ABSTRACT

Humans are proficient in complex in-hand manipulation. A key ingredient for achieving a high level of dexterity and robustness is the presence of both series and parallel compliance's within the joints in the fingers. The muscles and tendons help modulate joint stiffness in accordance with the environment and are able to control end-tip desired stiffness according to the task. In comparison to dexterous manipulation by humans, robotic dexterous manipulation is still in its infancy, and the development of robotic hand setups to perform complex dexterous manipulation tasks is an active area of research.

A robotic finger is developed in this thesis that imitates the two phalanges of the human finger. This robotic finger is developed with the ability to manipulate and achieve a range of desired end-point stiffnesses. The achievable stiffnesses ranges (of end-tip stiffness) and the impact of adding both parallel and series compliance at the joints (similar to a human finger) have in earlier works been characterized using passivity theory. With the help of an end-tip stiffness control architecture, these stability boundaries are studied and validated experimentally. The experimental results highlight the advantage of adding parallel compliance and the corresponding increase in stability boundary across a reasonable workspace.