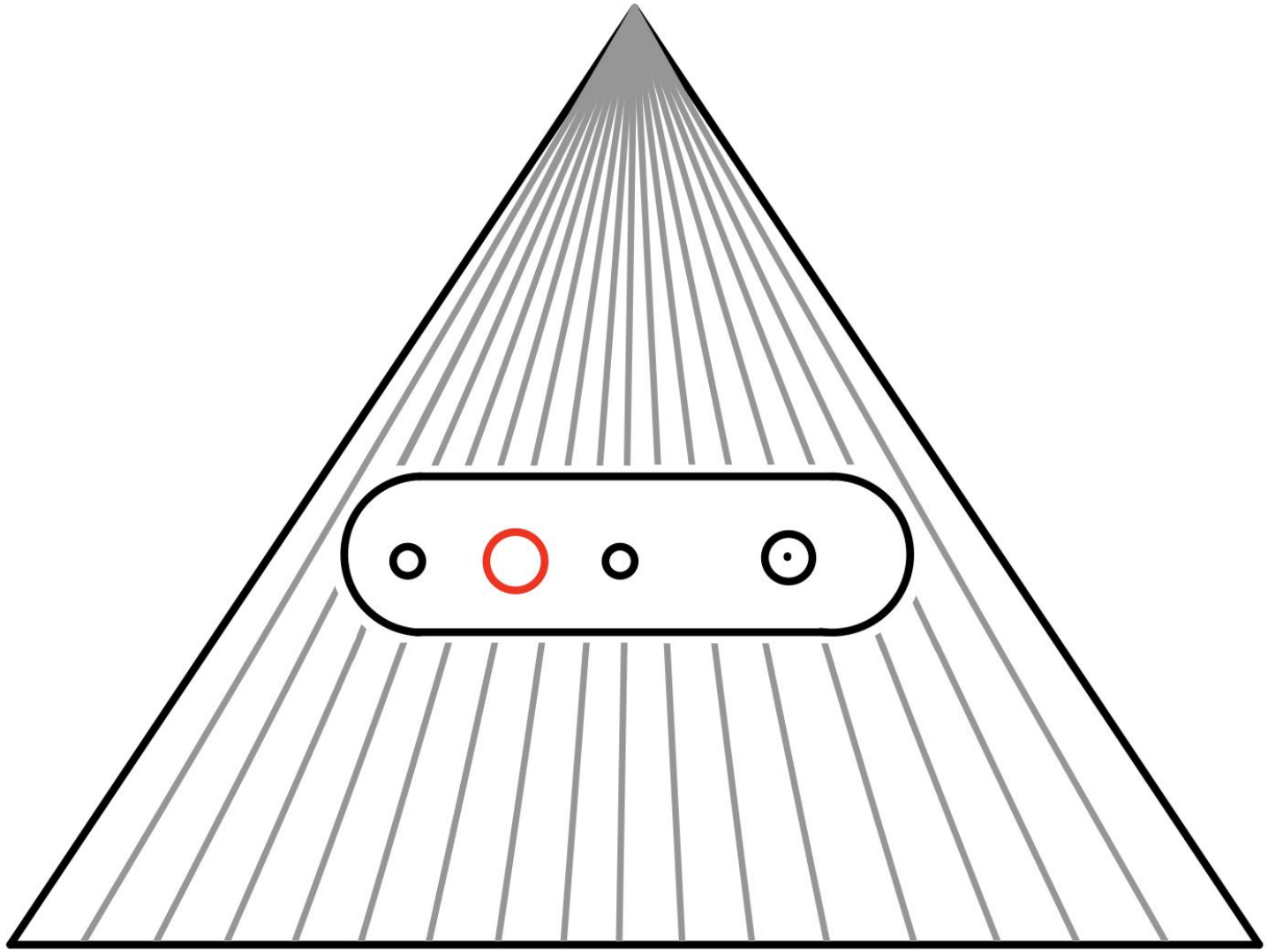


C – camera
A – arm
T – tracking

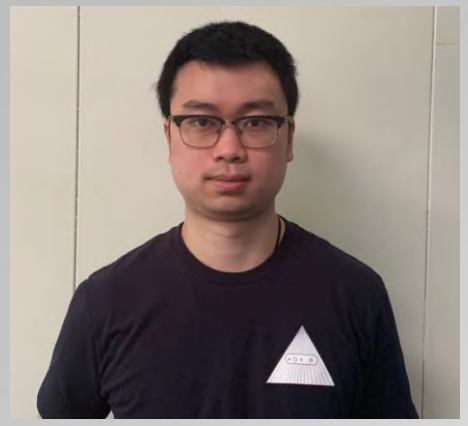
Collision Avoidance

With

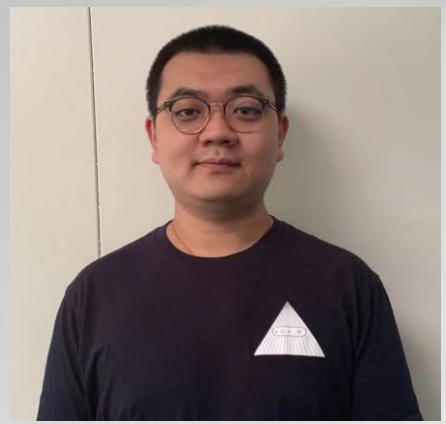
Depth Detection Camera

Development Team

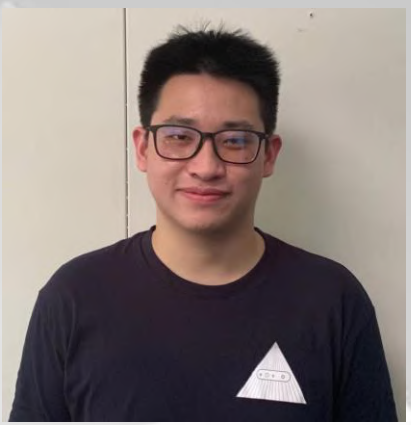
Jiaqi Tang
Team Lead
