Compact LED-based digital inline-holographic microscope for live-cell identification

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Compact live-cell monitoring devices offering both in-situ and real-time imaging measurements have become more essential nowadays in life science to understand the cell growth mechanism and its related pharmacological treatments. For diabetes research, imaging systems that can be permanently applied to the living tissues (e.g. pancreatic cells) and direct integration into a cell incubator or microfluidic organ-on-chip system can facilitate the understanding of pancreatic islet micro physiology [1]. Moreover, for the developing countries, where access to expensive laboratory facilities for disease diagnosis is still limited, an alternative low-cost, autonomous analytical tool including a high-resolution microscope would be very advantages [2].
To overcome those issues, in this work, a compact digital inline-holographic microscope combined with a microfluidic perfusion system (MPS) had been developed for real-time cell monitoring. Our integrated setup (Fig. 1(a)) comprises a custom-engineered LED light source, an MPS, a CMOS image detector, an embedded microcontroller, and a 3D printed housing. Image post-processing and reconstruction were conducted by angular spectrum method combined with a twin image elimination technique [3]. From the experiments, NMRI mice pancreatic islets could be identified, counted, and continuously measured with a large field-of-view inside the MPS, in which some cells have been localized in the channel bifurcation (Fig. 1(b)). A further test was successfully conducted to monitor a cell culture, where the built device has been integrated into a microwell plate and placed inside a cell incubator allowing long-term studies of cell growth and movement (Fig. 1(c)). Besides, by replacing the single LED light source with an LED matrix having different illumination angles, a tomographic imaging could be realized and its results will be analysed and presented.

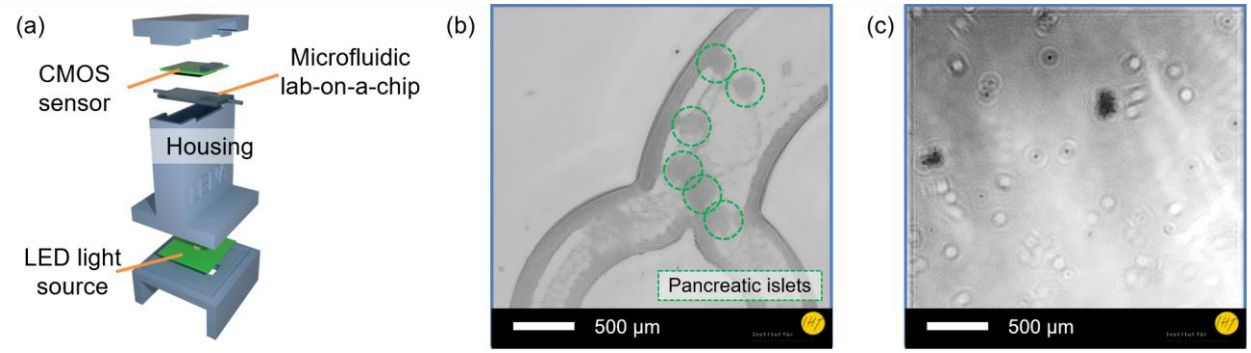

Figure 1. (a) 3D sketch of inline-holographic microscope for live-cell monitoring. Microscopic images of (b) the identified pancreatic islets at the channel bifurcation inside an MPS and (c) the cultivated cells inside an incubator setup.

References:
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[2] Y.S. Zhang et al., *Scientific Reports*, 6, 22691 (2016).
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