UNIVERSITY OF
ILLINOIS
URBANA-CHAMPAIGN

Hand Gesture Robot Control

Team Envision

Asher Mai, Joshua Cox, Ian Xu

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Motivation

Gesture Control

- Simplify real-time control of robot with gestures rather than joysticks or keyboard inputs
- Allows for remote control, teleoperation, and telepresence
- Hand gestures are a natural and easy form of communication for humans
- More accessible to control for the less technologically savvy
- A full vision approach doesn't require additional hardware

*Cool*ness Factor

- Who doesn't want to control a robot like Hugh Jackman?

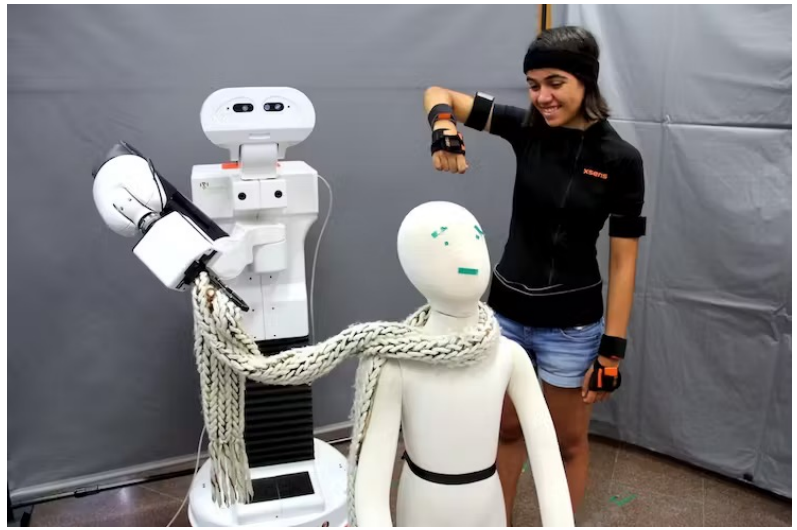
Background

Similar Solutions

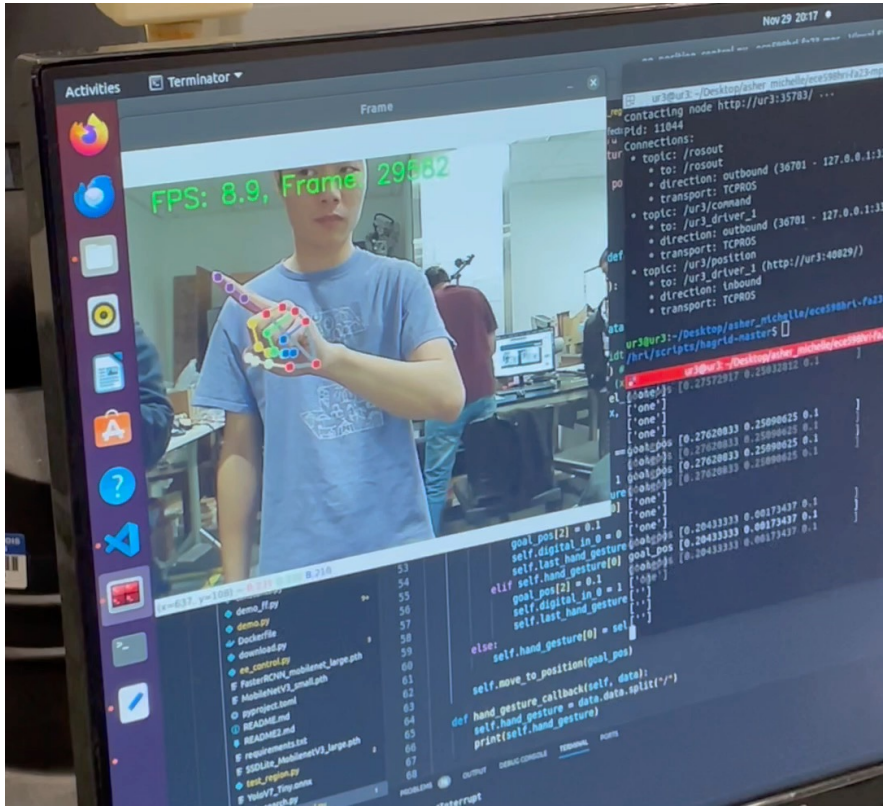
- Robot teleoperation is nothing new, however our solution uses a single camera
- This example from MIT shows the user requiring an Oculus Rift and some joysticks
- Institute of Robotics and Computer Science (Spain) have a similar example below

