Human Robot Interaction

Final Project Presentation

Sawyer Teleoperation

Overview

- Overview of Task
  - Motivation
  - Task
- Related Research
- Interface Designed
- Testing
  - Participants and experimental set up
- Results
- Conclusion

Motivation

- Teleoperation is a very useful mode of operating robots, in the unknown and unstructured environments.

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  - Space – Maintenance, Exploration etc.
  - Resource Industry – Power line maintenance, Mining etc.
  - Process Control Plants – Nuclear, Chemical etc.

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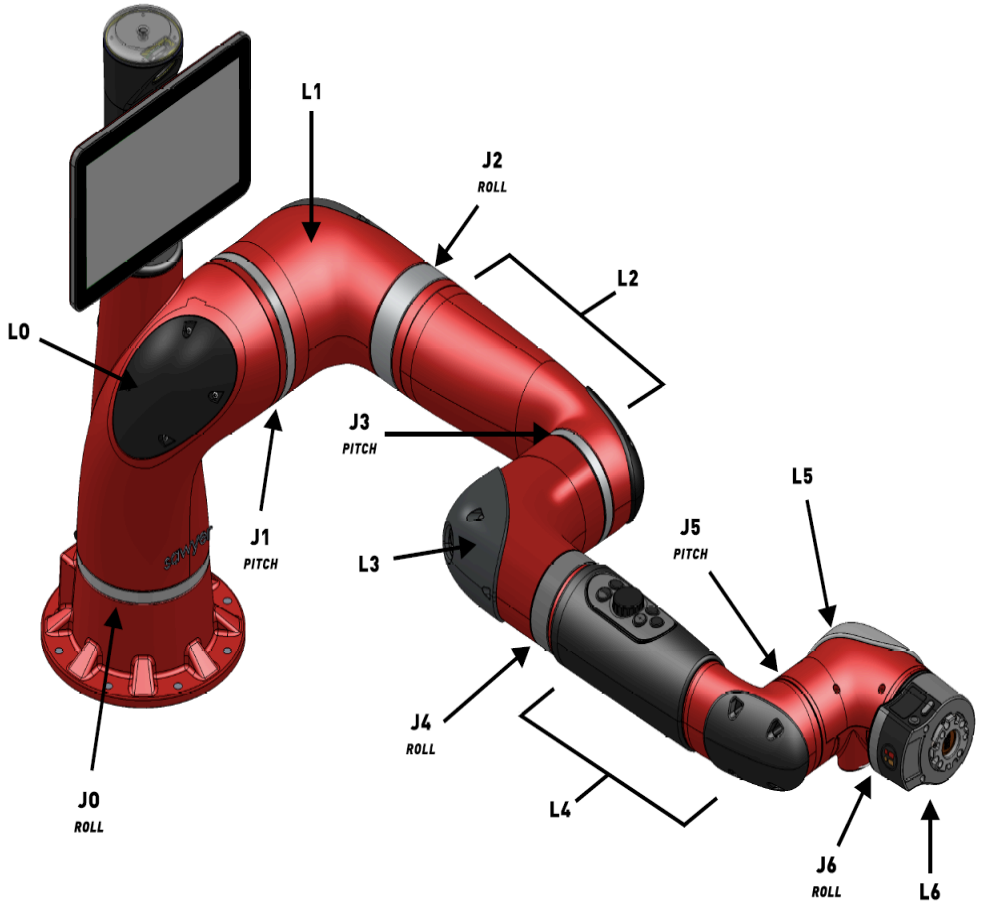
- Tele Nursing Robots.

Robot Chosen - Sawyer

- Naming Joint and Link start at base.
- Increases incrementally up.
- Joints
  - J0 – J6
- Links
  - L0 – L6

