Automated Control of Magneto-Thermally Responsive Soft Grippers for Pick-and-Place of Biological Cargo

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We describe recent studies on design, characterization and automated planning and control of stimuli responsive untethered soft grippers. We utilized photopatterning to fabricate these grippers composed of a rigid, non-swellable SU-8 layer and a second magneto-thermally responsive (pNIPAM-AAc doped with iron oxide) hydrogel layer. These gripper structures spontaneously and reversibly closed and opened on heating and cooling. Further, the incorporation of biocompatible magnetic nanoparticles allowed them to be controlled by magnetic fields. Additionally, closed-loop control software was used to regulate the current in a three-axis electromagnetic coil system, remotely manipulating the local magnetic field gradients to move the magnetic grippers. Finally, a Peltier element was used to change the temperature and control the opening and closing motion. Thus, a fully automated system for moving and opening the soft-grippers was developed. We discuss application of this system for pick and place of a variety of cargo including porcine muscle tissues for potential applications in microassembly, soft-robotics, medicine and minimally invasive surgery.