Limitations

- Latency could create difficulty of use
- Single camera means 3D movements are hard
- Limited range of motion

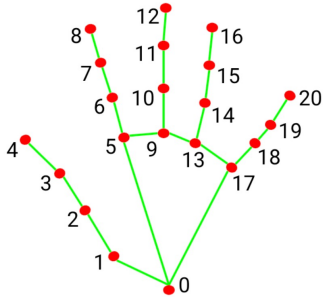


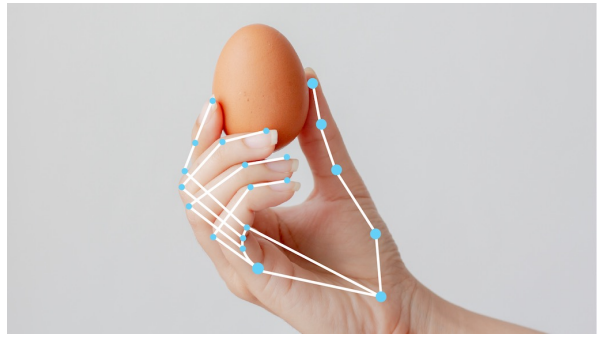
Gesture Detection Pipeline



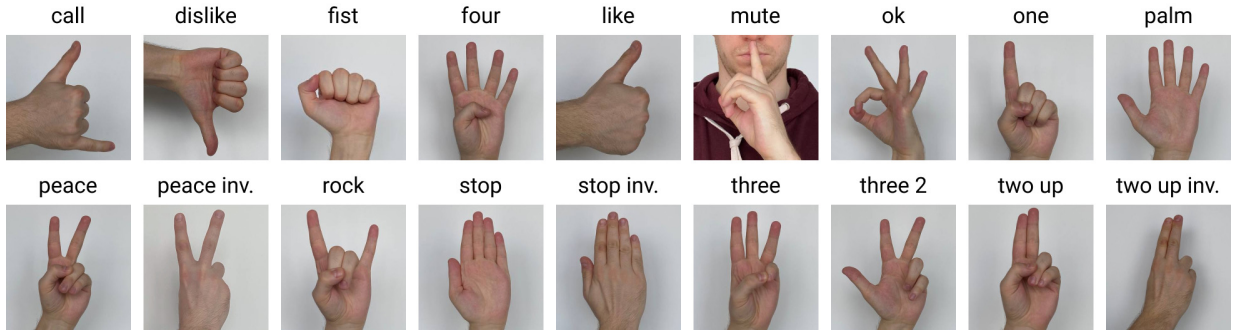
MediaPipe Hand landmarks detection

MediaPipe





HaGRID - HAnd Gesture Recognition Image Dataset



Kapitanov, Alexander, Andrew Makhlyarchuk, and Karina Kvanchiani. "Hagrid-hand gesture recognition image dataset." (2022).
Mediapipe hands. https://developers.google.com/mediapipe/solutions/vision/hand_landmarker, 2019.