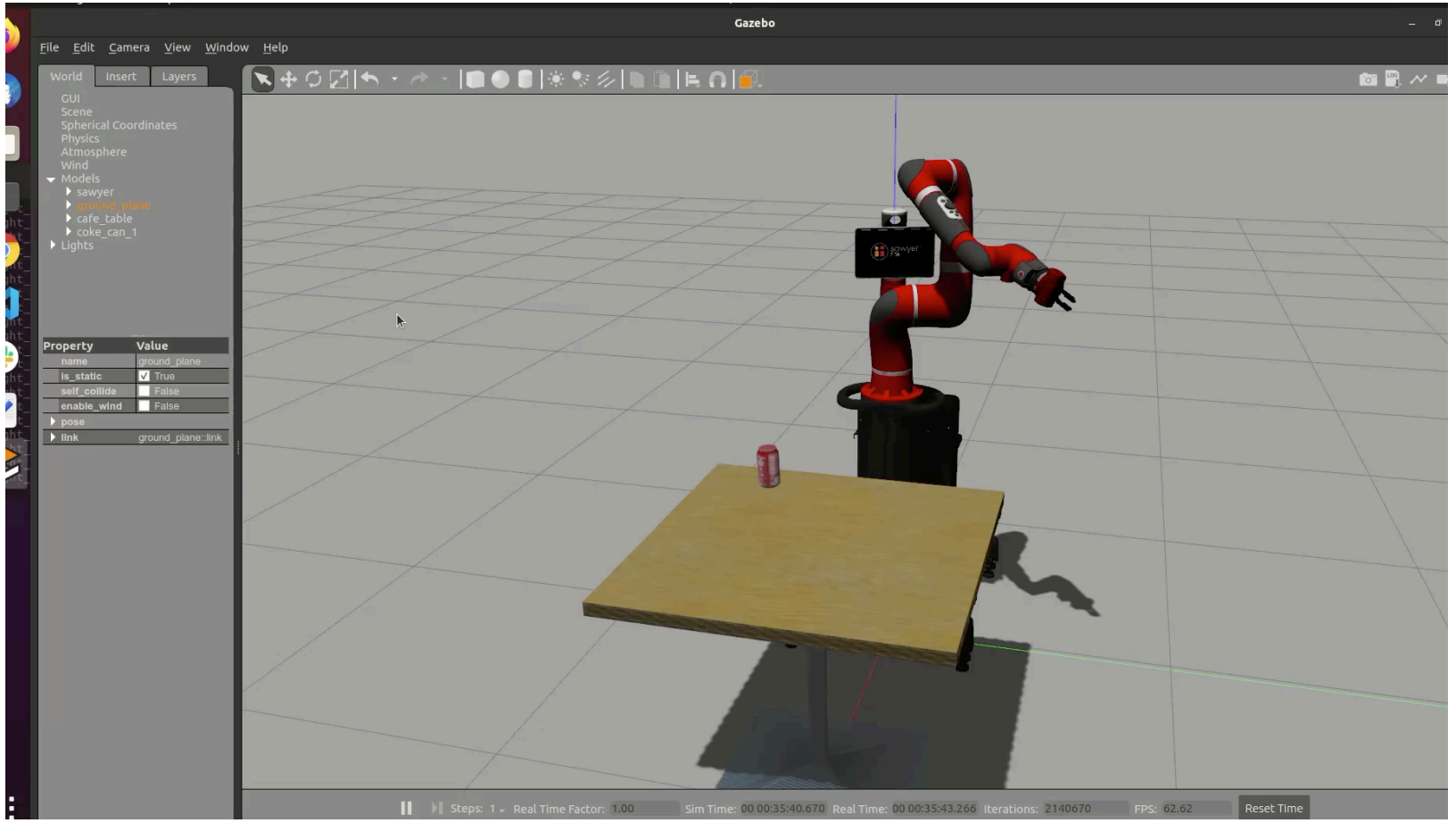


Task

- Teleoperating Sawyer.
  - Keyboard
  - GUI for Joint Control
  - GUI for Pose control

- Moving from one position to another.

Keyboard Teleoperation



Related Work

- Real-Time Joystick Teleoperation of the Sawyer Robot Using a Numerical Approach. [1]

  - Open framework which allows a robot (Sawyer was used in their experiment) to be teleoperated in real time using joystick.

  - The joystick acts as a velocity controller that drives the robot motion in cartesian space using a numeric approach to solve for inverse kinematics.

Related Work

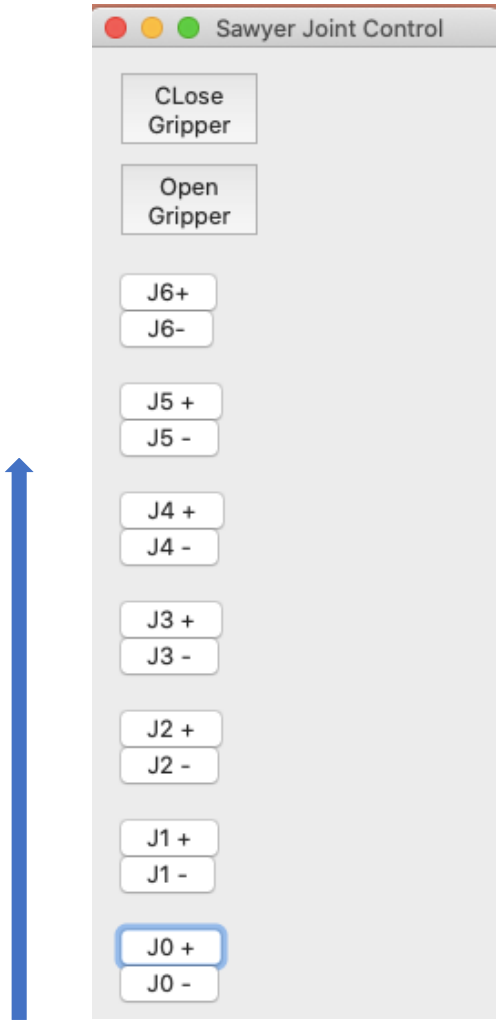
- Virtual Reality Mediated Robot Teleoperation and Grasping. [2]
  - Unity Game Engine based Virtual Environment.
  - User wears HTC Vive Headset and Manus Data Gloves.
  - As user moves in VR, Sawyer follows the motions and when user picks up an object in VR, the Sawyer despite being kinematically dissimilar, follows the user’s motion and picks up the corresponding real object.

