



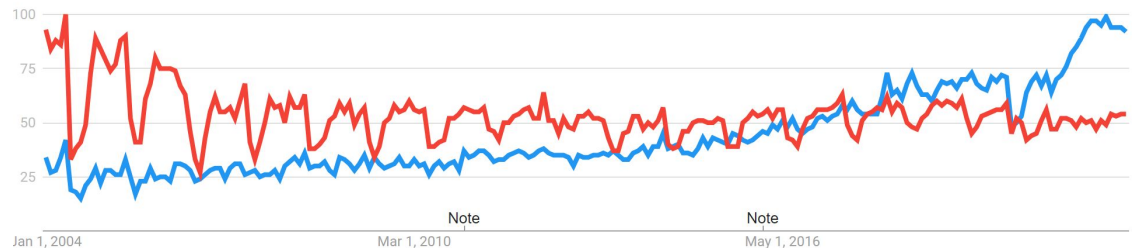
KBBQ for KBBeginners

Design Review

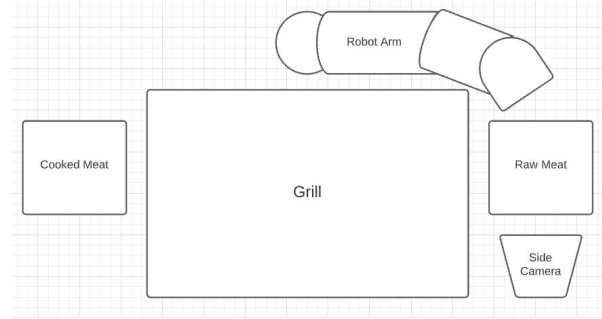
Team_B5_Jang_Lessiohadi_Ngo

Application Area and Use Case

- Korean food is growing in popularity
- KBBQ is a “do it yourself” type of food, but may be intimidating to newcomers
- Robotic Arm must be able to have a maximum reach of 20”. Dish and Grill area will be confined to a 14” by 20” area (Grill is 13” by 13”)
- Able to function for at least 20 min., at most 45 min.
- Should be cooked “just right” 70% of the time
 - No undercooking, no black burnt meat, but a good brown color
 - Determine by time (each side of meat should be cooked for 3- 5 minutes)
- CV algorithm should be able to process twice per second.