Software – MCU



Joe Yu
Hardware
Motor



Ming Wen
Hardware
Motor



Kerr Ding
Software – GPU

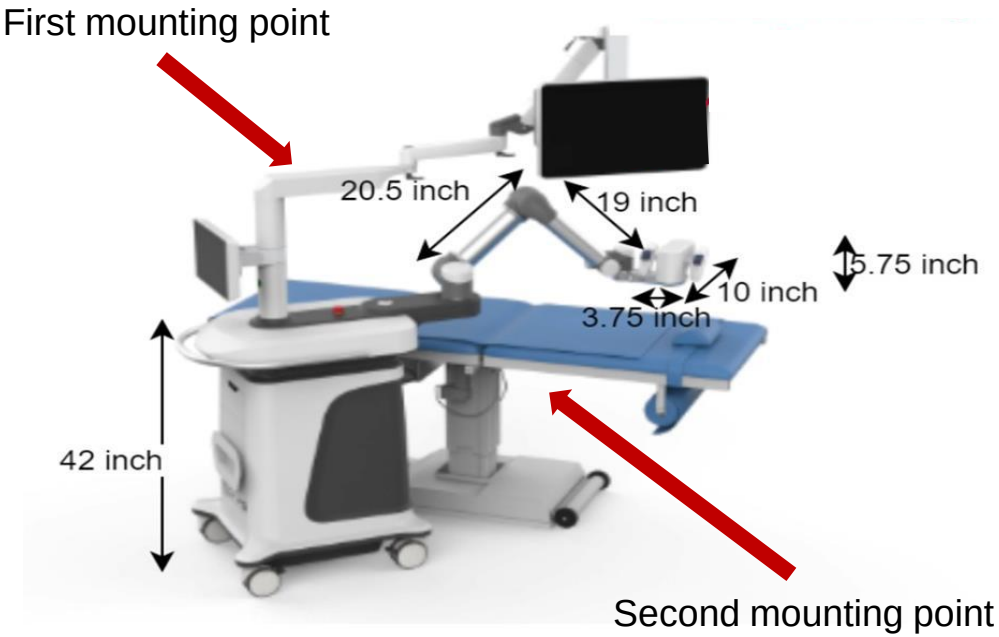
Zhanglu Wang
Software – GPU
3D modeling

Introduction

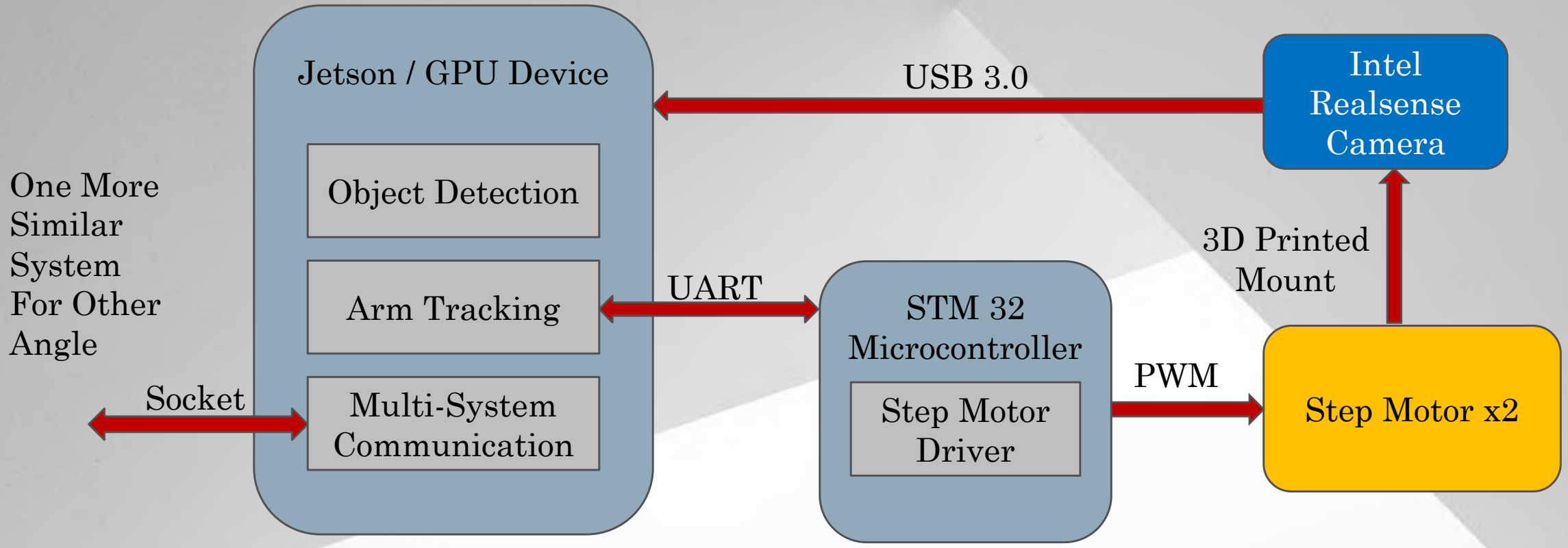
- Supporting system for eye surgery
- High-end electronic microscopes attached to robotic arm
- A collision could damage the sophisticated and sensitive microscope

Goals and General Design

- Use depth/object detection to avoid robotic arm collision
- Mount 3D cameras onto/around the surgical cart
- Rotate the cameras to track arm position



