Actuating the Redundancy

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Abstract

While a redundant number of degrees of freedom provides greater dexterity to robotic hands, actuating each degree of freedom individually becomes increasingly unfeasible. Thus, underactuated robot hands with fewer actuators than degrees of freedom have become popular. The key ingredient of underactuated hands is the adaptive (differential) mechanisms that allow the hand to passively adapt to environmental constraints and thus form powerful and stable grasps. However, existing systems utilize only one actuator to produce motion in the multiple degrees of freedom in the serial chain of each finger. We have explored how the performance of an underactuated serial link chain changes as more actuators are added. The fundamental question of what extra capability an additional actuator provides to an underactuated system and how best to implement it has not yet been quantified in the literature. Using a simple linear underactuated mechanism, we show that the performance of a single actuator system (measured as the average number of contacts made with the environment) quickly plateaus as the number of degrees of freedom of the mechanism is increased. Also, we show that as the number of actuators is increased, the system's passive adaptability improves as the mechanism implementation spreads the actuators across the joints.