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Interaction Motion Control on Tri-finger Pneumatic Grasper using Variable Convergence Rate Prescribed Performance Impedance Control with Pressure-based Force Estimator

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Abstract

Pneumatic robot is a fluid dynamic based robot system which possesses immense uncertainties and nonlinearities over its electrical driven counterpart. Requirement for dynamic motion handling further challenged the implemented control system on both aspects of interaction and compliance control . This study especially set to counter the unstable and inadaptable proportional motions of pneumatic robot grasper towards its environment through the employment of Variable Convergence Rate Prescribed Performance Impedance Control (VPPIC) with pressure-based force estimation (PFE). Impedance control was derived for a single finger of Tri-finger Pneumatic Grasper (TPG) robot, with improvement being subsequently made to the controller's output by appropriation of formulated finite-time prescribed performance control . Produced responses from exerted pressure of the maneuvered pneumatic piston were then recorded via derived PEE with adherence to both dynamics and geometry of the designated finger . Validation of the proposed method was proceeded on both circumstances of human hand as a blockage and ping-pong ball as methodical representation of a fragile object. Developed findings confirmed relatively uniform force sensing ability for both proposed PEE and load sensor as equipped to the robot's fingertip with respect to the experimented thrusting and holding of a human hand. Sensing capacity of the estimator has also advanced beyond the fingertip to enclose its finger in entirety. Whereas stable interaction control at negligible oscillation has been exhibited from VPPIC against the standard impedance control towards gentle and compression-free handling of fragile objects. Overall positional tracking of the finger , thus, justified