Related Work

- Hands-Free: a robot augmented reality teleoperation system. [3]
  - Vision and deep-learning based teleoperation system that uses OpenPose to extract hand position and estimate the hand skeleton.
  - The operator can teleoperate the end-effector with their hands in real-time.
  - Hands-Free v2 to teleoperate robotic manipulators: three axis precise positioning study.

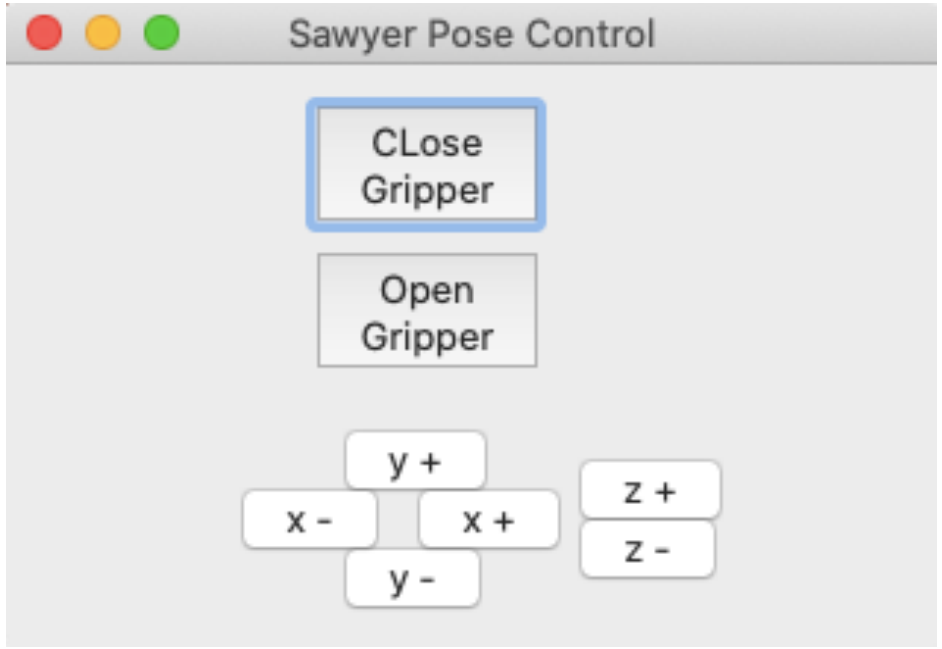
UI-Design for the task (1)

- A Graphical User Interface
- Joint Control
- Designed to match the naming convention of the actual robot.



UI-Design for the task (2)

- A Graphical User Interface
- Pose Control
- The end effector current pose is defined by
  - Position: (x, y, z)
  - Orientation: (x, y, z, w)
- Click is a small unit movement
  - x, y, z

