Nano-biophotonics explored by Light Robotics

Glückstad, Jesper; Villangca, Mark Jayson; Palima, Darwin; Banas, Andrew Rafael

Publication date:
2016

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

Link back to DTU Orbit

Citation (APA):

General rights
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.
Nano-biophotonics explored by Light Robotics

J. Glückstad*, M. Villangca#, D. Palima#, A. Banas*
#DTU Fotonik, Dept. of Photonics Engineering,
Technical University of Denmark, DK-2800 Kgs. Lyngby, Denmark
*OptoRobotix ApS, DK-2000 Frederiksberg, Denmark

jesper.gluckstad@fotonik.dtu.dk
www.ppo.dk www.OptoRobotix.com

The 2014 Nobel Prize in Chemistry celebrated the invention of so-called ‘optical nanoscopy’ - a highly advanced nanoscale light-based microscopy modality that can surpass the classical far-field diffraction limit and provide optical resolutions down to a few nanometers. Associated with this breakthrough is the rapidly emerging field of light-based 3D printing based on powerful approaches offered by e.g. nonlinear photo-polymerizations. Currently, it is possible to 3D laser-print nanoscopic structures with voxel resolutions down to a few tens of nanometers. By adding a third key scientific accomplishment - namely the fascinating ability of focused light to capture, trap and manipulate tiny objects - one can approach a triangulation of new functionalities required for true light-driven nano-robotics. By integrating all these amazing optics and photonics breakthroughs we can create the conditions for harnessing most of the functionalities required to develop the fascinating concept of true so-called Light Robotics.

We foresee that it will soon become possible to equip 3D laser-printed robotic micro-structures with multi-functional biophotonics nanoprobes or nanotips fabricated with true nanoscopic resolution. The uniqueness of such an approach is that even if a micro-biologist aims at exploring e.g. cell biology at nanoscopic scales, the main support of each laser-robotic structure can be 3D printed to have a size and shape that allows convenient laser manipulation in full 3D – even using relatively modest numerical aperture optics. An optical robot is typically equipped with a number of 3D printed "trackballs" that allow for real-time 3D light manipulation with six-degrees-of-freedom. This creates a drone-like functionality where each light-driven robot can be e.g. joystick-controlled and provide the user a feeling of stretching his/her hands directly into and interacting with the biologic micro-environment. The light-guided robots can thus act as free-floating probes to monitor micro-biologic processes and provide spatially targeted mechanical, chemical or even optical stimuli that would otherwise be impossible to achieve in a full 3D biologic environment.

• Wu, C., Palima, D, Novitsky, A; Ding, W; Gao, D; Shukovsky, S; and Glückstad, J., “Engineering light- matter interaction for emerging optical manipulation applications”, Nanophotonics 3, 181 (2014).

Fig. 1: The latest generation of our syringe-equipped light-driven micro-robotics. Adapted from ref. NPG-LSA 2016.