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Implementing the Concept of IOT in combined Grill and Smoker Machine

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***Abstract*—A Barbeque grill is a device that cooks food by applying heat from below. There are several varieties of grills available in today's world. Smoking is the process of adding flavour or preserving the food for long period of time. Through emerging technologies, it is possible to efficiently extend everyday objects with communication for sensing and actuating. Programming a controller that monitors the temperature in the smoker. That adjusts the airflow to the charcoal to maintain the correct temperature. It provides a way to monitor the temperature of both smoker and meat probes remotely. The objects can communicate with each other as well as with humans. The movement that is concerned with applying and investigating these technologies called Internet of Things. Grilling is used for slow cooking food at low temperature over longer period of time. Smoker cooks meat on a low heat using plant pulp fuel and smoke, such as charcoal or wood chips. It will impart a rich flavour and tenderize the meat.**

Keywords*—IOT, Grill and Smoker, NodeMCU8266, Barbeque cooking process

I. INTRODUCTION

BARBEQUE GRILL

A barbeque grill is a device that cooks food by applying heat from below. There are several varieties of grills, with most falling into one of two categories gas -fueled or charcoal.

Grilling has existed in the America since pre-Colonial times. The Arawak people of South America roasted meat on a wooden structure called a barbacoa in Spanish. For centuries, the term 'Barbacoa' referred to the wooden structure and not the act of grilling, but it was eventually modified to "Barbeque". It was also applied to the pit-style cooking techniques now frequently used in the Southeastern United States. Barbeque was originally used to slow-cook hogs. Charcoal grills use either charcoal briquettes or natural lump charcoal as their fuel source. When burned, the charcoal will transform into embers radiating the heat necessary to cook food.

SMOKER

Smoker is used to produce the smoke from burning charcoal gives the grilled food a smoky flavor. It is one of the reasons why barbequing with charcoal is still popular next to electric grilling and gas barbeques, which are easier to control. Since heat will go up, the smoke reaches the bottom of the meat first. This means that for food that is grilled on only one side the smoky flavor will be less pronounced than grilling it on both (or more) sides. The smoking of food likely dates back to the time of primitive cavemen. As caves or simple huts lacked chimneys, these dwellings would probably have become very smoky.

It is supposed that early men would hang meat up to dry and out of the way of pests, thus accidentally becoming aware that meat that was stored in smoky areas acquired a different flavor, and was better preserved than meat that simply dried out. This process was later combined with pre-curing the food in salt or salty brine, resulting in a remarkably effective preservation process that was adapted and developed by numerous cultures around the world. Until the modern era, smoking was of a more "heavy duty" nature as the main goal was to preserve the food. Large quantities of salt were used in the curing process and smoking times were quite long, sometimes involving days of exposure.

INTERNET OF THINGS (IOT)

In the early 2000's, Kevin Ashton was laying the groundwork for what would become the Internet of Things (IoT) at MIT's AutoID lab. Ashton was one of the pioneers who conceived this notion as he searched for ways that Proctor & Gamble could improve its business by linking RFID information to the Internet.

If all objects in daily life were equipped with identifiers and wireless connectivity, these objects could be communicating with each other and be managed by computers. At the time there were more questions than answers to the IoT concepts in 1999. Today, many of these obstacles have been solved. There will be billions of objects connecting to the network with the next several years.

Internet of Things (IoT) is the network of physical devices, vehicles, home appliances, and other items embedded with electronics, software, sensors, actuators, and connectivity.

Which enable these things to connect and exchange data, creating opportunities for more direct integration of the physical world into computer-based systems, resulting in efficiency improvements, economic benefits, and reduced human exertions.

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II PROBLEM DEFINITION

OVER OR UNDERCOOKING

The frequency of using the barbeque is not that high and the cooking process is complex, learning by doing is hard and can be discouraging. In terms of food, there are some risks such as burning, overcooking or under-cooking it.

- The meat always looks done, but when we take it off the grill to serve, we get complaints that it's raw in the middle.
- The food on skewers never cooks evenly.
- The food falls between the grates and into the fire.
- Requires continuous monitoring.

