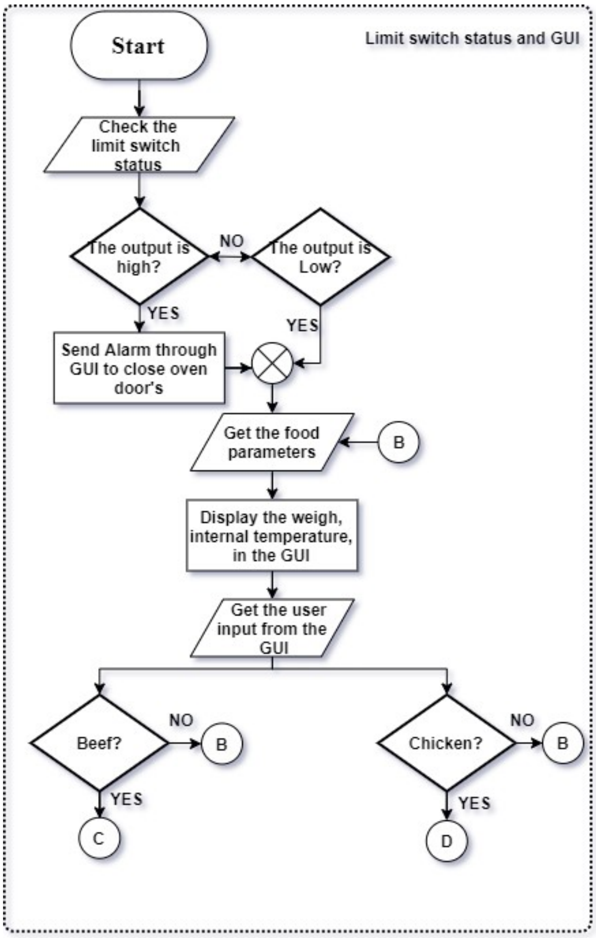


Figure. 1. Flowchart of the proposed system

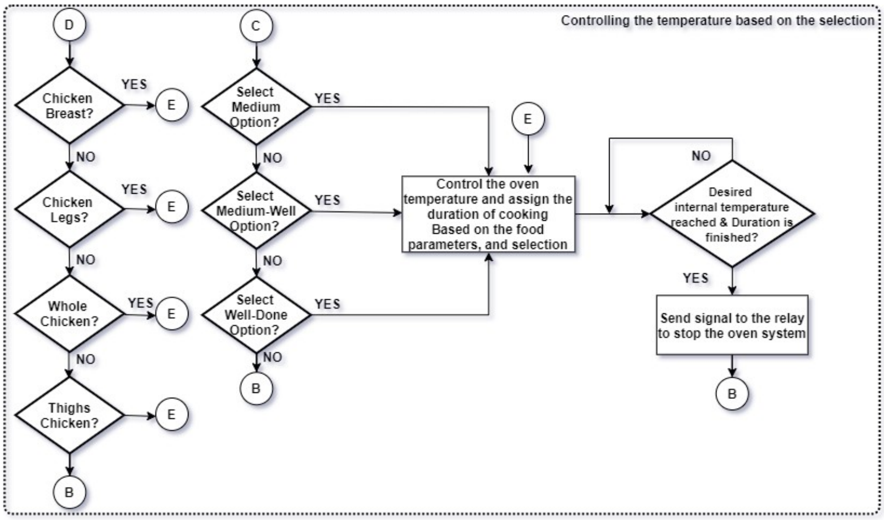


Figure. 2. Complete flowchart

The modified block diagram for the smart oven system shown in Figure 3. The important improvement is made on the design to enhance the system, and to make the system user friendly. The block diagram is self-explanatory, the general components that used to accomplish the smart oven system are elaborated in the block diagram.

The block diagram for the system is divided into five main sections which are power supply, microcontroller, input of the system, output of the system, and the IOT platform. The role and the job of each components that will be used in the system can be explained in the block diagram.

To power the system, the microcontroller must be connected to the power supply. As the microcontroller needs 7V to be operated, the adapter will be used to generate this voltage amount. This power would be sufficient to operate all the components that would be integrated in the system.