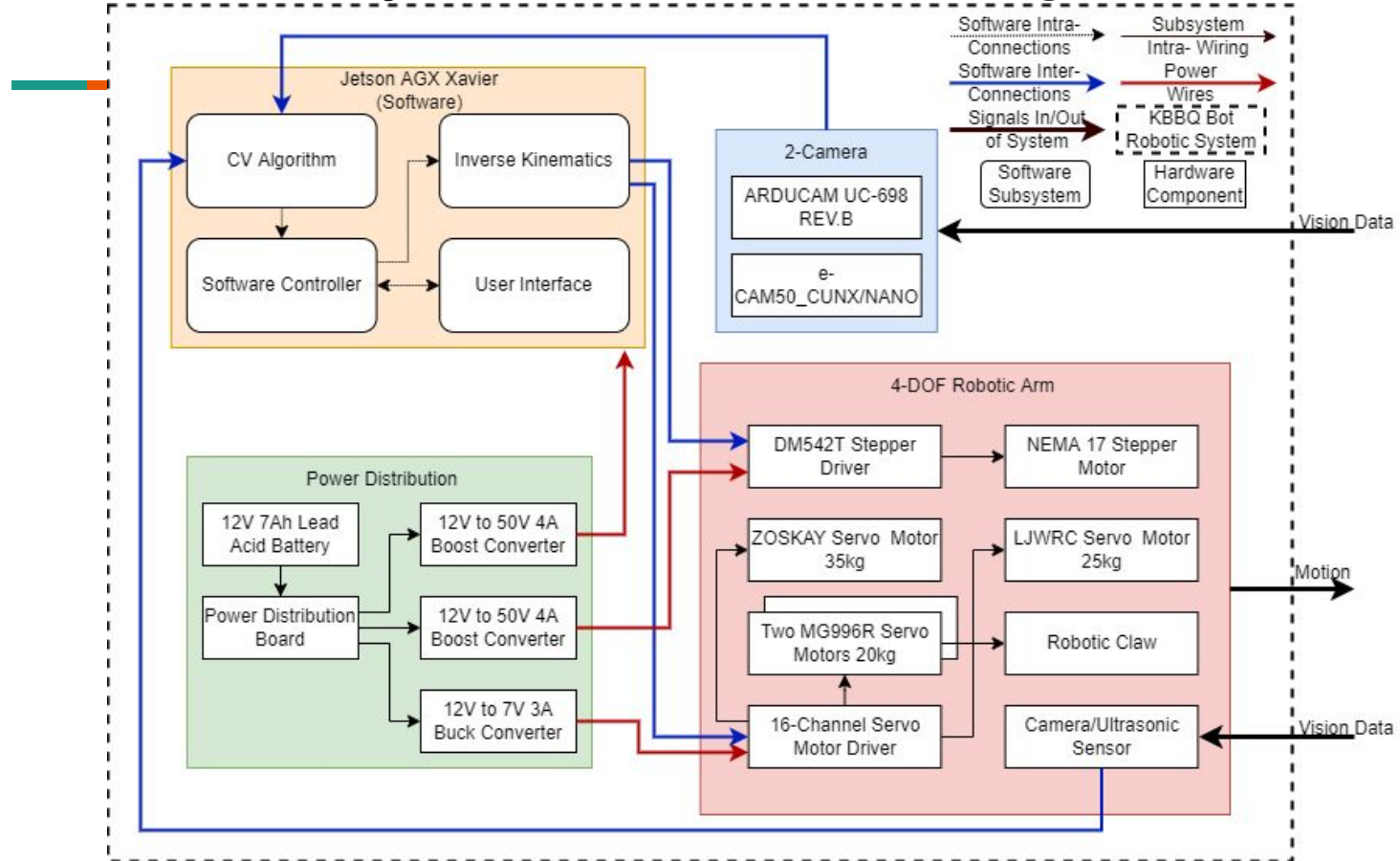


Solution Approach

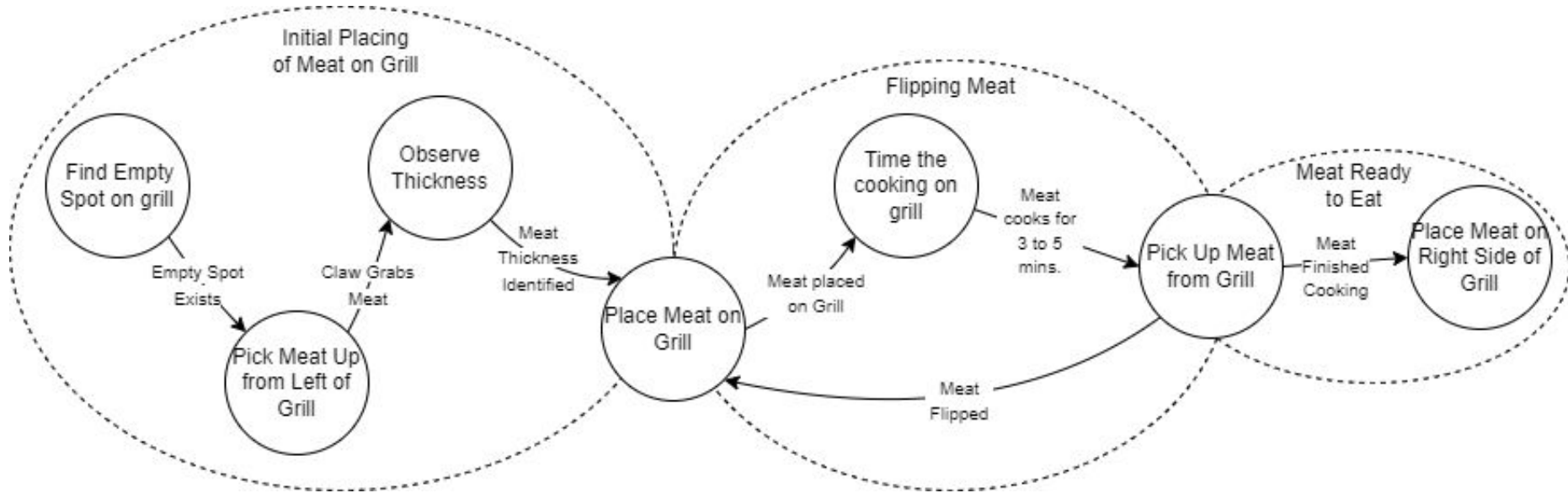


- Meat placed in designated area next to grill, below side camera which will scan for food twice per second
- If the camera detects food there and there is empty space on the grill, then it will signal the robot arm to pick up the meat and pass it in front of the side camera to get a cross-section view
- Computer vision will determine how thick the meat is and will use that information along with the temperature of the grill to determine how long that cut of meat should stay on the grill
- We will prioritize flipping and removing meat that is currently on the grill over putting new meat on empty space by having a separate queue for each
- Once our algorithm decides that a certain piece of meat is finished cooking, the robot arm will then place it on a plate on the opposite side of the raw ingredients

