KBBQ for KBBeginners

Team B5 - Joseph Jang, Jasper Lessiohadi, Raymond Ngo

KBBQ - What is it?

- Korean cuisine of grilling meat
- KBBQ is cooked on a 400℉ - 500℉ grill that is either open flame or a heated metal plate
- Variety of meats
- Types of meats - internal cooking temp. of 145-170°F (63-77°C)
    - Pork belly (Samgyupsal)
    - Beef short rib (Galbi)
    - Marinated Beef (Bulgogi)
    - Marinated Pork (Pork Bulgogi)
    - Beef Brisket (Chadolbaegi)

Problem Statement

- However, because experience of KBBQ is a social one, it is easy to get distracted from the cooking
- Additionally, beginners may not be able to correctly judge the timing to cook each ingredient

Use Case

Want to improve the experience of people trying KBBQ for the first time by reducing instances of under/overcooking.

Removes the burden of being overwhelmed by the experience by having the system cook the food.

Essentially converts the experience of KBBQ to an experience like that of Benihana until the user feels confident enough to turn off the arm

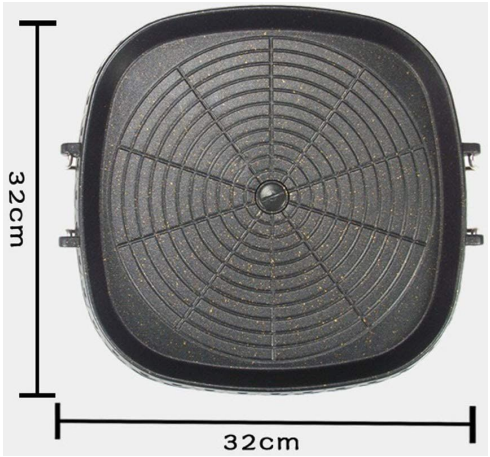
Areas: Software Systems, Signals and Systems

Software Requirements

- CV
  - Should correctly identify thickness and dimensions of meat, ±1/8th inch.
- UI
  - User should be able to override computer algorithm's predictions.
  - User should be able to prevent the robotic arm from flipping/moving the meat for the user.
- Prediction Algorithm
  - Should never result in the product being cooked at less than well done.
  - Should be cooked just right 70% of the time
- Controller
  - Able to take in CV and distance sensor data to precisely move robotic arm, movement error of ±1/8th inch
  - Keep track and make decisions for at least 1 and at most 5 pieces (cuts) of meat

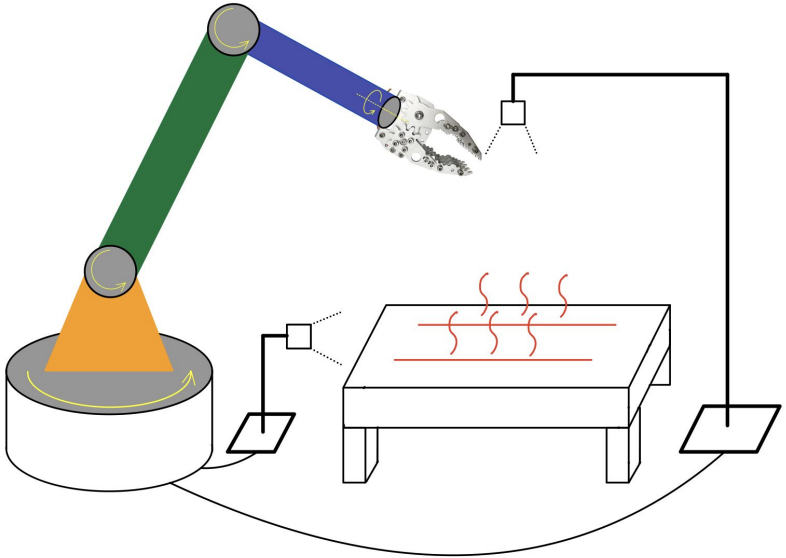
Hardware Requirements

- Flipping-mechanism system
  - 4 Degrees of Freedom
  - Grab and lift meats that are at most 2 lbs
  - Reach of at least 20”
  - Flip meats (180 degree flip)
- Able to Reach around a 12” x 12” - 20” x 20” grill or less
- Computer must handle processing of large amounts of data
- Metal claw and insulating material for heat resistance
- System must be able to function for at least 30 minutes
- Use of inverse kinematics
- Use distance and meat dimension information to make decision



Solution Approach

- Use OpenCV library
- CV system processes camera images, sends information to planner
- Software Planner makes decisions and controls robotic arm
- 3D-Print Robotic Arm links/joints
- Use of 4 servo motors and 1 stepper motor to control robotic arm
- Jetson Agx Xavier, plug-in to wall for power
- Portable lead-acid battery for robotic arm (12V, 8 Ah)
- 2 Cameras (put name)



Technical Challenges

Computer Vision: Identification of thickness cuts of meats

Cooking Time: Should correctly predict doneness of meat without needing a thermal probe

Operating Temperature: Robot arm needs to operate above a grill up 500℉

Zone Identification: Should not be confused between several different pieces of meat on grill

Testing, Verification, and Metrics

- Software
  - Have our camera be able to detect the thickness of the selected meat and compare to manually measured thickness
  - Use the detected thickness to estimate the appropriate cooking time and manually check if the meat is fully cooked
- Hardware
  - Make sure our robotic arm can pick up thin pieces of a substitute meat material
    - Line up arm with a side view camera and a camera attached to the end of the arm
  - Make sure the arm is capable of reliably flipping said material over

