

Intuitive Control of a 6DoF Robot Arm

EECS 452: Digital Signal Processing Design Lab (Winter 2023)
Nick Farid, John Getty, James Wishart, Justin Yu

Motivation

- Improve human-robot interaction (HRI)
- Enhance control of high degree-of-freedom (DoF) robotic arms; unintuitive with traditional input devices
- Remove need for mechanically complex input hardware

Introduction

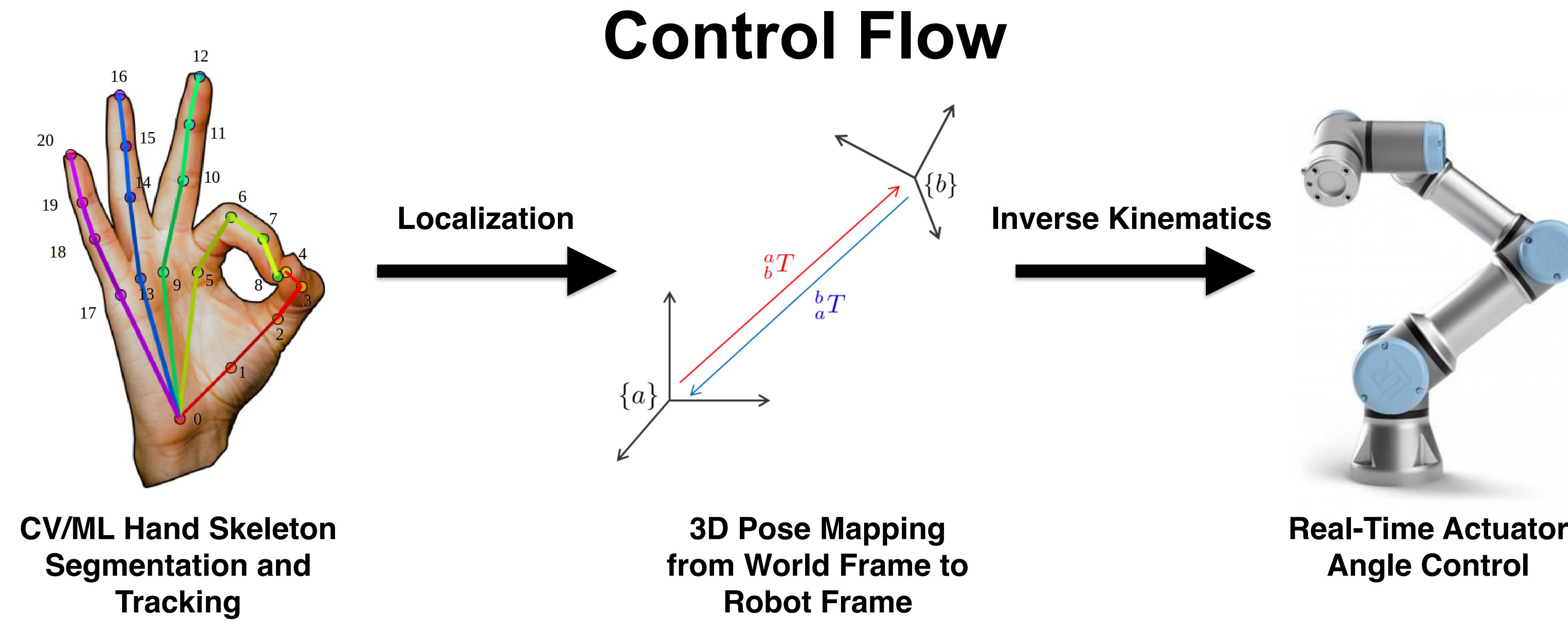
We aim to create an intuitive real-time tele-operation control scheme for robotic arms (RAs) that emulates the movement of a human arm-hand end effector system.

Stereo Computer Vision (CV) with an integrated Machine Learning (ML) pipeline will be used to implement hand pose estimation and localization in 3D space.