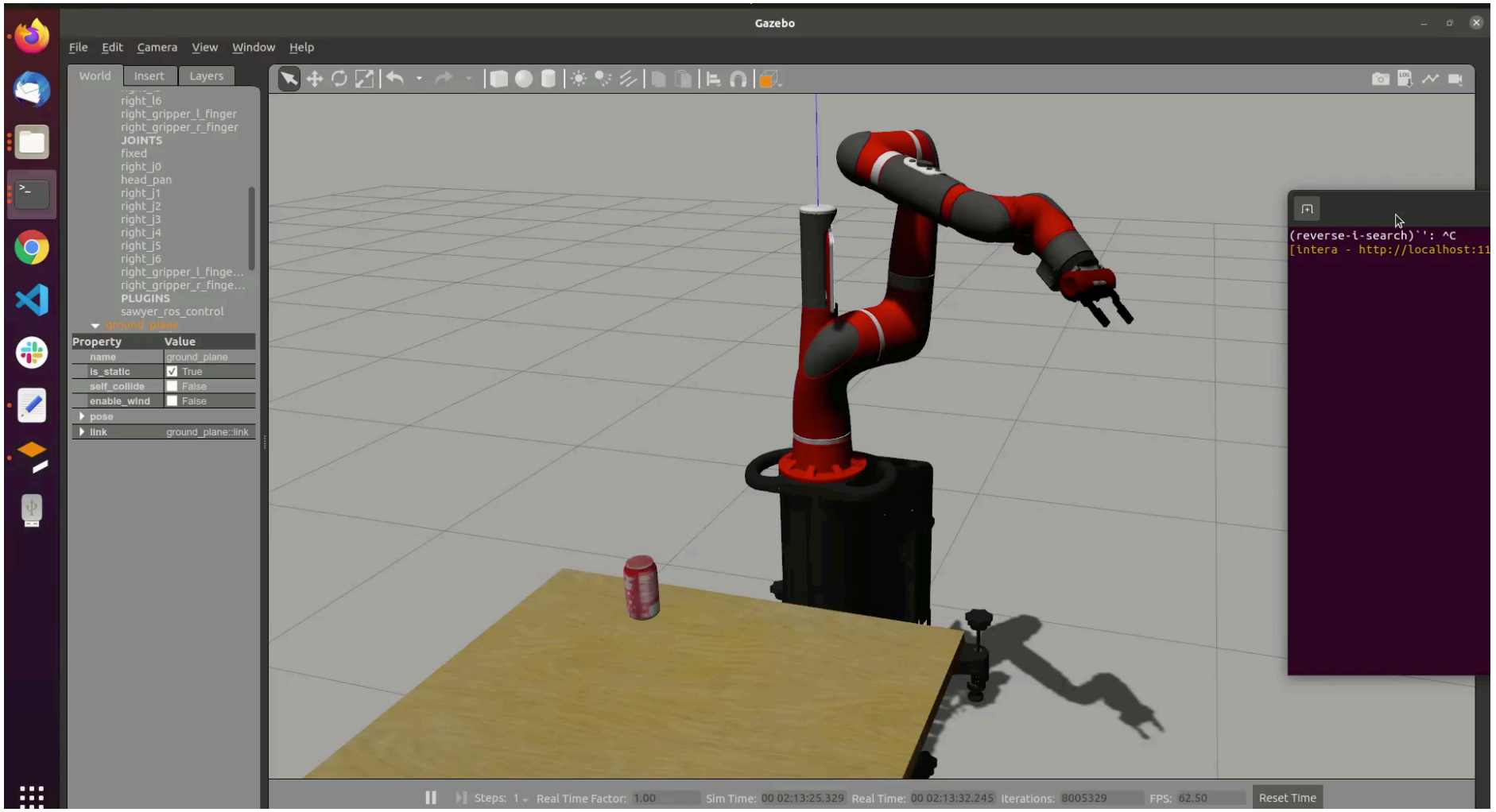


Experiments

- 5 participants.
  - 1 CS PhD student
  - 1 CS undergrad student
  - 1 Management PhD student
  - 1 Environmental Science undergrad student
  - 1 Corporate Finance

- Setup:
  - Participants were asked to try out each teleoperation mode, without the table and object in the environment.
  - Keyboard Teleoperation
  - GUI-1: Joint Control
  - GUI-2 : Pose Control

Experiments



Results- Time taken to complete task (in sec)

	Keyboard joint	GUI-joint	GUI-Pose
P1	45	31	28
P2	65	50	30
P3	55	45	35
P4	105	95	40
P5	65	58	40
Mean	**67**	**55.8**	**34.6**

Results- User preference order

	Keyboard joint	GUI-joint	GUI-Pose
P1	3	2	1
P2	3	2	1
P3	3	1	2
P4	3	2	1
P5	3	2	1

Conclusion

- Keyboard Teleoperation
  - Most difficult, takes the longest.
- GUI-2 : Pose
  - Fastest.
- Observation (Joint Control): Participants with no experience with robots want to hold the can from the side.

References

1. J. Cornejo, E. Denegri, K. Vasquez and O. E. Ramos, "Real-Time Joystick Teleoperation of the Sawyer Robot Using a Numerical Approach," 2018 IEEE ANDESCON, 2018, pp. 1-3, doi: 10.1109/ANDESCON.2018.8564651.
2. K. Chen, P. Dahal, M. Avagyan, K. Huang, " Virtual Reality Mediated Robot Teleoperation and Grasping" 2018.
3. C. Nuzzi, S. Ghidini, R. Pagani, S. Pasinetti, G. Coffetti and G. Sansoni, "Hands-Free: a robot augmented reality teleoperation system," 2020 17th International Conference on Ubiquitous Robots (UR), 2020, pp. 617-624, doi: 10.1109/UR49135.2020.9144841.