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HYBRID CONTROL OF A PNEUMATIC GANTRY ROBOT FOR CONTOUR TRACKING: PROPORTIONAL PRESSURE VERSUS PROPORTIONAL FLOW CONTROL

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ABSTRACT

The application of a pneumatic gantry robot to contour tracking is examined. A hybrid controller is structured to control the contact force and the tangential velocity, simultaneously. In a previous study, experimental contour tracking results for the robot were obtained with electronic proportional pressure control (PPC) valves. The results demonstrated the potential of pneumatic actuation for contour tracking applications. In another study it was found that improvement in performance was limited by system lag and Coulomb friction. A neural network (NN) compensator was developed to counter both effects. Simulation results demonstrated the effectiveness of the NN compensator. Although improvement in performance with NN compensation was significant, this was offset by the requirement for substantive design effort. This paper shows experimentally that equally significant improvement can be achieved by switching from PPC valves to proportional flow control (PFC) valves. The PFC approach requires less design effort.

In many applications that require contour tracking the exact geometry of the workpiece is not known. Approaches to the tracking of unknown planar contours include: iterative learning [2], neural networks [3] and neuro-fuzzy networks [4]. A novel approach to the problem was presented in [5]. A hybrid force controller was used whereby velocity replaced position in a traditional force/position controller. The later needs a global model of the workpiece, but the former only needs local information. Another application of a force/velocity controller can be found in [6], where it was again argued that this approach is the most appropriate for planar contour tracking applications of workpieces with unknown geometries.

Much research has been conducted on force control with electric robots [7]. By contrast, little research has been conducted on force control with pneumatic robots. This is understandable as pneumatic actuators are more difficult to control because of low bandwidth and high nonlinearity due mainly to air compressibility and Coulomb friction effects. However, relative to electrically