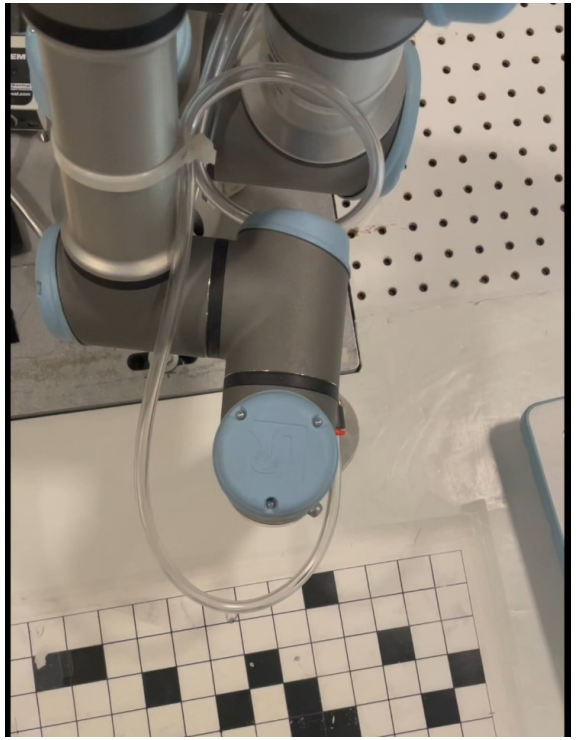
Control

Position Control v.s. Velocity Control

- Position control moves the robot from one point to another, often stopping at each point before moving to the next
- Velocity control commands the robot to move at a specified speed (velocity) in a particular direction