The second section of the block diagram is the microcontroller which is NodeMCU. This microcontroller will be used to read the information from the inputs and deliver the necessary instructions to the connected outputs. This microcontroller will receive the important data from the GUI through IOT, where the selection from the user will be updated in the Firebase "Cloud", then the NodeMCU will receive the selection from the "Cloud". Based on the selection made, the system will be operated accordingly. An android application is to be used as the GUI of the system usingMIT app inventor.

The third section of the system is the input, there are five main components which will be interfaced with the microcontroller, these components are load cell, temperature sensor K-type thermocouple, food thermometer, and the relay switch. These inputs will be read by the microcontroller and updated to the GUI through IOT. Each input will deliver the necessary output as the shown in the output section. The outputs of system are clearly shown in the output section of the block diagram. These outputs are generated based on the input fed to the microcontroller.

Fisting first, the limit switch status considered as one of the outputs of the system. Based on, the limit switch status the oven will turn on or off in which if the door of the oven is open, the limit switch status will be "HIGH" therefore, the relay switches will be deenergized. On the other hand, if the door of the oven is close, this means that the limit switch status will be "LOW", therefore the relay switches will be energized. Secondly, the weight of the food will be generated based on the load cell. The K-type thermocouple and the food probe sensor will be used to get the ambient temperature of the oven, and the internal temperature of the food, respectively. Lastly, the relay switch is to be connected to the hotplate element of the oven. This will be used to control the temperature of the oven, where once the user presses the start button in the GUI, then the relay will energize the hot plate element of the oven. Then, once the temperature exceeds the set temperature" Desired temperature", the relay will switch off the hotplate element. On the other hand, once the temperature goes below the set temperature the relay will switch off the hot plate element.

The temperature will be specified according to the user selection. For instance, if the user select chicken to be cooked. Then, the system will control the temperature of the oven to be around 200℃. This temperature is suitable to cook the chicken. Then, based on the duration and the internal temperature of the food, the system will switch off the oven system, where the relay will switch off the hot plate element once the duration is finished and the desired internal temperature reaches.

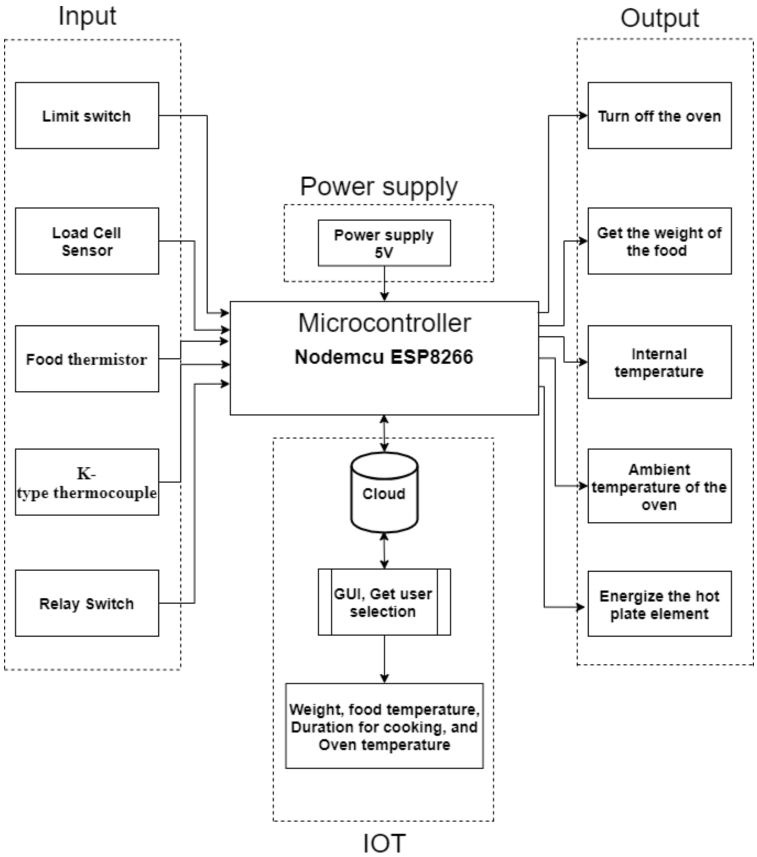


Figure. 3. Block diagram of the proposed system

4. System wiring diagram

After the block diagram of the whole system was established, it was time to construct the wiring diagram to accomplish system. The overall wiring diagram of the smart oven can be shown in Figure 4. This diagram shows how the components will be connected. Starting with the load cell, this sensor has four wires which are red, green, black, and white. Each one of them will be connected to HX-711 amplifier as follows, the red wire connected to Excitation+(E+), the black wire connected to Excitation - (E-), white wire connected to Amplifier (A+), and the green wire connected to Amplifier (A-). In addition, the VCC, and the ground of HX-711 amplifier will be connected to VCC and ground of the microcontroller, while the SCK "Clock" and DT "Data" will be connected to D6, and D5, respectively.

