Image Guided Autonomous Optical Manipulation of Cell Groups

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The objective of this research is to create computational foundation, methods, and tools for efficient and autonomous optical micromanipulation using microsphere ensembles as grippers. The envisioned system utilizes a holographic optical tweezer, which uses multiple focused optical traps to position microspheres in three-dimensional space. Our approach involves the following research components. First, it provides an experimentally validated optical-tweezers based workstation for concurrent manipulation of multiple cells. Second, it provides algorithms for on-line monitoring of workspace to support autonomous manipulation. Finally, it provides real-time image-guided motion planning strategies for transporting microspheres ensembles.

This research is expected to lead to a new way of autonomously manipulating difficult-to-trap or sensitive objects using microspheres ensembles as reconfigurable grippers. The on-going work in our lab is making fundamental advances in several cyber physical systems areas by providing new approaches to micromanipulations, fast and accurate algorithms for on-line monitoring of moving microscale objects, and real-time motion planning algorithms to transport particle ensembles.

The ability to quickly and accurately manipulate individual cells with minimal training will enable researchers to conduct basic research at the cellular scale. Control over cell-cell interactions will enable unprecedented insights into cell signaling pathways and open up new avenues for medical diagnosis and treatment. The integration of research with education is training students with a strong background in emerging robotics technologies and the inner workings of cells.