Tasks and Division of Labor

- **Robotic Arm**: Joseph
  - Design, create robotic meat flipping arm
  - Arm to software interfacing
- **Computer Vision**: Raymond
  - Computer vision meat thickness identification algorithm
- **UI**: Jasper
  - User interface to override incorrect identification, robotic arm action
  - Cooking time estimation algorithm
- We will all work on the software controller program
  - Interfaces between robotics software, CV, and UI
  - Decision making for our subsystems

Schedule

KBBQ 4 KBBeginers

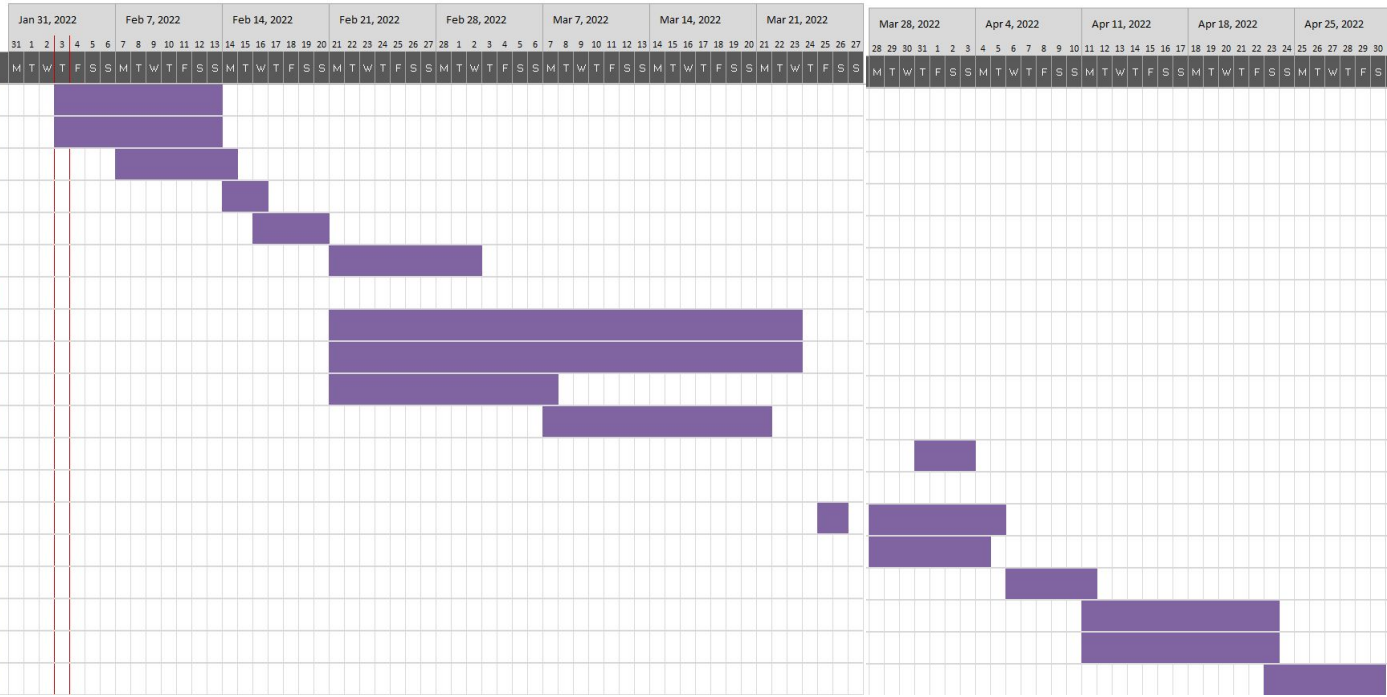
Team B5

SIMPLE GANTT CHART by Vertex42.com
https://www.vertex42.com/ExcelTemplates/simple-gantt-chart.html

Project Start: Thu, 2/3/2022

Display Week: 1

TASK	ASSIGNED TO	PROGRESS	START	END
Task 2	Research and Design CV Algorithm	0%	2/3/22	2/13/22
Task 3	Design Software Controller/UI	0%	2/3/22	2/13/22
Task 4	Design and CAD of Robotic Arm/Controls	0%	2/7/22	2/14/22
Task 5	Create Subsystems Integration Plan	0%	2/14/22	2/16/22
Task 6	Design Review Presentation		2/16/22	2/20/22
Task 7	Design Review Report		2/21/22	3/2/22
Phase 2 Development				
Task 1	Develop CV Algorithm	0%	2/21/22	3/23/22
Task 2	Develop Software Controller/UI	0%	2/21/22	3/23/22
Task 3	3D Print/Assemble Robotic Arm		2/21/22	3/7/22
Task 4	Program Robotic Arm		3/7/22	3/21/22
Task 5	Work on Final Report		3/31/22	4/3/22
Phase 3 Integration and System Testing				
Task 1	Integrate Software Controller and CV Algorithm		3/25/22	4/5/22
Task 2	Integrate Software Controller and Robotic Arm		3/28/22	4/4/22
Task 3	Integrate All Subsystems		4/6/22	4/11/22
Task 4	Testing CV on Actual Grill and Meats		4/11/22	4/23/22
Task 5	Test Robotic Arm on Actual Grill and Meats		4/11/22	4/23/22
Task 6	Complete Final Presentation/Document		4/23/22	4/30/22



Conclusion

- Our system will allow both beginners and experienced eaters to experience KBBQ in a more convenient and stress-free environment
- Automates the cooking process so that users can focus less on the food and more on enjoying the presence of those around them
- Use our product and go from being a KBBeginner to joining the KBBandwagon