LOW OR NO SMOKE

Low or no smoke production is one of the most common problems encountered when using charcoal smoker. The design of the smoker and the cooking temperature both have an impact on how well the wood chips smoke.

Some commonly arising problems are

- Not controlling the temperature inside the grill.
- Too much smoke.
- Not allowing enough time.
- Trusting the thermometer on a dome smoker is not accurate.

Less expensive vertical charcoal smokers have no lower vent adjustment for temperature control. It consumes less or more charcoal for lower or higher cooking temperature and it's an imperfect system.

III. LITERATURE REVIEW

In this chapter, the discussions are more about the previous researched that have been done. In the never ending effort of the humanity to simplify their work, came the birth of automatic controlled grill and smoker. This project involves the fabrication, modeling and construction of grill and smoker with a specification regarding selection of material and cost. The grill and smoker machine as simple in use ,will provide better serviceability ,higher efficiency, low cost and better heat radiation controllability.

"Global Journal of Researches in Engineering Mechanical and Mechanics Engineering", Volume 12 Issue 7 Version 1.0 Year 2012, Pages 44-46, Types: Double Blind Peer Reviewed International Research Journal Publisher: Global Journals Inc. (USA) Online ISSN: 2249-4596 Print ISSN: 0975-5861 by Lawrence Gyansah. Stainless steel 304 are covered by the following specifications: AMS 5513; ASTM A240; ASTM A666. This illustrates the detailed information on the type of stainless steel which is selected for the design.

"Effect of Grilling and Roasting on the Fatty Acids Profile of Chicken and Mutton", World Applied Sciences Journal 17 (Towards the Traceability of Halal and Thoyyiban Application): 29-33, 2012 ISSN 1818-4952, Pages 29-30, by A.R. Alina, A.H. Nurul Mawaddah, A. S 1 2 1 iti Mashitoh, 2Z.H.Shazamawati, 2M.S. Nurulhuda, 2H.S. Ummi Syuhada and 1A.K. Imtinan.

The fact that cooking seems to affect the different families of FAs.This is particularly important in view of the recommendation for cooking methods suitable for the meat.

"IoT based home automation system using Node MCU ESP8266 module", International journal of advance research and development, volume 3, issue 3, Pages 332-333, by Suraj Tonage, Sandhya Yemul, Rajendra Jare, Veena Patki .In this paper a home control and monitoring system using an embedded micro-web server, with IP connectivity for accessing and controlling appliances remotely using Android based Smart phone app. To demonstrate the feasibility and effectiveness of this system, temperature sensor and current sensor have been integrated with the proposed control system.

"Cryogenic insulation a review properties of inorganic materials for ITER magnets", Materials Reliability division, Material Science and Engineering Laboratory, National institute of Standards and Technology Boulder, Colorado 80303-3328 Sponsored by: Department of Energy Office of Fusion Energy Washington, DC 20545 issue December 1994,Pages 147-161, by N.J. Simon. This illustrates thermal insulation properties of Mica which is selected as a thermal insulation for this project.

"BRUSHLESS DC MOTOR SPEED CONTROL USING MICROCONTROLLER", ISSN (PRINT): 2393-8374, (ONLINE): 2394-0697, VOLUME-2, ISSUE-2, 2015, THIAGARAJAR COLLEGE OF ENGINEERING, ELECTRICAL AND ELECTRONIC ENGINEERING MADURAI, TAMIL NADU, PAGES 182-187, BY G.SANTHOSHKUMAR, S.AROCKIA EDWIN XAVIER. THE HARDWARE FOR CLOSED LOOP CONTROL OF BLDC MOTOR USING MICROCONTROLLER IS DESIGNED. BY USING THE PWM TECHNIQUE SPEED OF THE BLDC MOTOR WAS CONTROLLED AND IT WAS MADE TO RUN AT EXACTLY ENTERED SPEED.A COMMON SMOKER IS USED TO FULLY COOK SMOKED MEATS. WITH A MAXIMUM TEMPERATURE OF 170˚-180˚, THESE SMOKERS ARE PERFECT FOR SMOKING FISH AND MAKING JERKY, BUT BECAUSE OF THE LOW SMOKER TEMPERATURE IT'S NOT RECOMMENDED THAT THEY BE USED FOR SMOKING MEATS LIKE PORK, BEEF.