In addition, as the food probe sensor is a component whose resistance is vary depending on the temperature, it was required to change the resistance value to temperature using Steinhart-Hart Equation. This probe sensor will be connected to 10k resistor, where one end of 10k resistor is connected to 5V power on the NodeMCU, while the other end is connected to one lead from the probe. The remining lead of the thermistor probe will be connected to the ground in the NodeMCU microcontroller. Then, a wire was connected in between the resistor and the thermistor to an analog input of the microcontroller. As microcontroller will read the voltage, therefore the resistance was added to know the amount of the voltage deliver to the anlaog pin, where voltage divider concept where applied to get the voltage that changed according to the resistance value.

Relay switch will be connected to the hotplate element of the oven system, the relay switch has five terminals which are DC- which connected to the ground of microcontroller, DC+ which connected to the VCC of the microcontroller, Input which connected to the digital pin " D4", and the Normally Open, and the Voltage input terminals are to be connected to the hotplate element. The hot plate element will have 230V "Ac voltage".

K-type thermocouple sensor will be connected to MAX6675 amplifier, to increase the signal output. This amplifier has three terminal which are SLK (Clock) which is the input to the amplifier connected to pin D1 of NodeMCU, DO (data out) which is the output from the amplifier connected to pin D3 of NodeMCU, and CS (chip selected) which tells the chip, the time read the thermocouple sensor. This chip is to be connected to pin D2.

Lastly, the limit switch has three terminal which are COM, Normally open, and Normally close. 10k resistor was added in between the output signal which represent "Normally open terminal" and the power supply "5v" which generated from microcontroller, and COM terminal was connected to the ground of the microcontroller. 10k resistor was added to decrease the amount of the voltage amount that deliver to pin D4. Hence, the status will be "LOW" once the limit switch was pressed.

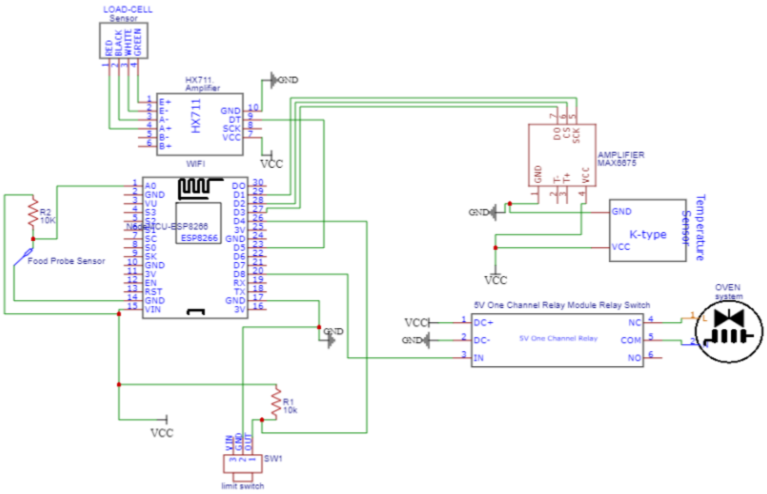


Figure. 4. System wiring diagram

5. Testing and Result

This chapter will include the tests that were performed to validate the aim and objectives of the project that stated earlier. The oven system is to be tested with five different tests. After that the discrepancy between the theoretical and experimental results are to be discussed. The error found in the system will be analyzed.

5.1 Weight of the food using loadcell

To test the load cell, different weights of food were placed into the load cell. Then the actual weight, and the weight that measured from the load cell are analyzed. The load cell will be attached to the wood part and it will be located under the oven system to ensure that there is not much heat transferred to it. In addition, the supply voltage is fixed with 5V which was gotten from the microcontroller. Based on the supply voltage the data will be collected.

