Towards Lightguided Microrobotics

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Publication date:
2012

Document Version
Publisher's PDF, also known as Version of record

The 124th GCOE SPECIAL SEMINAR

DATE: 13:30–15:00, Sep. 7(Fri), 2012

PLACE: 3F Venture Hall, Venture Business Laboratory., Nagoya University

TITLE: “Towards Light - guided Micro - robotics”

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ABSTRACT:

Robotics in the macro-scale typically uses light for carrying information in machine vision for monitoring and feedback in intelligent robotic guidance systems. With light’s miniscule momentum, shrinking robots down to the micro-scale regime creates opportunities for exploiting optical forces and torques in micro-robotic actuation and control. Indeed, the literature on optical trapping and micro-manipulation attests to the possibilities for optical micro-robotics. Advancing light-driven micro-robotics requires the optimization of optical force and optical torque that, in turn, requires optimization of the underlying light-matter interaction. The requirement of having tightly focused beams in optical tweezer systems exemplifies the need for optimal light-shaping in optical trapping. On the other hand, the recent report on stable optical lift shows that optical manipulation can be achieved, even when using unshaped light, by using an appropriately shaped structure instead. Therefore, a generic approach for optimizing light-matter interaction would involve the combination of optimal light-shaping techniques with the use of optimized shapes in the micro-robotics structures. In this work, we designed different three-dimensional micro-structures and fabricated them by two-photon polymerization. These micro-structures are then handled using our BioPhotonics Workstation to show proof-of-principle demonstrations illustrating the 6DOF optical actuation of these two-photon fabricated three-dimensional microstructures. Furthermore, we exploit the light shaping capabilities available in the workstation to demonstrate a new strategy for controlling microstructures that goes beyond the typical refractive light deflections that are exploited in conventional optical trapping and manipulation e.g. of micro-spheres. We also propose designing micro-structures for so-called structure-mediated access to the nanoscale.

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