IV. PROJECT DESCRIPTION

DESIGN BRIEF

Redesign the barbeque experience using modern communication technologies. From the barbeque as stand-alone device a product-service will be created. Depending on the user demands that will be prioritized during the project, one or more of the challenges or opportunities from the problem definition will be addressed.

The method that was used in this project is an iterative design process, currently described as 'design

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tornadoes'. The strengths of this approach are being able to evaluate technologies and getting user input early. These results will either be included in the final design or 'fail fast and fail cheap', resulting in more insights overall. Because of the intended use of relative new technologies, the method seems to fit the project well. Also the early user insights are important in order to design the intended interaction qualities.

BARBEQUE ANALYSIS

Barbeques come in all sizes and shapes. For the project a specific type was chosen in order to limit the amount of possibilities later on, keeping things manageable within the chosen time scope. The barbeque experience is a typical one and has a lot of history to it. The specific size of barbeque chosen for this project is about 0.5kg to 1.5kg.

BARBEQUE TYPES

- Charcoal fueled barbeque
- A typical gas barbeque
- Ceramic barbeque

Properties of Barbeque Types

- Regular barbeque using charcoal and a steel casing, the heat can fluctuate, which can either be positive or negative.
- Barbeque that uses propane gas that allows for easy temperature control but wood chips should be added in order for the food to taste smoky.
- A ceramic barbeque that stays warm more easily but is expensive and hard to handle. All three can be used with or without a lid and this has a lot of impact on the functionality.

EXISTING SOLUTIONS

- Bright Grill
- General Electric smoker
- Lynx Smart Grill
- Weber Tools

BLOWER

Getting more insight in how adding more air (oxygen) to the barbeque will influence the temperature.

Prototype: Barbeque with thermocouple and Brushless D.C is used as fan.

IDEA

One of the ideas was to use a fan in order to add more oxygen to the barbeque while the lid is closed. This way the grilled food is heated from all sides while the temperature should be easier to control. A regular barbeque was hacked; it was hooked up with a temperature sensor and an Arduino-controlled computer fan. The adjusted barbeque was tested by trying out different fan speeds and noticing what impact they have on the temperature in the barbeque (with the lid closed).

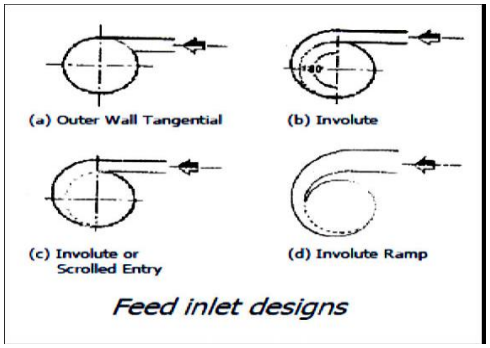
From the barbeques that were done before, it was noticed that the temperature of the barbeque dropped when the lid was closed. The reason for it being that there is less oxygen directly available and the smoldering will therefore have a lower intensity.

The temperature would be stable but there is no sense of control.

By adding more oxygen it was anticipated that the temperature could be increased. This way by controlling the fan (while the lid is closed) the temperature can be controlled.

What was anticipated beforehand was that the air that goes in cools down the barbeque a bit. The oxygen that is supplied however would make the smoldering more intense resulting in an overall increased temperature.

In this test however this was not the case. Different fan speeds were tested and they resulted in a decrease of temperature in the barbeque up to 30 degrees Celsius. Noticing however that the temperature without fan was around 200 degrees Celsius, the cooling effect does not have to be a negative thing. Cooling is also a way to control temperature and 200 degrees is actually too hot for most cooking and resting processes.



In our project we select outer wall tangential feed inlet design for positioning the blower.