System Design

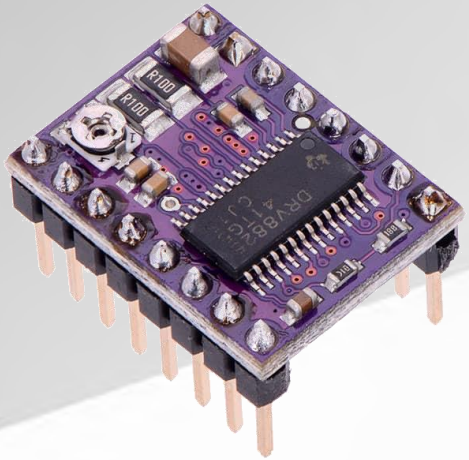


STM32 and Step Motor

STM32 Microcontroller

PWM &
GPIO

Motor Driver



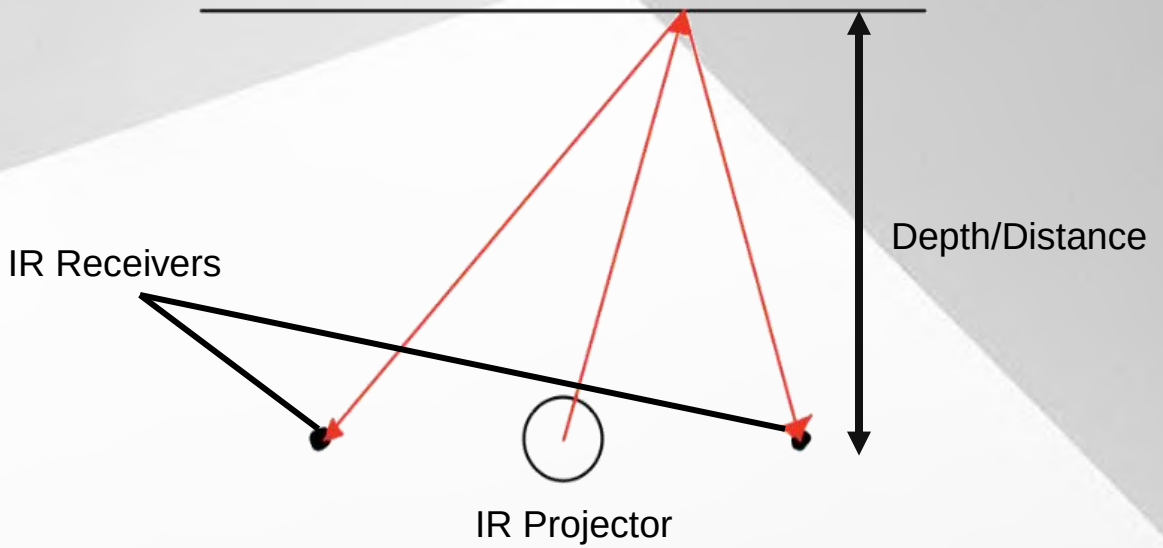
4 Bit Step
Info

Step Motor

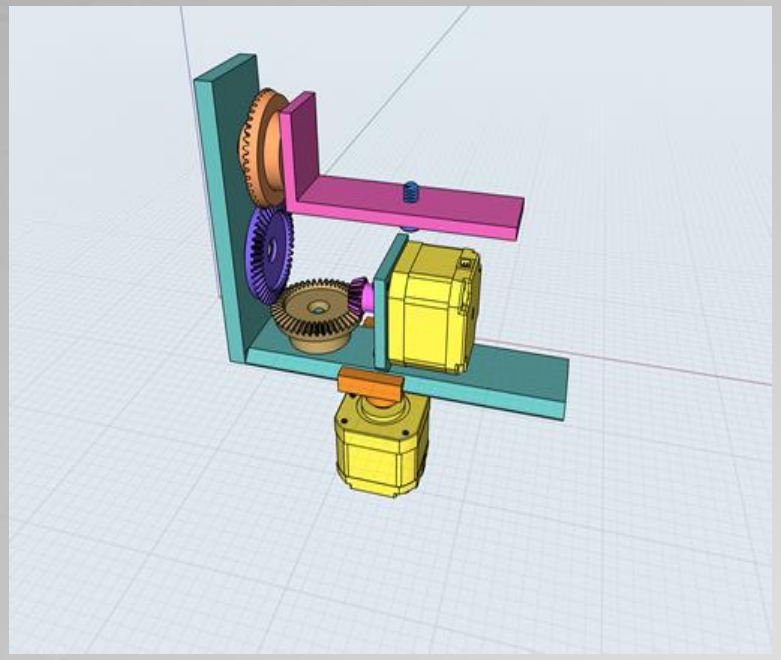
Depth Detection Camera

Intel Realsense D435i

- Active IR technology
- High resolution RGB camera
- SDK for most programming language
- USB 3.1 which requires a high-level micro controller