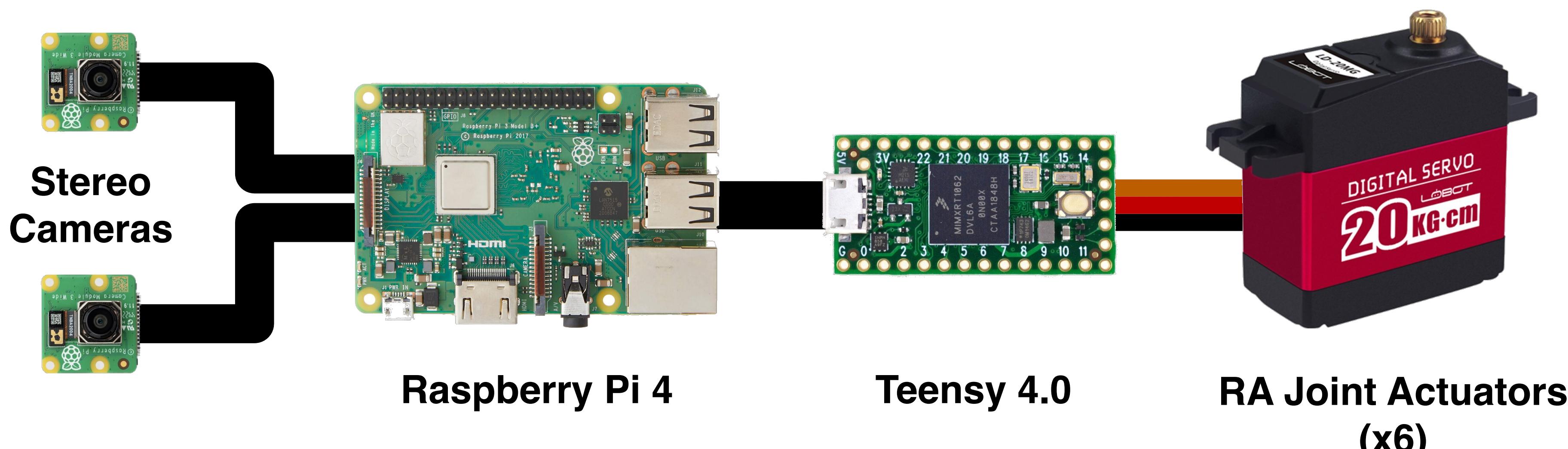
The localized hand pose is re-mapped to the coordinate frame for a 6 DoF RA. The joint angles are calculated and the RA is actuated to achieve the desired pose.

