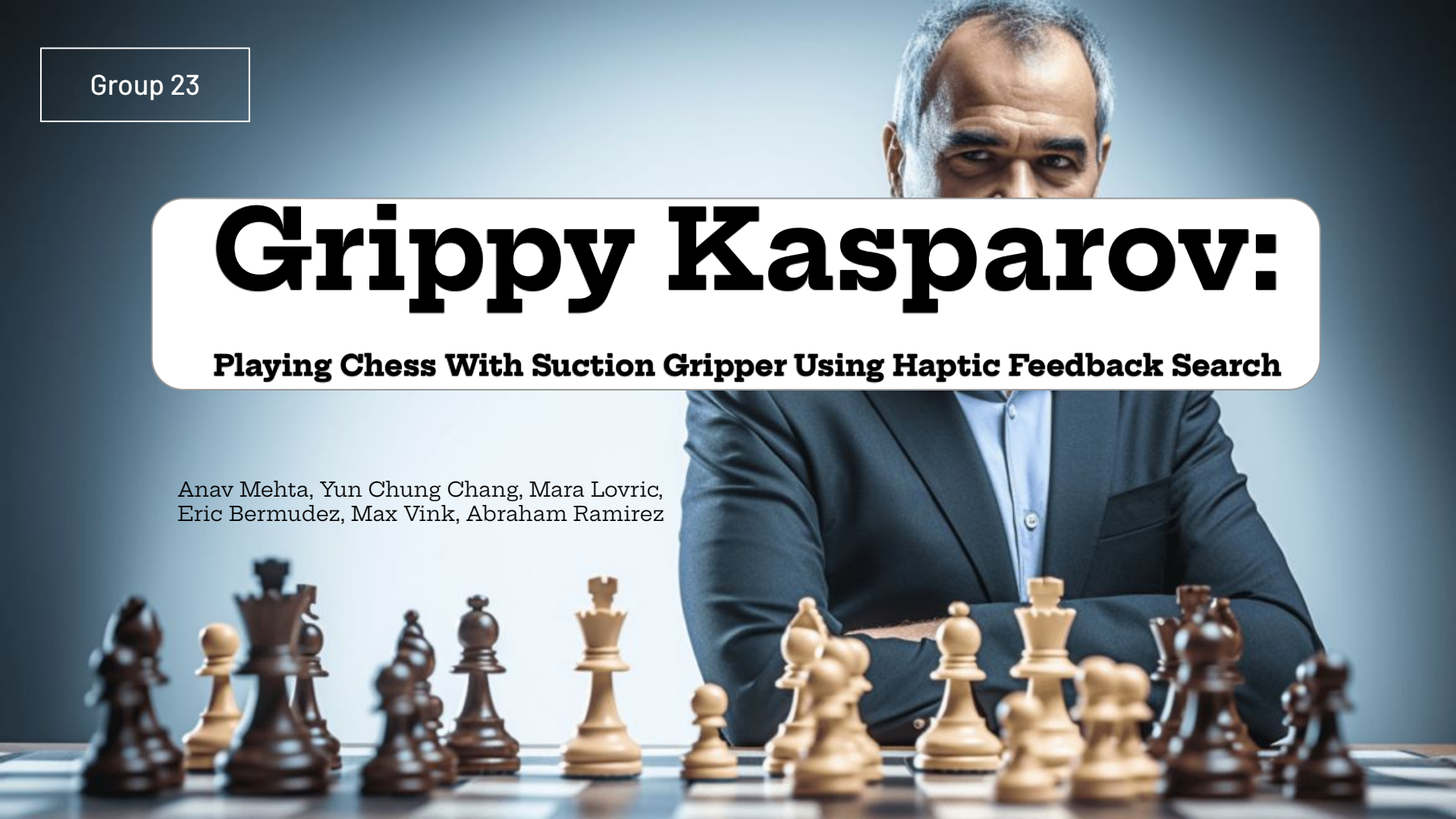
Group 23

Grippy Kasparov:

Playing Chess With Suction Gripper Using Haptic Feedback Search

Anav Mehta, Yun Chung Chang, Mara Lovric,
Eric Bermudez, Max Vink, Abraham Ramirez



Project Requirements:

1. Hardware:
- Universal Robots UR10
- Circuit to control solenoid actuation

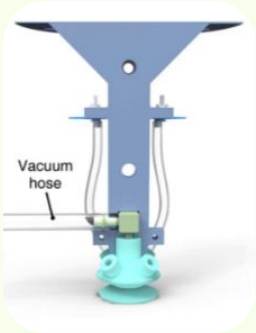
2. Sensing:
- Detecting chess pieces using pressure sensor.
- Using haptic feedback to determine tool movement

3. Planning:
- Determining robot arm movement based on the move to be made.

4. Actuation:
- Activating solenoid to enter push, pull, and off gripper states.
- Universal Robots RTDE Interface

01

02



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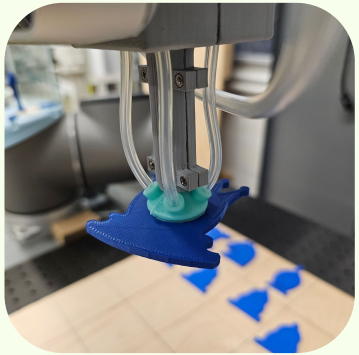
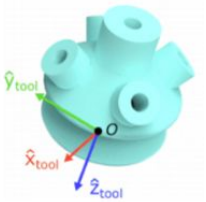
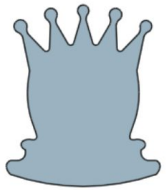
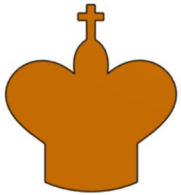


Original Goals:

- Implement a **circuit for positive pressure** in the system.
- Use Stockfish to calculate the next move and record the game state.
- **Pick and place** the piece in an accurate and timely manner.
- Account for **chess move edge cases** (i.e. castling, promotion)
- Implement **haptic feedback to search** for pieces with complex geometries.
- Detect the center of the game board using computer vision.







Applications:

Chess Playing Robot:

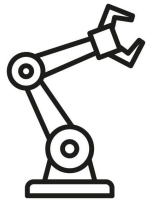
- Human companion robot to play chess
- Give the ability to play chess for people with decreased mobility.

Haptic Feedback:

