Actuator Design for a Passive Haptic Display

A Thesis Presented to The Academic Faculty

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Actuator Design for a Passive Haptic Display

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Dedication

Dedicated to my four grandparents Laura Tognetti, Emio Tognetti, Irene Faoro, and Julius Faoro. They have provided the foundation so that their family may have a better life. In their actions they demonstrate the importance of strong family support.

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Summary

Haptic interfaces have various applications ranging from training devices to super joysticks for remotely operated robots. Existing marketed haptic interfaces rely on powered actuators to resist motion or apply force to the user, simulating desired virtual boundaries and other haptic features. Due to the size or nature of certain applications, it may not be desirable to use a haptic interface with capabilities of overpowering the human's input. This has opened the area of passive haptic interfaces. Passive haptic interfaces do not use actuators capable of adding energy to the system, but rather utilize actuators that dissipate or redirect user supplied energy. PTER (Passive Trajectory Enhancing Robot) is a two-degree of freedom passive haptic robot test bed, utilizing clutches to dissipate or redirect user supplied energy in order to simulate virtual boundaries. Deficiencies in PTER's actuators have been identified in past research.

This research initially surveys industrial available clutch / brakes, but none are found to suit the project's requirements. Efforts are then turned to redesigning the existing Dynacorp electromagnetic friction clutches. The new clutches incorporate provisions to measure actual applied torque for use with feedback control and rely on a new spring back mechanism to ensure repeatable engagement and disengagement. Careful attention is given to torque measuring sensitivity and endurance strength of the new components. One prototype clutch is built, tested, and modeled. Benefits of closed loop proportional torque control are demonstrated with experiments and advantages of various digital controllers are simulated.