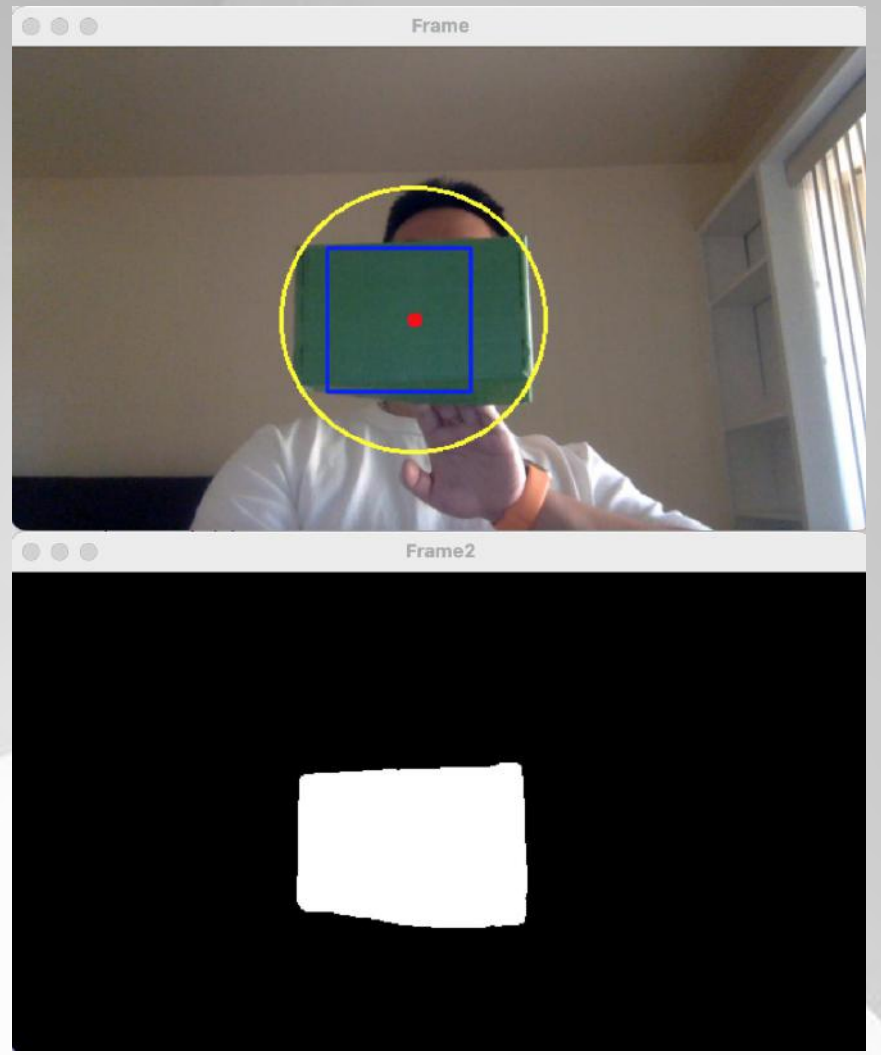
3D Printed Mount



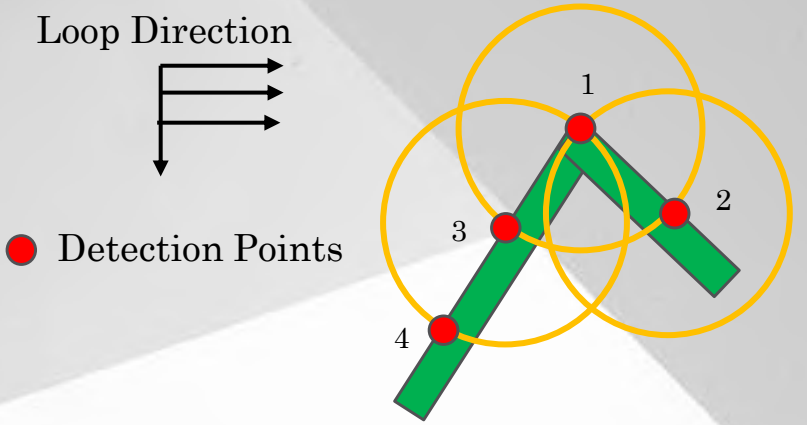
- 360 degree turning angle both vertically and horizontally
- Two sets for different perspective point