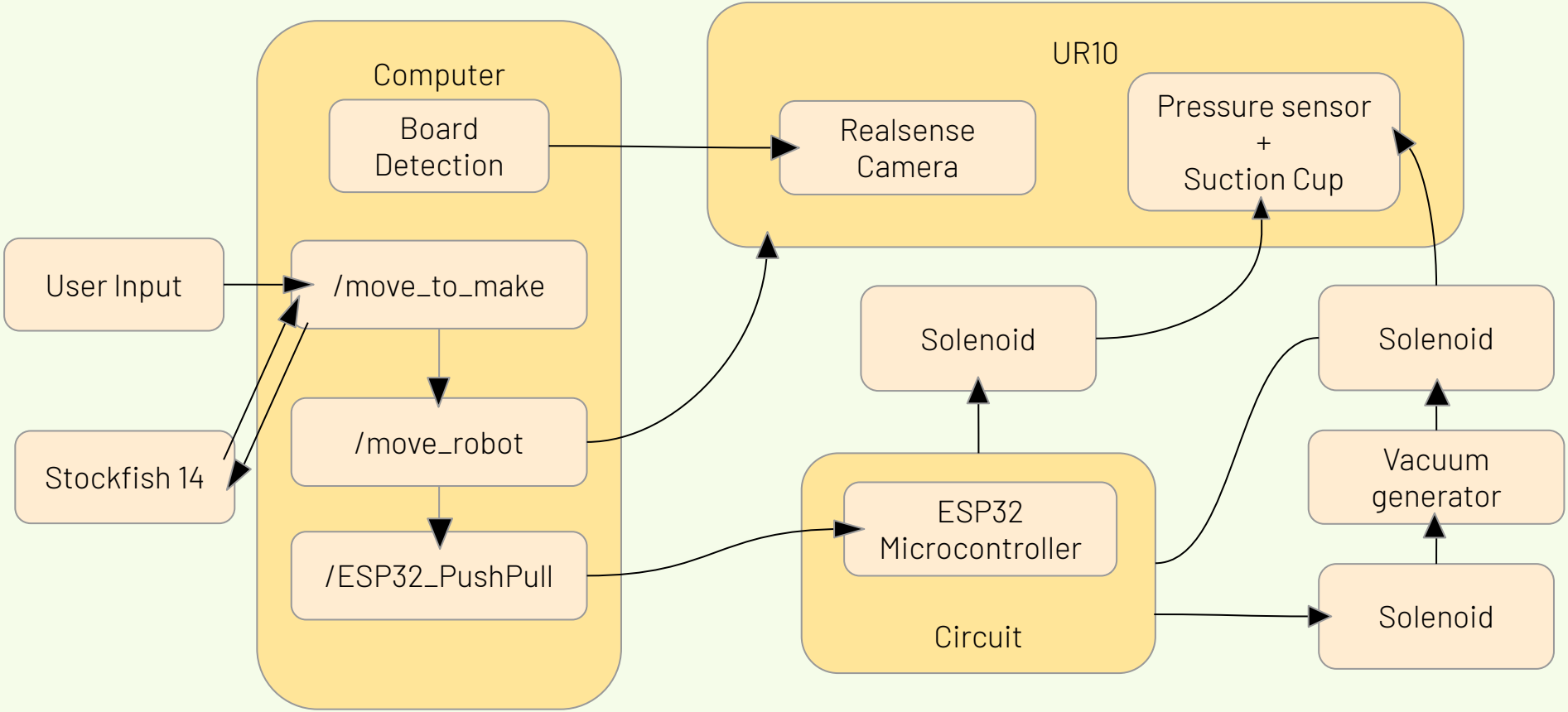
- When computer vision cannot be used (i.e. darkness, with high glare, or with clear/porous objects

Suction Cup Gripper:

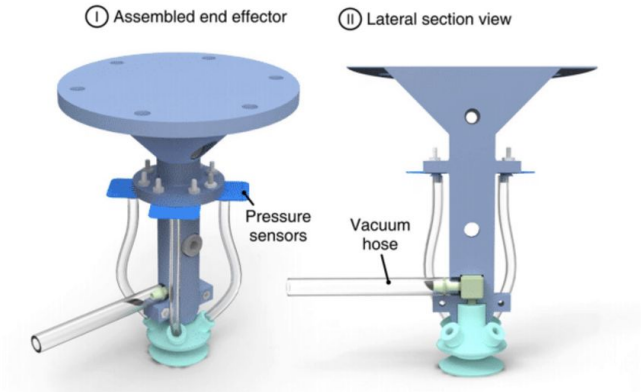
- Picking up objects with complex geometries (i.e. thin, curved)
- Warehouse sorting operations for objects with varying geometries (i.e. Amazon)