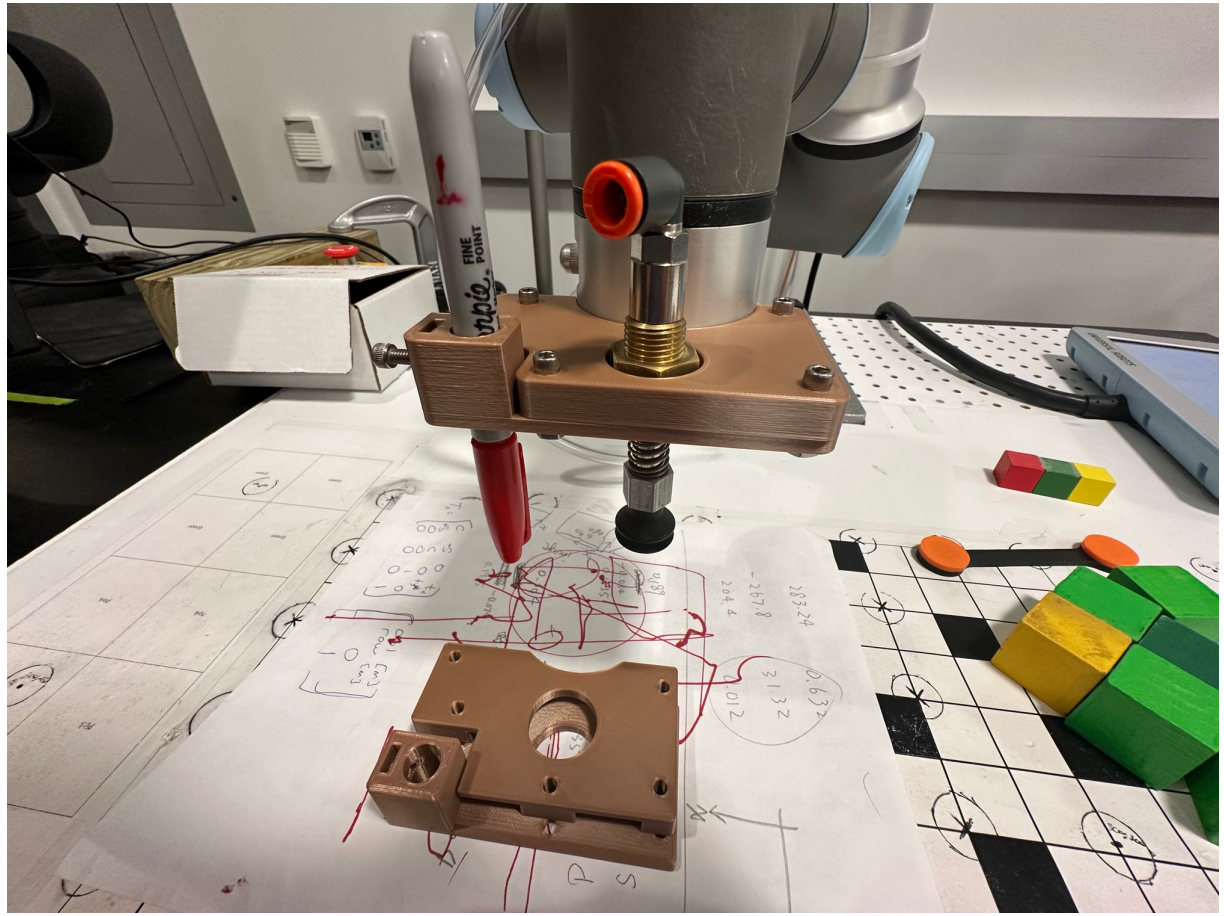
PD Control

Control Frequency

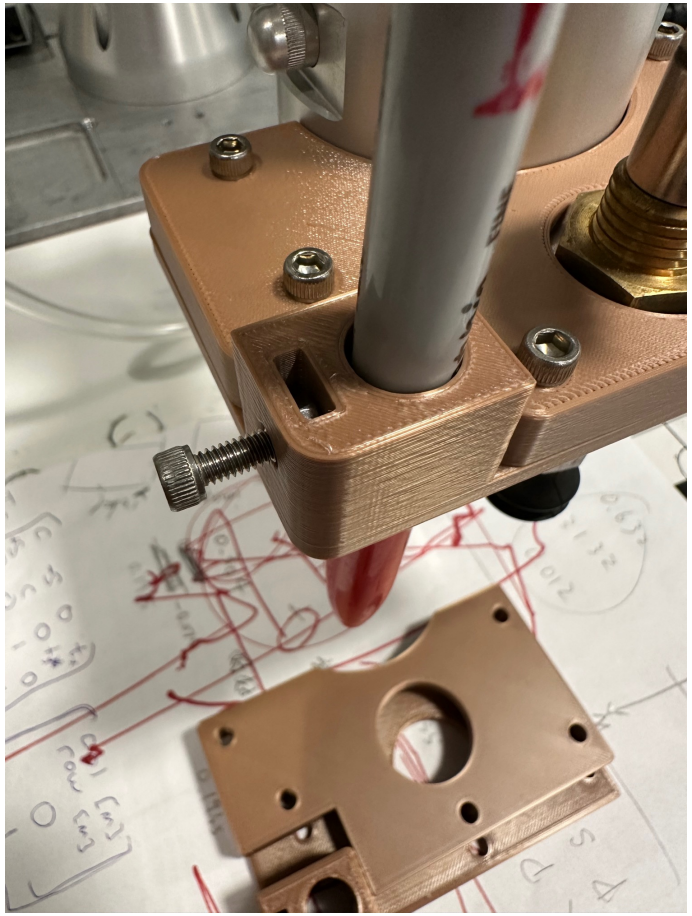


UR3 moving in a circular path using velocity control

End-Effector Attachment

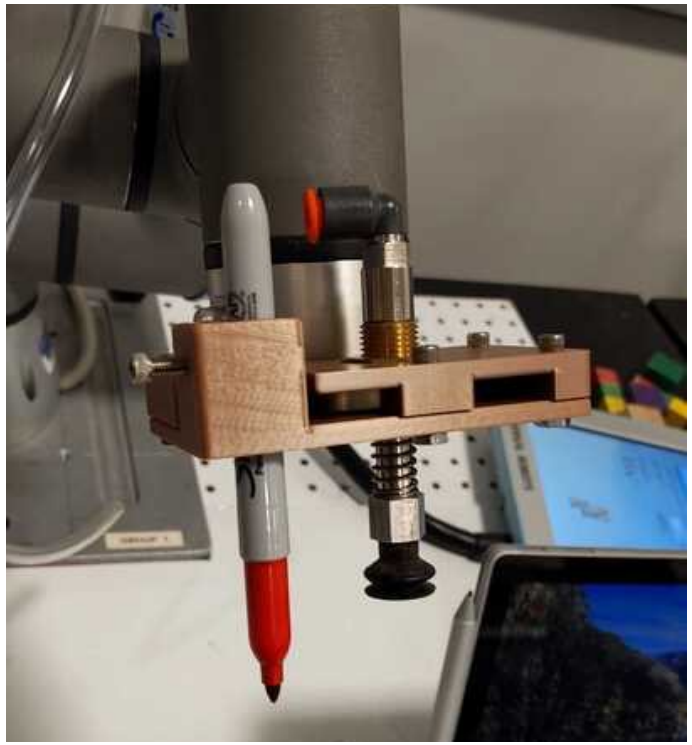