Challenges

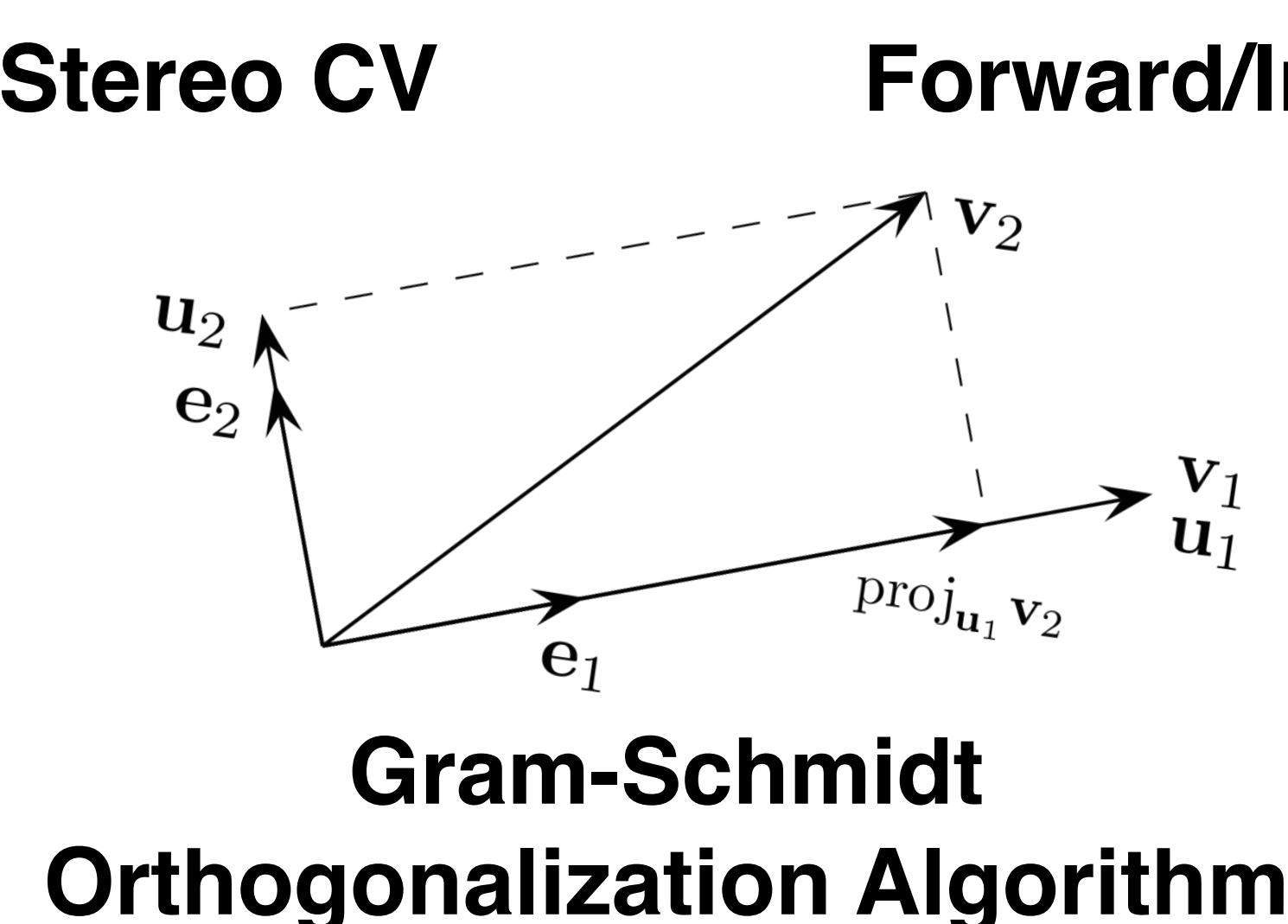
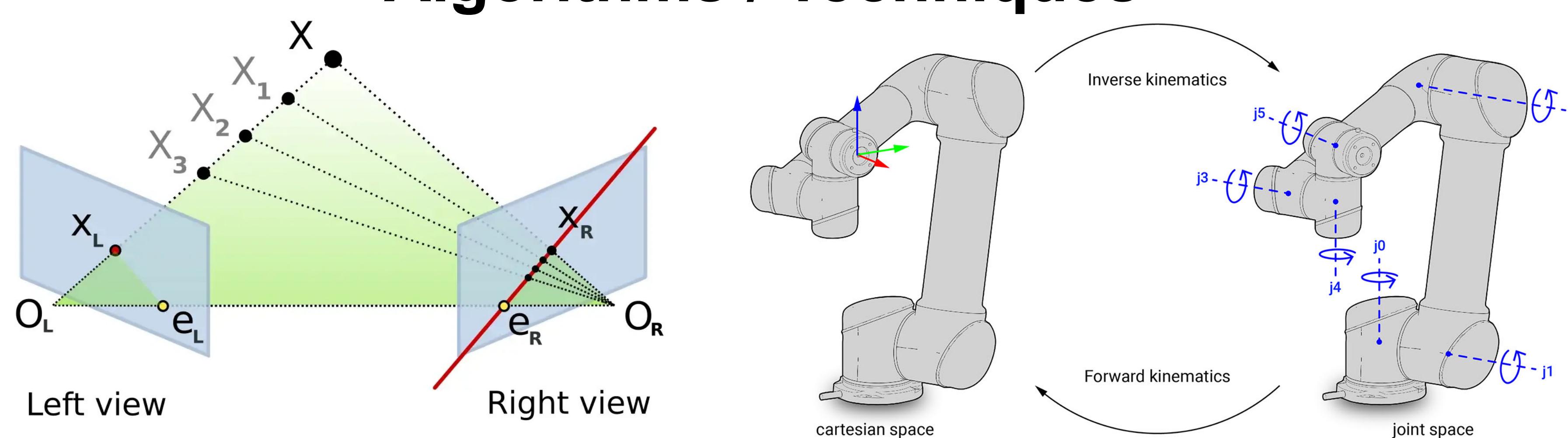
- Real-world frame re-mapped to RA frame
- Appropriate re-map scaling required
- Systems are not fully analogous
- Inverse Kinematics (IK) required
- RA self-collision must be reconciled
- Re-mapped hand pose may end up outside RA configuration space
- Must construct orthogonal frame from 3D hand pose
- Real-time data sync between stereo cameras



System Architecture



Algorithms / Techniques



Progress

During the internal pitch of this project idea, the hand tracking pipeline was demonstrated using a laptop webcam, with the ability to extract hand skeleton segment pixel coordinate information.

Currently, no progress has been made on the hardware development of this project; course is still in instruction until roughly halfway through the semester.

This poster therefore represents our project concept thus far and lays out the anticipated hardware implementation.

Next Steps

- Research and gather pertinent literature for the discussed algorithms and techniques
- Purchase hardware necessary for vision pipeline development
- Define stereo camera physical configuration
- Develop or purchase RA Hardware
- Develop hardware suite for testing the RA

Acknowledgements

We thank Dr. Armin Sarabi and Audrey Cooke for their help and guidance on this project. We would also like to thank Dr. Sarabi for providing the funding that allowed this project to happen.