Microassembly using Stress-engineered MEMS Microrobots

Igor Paprotny

Abstract

This talk will encompass my Ph.D. work at Dartmouth College (and in residence at Duke University) on parallel control of stress-engineered MEMS microrobots. I will present designs, theory and the results of fabrication and testing for our parallel microrobotic assembly scheme using groups of stress-engineered MEMS microrobots. Our robots are 240-280 microns by 60 microns by 7-20 microns in size, and each robot consists of a curved, cantilevered steering arm mounted on an untethered scratch drive actuator (USDA). The robot receives a signal, via a capacitive coupling with an underlying electrical grid (called the operating environment), which powers the USDA and controls the robots motion. The operating environment is designed to couple the same, single, power and control signal to all operating microrobots. Consequently, only this single global signal can be used to maneuver multiple stress-engineered microrobots within the same operating environment.

I will present control algorithms that allow multiple microrobots to be maneuvered independently (while implementing microassembly) via a single power and control signal. I will discuss the scalability of our approach, and show novel theoretical results that allow us to maximize the number of simultaneously controllable stress-engineered MEMS microrobots within the same operating environment. I will also present the designs and fabrication for four independently-controllable microrobot species, and show how these species were used to demonstrate microassembly of several (five) different types of planar microstructures. Our robots achieved an average docking accuracy of 3 micrometers, with a 96 % match (average) between the assembled and the target structures.