Virtual Reality Robotic Telesurgery Simulations Using MEMICA Haptic System

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There is an increasing realization that some tasks can be performed significantly better by humans than robots but, due to associated hazards, distance, etc., only a robot can be employed. Telemedicine is one area where remotely controlled robots can have a major impact by providing urgent care at remote sites. In recent years, remotely controlled robotics has been greatly advanced. The robotic astronaut, "Robonaut," at NASA Johnson Space Center is one such example. Unfortunately, due to the unavailability of force and tactile feedback capability the operator must determine the required action using only visual feedback from the remote site, which limits the tasks that Robonaut can perform. There is a great need for dexterous, fast, accurate teleoperated robots with the operator's ability to "feel" the environment at the robot's field.

Recently, we conceived a haptic mechanism called MEMICA (Remote MEchanical MIrroring using Controlled stiffness and Actuators) that can enable the design of high dexterity, rapid response, and large workspace system. Our team is developing novel MEMICA gloves and virtual reality models to allow the simulation of telesurgery and other applications. The MEMICA gloves are designed to have a high dexterity, rapid response, and large workspace and intuitively mirror the conditions at a virtual site where a robot is simulating the presence of the human operator. The key components of MEMICA are miniature electrically controlled stiffness (ECS) elements and Electrically Controlled Force and Stiffness (ECFS) actuators that are based on the use of Electro-Rheological Fluids (ERF). In this paper the design of the MEMICA system and initial experimental results are presented.