Microscope-on-a-disc: Wireless Powered/Transmitted Real-time Microscopic Imaging

Hwu, En Te; Serioli, Laura; Thoppe Rajendran, Sriram; Zor, Kinga; Boisen, Anja

Publication date:
2018

Document Version
Peer reviewed version

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.
Microscope-on-a-disc: Wireless Powered/Transmitted Real-time Microscopic Imaging

Edwin En-Te Hwu¹, Laura Serioli¹, Sriram Thoppe Rajendran¹, Kinga Zos¹ and Anja Boisen¹
¹The Danish National Research Foundation and Villum Foundation’s Center for Intelligent Drug Delivery and Sensing Using Microcontainers and Nanomechanics (IDUN), Department of Micro- and Nanotechnology, Technical University of Denmark, Kgs. Lyngby, 2800, Denmark
etehwu@nanotech.dtu.dk

Keywords: Lab-on-a-disc, Optical microscope, wireless power, Real-time, Microscopic imaging

Abstract: A miniature optical microscope on a disc (MoD) is developed for monitoring microscopic samples while spinning. The MoD is wirelessly powered, which streams real-time video wirelessly to a smartphone. The MoD can monitor micro sized containers movement on a spinning disc from 0 to 2,400 rpm.

Centrifugal microfluidics disc or so-called Lab-on-a-disc (LoD) integrates mixing, filtering, metering, and routing operations, which is a compact, affordable and scalable platform for biosensing [1]. However, it is tedious to capture an optical image on a spinning disc. A conventional approach utilizes strobe photography based imaging method [2]. The strobe imaging method requires precise synchronization between a strobe light source and a camera shutter setup. Also, the strobe imaging system is heavy and bulky that limits portable optical sensing based applications.

We developed a miniaturized optical microscope-on-a-disc (MoD) which is powered by commercial mobile device wireless inductive "Qi" [3] energy transmission interface, as shown in Fig. 1 a). The MoD integrates a miniaturized Complementary Metal-Oxide-Semiconductor (CMOS) sensor with color and infrared imaging ability. Moreover, an infrared light source (wavelength 1.050 nm) can illuminate microscopic sample while imaging. The CMOS captures real-time video and picture which are transmitted to a mobile device or a PC through a Wi-Fi transmitter. A high numerical aperture (NA) optics enables an optical imaging resolution of 10 μm. Fig. 1b) shows a microscopic image captured by the MoD at 0 rpm. A micro-container with a known diameter of 300 micron works as a scale bar for MoD resolution analysis. Fig. 1c) shows a photo of the MoD spinning test while streaming real-time video to a smartphone. A mobile app controls the MoD functions such as imaging resolution (1080p, 720p, 640p), infrared illumination adjustment and video/photo capture switching.

Fig. 1 d) - i) shows microscopic images captured by the MoD at different spinning speed (video online). The µ-container 1 and 2 were moved by centrifugal force at 1,200 and 2,400 rpm, respectively. The horizontal noise lines in Fig. f) – i) were caused by the non-homogenous background of the spin stand. The preliminary experiment shows that the MoD is capable of imaging microscopic structures and streaming real-time video to mobile devices. The MoD optics can be optimized for higher imaging resolution. Furthermore, the MoD can equip multiple CMOS sensors for multi-channel real-time imaging on a disc. The MoD may unleash optical imaging based LoD tasks in a portable fashion, such as on-site multi-channel antibiotics testing, real-time cell growth monitoring and portable cell counting applications.