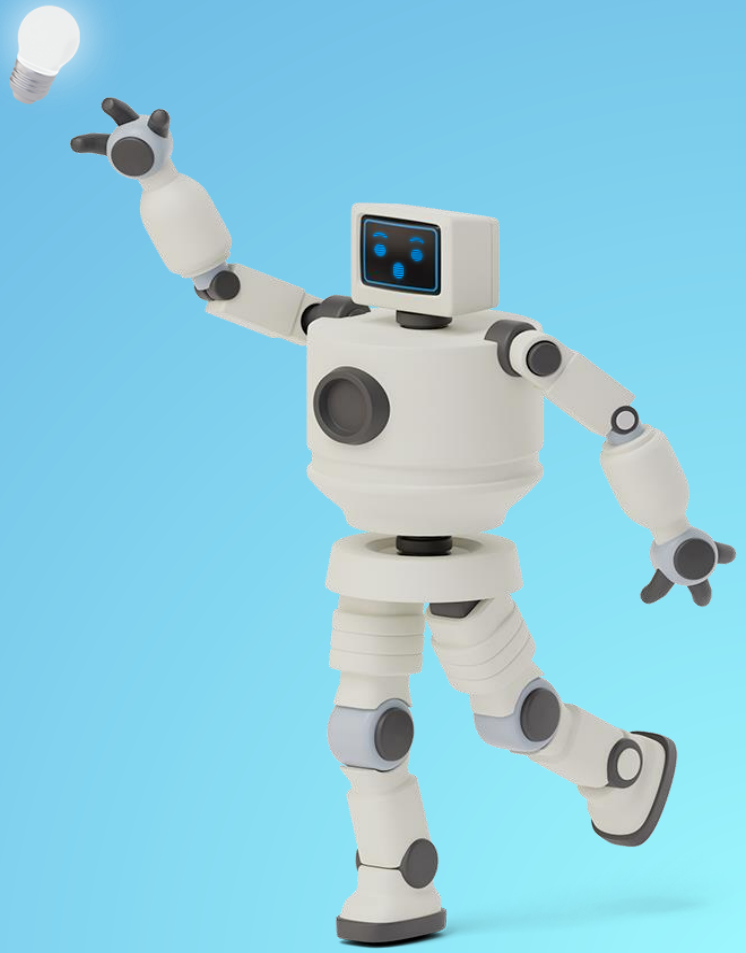
ROBO-RESPONSE



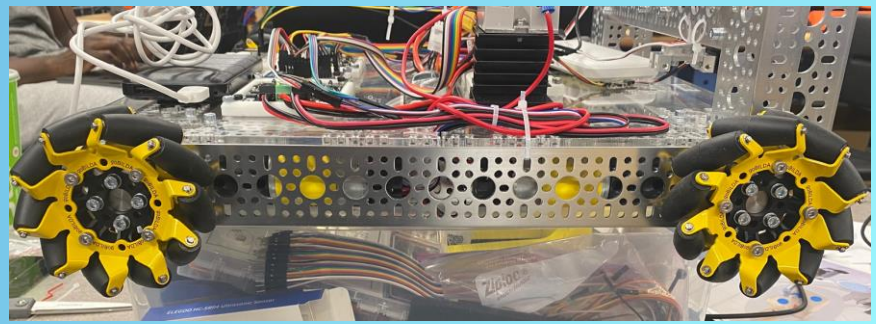
MOBILE ROBOT

Strategy

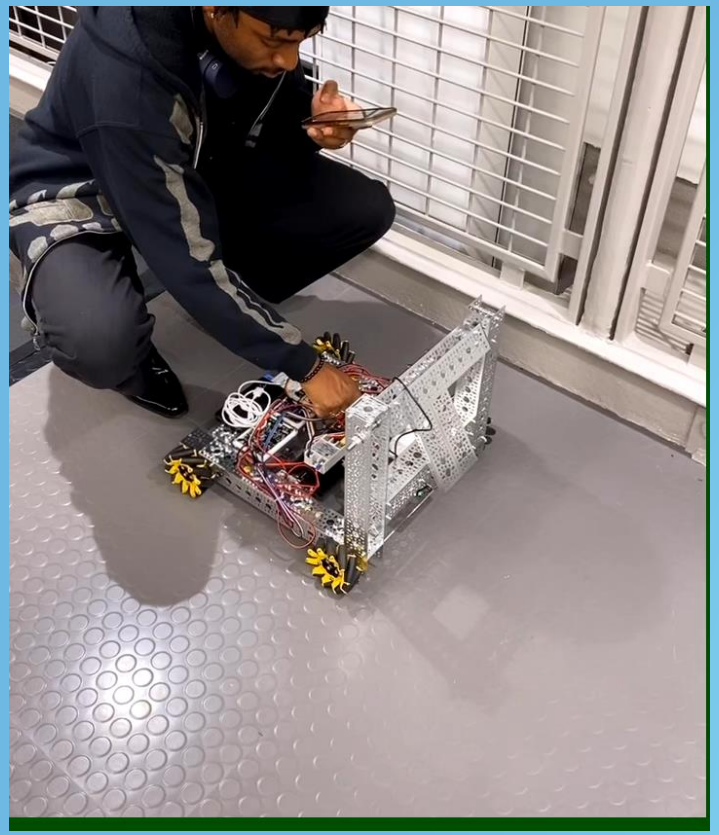
- Autonomous Navigation
  - Switch to manual control
- Controller:
  - UP - arm raised
  - DOWN - arm lowered
  - RIGHT - turn right
  - LEFT - turn left
  - JOYSTICK - F, B, L, R