Two 3D-printed pieces are screwed together to be attached to the end-effector

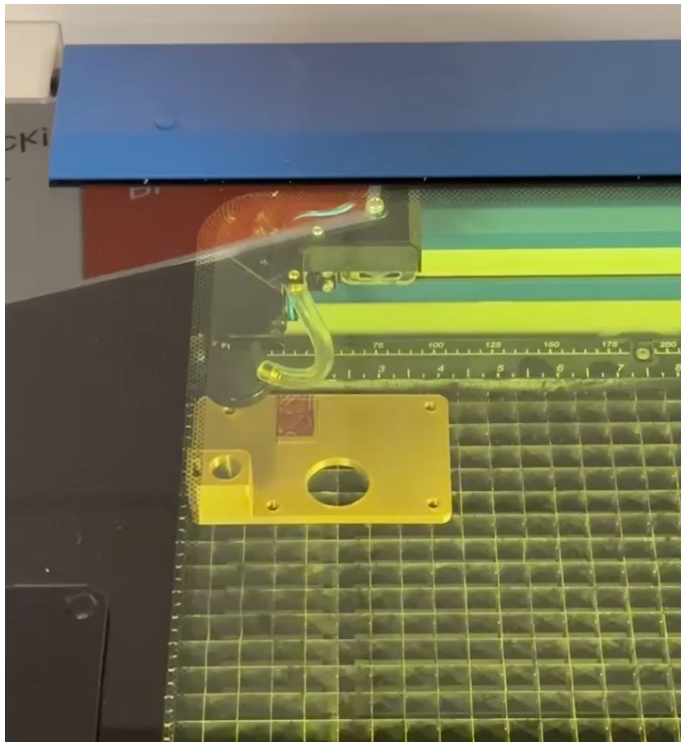


A screw is used to hold the pen in place

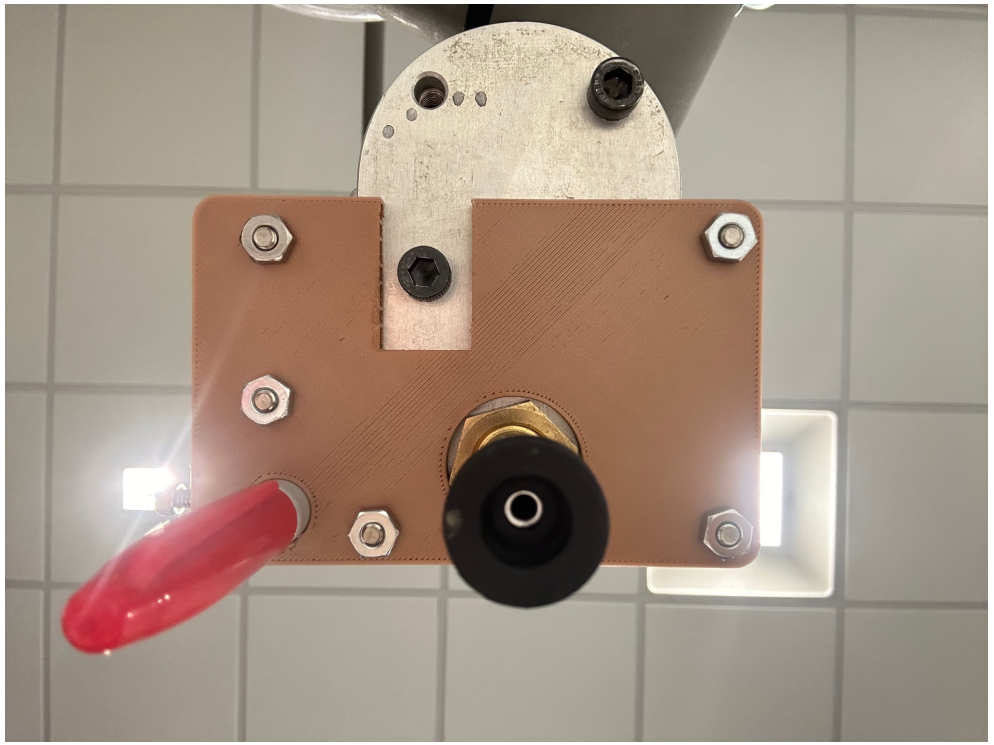
End-Effector Attachment



First iteration, a bit unrefined and wobbly