The data for different weights of food that inserted into the oven is will be collected as shown in Table 1. These weights are whole chicken "1000gram", chicken leg "130gram", chicken breast"172gram", chicken thigh"360gram", and ground beef"85.05gram". The Table shows the load cell is changed its weight based on the amount of the object that placed into it. The output voltage generated from the HX-711 amplifier is proportional to the amount of weight placed in the load cell. Lastly, the error was calculated by diving the difference between the actual and measured valued by the actual.

Table 1. Weight of the food tested

Type of food	Actual weight (Gram)	Weight that measured from load cell (Gram)	Output voltage (mV)	Error (%)
Whole chicken	1000	1022	1.53	2.2
Chicken Thigh	360	380	0.57	5.5
Chicken Breast	172	190	0.285	10.46
Chicken Leg	130	155	0.2325	19.23
Beef (Ground Beef)	85.05	100	0.15	15

Figure 5 shows five different weights and the respective output voltage. It can be observed that the output voltage is proportional to the weight. Increasing the weight of object will result increase the amount of the output voltage and vice versa. Since the selected load cell had a capacity of 1000gram and its output related is 0.015 mv/V when the input voltage is 5V. Therefore, to get the output voltage for each weight applied, the weight of the food will be multiplied with the output related is 0.015 mv/V, then divided by the maximum weight "1000gram". Each blue bar represents the output voltage and its respective weight. The highest output voltage "1.53mV" was occurred when the highest weight was placed in the load cell "1022gram".

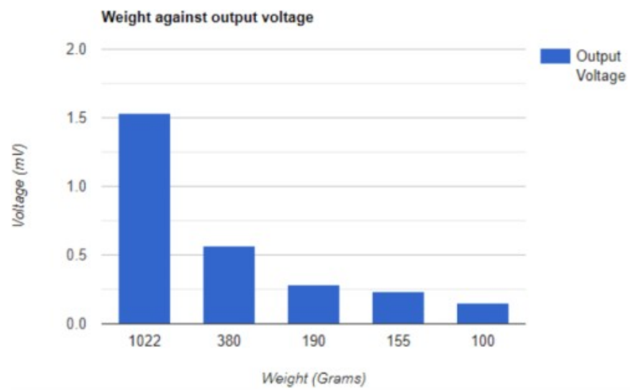


Figure. 5. Different weights and voltage

5.2 Ambient temperature of the oven

Thermocouple sensor was attached at the back of oven system. This will be used to get the ambient temperature of the oven system. Its known that the voltage is proportional to the resistant. As soon as the resistance increases the temperature will get increased. This is due to increase in vibration of modules inside the conductor. Resulting this, the voltage gets increased when temperature increased. The time needed to heat the oven to desired level, and the output voltage from K-type thermocouple sensor is to be discussed.

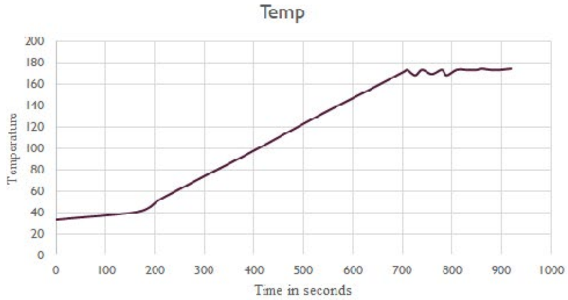
It was observed that, the thermocouple K-type increases its voltage as the resistance was increase. Thus, the temperature can be found out from this voltage, where the ADC output of this voltage will be processed by helping of microcontroller to give the accurate temperature. Table 2 shows different temperature values generated from the heating element, the output voltage from the thermocouple, along with the time needed of the oven to reach to the desired temperature.

Table 2. Temperature of hot plate element

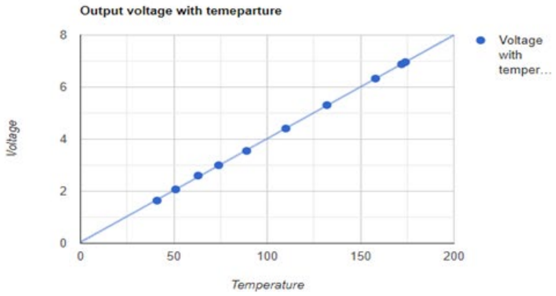
Temperature of hotplate element "Measured by K-type" (°C).	Time "Seconds"	Output voltage (mV)
41.0041	168	1.64
51.755	208	2.07
63.75	257	2.55
74.507	301	3
88.87	362	3.55
110.14	448	4.41
132.76	538	5.31
158.45	646	6.33
172.09	702	6.884
172.08	703	6.883
174.07	710	6.96