V. WORKING PRINCIPLE

Placing meat can be done differently for aesthetic reasons (grill stripes) or cooking performance (heat).Most heat comes from the bottom, food should be turned before it burns but nog before it is seared. The meat should be given enough time to eather sear, cook or rest. Extra flavor can be added, especially on big pieces of food. Checking the food can be done by feeling its resistance, measuring temperature or by sight after cutting it. The barbeque fuel also needs to be considered: it should be refilled in time and heat up again. Eating: Eating will be done during and after barbecuing but this can be different for the main user.

Principle of Grilling

- Conduction
- Convection
- Radiant Heating

This unfortunate situation can happen as one is learning to use a new gas grill or even a charcoal smoker. In an effort to help prevent these situations from happening to future grillers, We thought it would be a good idea to discuss the science of proper grilling principles. It is important to understand three scientific principles behind heat transfer as it

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refers to grilling. Conduction, convection, and radiant heat (radiation) will be described below so we will be able to apply these ideas to your next grilling experience.

Conduction is the process of heat transfer by direct contact of the food to the heat source. This usually occurs at higher temperatures, thus creating a searing effect. Infrared grilling is a good example of conduction. Conduction also occurs at the grilling surface (grill grates).

Convection occurs when the heat is carried to the food that is being cooked. The use of some type fluid such as air, water and even oil will act as a carrier for heat transfer. In grilling, this process is also termed "indirect grilling". Indirect grilling occurs when food is not in contact with the heat source. The food is cooked away from the heat and the heat is circulated around the food. There many forms of convection grilling and the research on this matter is quite extensive. Convection or indirect grilling is a good method for slow smoking or grilling. Convection occurs at the top of the grill or smoker. Because of this, it is important to have a hood that seals properly. A grill or smoker with thicker or heavier metals in the hood will help with the convection process by keeping the heat trapped longer.

Ventilation is important otherwise, the heated air does not circulate and will accumulate above the food instead.

Radiation is the transfer of heat by the direct exposure to the heat source. This is another form of conduction and is responsible for such things as grill marks. The food makes direct contact with the hot grill grates, the natural sugars and moisture of food erupt, thus caramelizing and leaving the charred markings.

Grill head shapes dramatically influence radiant and convection heating. Units used for smoking characteristically have dome shaped hoods because they really almost exclusively on convection cooking. The dome forces heat to circulate around the food and keeps it from stagnating at the top.

A high quality grill will also use the same principle with the hood having a dome shape to help reflect and circulate the heat evenly across the cooking surface. This is why we will not find square or rectangular shaped hoods on quality grills.

With some food such as steak, fish, and some vegetables first cook using the conduction method and then configure the grill to cook using convection heating. To configure the grill to do this, turn off all and move the food on the grilling surface away from the direct heat.

Cooking Process

The cooking process is complicated and cooking on the barbeque makes it even more complex. It adds several ways of influencing the flavor and texture of the food. For meat, the cooking process probably is the most difficult. Three stages can be identified in grilling meat: searing, cooking and resting.

- Searing
- Cooking
- Resting
- The barbeque flavor
- Smoke
- Heat

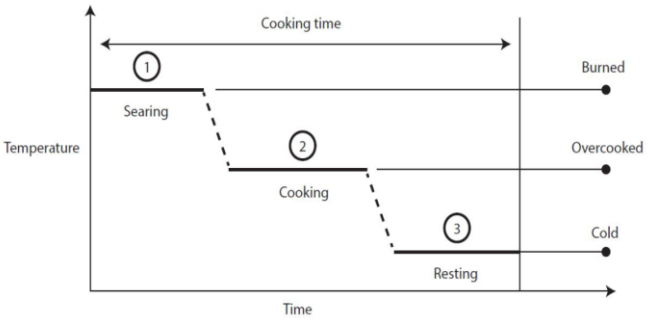
Searing

During searing, the meat is grilled on high temperature in a short amount of time. The outside of the meat reacts to the heat and the color changes. This is called the Maillard reaction and during this process the color and taste of the product will permanently change.