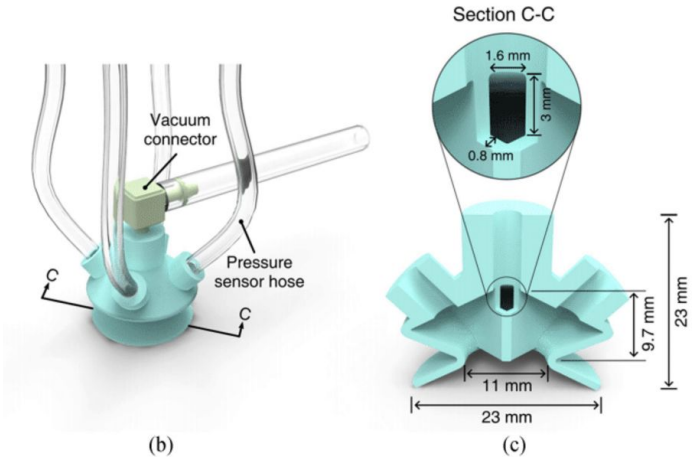


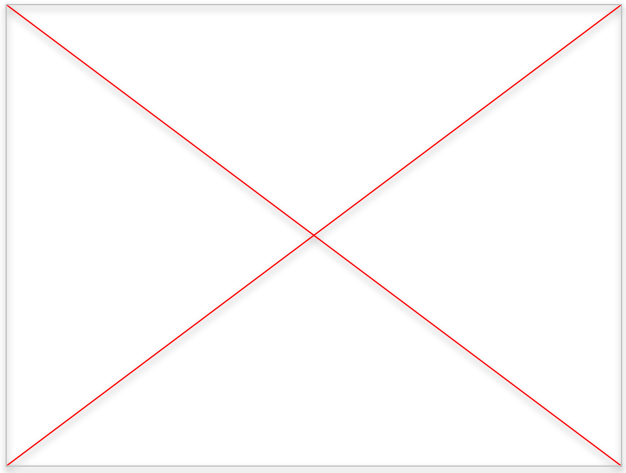
System Diagram

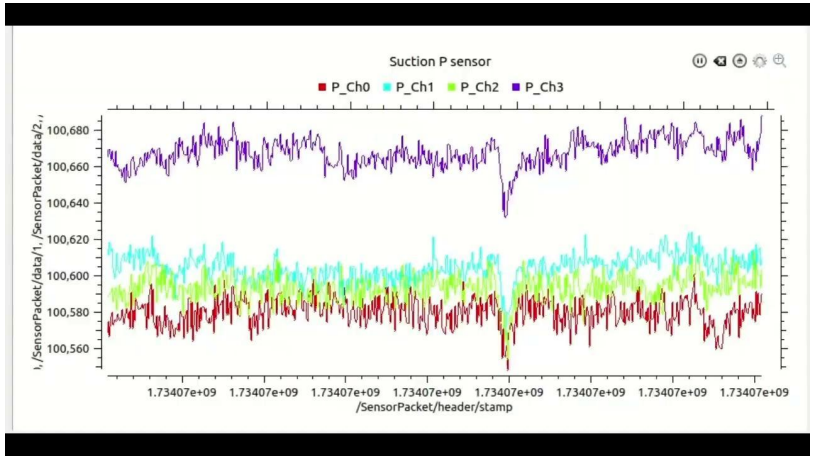


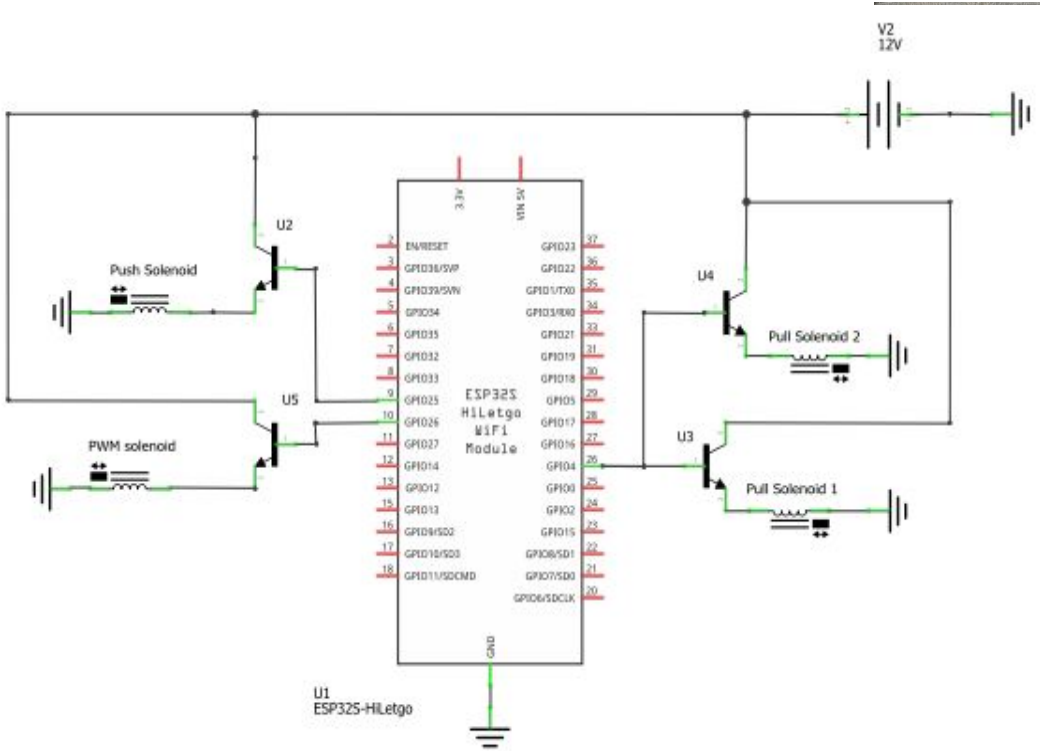
Haptic Search Using Suction Cup End Effector