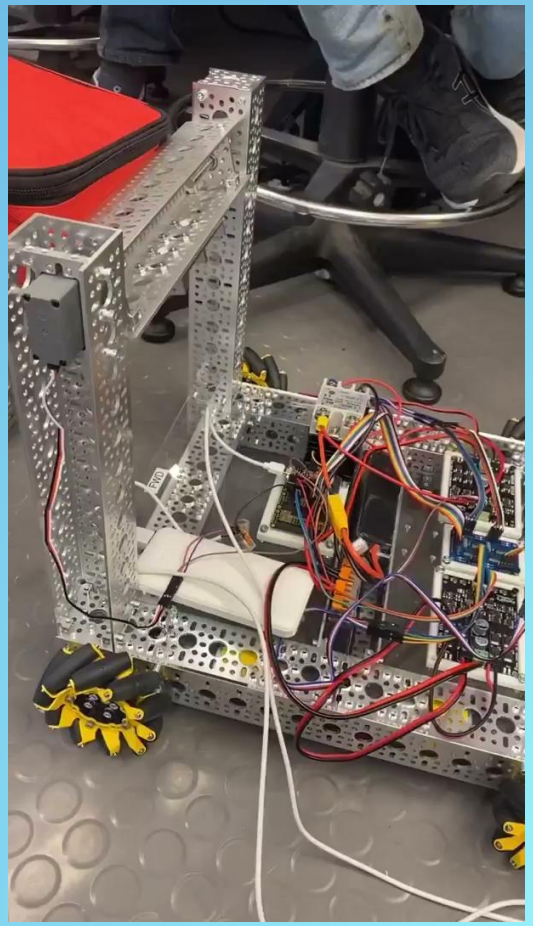
Navigation

- Mecanum Wheels
- Waypoints to:
  - AED location
  - Patient
- Controller



MOBILE ROBOT

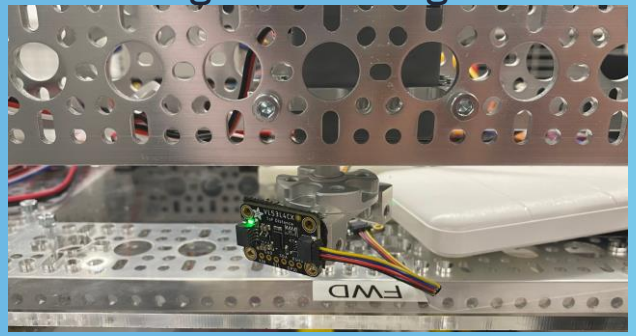




MOBILE ROBOT

Autonomous Obstacle Detection

- Time of Flight sensor on servo
  - 90° range of “vision”
- If distance drops below threshold →
  - Move laterally
  - Resume navigation to target