Cooking

In this, the proteins in the meat or fish are denaturalized. This process is irreversible and means that the texture and taste change permanently.

The heat during cooking also makes the food lose its juices which can have a negative impact on the tenderness. In order to have food that is tender, safe and tasty, a balance is to be found in the length of the cooking process and the temperatures involved. Some types of meat and fish are safe to eat raw while having a tenderness that makes it still pleasant to chew: beef and salmon for example. These kinds of food can be grilled for added flavor and texture (Maillard). The extent to which it is cooked from raw to 'cook all the way' is called 'doneness'. It can be personal, some people just prefer meat that is more red, or situational: pregnant women avoid eating raw meat and fish.



Resting

For the types of meat that aren't cooked all the way and still have a degree of doneness, the resting phase is important. A lot of fibers in the meat are stressed by the high temperature and lose their juices.

When the meat has reached the desired doneness and is cut immediately, a lot of the juices will be lost. In the resting phase, the temperature will stabilize and the fibers start relaxing and reabsorb most of the juices. The resting phase therefore has a positive impact on the tenderness of the meat, under the condition that it is not overcooked.

The Barbeque Flavor

Cooking with the barbeque does bring something extra to the food next to just the experience. The flavor is

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different and this is caused by the key features of grilling mentioned before.

Smoke

The smoke from burning charcoal gives the grilled food a smoky flavor. It is one of the reasons why barbequing with charcoal is still popular next to electric grilling and gas barbeques, which are easier to control. Since heat will go up, the smoke reaches the bottom of the meat first.

This means that for food that is grilled on only one side the smoky flavor will be less pronounced than grilling it on both (or more) sides. Also, for large pieces of food, the smoke needs time to really get through and give more flavors to the inside.

In some cases therefore, the lid is closed in order to keep more smoke inside as well as to enable the smoke to enter the food from all sides.

Besides the smoke from charcoal, other material can be added to enhance the flavor by smoke. Natural wood chips for example, wood chips that have been flavored with apple wood or cherry wood. Also some (dried) herbs are suitable for putting directly on the charcoal, enhancing the grill flavor.

Heat

The source of the heat in a barbeque is smoldering charcoal. It can exceed 260 degrees Celsius and therefore it is very suitable for the Maillard reaction mentioned before. Through the combination of radiant heat and direct conduction (contact heat) the Maillard reaction has different intensities and these levels increase the 'depth' of the flavor.

Temperature

Whether one is cooking meat, vegetables or fish, the temperature of the barbeque will determine the end result. This temperature can be adjusted by controlling parts of the barbeque.

- Measuring temperature
- Temperature control
- Combining

Setting Temperature

Temperature to be set by using ESP8266 which is enabled by smart phones.

Measuring Temperature

For the measurement of the temperature a regular thermometer won't do. There are often sensitive electronic parts that cannot withstand the hot barbeque environment.

Thermocouple

A thermocouple is a simple, robust and cost-effective temperature sensor used in a wide range of temperature measurement processes. It consists of two dissimilar metal wires, joined at one end. When properly configure, thermocouples can provide measurements over a wide range of temperatures.

Testing

In order to read the values of a thermocouple, additional hardware is needed that is able to translate the signal. An arduino board was used to connect the hardware and display the values. At room temperature, the thermocouple was tested for reaction time. Because the temperature will be relevant for the cooking time on the barbeque, this reaction time is important for accuracy. While heating up seemed to go fast (within seconds), cooling down was a problem. It took way to long for the values to return to normal. After a technical consult the problem became clear: heat will apply a current on the thermocouple and this will result in the temperature value. When the device can't easily lose the heat, the value won't drop as fast either.

In the case of room temperature, active cooling would help the cooling down reaction time. On the barbeque however, there is a big difference in temperature inside and outside of the barbeque. This effect can help the thermocouple to lose heat and be more accurate. Arduino monitored thermocouple that measures up to around 1000 degrees Celsius.

Temperature Control

The dominant factor in barbecuing. There is a couple of ways of changing the cooking temperature of the food that is being grilled.