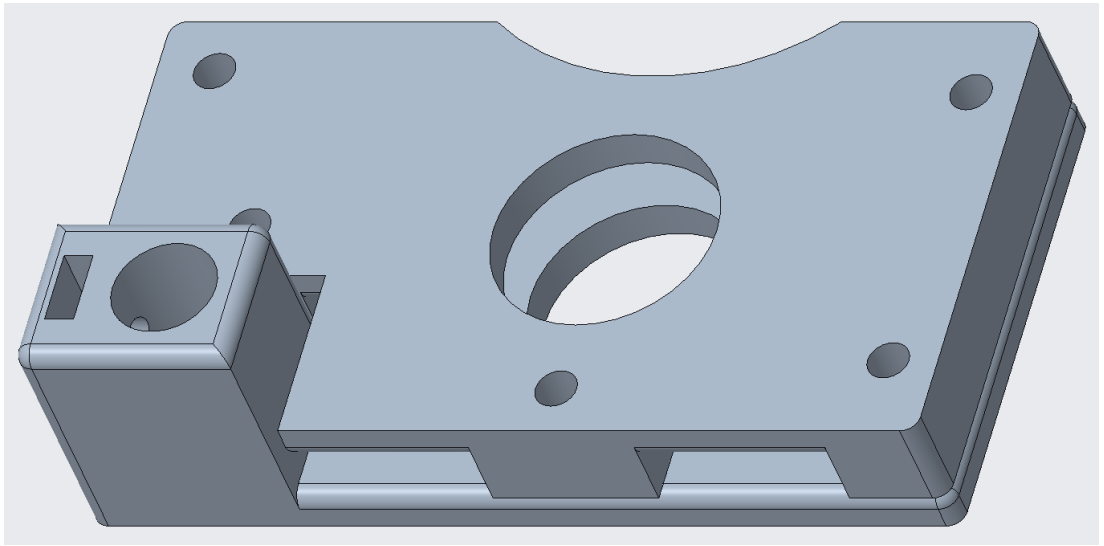


Had to laser cut corrections

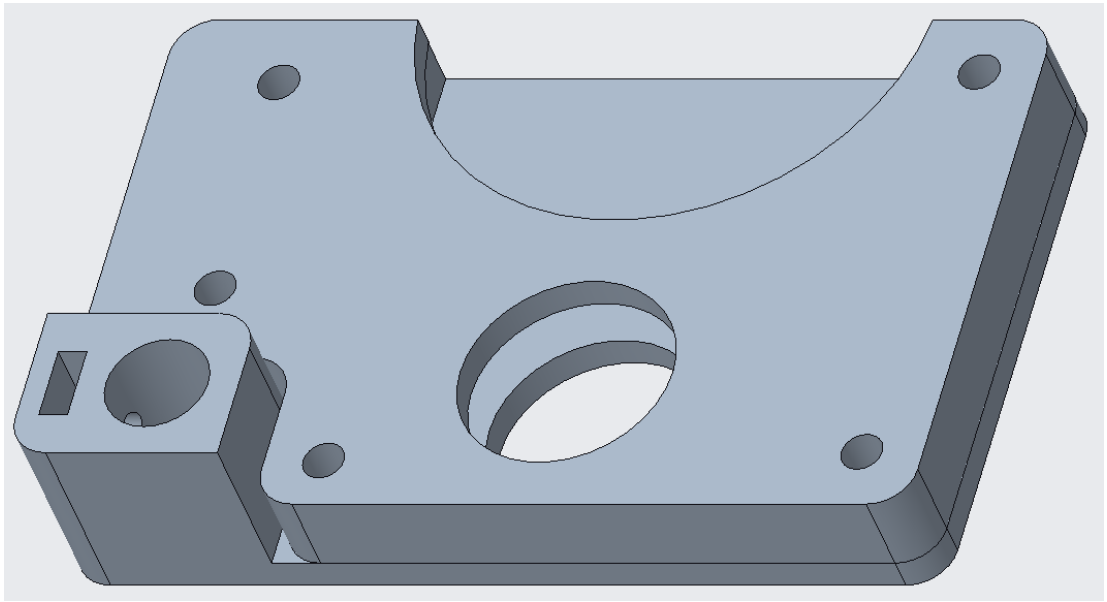


The bottom piece of the attachment after laser cutter correction

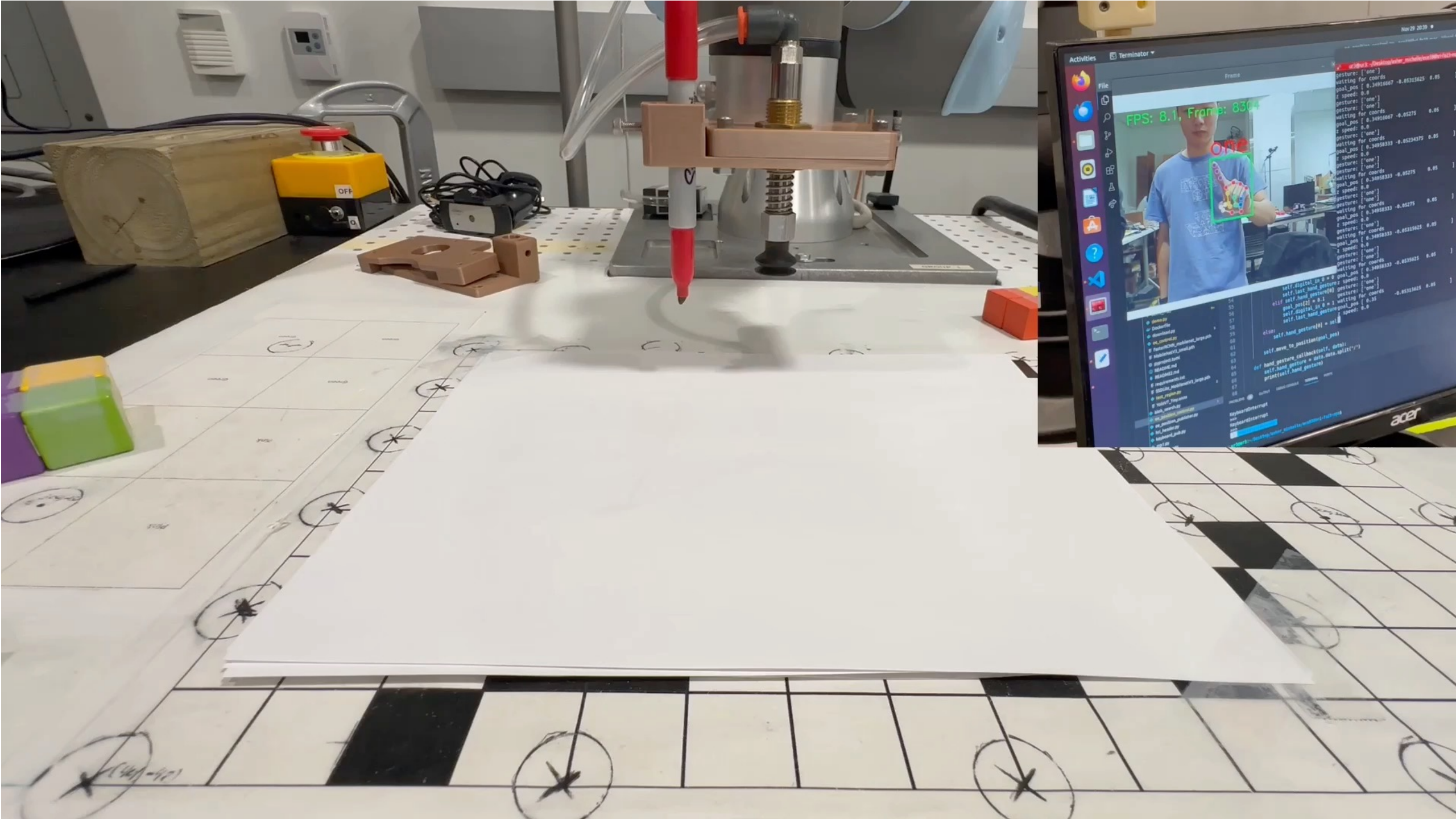
End-Effector Attachment



First CAD Model