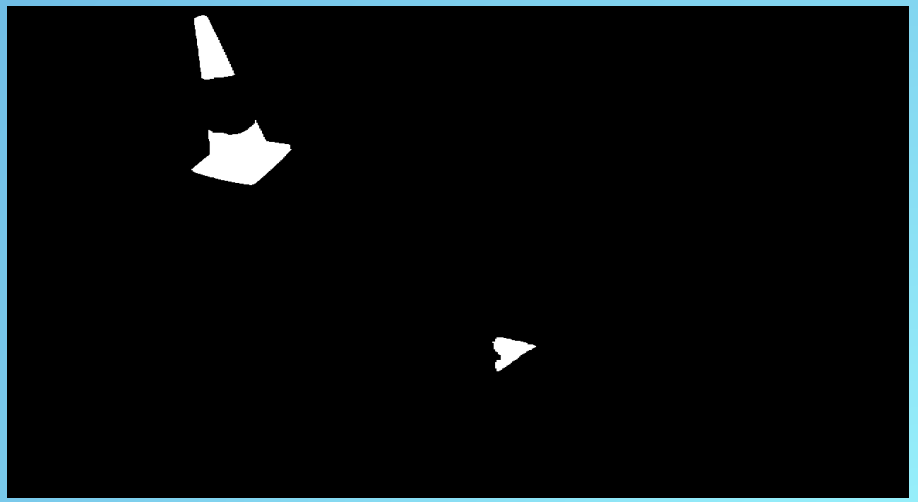
Lift Mechanism

- Arm:
  - Tilts upward (pick up) or downward (drop off)
- Use joystick for arm control
- Transport AED at lifted angle

UR5 VISION CONTINUED

Triangle and Red Object Detection

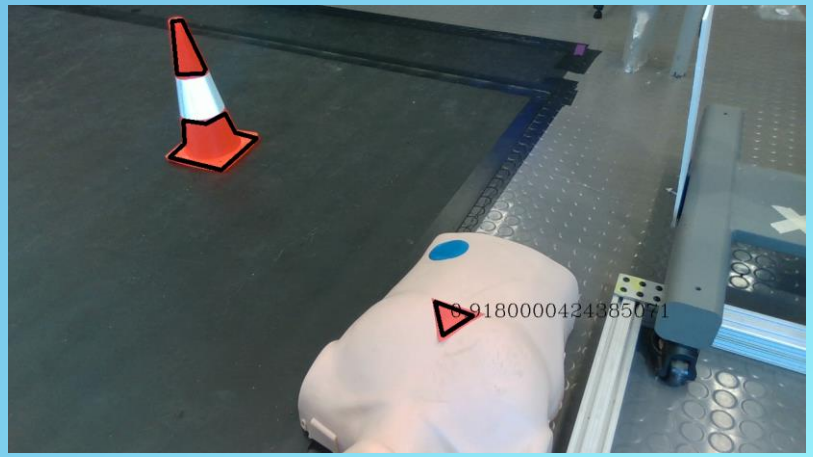
1. Start the color and depth frame streaming for the intel D435i RealSense Camera
2. Using a range of HSV values <(0,255),(134,255),(205-255)> detect red objects in the image frame and apply a mask
3. From the red objects in the image, detect how many contours there are for each object, object with 3 contours is the triangle.
4. Compute the Center of the Triangle



UR5 VISION CONTINUED

Determining Depth and Coordinate Transformation

1. Using the depth frame and the center of the triangle determine the distance normal to the camera lens(in meters).
2. Using the camera intrinsics and the depth distance to the object, convert the (x,y) pixel coordinates to the (x,y) 3D coordinates.
3. Transform coordinates from camera reference frame to ur5 base frame
4. Send the coordinates of the Triangle to the ur5 manipulator