- Changing the distance between food and heat source
- Changing the amount of fuel that is being burned
- Block the direct heat and use indirect heat
- Adjust the oxygen supply
- Use the lid

Changing the Distance Between Food and Heat Source

Heat is radiated from the smoldering charcoal in the barbeque. In most barbeques, this heat is not contained very well and therefore it is easily lost.

Because most of the heat 'travels up' the heat source is located below the grill: the heat will reach the meat from below. The properties of heat make it decrease when the distance between the heat source and grill increases. Using this phenomenon, heat can be increased or decreased by either changing the position of the heat source or changing the grill position.

Block The Direct Heat and Use Indirect Heat

The grill supports food that is heated by the smoldering charcoal. Besides the grill bars, the only thing that separates the food from fire is air. Heat will pass through the air and directly cook the food. When an object is placed between the heat source and food, the heat is no longer able to directly 'touch' the food. Cooking will either be slow or may not even happen at all. A common way of smoking food uses this method of blocking direct heat. What is important here though is that the heat is still able to somehow reach the food. This is often achieved by closing the lid to prevent the heat from escaping the barbeque before heating up the food.

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Adjust the Oxygen Supply

A lot of the time, barbeques will be closed at the bottom and the oxygen that is needed to maintain the smoldering or fire is attracted from the top. When there is no lid, a lot of air, and therefore oxygen is available. When the lid is closed it is much harder for oxygen to reach the fire. This is why some barbeques have extra (closeable) holes. There are barbeques that have these holes at the bottom so that even without the lid, the fire can also attract oxygen from below.

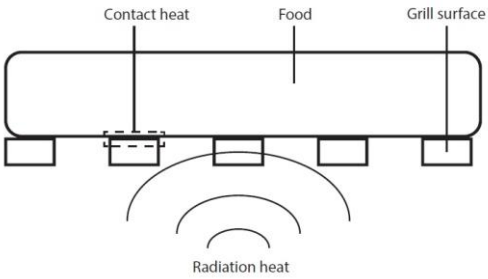
Use The Lid

The lid can be placed on the barbeque in order to bring down the temperature. This takes away a big portion of the oxygen supply but it also makes it harder for heat and smoke to 'escape'. Heat is contained better and the barbeque becomes more like an oven. Depending on how much oxygen is still able to pass through, the temperature will start dropping and become relatively stable.

Temperature and Cooking

Taking into account the cooking process described in the previous post, a way to use the methods above could be the following scenario:

- In the searing step, the heat source and grill are close together resulting in high temperatures and a Maillard reaction.
- For cooking, the distance between grill and heat source is increased, resulting in a lower temperature. This way the meat will have time to cook and the chance of burning or overcooking it is reduced.



Input

In the cooking process, the temperature and time are both important factors and were discussed before. Other factors that have to be taken into consideration are: food type and food dimensions.

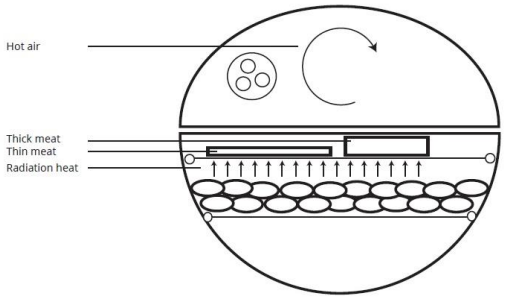
- Size matters
- Measuring meat
- Conclusion

Size Matters

If we look at the meat according to the three dimensions; length, width and height, we can see that one of the three is more decisive than the others. On the barbeque, the highest temperature is the radiation heat from the smoldering charcoal (and the effect this has on the grill). This applies the biggest amount of energy to the meat. This radiation heat is applied to the surface of the meat: the length times the width.

