DEVELOPMENT OF HIGH BANDWIDTH TORQUE SENSOR FOR CONTROL OF HIGH PERFORMANCE MANIPULATORS

A THESIS
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Abstract

In advanced manufacturing environments, the current state-of-the-art in robotic manipulators focuses primarily on improving the performance of position-based control through advanced vision systems and improved motor-amplifier technology. The fundamental issue of actuator position control has been left to motor amplifier designers to incorporate steady improvements on sensor and commutation methods. However, in all robotic control efforts, control of the link torque is paramount and it is here where design efforts should be applied to develop a new actuator position control scheme.

The ARTISAN manipulator, a high-performance torque-controlled, eleven degree-of-freedom manipulator and mini-manipulator system under construction at Stanford University, attempts to address the issue of fine actuator control by incorporating in its design a link torque control loop. By applying a fast link torque loop to the actuator, position control of the end effector is improved. The ARTISAN manipulator requires a high-performance, high bandwidth torque sensor in order for the link torque control loop to be successful.

This thesis focuses on the development of the high-bandwidth torque sensor. It covers the design of the sensor, transducer and converter selection, and compensation design. In addition, the physical components of the ARTISAN
wrist joint are identified, and together with the new torque sensor, are simulated using SIMULINK. Finally, a control algorithm is designed and simulated to demonstrate the improved performance versus the open loop system. Future direction and recommendations for continued efforts are also presented.
For my Dad, "the Lazy Lion"
“It is not the critic who counts, not the man who points out how the strong man stumbled, or where the doer of deeds could have done them better. The credit belongs to the man who is actually in the arena; whose face is marred by dust and sweat and blood; who strives valiantly; who errs and comes up short again and again; who knows the great enthusiasms, the great devotions; who spends himself in a worthy cause; who, at the best, knows in the end the triumph of high achievement, and who, at the worst, if he fails, at least fails while daring greatly; so that his place shall never be with those cold and timid souls who know neither victory nor defeat.”

- Theodore Roosevelt
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