UR5 CPR

Position Control

- Determine z-position of chest
- Generate points above and below calibrated z-position
- Command arm to move to the points using rtde control commands
- Offset drift by checking actual position after each command and shifting pose commands accordingly
- Attempts to integrate force control were unsuccessful

BEST PERFORMANCE: 80% success rate, maximum ~90 bpm (one green light)

Force Control

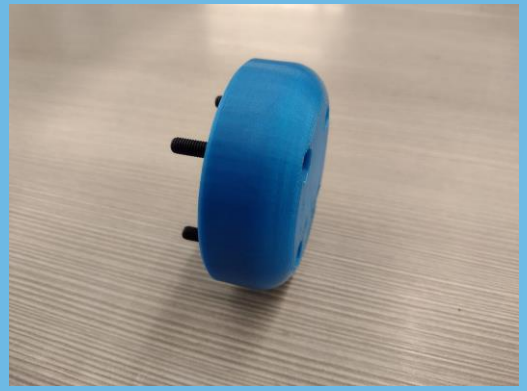
- Determine z-position of chest
- Command pumping motion using forcemode – the robot adjusts its position along a given axis in order to achieve the specified force
  - Force feedback built into forcemode function
  - Forces generated at a given frequency using a sine wave
- Generally a lot easier and more reliable than position control (free of drift, no limits on frequency of commands)

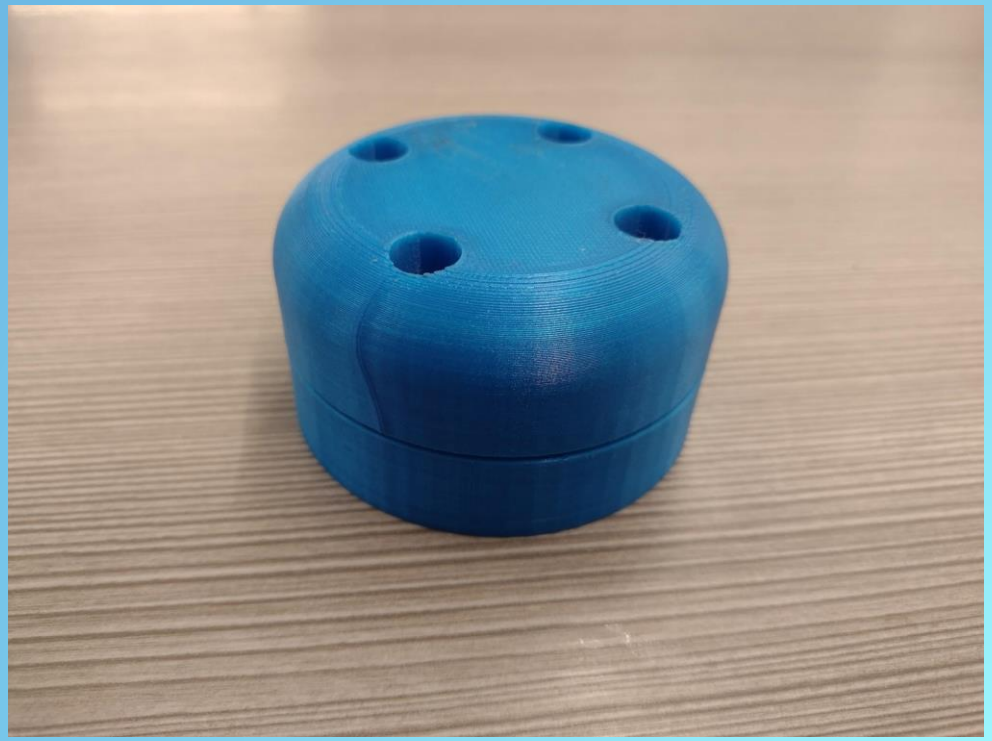
BEST PERFORMANCE: 100% success rate, consistently gets two green lights