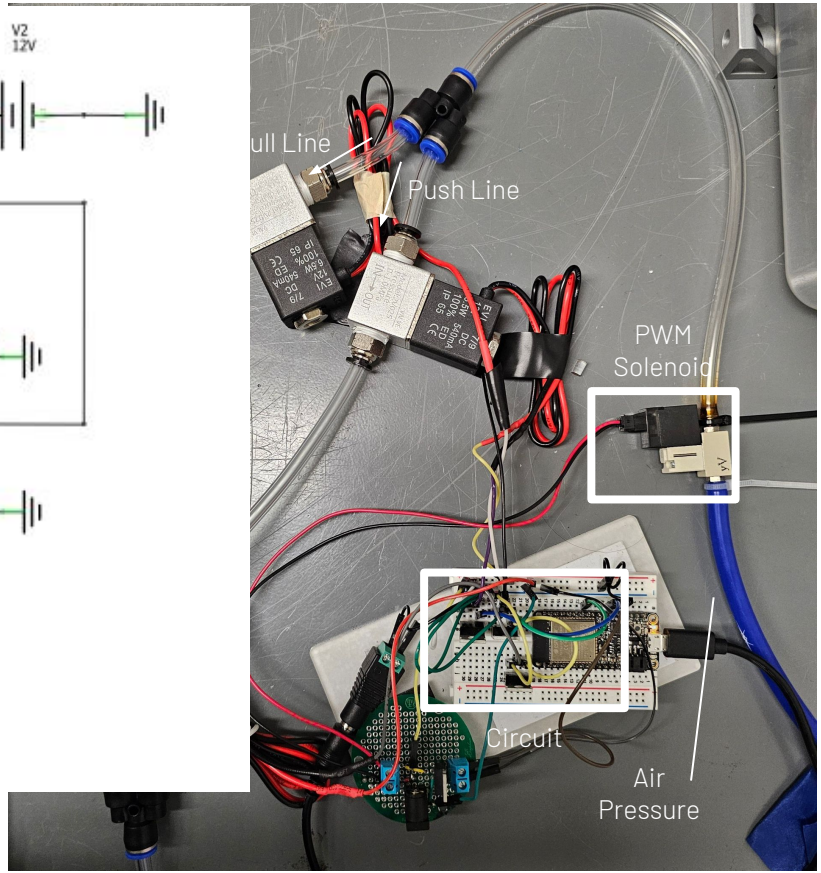









V2
12V
U2
Push Solenoid
U5
PWM solenoid
U4
Pull Solenoid 2
U3
Pull Solenoid 1
ESP32S
HiLetgo
WiFi
Module
U1
ESP32S-HiLetgo