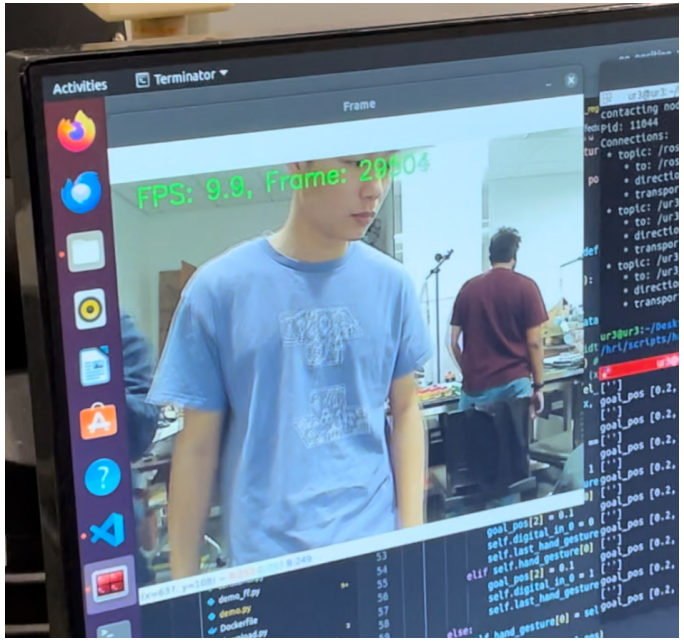
Second CAD Model


Activities
Terminator
File
FPS: 8.1, Frame: 830
one
acer

Results

Achieved

- Distinguish intentional gestures
- Compatibility of the drawing utensils with UR3 end-effector
- Control via gestures
- Smooth robot movement
- Drawing task and pick-and-place task



Challenges

- Not the most intuitive control
- We wanted real time, but bad CPU and GPU did not help with this
- Processing lag made the controls more difficult than expected

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