Figure 6 (a) shows the measuring temperature when the oven system starts operated by 230 V /AC. Once the oven system received an alternative current, the hot plate element will be energized resulting this the temperature will be keep increasing. The temperature of the oven system was controlled to be 170℃, where this can be achieved within 6 seconds. The temperature of the oven will be decreased when the temperature exceeds 170 ℃. It also can be observed from graph that the temperature will be settled within 710 seconds. There is a small overshoot as shown, where the temperature exceeds the desired one. This is because the reading of the thermocouple was not accurate. Resulting this, the temperature was exceeded the set temperature.

Figure 6 (b) shows the relation between the output voltage of the thermocouple that measured from ADC signal that produced from the microcontroller, and the respective temperature. The graph shows how the temperature is changed according to the output signal. The output voltage is proportional to the temperature that being produced from the hotplate of the oven. As soon as the temperature increased, the resistance will be increased as well, this is due to increase in vibration of modules inside the conductor. Resulting this, the output voltage will be increased as well. As shown, when the temperature is reached to the desired set point which is 170, then the output voltage of the thermocouple will be at the maximum.



(a)



(b)

Figure. 6. The figures can be divided into (a) time needed to reach to the desired temperature, (b) Output voltage of the k-type at different temperature measured.

5.3 Cooking Duration of different weights of chicken part

Duration for cooking is one of the important parameters to be taken in consideration. Four different chicken parts to be tested according to the weight that measured from load cell. This test will be made to validate the duration specified for each chicken part.

The duration for cooking of different types of food based on the doneness level chosen was set in the GUI and the weight of the food which inserted into the oven system. This duration will be shown in GUI, then the user will get alert through GUI when the duration is finished. The data that was collect for duration time is to be tabulated under the data collection section.

The duration for cooking was estimated based on the experiences that was done in the chosen oven system. Table 3 shows different chicken part, with the respective duration and internal temperature. The duration is increased as the weight of chicken increased. The oven temperature of the oven was set to 180, where all the chicken part can be cooked in this temperature.

Table 3. Duration for different chicken part

Part of chicken	Weight	Duration (minutes)	Internal temperature	Temperature of oven
Whole chicken	1-2 Kg	45	165°F =74°C	180 °C
Leg	100 - 113 gram	30		
Breast	115 grams	38		
Thighs	100 grams	25		

Figure 7 shows the duration and the desired internal temperature of different chicken parts with the respective weight. It can be observed that the duration is increased as the weight increased and vice versa. The desired internal temperature for all chicken is 165°F. However, the duration needed to reach to this temperature is increased as the weight of chicken increased. This can be said because when the weight of chicken increased, it needs more time reach to the desired and safe internal temperature.

This can be clearly shown in mentioned figure, when the weight of food is 1-2kg which is the maximum weight that tested during implementation process, the duration will be at maximum around "44 second". On the other hand, the lowest weight is 100 grams that was tested will reach to the desired internal temperature within lowest duration which is 25 second.

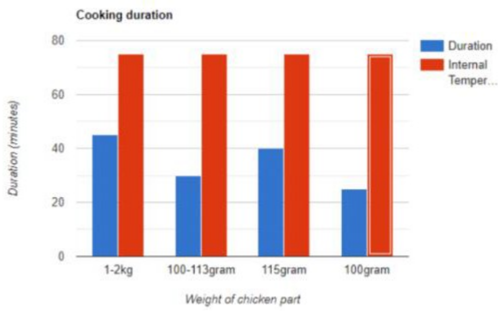


Figure. 7. Duration for cooking different chicken part

5.4 Food probe sensor to be tested with different power supply

Food probe sensor will be used to get the internal temperature of the food that inserted in the oven system. This sensor is changed its resistance as the temperature changes. However, a microcontroller cannot determine the resistance changed. Instead, it has a voltage reader known as along to digital converter. To read the temperature, the resistance value will be converted into voltage. This will be archived by adding another resistor and connect them in series, and then the voltage at the middle point is to be measured by the microcontroller.