ull Line
Push Line
PWM
Solenoid
Circuit
Air
Pressure

Difficulties we encountered

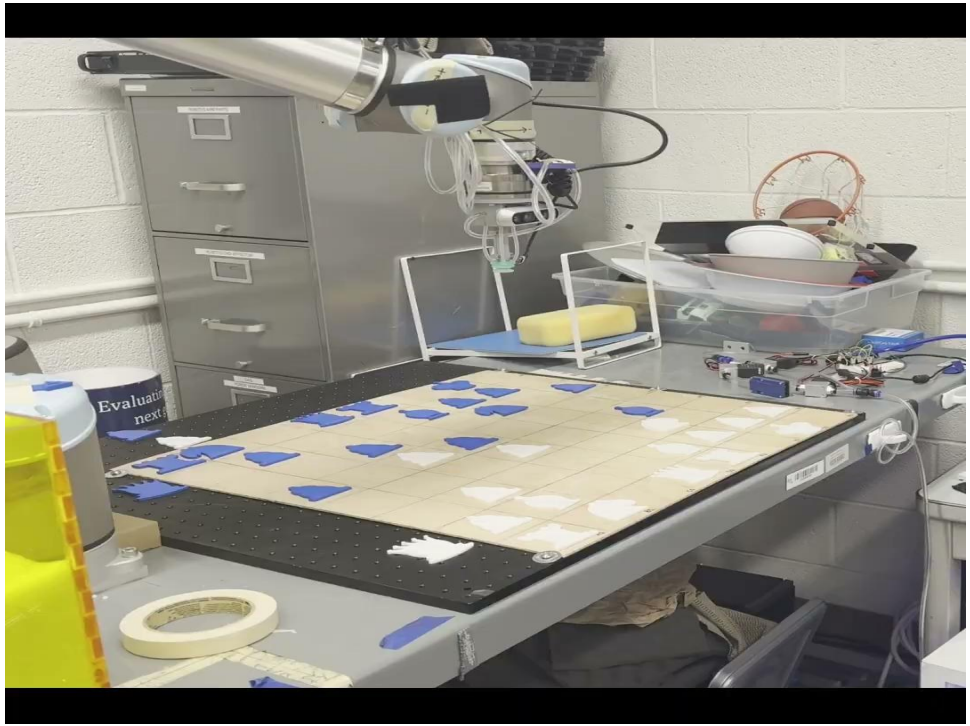
- The secured suction prevented the manipulator from releasing its grip after we finished suctioning the chess piece.
- Problems with circuit caused confusion about successful implementation
- Learning a new robot system and its documentation
- Complex pieces were not able to be picked up by suction cup gripper
- Managing timing between manipulations of our custom hardware and of the robot
- Problems with suction cup pressure readings skewing our haptic search algorithms
- Trajectory planning such that we stay within the safety parameters of the robot
- Having to change project last minute due to safety concerns

Improvements & Extensions!

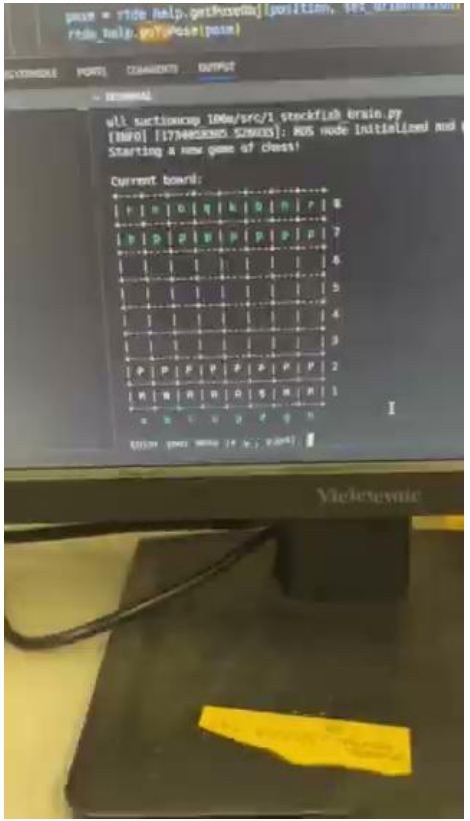
- Reset the board to any state
- Remove human input via terminal through pressure sensors under each square
- Implement Computer Vision and ML to detect the board and play at any state
- Introduce voice recognition

