Telenursing RoboPuppet 2020-21

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Introduction

RoboPuppet is a scale-model version of Kinova Robotics' Gen3 Arm used for intuitive remote control. This platform is ideal for enabling nurses with limited robotics expertise to work remotely with patients in high-risk and contaminated environments. The arm contains joint angle sensors and motors which allow for gravity compensation and vibration haptic feedback. The project includes a ROS package for controlling the Kinova Arm both in real life and in the Trina2 simulated hospital environment, with a basic real-time GUI for calibration and debugging.

RoboPuppet is an ongoing MQP project at the WPI Human-Inspired Robotics Lab. The 2019 team improved calibration ease using absolute angle and hall-effect encoders, and the 2020 team successfully integrated motors but dealt with a bulky arm that required both hands to maneuver.

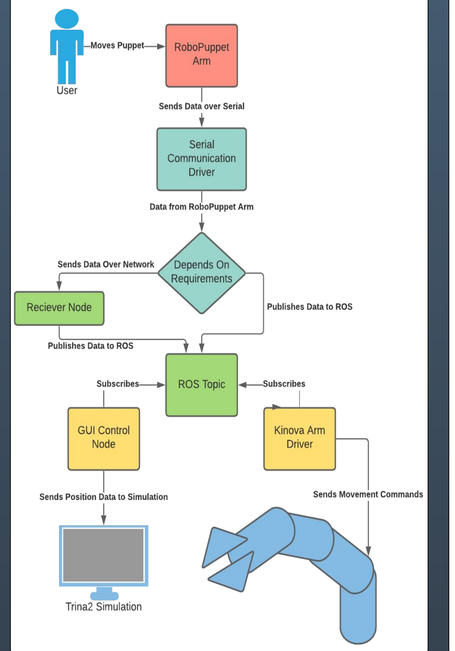
Project Goals

Our team planned a full redesign of the previous RoboPuppet systems, as previous iterations were designed for the Baxter Robot. We wanted to emphasize usability by making the arm as maneuverable as possible while still providing all previous features. For the software, we wanted to keep an easy to use interface for the setup of the system, as well as add remote capability to control the Kinova Arm. These main goals are stated below:

- Successful control of Kinova Gen3 Arm
- Fully motorized to be able to hold position
- Lightweight for ease of maneuverability
- Add vibration motors for haptic feedback
- Remote control over internet of the Kinova Gen3 Arm

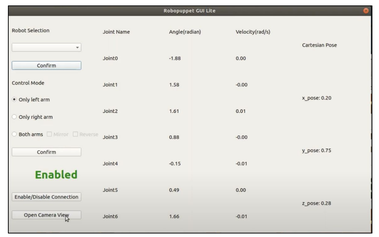
System Architecture

Angle data is published on a ROS topic which is subscribed to by either the Trina2 simulation or the physical Kinova Arm.

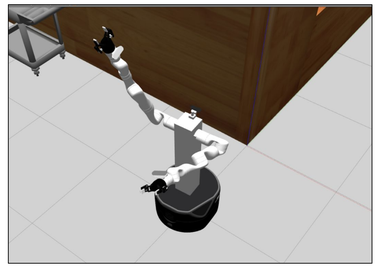


GUI

Two custom GUIs, GUI Lite and GUI Pro, allow for both casual and expert users to monitor and debug the RoboPuppet. The GUI can also be used to interface with the Trina2 Simulated Environment.

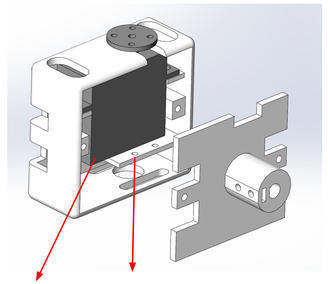


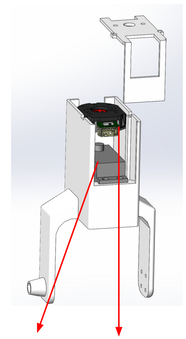
GUI Lite Interface



Trina2 Simulated Environment

Mechanical Design





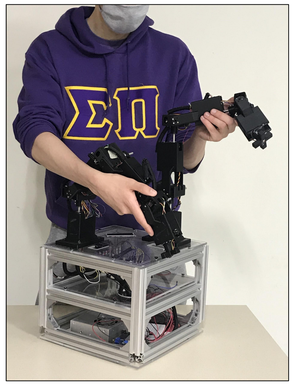
- 7 joints to mirror the Kinova arm's range of motion
- Made of 3 repeating sections for ease of assembly
- Motors of varying torques selected based on initial calculations
- Designed to keep motors, sensors, and wires inside
- Arm 3D printed in PLA+

Results

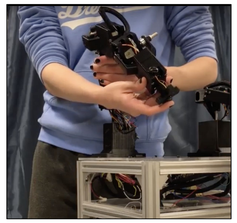
Our project was successful at creating a scale model of the Kinova Gen3 arm that can control both the Kinova Arm and the robot in the Trina2 Environment. The joints all have internal motors, sensors, and wiring. RoboPuppet can enable gravity compensation that can hold the arm at its current position, and can give the user haptic feedback in cases when the Kinova arm might be near the edge of its workspace. The project makes an intuitive controller for the Kinova arm.

One of the primary proposed use cases for the Telenursing RoboPuppet was infectious wards where robots could assist in interacting with patients. In a post-COVID-19 world, this has become even more relevant. Further refinement to RoboPuppet could reduce risk to medical personnel and decrease the need for PPE by enabling remote interactions with patients..

Final RoboPuppet Arm

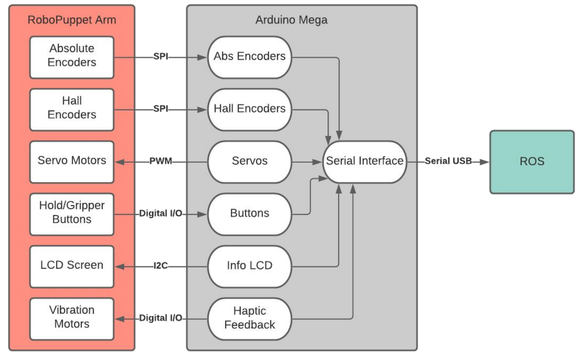


Left: The Final RoboPuppet Arm
Below: The Kinova Gen3 Arm mimicking RoboPuppet's position to remotely hand a patient a cup



Electrical & Control Systems

- Arduino Mega 2560 runs control systems and sends angle data over Serial USB to ROS node on computer
- Firmware consists of modular subsystems to interface with each electronic component separately



Acknowledgments and References

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- Demo Video: https://youtu.be/c4mms8OWLoM