Based on the voltage divider equation, when resistance changes, the voltage changes too. Therefore, the temperature can be measured by the microcontroller. This test will be made to observe the temperature reading from the probe when the power supply is 3.3V, and when the power supply is 5V.

The data was collected and tabulated as shown in Table 4. The temperature measured with the probe is varied as the voltage changed. The table shows the actual temperature, temperature when 3.3V was applied, and temperature when 5V was applied.

Table 4. Temperature measured with the food probe at different power supplied

Samples	Actual temperature (°C)	Probe temperature "5V" (°C)	Probe temperature "3.3V" (°C)
1	26	76	27
2	40	89	42
3	70	99	73
4	90	116	93
5	110	160	113

Figure 8 shows the actual temperature, and the reading temperature when 3.3V, and 5V are supplied. It can be observed that when 3.3V power was supplied to the probe, the temperature was near to the actual temperature. Unlike, when 5V was supplied to the probe. The graph is clearly outline three curves for different power supply. The gap between actual temperature and the reading temperature when 5v is huge. Unlike when 3.3V is supplied.

It can be observed that the 5V power supply that generated from microcontroller via USB cable does a lot of stuff on the esp8266 board. Also, it is always much noisier than 3.3V. This is because 3.3V pin goes through a secondary filter. This regulator stage can make 3.3V more stable than 5V. Resulting this, the temperature reading is more accurate than 5V.

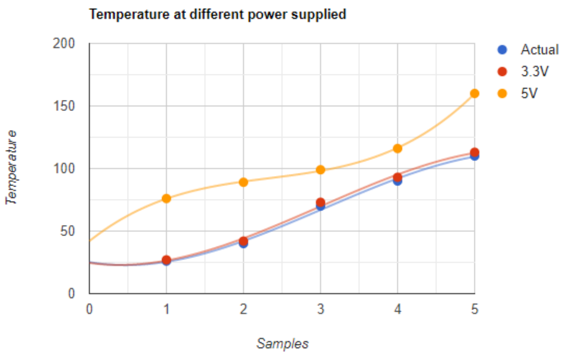


Figure. 8. Temperature measured with different power supplied

5.5 IOT platform efficiency

IOT platform is an important part of the proposed system. All the data will be stored in the database of the system. As the data will be stored on the internet, the user will be able to control the oven system from anyplace. The user can monitor the cooking process from anywhere. This test will show the delay time between receiving and sending data from and to the firebase platform.

The data to be obtained from the smart app. Then, it will be transmitted to the firebase. As the application of the smart oven system is integrated with Wi-Fi, the gathered information can be transported to the server. The collected data will be processed in the cloud. This test will show the performance of the IOT platform.

The data being collected as shown in Table 5 , where the total time needs when the data is sent from the GUI to be collected in real-time database is determined with different distances between the internet roller and the ESP8266 microcontroller.

The microcontroller was placed at three different distances, and the latency was determined. The latency shows the time different between sending the data from app and receiving it to the firebase.

Table 5. IOT latency at different distances

Distances (m)	Latency (s)
4	1
10	3
15	6

Based on the data collected the analysis will be made. Figure 9 represents the latency for the sending and receiving the data from and to the firebase. The microcontroller was placed at different distances, and the respective latency was calculated. From the graph it can be observed that the latency will get increased when the distance between the router and microcontroller increased and vice versa. This is because when the signal has longer distance to travel, the time needed to be received will get increased. Resulting this, the latency will be affected. The graph is clearly elaborate this.

Figure. 9. IOT platform efficiency

5.6 Cooking Duration of different weights, and doneness level for beef

The duration for cooking of different types of food based on the doneness level chosen was set in the GUI. This duration will be shown in GUI, then the user will get alert through GUI when the duration is finished. The data that was collect for duration time is to be tabulated under the data collection section.

Table 6 shows the duration for different doneness level of beef. The doneness levels that were tested are medium, medium-well, and well-done. The duration is changed according to the weight and type of beef.

The oven temperature was set to be either 180, or 200. Then the duration was collected when the desired internal temperature reached. There are some beef types that were tested which are Leg, Sirloin roast, Top round roast, and rolled. The analysis of the data will be shown under data analysis section.