UR5 END EFFECTOR

End Effector

- Robust, passive design
- Bolts directly to the adapter plate
- No magnets to damage the force sensors in the UR5
- Rounded to prevent stress points on the patient's skin





AVATAR

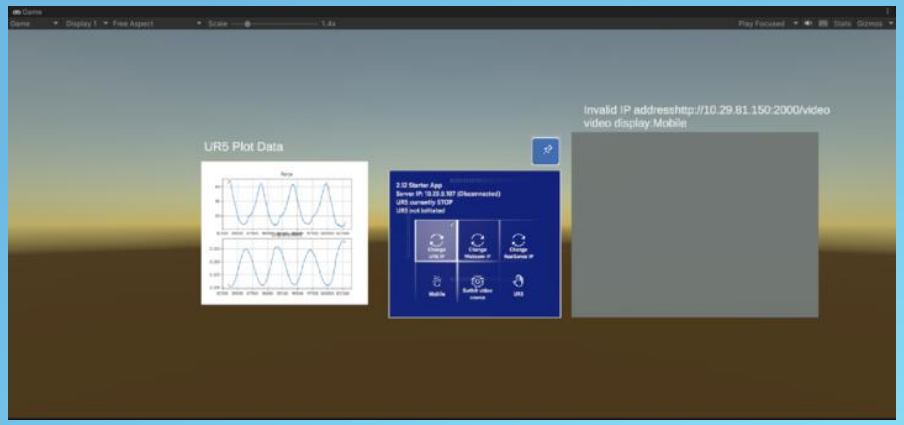
GUI for Remote Robot Control

- Streaming real-time robotic arm /force displacement data to Hololens via IP
- Visualize state of robotic arm using this data
- Enable IP change with buttons and keyboard input
- Remote clinician override functionality with intuitive button-based interface

Video Feed for Remote Monitoring

- HTTP video stream to Hololens via Raspberry Pi
- Read streams on hololens with webcam package
- Display video streams on Hololens with mesh render
- Enable video source switching in hololens for multiple inputs/robots

AVATAR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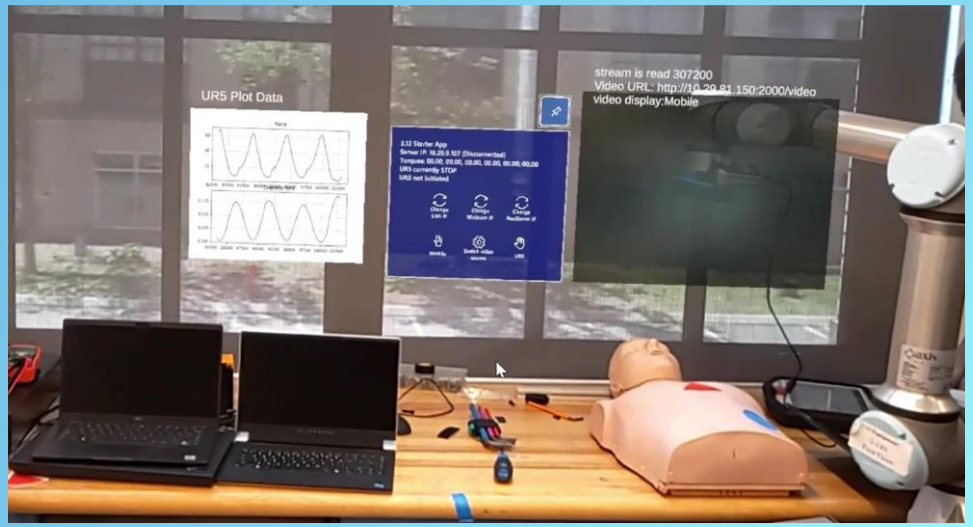
video display:Mobile
UR5 Plot Data


UR5 Plot Data
stream is read 307200
Video URL: http://10.29.81.150:2000/video
video display:Mobile