Project Plan

1. Give a title for this project. (This can change later)

Pass the Butter!

2. Describe the project in 2-3 sentences.

Build a robot which is capable of locating different people at a dinner table and passing butter to them when commanded. This is an idea made popular by a scene from Ricky and Morty. A toy is being produced for a similar purpose, but ours should be more customizable.

3. List the subsystems for this project and specify what each group will deliver by the end of the project.

Core subsystems

- **Speaking:** Shout out fun phrases when the robot engages in different actions.
- **Listening:** Listen to people and activate actions (e.g. passing butter) when certain key words are spoken. This subsystem must also provide the direction of spoken words (microphone arrays can do this).
- **Butter Passing:** Using either passive or active actuation, move butter around the table.
- **Driving:** Provide wheels, frame, and motors for rover to drive around upon. This can be done from scratch or by assembling a kit; that decision depends on available team members and interests.
- **Obstacle Avoidance/Pathfinding:** Avoid obstacles on the table and keep from falling off the table.

Possible extensions

- **Conversing**: Use Natural Language Understanding (NLU) to engage in a full conversation with people.
- **Teleoperating:** Control the robot and view its camera remotely using a computer, phone, or even Twitch chat.
- **Voice Recognition:** Identity the speaker using their voice, and then respond differently to different voices.
- **Face Recognition:** Same as voice recognition, except using faces.
- **XYZ Passing:** Pickup and move around other things (plates, trash, utensils, etc.) besides butter

4. How many people do you think you need on your team? Mention roles and skills if possible.

6-8 people, myself included (I fall into both the Computer/Software Engineer roles). We can support more software engineers (up to 6) if there are extra people available.

- 1-2 Mechanical Engineers to focus on robot body design/3D printing, motor placement, and actuator design for driving and butter passing.
- 2 Electrical/Computer Engineers to handle power distribution/wiring/pcb design and possibly help with some programming work.
- 3-4 Software Engineers to integrate and control all subsystems, with the bulk of their work being divided among the listening and obstacle avoidance subsystems.

5. List out parts your project will need, along with links for where to order them from.

    a. **[Already purchased]** OAK-D AI + Depth Camera: https://www.kickstarter.com/projects/opencv/opencv-ai-kit
    b. Speaker: https://www.amazon.com/dp/B087D2BPBC/ref=cm_sw_em_r_mt_dp_6CT.FbAHCDT44
    c. Microphone array (directional audio): https://www.digikey.com/short/477r2v OR https://www.seeedstudio.com/ReSpeaker-USB-Mic-Array-p-4247.html
    d. Jetson nano: https://www.amazon.com/dp/B084DSDDLT/ref=cm_sw_em_r_mt_dp_2IT.FbE0Y5RNH
    e. WiFi for Jetson nano: https://www.amazon.com/dp/B07V9B5C6M/ref=cm_sw_em_r_mt_dp_oJT.Fb4XAX22R
    f. Micro sd card: https://www.amazon.com/dp/B08879MG33/ref=cm_sw_em_r_mt_dp_g5T.FbC1ADJK3
    g. Jetson fan: https://www.amazon.com/dp/B071FNHVXN/ref=cm_sw_em_r_mt_dp_85T.FbS3C6MND
    h. Jetson test bench Power Supply: https://www.amazon.com/dp/B07413Q5Y4
    i. [Many Options, Choose 1] Motors + motor driver + chassis:
        i. Jetbot kit https://www.adafruit.com/product/4225
        ii. Tank Tread kit: https://smile.amazon.com/dp/B08F23SDF5/ref=cm_sw_em_r_mt_dp_ZSJaGbBWMGKRD

iii. Elegoo Kit https://smile.amazon.com/dp/B07KPZ8RSZ/ref=cm_sw_em_r_mt_dp_dlT1_rTJaGbBSVW61Z?_encoding=UTF8&psc=1
iv. Tank with arm kit: https://smile.amazon.com/dp/B07Q3RQCQS/ref=cm_sw_em_r_mt_dp_UTJaGbGKZDVG3
v. Osoyoo kit: https://smile.amazon.com/dp/B08JLS3J7Q/ref=cm_sw_em_r_mt_dp_AUJaGb61WHR82
vi. 3-layer kit: https://www.adafruit.com/product/3244

j. Battery + regulators: https://forums.developer.nvidia.com/t/power-supply-considerations-for-jetson-nano-developer-kit/71637/245
   i. Most likely option: 2s LiPo battery with motor drivers provided by kit and possibly a 5V regulator and/or separate battery for the jetson; I already have a 2s LiPo
   ii. 5V Regulator (can work for servos and/or Jetson): https://www.amazon.com/dp/B00C63TLCC/ref=cm_sw_em_r_mt_dp_zvKaGbWTP4BB2
k. Table edge detection (if not in kit): https://www.amazon.com/dp/B00XT0PBC0/ref=cm_sw_em_r_mt_dp_ebKaGbQN4BDSX
l. Robot arm servos (MG90S): https://www.amazon.com/dp/B07FLXZ1VK/ref=cm_sw_em_r_mt_dp_lqKaGbN11ACJW
m. Robot arm gripper: https://www.pololu.com/product/3551