System Architecture Diagram

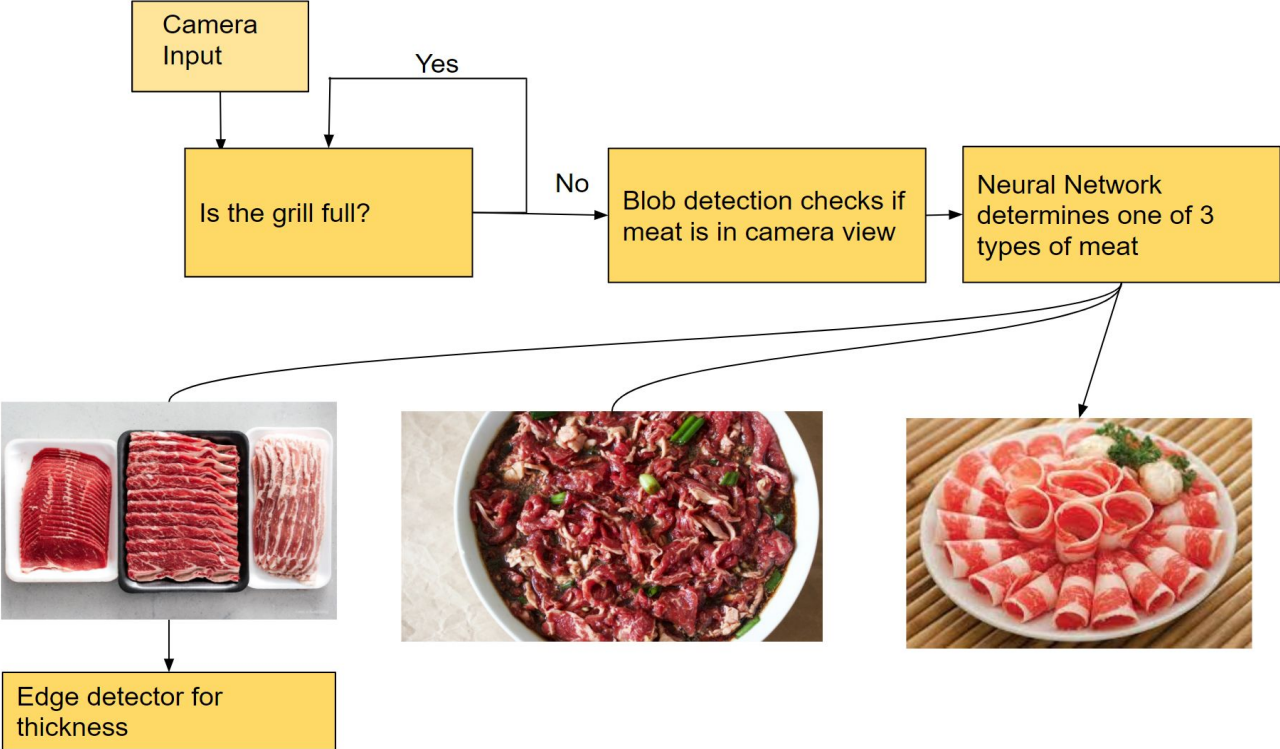


System States




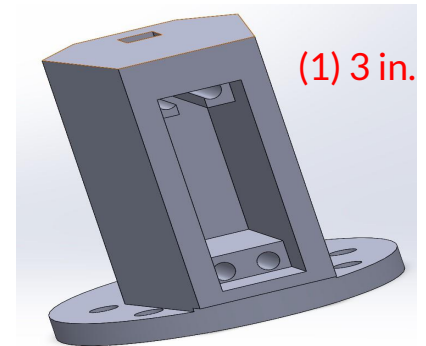
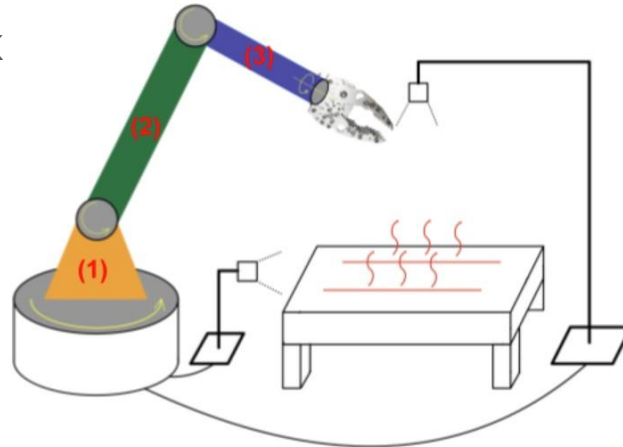
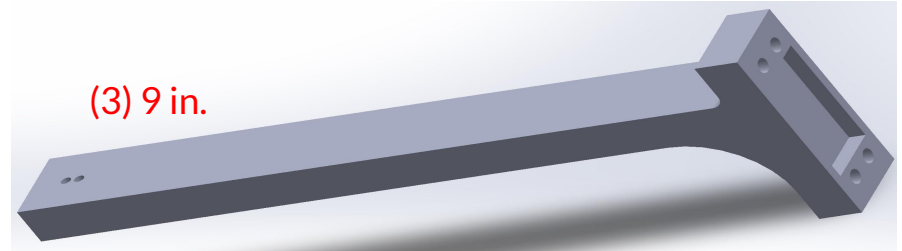
- Meat Cycle System States for one Piece of meat
- For multiple pieces of meat, a double queue system will be implemented