Table 6. Duration for cooking beef

Beef types	Weight	Doneness Level mode	Approximate (minutes)	Internal temperature	Temperature of oven
Leg	900 grams	Medium	40	71°C	200 °C
		Medium-Well	48	77°C	
		Well-Done	54	82°C	
Sirloin roast	400 grams	Medium	30	71°C	180 °C
		Medium-Well	34	77°C	
		Well-Done	40	82°C	
Top round roast	500 grams	Medium	55	71°C	180 °C
		Medium-Well	67	77°C	
		Well-Done	78	82°C	
rolled and tied	600 grams	Medium	30	71°C	200°C
		Medium-Well	38	77°C	
		Well-Done	44	82°C	

Figure 10 shows how the duration for cooking is varied based on the weight of lamb type. There are three modes were tested for different type of lamp. It can be observed well-done cycle has the highest duration for all type of beef, while the medium mode has the lowest duration for all type of lamp. For each type of beef, the duration will be increased as the weight increased.

This is because the cutting process for each type is different than others the top-roast lamp will have the highest duration, among others, while the rolled lamp will have the lowest duration, among others. Lastly, the reason that make well-done mode to have the highest duration among the three other modes is because it has the largest internal temperature among other modes. The internal temperature for the three modes which are medium, medium-well, and well-done is 71°C, 77°C, 82°C, respectively.

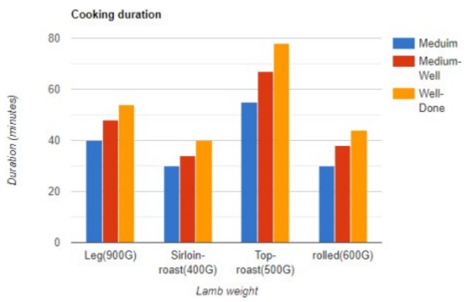


Figure. 10. Duration for cooking beef

6. Hardware and/or Simulation results

This section shows the result of the system when the implementation process was accomplished. The hardware system was implemented to fulfil the objectives stated earlier. Figure 11 shows the smart oven system when the whole chicken is inserted in the oven. The weight of the chicken is to be updated in the GUI. Additionally, the internal food temperature as well as the oven temperature are to be displayed in the GUI. The duration will be assigned based on the weight of the food, and the selection made. Also, the oven will turn off once the duration is finished, and the desired internal temperature reaches. This can be shown clearly is mentioned figure where the user will be alerted though GUI by message "Cooking process is finished". The food reading from food probe sensor was not accurate therefore, the calibration was done to make the reading more accurate. The desired internal temperature was set to be 106 ℃ while the duration was set to be 44 minutes, and the over temperature was controlled to be around 150 ℃.

(a) (b)

Figure. 11. The figures can be divided into (a) while cooking chicken, (b) cooking is finished

7. Conclusion

As the technology improved, the way people interact with other equipment and device gets enhanced. One of the main devices could be improved is the oven system. The common available oven system designed where, the user should set the heating level, and the total cooking duration manually. This process for setting the heating level and the total duration time seems to be complex, as it should be made by considering some food parameters such as the weight of the food, and the current internal temperature. This method seems to be complicated specially for people who have less knowledge about the cooking procedure. However, by developing the proposed system, the user would be cooked the food without estimating any parameters, where the system would be able to specify the desired heating time, and the total duration of cooking automatically according to the weight of the food and the internal temperature. The literature review was done for 10 different researchers which is about the electrical oven system. The work done by the researchers are discussed, the solution of the problem statement along with the methodology of the system, and the results achieved by these researchers are included. Also, the limitations found in these researchers involved. It was observed that these researchers have some limitations in terms of measuring the internal food temperature. Hence, the proposed system was designed where it can monitor the current cooking progress. This was achieved the using food sensor thermocouple probe which can be used to obtain the internal temperature of the food. After the literature review was made and the knowledge was gotten, it was the time to start the method that will be followed to achieve the objectives stated. This was done by selecting the appropriate tools and components which will be used to accomplish the project. However, the NodeMCU microcontroller was chosen to be used to control the inputs data and the generated output. Also, the GUI is to be developed where it can show the current cooking progress and the total heating time in the GUI. This GUI is to controlled using IOT, where the user can select the between two options chicken, or meat and the respective cooking mode that needed for these two options. Then, the duration for cooking, the current internal temperature, and the weight for the inserting food will be updated in the GUI.

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