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Control of an Asymmetrical Design of a Pneumatically Actuated Ambidextrous Robot Hand

Authors : Emre Akyürek, Anthony Huynh, Tatiana Kalganova

Abstract : The Ambidextrous Robot Hand is a robotic device with the purpose to mimic either the gestures of a right or a left hand. The symmetrical behavior of its fingers allows them to bend in one way or another keeping a compliant and anthropomorphic shape. However, in addition to gestures they can reproduce on both sides, an asymmetrical mechanical design with a three tendons routing has been engineered to reduce the number of actuators. As a consequence, control algorithms must be adapted to drive efficiently the ambidextrous fingers from one position to another and to include grasping features. These movements are controlled by pneumatic muscles, which are nonlinear actuators. As their elasticity constantly varies when they are under actuation, the length of pneumatic muscles and the force they provide may differ for a same value of pressurized air. The control algorithms introduced in this paper take both the fingers asymmetrical design and the pneumatic muscles nonlinearity into account to permit an accurate control of the Ambidextrous Robot Hand. The finger motion is achieved by combining a classic PID controller with a phase plane switching control that turns the gain constants into dynamic values. The grasping ability is made possible because of a sliding mode control that makes the fingers adapt to the shape of an object before strengthening their positions.

Keywords : ambidextrous hand, intelligent algorithms, nonlinear actuators, pneumatic muscles, robotics, sliding control
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