Color Detection

1. Generate a color mask from RGB image
   - Get a 2-D array of 0 and 255
   - Mark pixels of selected color range with 255
2. Return a Geometric center
   - Use Opencv2 package
   - Use the center point to tracking the robotic arm



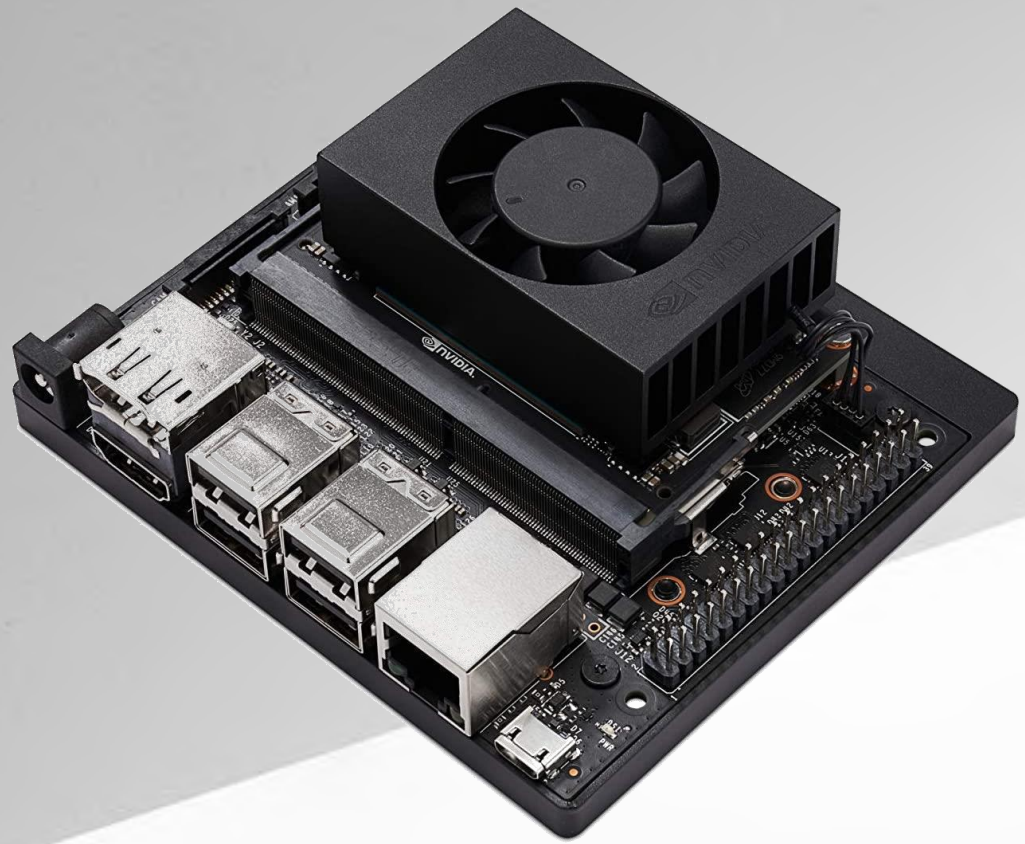
First Attempt on Raspberry Pi



Robotic Arm
(color detection)

