SAG Additional Documentation – Final Report

Human Interactive Robotics Lab

This semester, the Human Interactive Robotics Lab had seven students researching and working on projects utilizing the UR5 robotic arms, robotic grippers, and depth cameras. We were able to begin research and groundwork for a long-term project into assembly of CubeSATs and completed smaller, simpler projects to gain a better understanding of computer vision and ROS.

We continued to utilize a similar software stack to previous HIRo teams, utilizing the *Gazebo* and *RViz* simulation software to develop path planning and computer vision algorithms, and we utilized *ROS* and *MoveIt* to translate our simulated movement to actual robotic arm movement. Since we have not been able to interact with the physical robot since the Spring 2020 term, we spent some time updating some of the systems and restoring the robot to fully working condition, and we were able to successfully restore the robot and its grippers to full function.

Our main goal this semester was to begin to transition our team from working on smaller, self-contained projects to working on a longer term project while also onboarding new members. To achieve this goal, our team worked on two separate projects this semester—four of us began the groundwork and initial exploration for a new, long-term research project that involves the automation of CubeSAT assembly. This research involved looking into methods of two-arm path planning, computer vision systems that would allow for scene understanding and distance calculation, and path sequencing and algorithms to represent the different steps of the assembly process. New members worked on a smaller project in order to gain a better understanding of our software stack and computer vision and path planning syntax in Python. This project involved getting the robot to play the "perfection game" in which it places shapes in the proper slot.

In addition to this, we enhanced our documentation on our GitHub (github.com/olinrobotics/hiro/wiki), began to modify some of our core code-base, and created a virtual machine that would allow for researchers to connect to the robot and use simulation software without needing to install Ubuntu in a dual boot. We hope that moving forward, this improved documentation and virtual machine will make it easier for new members to join our team and contribute to our research.

SAG Additional Documentation – Reflection

Human Interactive Robotics Lab

This semester, we had the difficult task of resuming research after over a year of not using our physical robot while also transitioning our structure to focus on a single, long-term project rather than multiple shorter projects.

With the support of our award funding, we were able to purchase hardware that enables us to do far more complex operations in shorter periods of time. This hardware specifically proved to be useful in the development of two-arm path-planning algorithms, as one of the proposed algorithms utilized Reinforcement Learning to plan optimal and safe paths for our robot arms. This is a particularly difficult problem as we were planning on moving both robotic arms at the same time without colliding. The hardware that we purchased specializes in floating point operations, which are used in the training process of a reinforcement learning model, and thus made the training and testing of this model much faster.

Our goal is to integrate this hardware next semester more fully. More specifically, this would mean making this resource available to all members of HIRo at all times, so that we can easily test any machine learning models that we work on in the future.