As long as the meat surface does not exceed the char coal surface, the entire surface is heated up by the radiation heat. During earlier measurements this radiation heat was also found to be the highest one, sometimes by a factor two. This roughly means that there is not much difference in cooking times of two pieces of meat that have the same height but a different length and/or width (surface). The height therefore contributes more to the cooking time. If there would be two pieces of meat with the same volume but a different height, it is likely that the piece with the smallest height will be cooked faster. This is one of the reasons why supermarkets are selling thin slices of meat that are meant for barbequing. Together with temperature and time, the meat volume determines the cooking time.

With height being the dominant factor of the dimensions, this information is important to obtain. Some of the current solutions in smart barbecuing make use of the weight of the meat. This is said to roughly indicate the cooking time, together with the type of meat and of course time and temperature. The weight has to be manually put in by the user, using an application on a smart phone or other device.



Barbeque Cooking Circumstances.

Above fig shows the cooking circumstances of barbecuing result in a couple of dominant factors: food height, barbeque temperature and time. Time and temperature are already accounted for.

COMMUNICATION

Communicating the time is tricky here. Showing a simple countdown timer would work to the extent that one knows that action is required when it reaches zero. But sometimes it is also convenient to know how much time actually passed already.

For example: taking something off the barbeque one minute earlier has a different result when the total cooking time is 4 minutes than when it is 20 minutes (25% vs. 5%). So what is important here is feedback and feed forward.

The exploration approach has led to several design directions that should come together somehow. In a first attempt to combine the IoT opportunities, a basic system is created that shows the elements and their connection. Combining the solutions regarding measurement, control and interface, a system is composed that enhances the barbeque in a way that it can boost the user's performance.

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The IOT opportunities are:

- Measuring temperature
- Displaying information to the user
- Measuring food height
- Computation(Energy=time*heat*height

Currently based on meat, the user input (3) and real-time temperature findings (1) are used to estimate (4) the outcome.

A prediction is made based on the thickness of the meat and the temperature on the barbeque. The time it will take to cook the meat all the way through is estimated. Because of the nature of the interface (2), where the progress can be seen, the user can make a conscious decision about taking off the meat, whether it should be cooked all the way or not. The system was tested with a user walk-through.the most important take-away were:

- Hard to see it work in practice with more people and food
- From a distance, the different colors were not easy to separate
- For a single piece of meat it worked quite well
- Feedback for moments of measuring are required
- Doubt about the functionality for vegetables and fish

Even though the different opportunities made up an interesting combination it did not seem to be a useful concept in practice. The main issue being that the system is limited to a single piece of food without an easy way to scale up. With further iteration the potential of this system will be investigated.

BARBEQUE DYNAMICS

With the previous prototypes, a basic system was composed that gave the user more control over the barbeque environment. The system was, however, limited to a single piece of meat. In reality, pieces of meat with a variety of dimensions can be placed on the grill. They might even be placed there at different intervals, so there has to be a way of managing these dynamics.

Tracking

- The meat management comes down to being able to track every piece of meat separately in the following cases (not exclusive):
- The meat dimensions vary and require different cooking times
- The meat is placed on the grill at different time intervals
- The doneness of the meat has to deviate because of personal preferences

Weber Thermometers

Weber's digital thermometer system uses a colored indicator to trace back the right temperature to the right piece of meat.

This is an example of a label that is represented by a color. Other options would be to add a number or other distinctive features like a specific pattern or symbol.

A dynamic solution like sensing the tongs' position is too much of a challenge in the barbeque environment. While the static solution of predefining areas puts too much cognitive load on the user. Using a separate interface to map the food on the barbeque seems a nice balance between a static and dynamic solution.

Lower the Pressure

Because of the rather complex cooking processes going on along with other events that require the user's attention, barbequing can be overwhelming. One might not feel comfortable in leaving the barbeque at all because his attention is required constantly. The product should provide him a way of knowing when it is okay to relax.

Barbeque Flow

From the barbeque flow three stages were identified: Searing, cooking and resting. The temperatures on the barbeque easily exceed 200 degrees Celsius which makes differentiating between searing and cooking hard. Resting however, can be done by taking food off the barbeque. Therefore now the searing and cooking phase will be treated as one, cooking, and the resting phase will be the second important stage.