Failed because of the limitation of Raspberry Pi and CPU intensive algorithm

Current Design



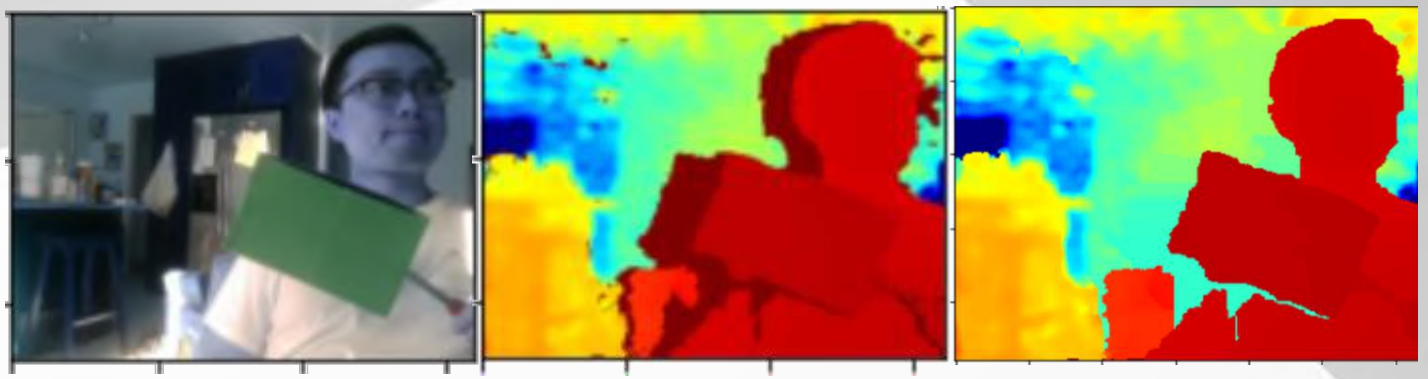
Jetson Based

- GPU on-board
- Faster object detection
- Detect all direction of the whole arm simultaneously

Image Postprocessing

1. Color Mask:
   - Use our own kernel to remove noise

2. Depth Frame:
   - Use filter to smooth the depth image
   - Hole filling



Object Detection

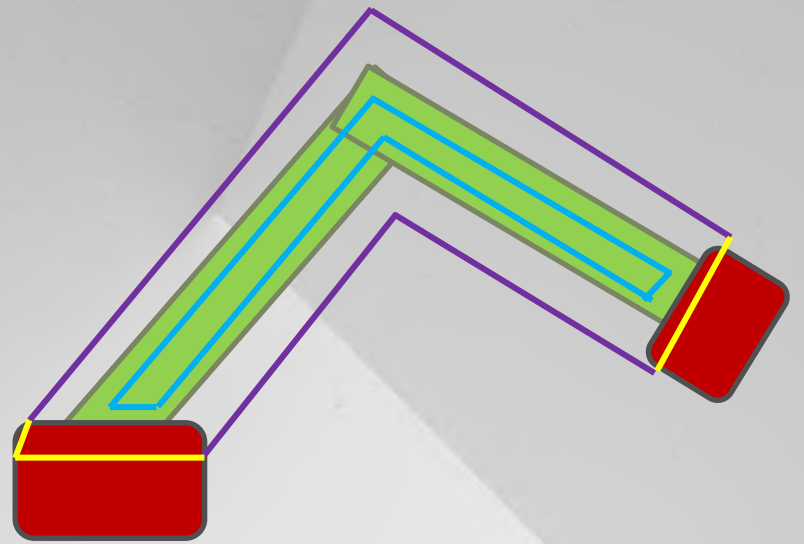
Robotic Arm
(Green Covered)

Ignored Device
(Red Covered)