CV Algorithm

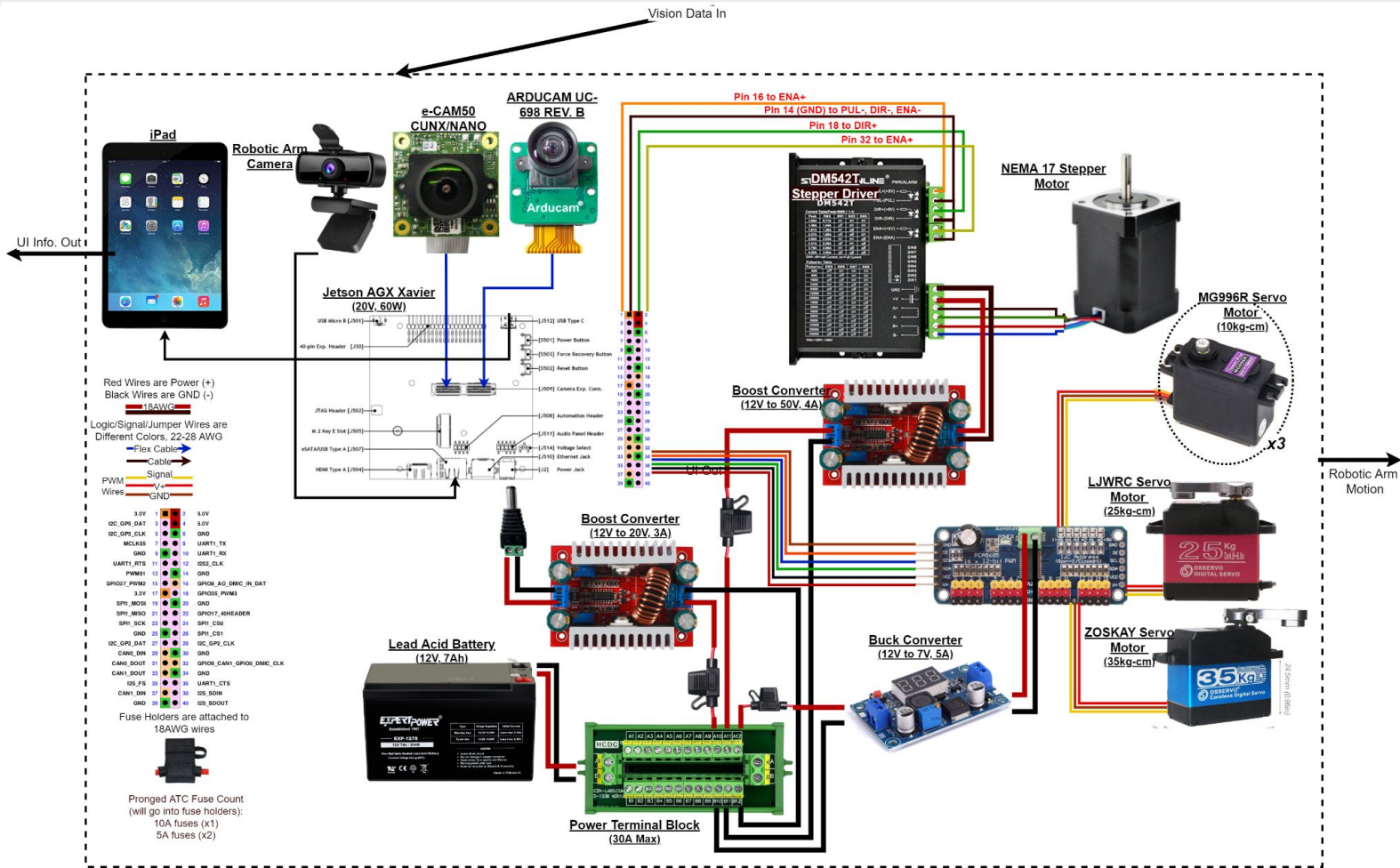


Robotic Arm

-  4 DOF - 3 Links, 4 Joints
 - Base is Yaw (360°)
 - 2 elbow joints is Pitch (270°)
 - Wrist joining is Roll (360°)
- Claw is 4 in. long
- Links will be 3D-Printed
- ROS, Matlab, and Python have Inverse Kinematics Libraries/solvers, such as IK Fast, IKPy, and tinyik.
- [Parts List](#) Created
- Possible Issue - Inaccurate Dimensioning Info. of Amazon Parts
- If System fails...buy a \$100-200 Robotic Arm on Amazon



Electrical Diagram





UI

- Rough outlines of UI elements
- Both manual and automatic modes will have an overhead camera feed of the grill so that users are kept knowledgeable of how the system is functioning
- The users will be able to tap on a section to manually flip or remove its meat, depending on if it has been flipped already

KBBQ for KBBeginners

Automatic

Manual

Automatic

New Meat Info:

Detected Thickness

0.25 inches

Time to Cook

2:00 minutes

Section

Section 1

02:00

Section 1

00:30

Section 3

01:30

Section 2

00:00

Section 4

Manual

New Meat Info:

Time to Cook

2:00 minutes

Section

Section 1

02:00

Section 1

00:30

Section 3

01:30

Section 2

00:00

Section 4

Software Controller



- Takes in information from CV Algorithm
- Displays CV data to UI
- Keeps track of multiple meats on grill, and their cooking times, calculates information for each meat and makes decisions
- Gives desired position to inverse kinematics algorithm
- System will prioritize flipping and getting meats off grill at the appropriate time over putting meats on grill
 - Two queue implementation, with queue 1 having priority over queue 2
- System will know that the dish of uncooked meats that need to be grilled will be at the left of the robotic arm and grill, while cooked meats will be placed on a dish at the right of the robotic arm and grill



Testing Metrics, Verification, and Validation

Feature	Testing Method	Output	Accuracy
Meat type recognition	Placing plates of food in front of camera	Algorithm item guess	Under 5 seconds 80%+ Accuracy
Thickness Recognition	Holding cuts of meat in front of camera	Thickness estimate	$\pm 1/16$ in
Robotic Arm Movement Error	See if Robotic arm can touch a predetermined point	Amount of Movement Error in kinematic software	$\pm 1/16$ in
Cooking Time Algorithm	Manually see if the amount of time calculated properly cooks given meat	Cooking time estimate	Meat fully cooked, but not burnt Internal temp of 145F pork, 170f beef min



Risk Management

-The main risk of this project is the heat of the grill

-To prevent damage to the robot arm and other components, we will only have the arm go over the grill while interacting with the ingredients. Otherwise, it will rest off to the side of the grill away from the heat

-Wires and Motors will be covered in a wire sleeve (wire insulation used in cars to protect from high heat)

-To prevent excessive overcooking or burning of the ingredients placed on the grill, we will exhaustively test our thickness detection and timing algorithm to ensure that the meat is on the grill for an appropriate amount of time

Project Management

KBBQ 4 KBBeginners

Team B5

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

Project Start:

Display Week:

