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Cooperative human finger motion analysis and optimal design of a three finger exoskeleton

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The scientific, medical, engineering and technological communities bestow intense interest in the surging field of rehabilitation robotics. Rehabilitation robotics can be envisioned as technology for the restoration and functional compensation of people suffering from physical disability or disorders, either for the rehabilitation therapy or assistance of people. In the field of robotics, exoskeletons are mechatronic devices of which segments and joints correspond to some extent to these of the human body and the system is externally coupled to the person as wearable robot. In general terms, exoskeleton is considered as an external covering to provide support and strength to the wearer. It draws inspiration from biology, where the exoskeleton of an animal acts like an external structure providing protection and safety to the creature, e.g., the shell of mollusks, crabs and tortoises. It also acts as an interface of sensory information between the body and the environment, muscle attachment surface and a tight water barrier. The focus of my work is on the understanding of human finger behavior in cooperative, task oriented motion and subsequently, optimal design and development of a three finger exoskeleton. Since human digits can perform a variety of possible motions, accomplishment of the aforementioned goals for rehabilitation purpose is challenging. Cooperative behavior of human thumb, index and middle fingers in rotational and translational object manipulations are studied. Thereafter, redundancy resolution of these digits in translation motion is performed through an inverse kinematic model by instantly varying a single, redundancy parameter. Finally, an optimal three finger exoskeleton is designed to track the human finger motion almost accurately.

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