Gesture-Based Teleoperation of Stretch Robot

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Motivation & Problem

Traditional control = joysticks, wearables

Need: natural, contact-free control

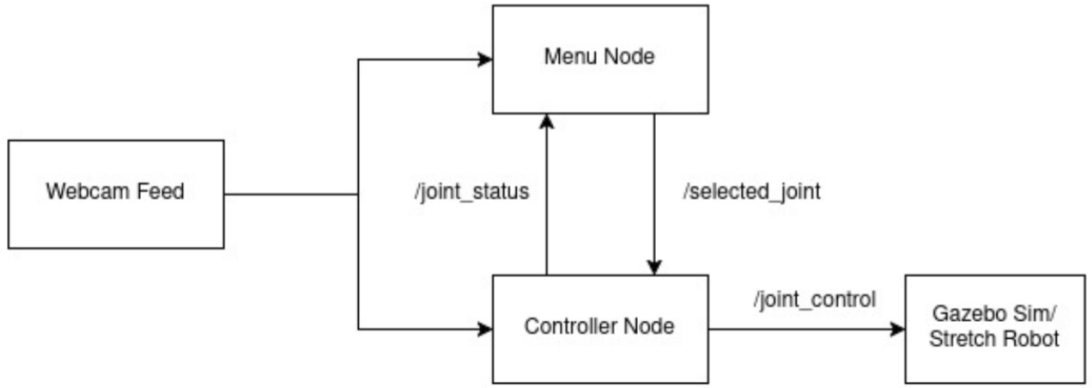
Goal: Robust gesture-based teleoperation