6. Layout a timeline of the milestones that need to be completed to finish the project. Expect there to be 10-11 productive weeks to complete the project.

- Mid February: Robot prototype assembled and motors moving
- Mid March:
  - Majority of mechanical/electrical body design/assembly (except arms) completed
  - Table edge detection working
  - Speaker working
- Mid April:
  - Arms functional
  - Microphone able to determine audio direction
  - Obvious obstacles autonomously avoided using camera
- May (final): Able to pass butter from one side of table to the other using voice commands.

Embedded Plans/Considerations

- [Efaz] Using Fritzing for system connection diagram
    - Don't worry about circuit diagrams as much unless we add more small components
- 2 Arduino nanos, one for arms/servos, another for locomotion
- Arduinos communicate with Jetson Nano over serial (rosserial package)
- IMU contacts arduino over I2C

Jetson Nano Software Plans/Considerations:

- LucidChart for software package diagram: https://lucid.app/lucidchart/invitations/accept/1264b90b-86f0-4d57-a3e3-523582440beb
- 30deg separation difference minimum needed for ultrasonic sensor to avoid interference
- Simplify arm IK by just doing it ourselves instead of integrating MoveIt: https://youtu.be/IN8tjTk8ExI
- **What is the max speed we will set for our robot?**

Mechanical Ideas/Plans:

- Linear rail MGN12 H (150 mm) for vertical cam movement provided by Spencer: https://www.aliexpress.com/item/32806622073.html?spm=a2g0s.9042311.0.0.27424c4dN0Uh1O
- Using black micro servos for arms.
- 2 arms if possible, but otherwise only one.
    - Could get higher torque even: https://www.adafruit.com/product/2307
- Gripper for arm that uses micro servo: https://www.pololu.com/product/3551
- Potential drive train depends on size of nano + other parts
    - https://www.amazon.com/dp/B08F23SDF5/ref=cm_sw_em_r_mt_dp_ZSJaGbBWMGKRD?pldnSite=1
    - https://www.amazon.com/DGJYT-Preminum-Raspberry-Learning-Caterpillar/dp/B08HSTC96H/ref=pd_sbs_6?pd_rd_w=Cu95D&pf_rd_p=c52600a3-624a-4791-b4c4-3b112e19fbbc&pf_rd_r=EGPAX2TZ5C7HD9GTEB1E&pd_rd_r=a116d607-1428-44cd-afc4-0f169cb4d952&pd_rd_wg=bfO2b&pd_rd_i=B08HSTC96H&psc=1
    - https://www.amazon.com/Experiment-Programable-Platform-Compatible-Raspberry/dp/B0892YJ3KQ/ref=pd_lpo_21_t_0/145-5431909-5385810?_encoding=UTF8&pd_rd_i=B0892YJ3KQ&pd_rd_r=de61afc3-d991-4596-9d8c-5dea2b8cdc0f&pd_rd_w=q9Eoi&pd_rd_wg=GygVy&pf_rd_p=16b28406-aa34-451d-8a2e-b3930ada000c&pf_rd_r=W7JTG1CQZ3TFHQY6RTX0&psc=1&refRID=W7JTG1CQZ3TFHQY6RTX0

    - Could consider 3D printing something from Thingiverse
        - https://www.thingiverse.com/thing:2024364
        -
- Motors with encoders: https://www.dfrobot.com/product-1457.html
- Max's servo: https://www.amazon.com/SunFounder-Waterproof-SF3218MG-Digital-Aluminium/dp/B07VJG5QTJ
- Micro servos:
    - https://www.adafruit.com/product/2307
    - https://www.adafruit.com/product/1143
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Reference Projects

1. Cliff detection and collision avoidance using IR sensors

- https://www.youtube.com/watch?v=d7J0Bb78y2s
- https://www.youtube.com/watch?v=BLYP94Yk12U
- https://www.youtube.com/watch?v=lN9uT30YzAg
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