Flexible, Low-mass Robotic Arm Actuated by Electroactive Polymers (EAP) and Operated Equivalently to Human Hand

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ABSTRACT

Actuation devices are used for many space applications with an increasing need to reduce their size, mass, cost and power consumption. Under a JPL's telerobotic task, efforts are made to develop EAP materials that provide large displacements, and two EAP categories were identified to produce large actuation strain. These categories include (a) ion-exchange membrane - platinum (IEMP) composite and (b) electrostatically driven polymer actuators. A comparison between EAP and the widely used transducing actuators shows that, while lagging in force delivering capability, these materials are superior in mass, power consumption and displacement levels. Several muscle configurations were constructed to demonstrate the capabilities of these EAP actuators. Further, using actuators that represent these two categories, a miniature robotic arm has been developed with unique articulation capabilities. Strings consisting of electrostatically driven films are used to form the equivalent of a human arm. The arm was connected to an end-effecter gripper with four IEMP composite strips that bend similar to fingers to allow grabbing and holding objects, such as rocks. The gripper operates with the capability to bend both forward and backward which exceeds the human hand capability.