System Overview

Uses Mediapipe + ROS2

Two ROS nodes: Menu Node & Controller Node

Webcam input → real-time control



Gesture-Based Interaction Interface

Menu Selection

•On-screen buttons for mode selection

•Fingertip hover → intuitive & error-resistant

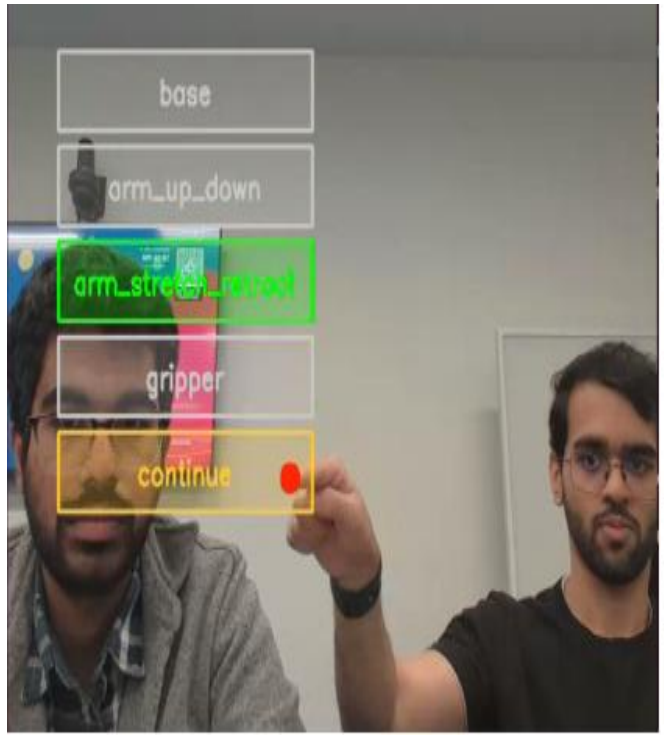
Gesture Commands

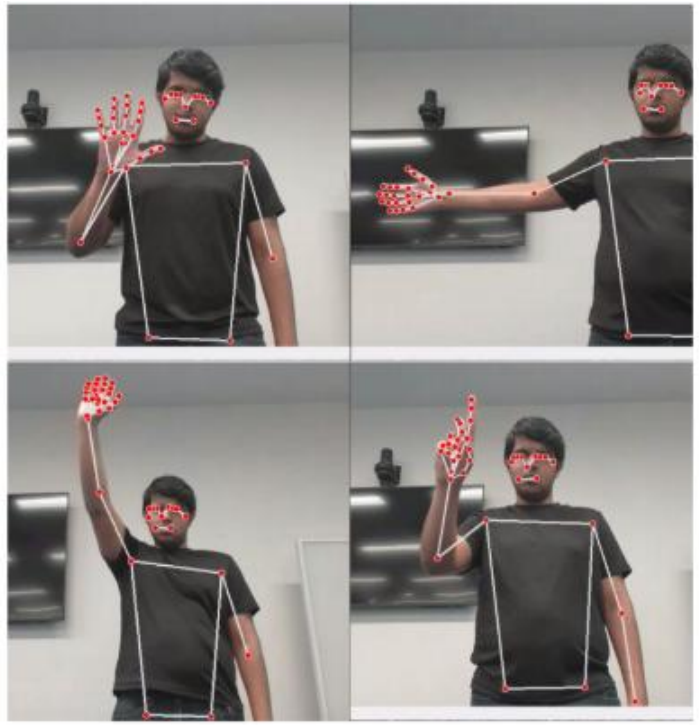
•Wrist to shoulder → Arm up/down

•Elbow angle → Arm stretch/retract

•Thumb-index gap → Gripper control

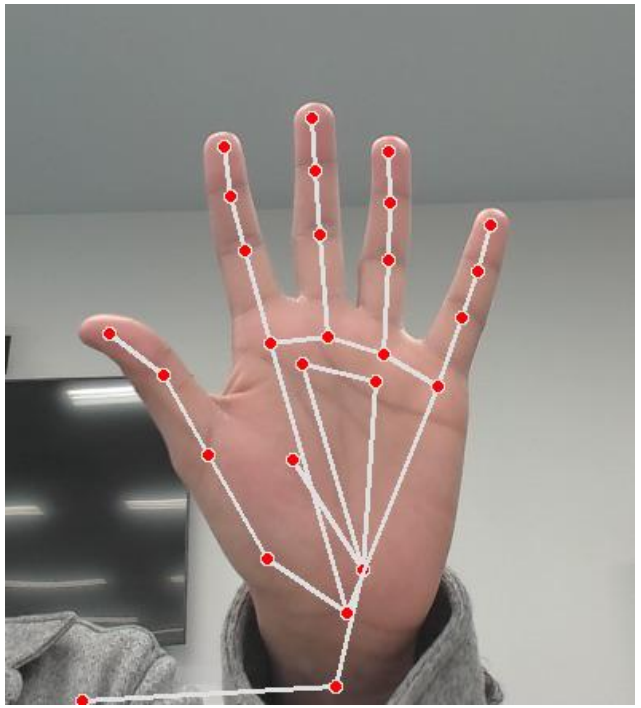
•Two open palms → Return to menu





Vision System – MediaPipe

- Real-time hand & pose tracking
- Uses standard webcam (no gloves or sensors)
- Extracts 21 hand landmarks + 33 pose landmarks
- Enables gesture recognition like arm raise, finger gap, and two palms
- Fast, lightweight – runs at 30 FPS on standard PCs