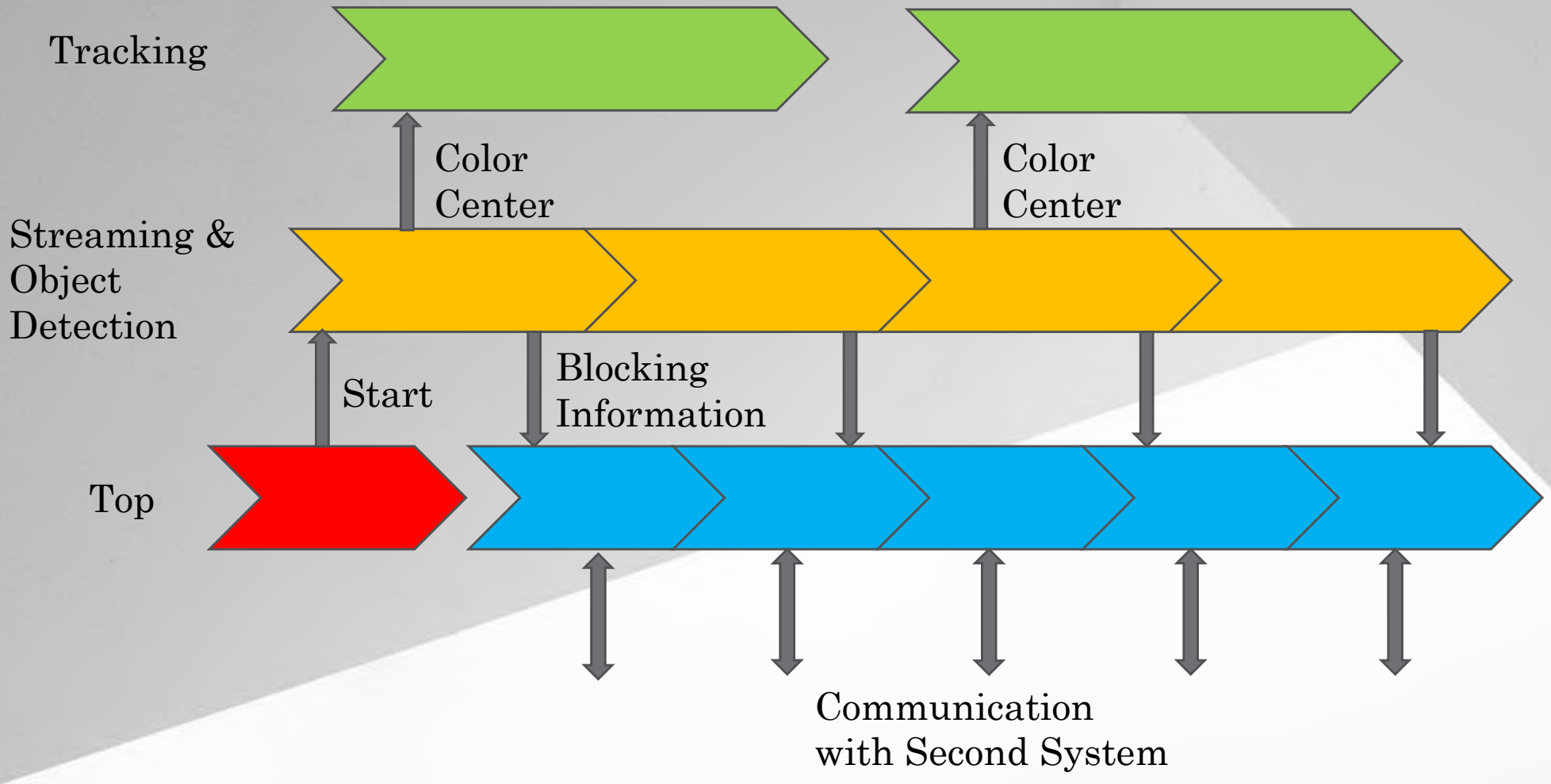
Inner Bound
(For Comparison)

Outer Bound
(For Detection)

Ignored Bound
(Skip Part)



Main Program



Thanks to

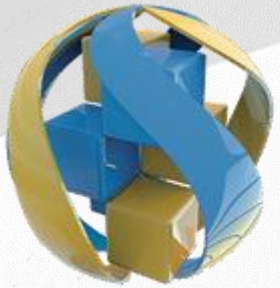
Yuepei Hu

Yogananda Isukapalli

Boning Dong

Trenton Rochelle

Alcon



UC SANTA BARBARA
engineering