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Paper Abstract

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Paper Title: **An 8 Degree of Freedom Force-Controlled Macro-Micro Robot for Manufacturing and Micro-Surgery.**

A manipulator capable of delicate interactions with its environment has been designed, developed and tested. The robot is capable of high accuracy and precise force control for such functions as polishing, finishing, cleaning, grinding, deburring and micro-surgery. These tasks are still being performed either manually or by delicate machinery due to the lack of cost effective multipurpose force-torque controlled robot.

An eight degree of freedom macro-micro manipulator robot was built as an answer to the above mentioned need. The macro-micro design couples a 3 degree of freedom micro robot to the end of a 5 degree of freedom macro robot. The main objectives of the design were to minimize end-effecter inertia, minimize joint friction, maintain tip orientation throughout the workspace and support a maximum payload or force exertion of 3 kilograms. The resulting tip inertia is roughly 250 gins. The joint friction was minimized by using direct-drive transmission and limited angle flex bearings at the joints. They do generate a spring force, however, which must be compensated for in the control design and performance. The micro manipulator is 35.5 by 17.8 centimeters, and the weight is 6.3 kilograms. The robot was realized by molding three key enabling concepts: (1) a macro-micro design to allow accurate tip forces, (2) the use of impedance control method to control the macro-micro robot and (3) a modular high ,

performance multi-processor system to provide the computational power needed by the advanced control algorithms.

This paper will present the experimental results that characterize the 8 degree of freedom macro-micro robot manipulator.with a description of its broad base applications to manufacturing and micro-surgery The high bandwidth, low effective end-effecter inertia that are important for precise force control give it unique capabilities unmatched by any other system. Test results that measure the key functional performance as the manipulator speed and precision, in terms of its accuracy, repeatability and resolution will be discussed.