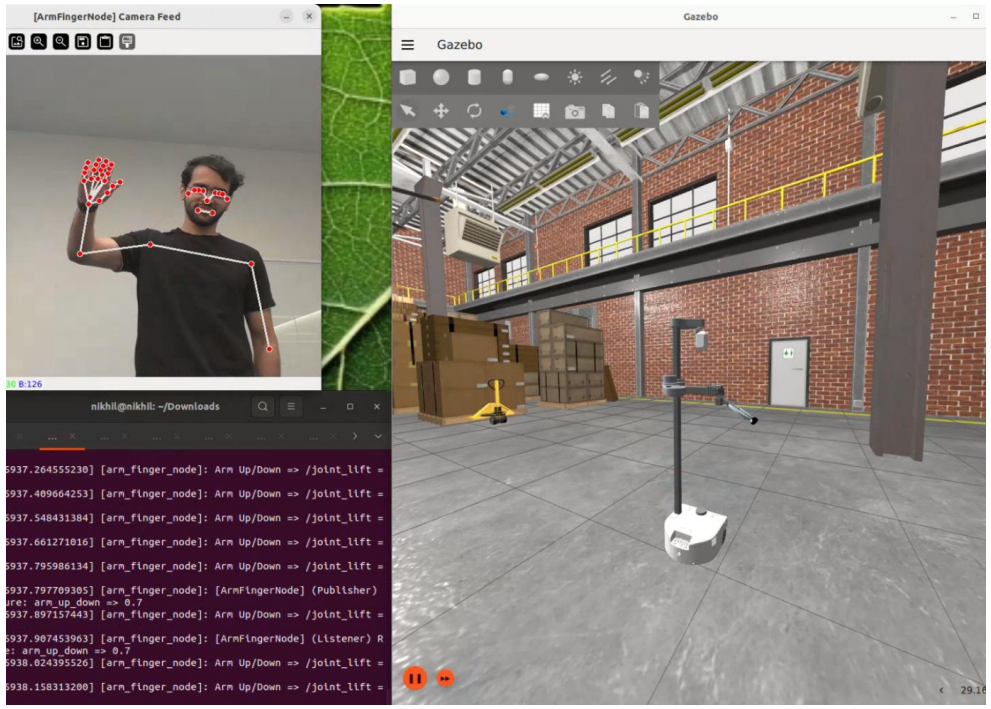


ROS2 & Robot Simulation Framework

- **ROS2:** Modular robotic middleware for control logic
- **Menu Node:** Manages hover-based UI
- **Controller Node:** Interprets gestures & sends commands
- **Gazebo (Ignition):** Simulated environment for Stretch 3 robot

Bridging Vision and Control – MediaPipe + ROS2

- **MediaPipe:** Extracts real-time body & hand landmarks from webcam
- **Landmarks → Gestures:** Wrist, elbow, thumb-index used to infer actions
- **ROS2 Menu Node:** Receives selected robot mode via hover interface
- **ROS2 Controller Node:** Converts gestures into robot commands
- Seamless handoff from vision to action in real time

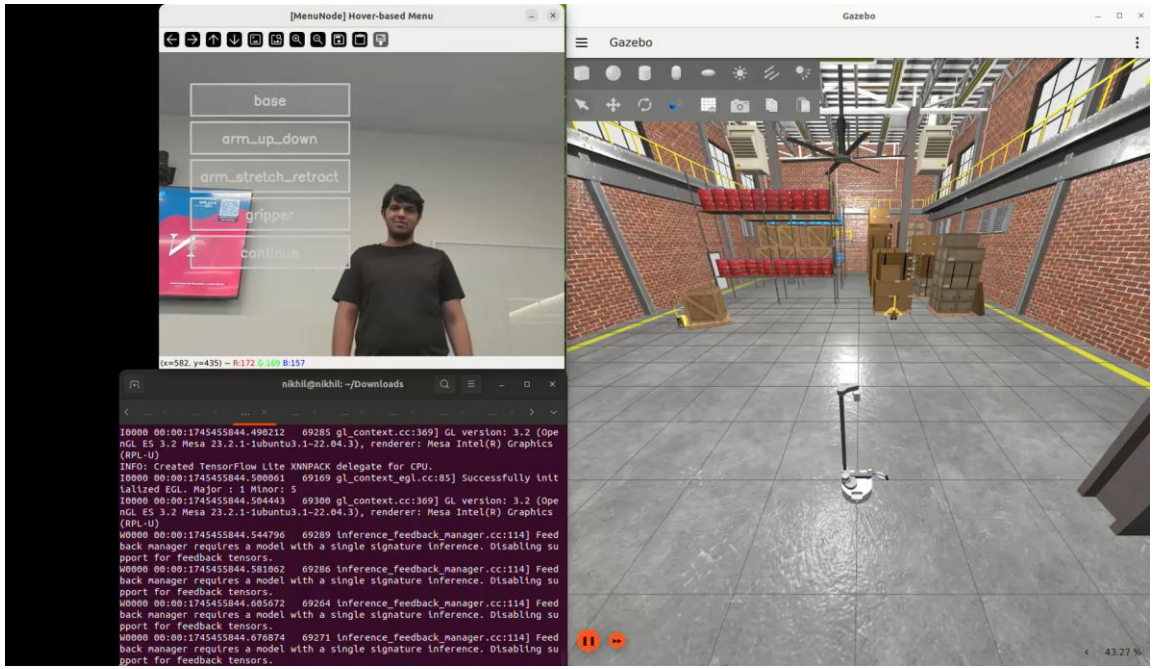


Results Summary

Gesture Type	Accuracy	Recall	Avg. Latency (s)	False Positives
Base Movement	0.95	0.93	0.20	0.05
Arm Up/Down	0.90	0.88	0.22	0.07
Arm Stretch/Retract	0.88	0.85	0.25	0.09
Gripper (Open/Close)	0.96	0.94	0.19	0.04
Two Palms (Quit Signal)	0.85	0.90	0.29	0.15

Table 1. Gesture Accuracy, Recall, Latency and False Positives rate results

Final Demo



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