One of the processing in cooking that is often overlooked is the resting phase. An iteration on the previous timer concept resulted in a new idea about the shape and function of these timers.

Looking at other representations of progression, an hourglass has an interesting interaction. Turning it upside down starts or resets the 'countdown'.

The timer makes for a good opportunity here. By making it able to be turned around, it can display a different progression bar: the resting time. An hourglass timer was also seen around a tea drinking ritual. It shows the time that tea has to dissolve in the water for several types of tea. By extending the functionality of the timers, not only the resting phase is accounted for but the flipping interaction also provides data about this action from the user.

SMOKING PROCEDURE

- *Prepare the coals for a long, slow cook.*

Smoking is a form of indirect cooking and usually takes place over a period of hours over low temperatures. Use indirect coal configurations and a combination of lit and unlit coals to keep the fire burning over a long period of time.

- *Add smoke wood.*

Hardwood smoke gives BBQ extra flavor, so try using some wood. You can use larger wood chunks, or convenient woods that have been soaked in water.

Different woods impart different flavors. Hickory,

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mesquite and oak wood impart a bold flavor for meats like beef and pork.

- *Smoke at 225°F to 250°F.*

Consistent temperature is the key to smoking. The ideal temperature range for most smoking is 225°F to 250°F. A simple way to monitor temperature is to place a meat thermometer in the top vent of your grill, so the probe hangs down and measures the temperature of the air inside the grill. If the temperature is above 250°F, close down the vents to reduce the amount of oxygen in order to reduce the temperature. If the temperature dips below 225°F, open up the vents fully to allow more oxygen in to increase the temperature

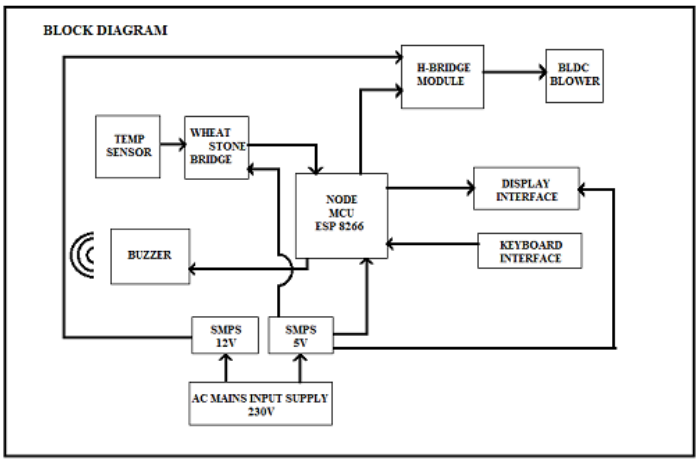
- *Keeps the fire burning.*

Ribs, brisket, and pulled pork take hours to smoke properly, so adding more coals will typically be necessary. There are two strategies to adding coals. The first way is to add more unlit coals, which you can do when you see temperatures begin to dip. Just add unlit coals; the lit ones will start them gradually. The second strategy is to add lit coals, which is important when the temperature drops below 225°F and you need to increase it quickly. Keep a chimney at the ready to fire up a new batch of lit coals, and pour them carefully into your cooker or add them with tongs

- *Don't peek.*

Perhaps the most difficult part of smoking is not lifting the lid. Every time you peek, you let valuable heat and smoke escape. Resist the temptation. Leave the lid on to avoid wild temperature swings or burning out your coals too quickly.

BLOCK DIAGRAM



ADVANTAGES

- Eat Less Fat.
- Vegetables on the Grill are better for us.
- Meat Retains Nutrients.
- Smoking Kills certain bacteria and slows down the growth of others.
- It extends shelf life of the product (food item).
- It enhances the smell and flavor of the food being smoked.

APPLICATION

- Slow-cooking food at lower temperatures over longer periods of time
- A smoker cooks meat on a low heat using plant pulp fuel and smoke, such as charcoal or wood chips. It will impart a rich flavor and tenderize the meat.
- Vegetables also cook in grill.

Food preservation can be done in smoker.

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