Demo

Hyperlapse Gameplay

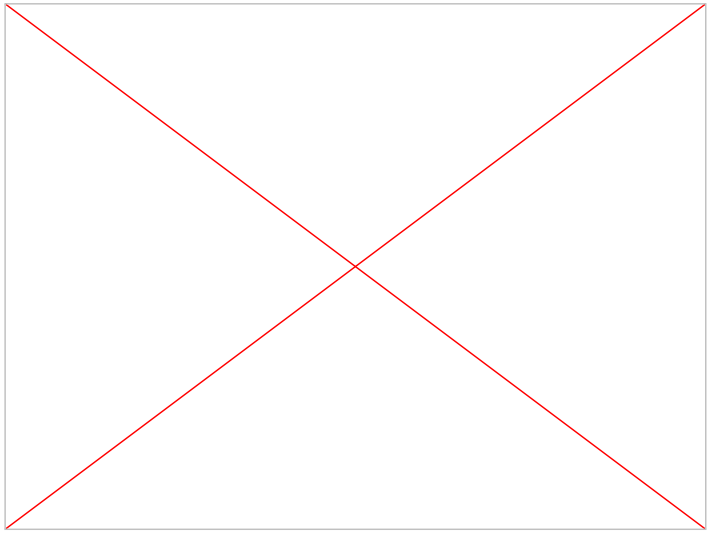


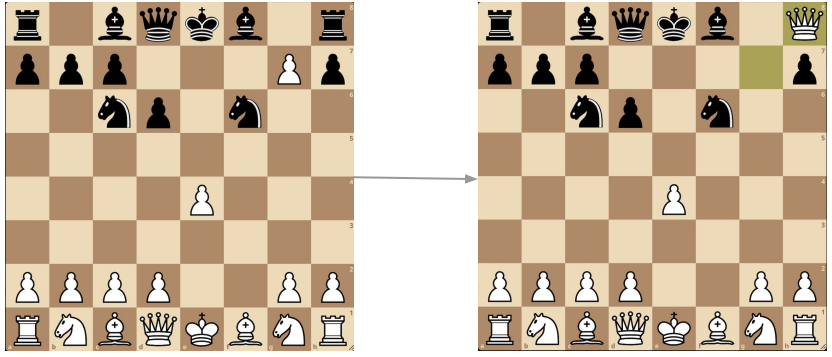
User Interface



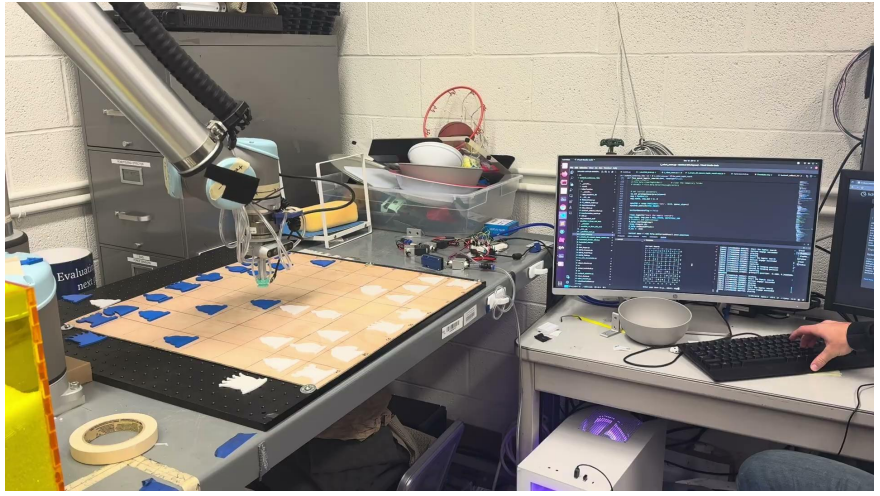
Chess Edge Cases

Capturing While Promoting





King Side Castling



Thank You!!

Have a wonderful winter break
and stay robotic