COMPACT MODULES FOR DIGITAL HOLOGRAPHIC MICROSCOPY IN MICROFLUIDICS

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We present a compact and cost-effective imaging module, implementing the interferometer architecture for off-axis digital holography on a commercial microfluidic chip and using a laser diode as light source.
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1. Introduction

The development of Lab-on-a-Chip (LoC) devices has experiences a steady growth in the last years. Their diffusion is promoted by the introduction of accurate and cheap technologies to fabricate microfluidic platforms and to control and manipulate fluids and micro-particles. At the same time, the research community is striving to transfer more and more of the functionalities of a modern analysis laboratory on LoC platforms. One of the most promising applications of these compact systems is the possibility to introduce point-of-care diagnostics in low-resource settings, where adequate instruments, costly facilities, and clinical laboratories for accurate analysis are still missing. Clearly, the possibility to observe the samples inside the LoC platforms is fundamental to fully express the diagnostic potentialities of these devices. In particular, a suitable imaging system should satisfy different needs: high-throughput data collection, label-free imaging, quantitative measurements and compactness.
In this framework, Digital Holography (DH) microscopy is an interesting technique, able to provide quantitative phase information of the samples by label-free image acquisition. However, standard DH setups do not conform to the requirements of compactness and portability.

2. Methods and results

In this work, we present a compact module that reproduced the interferometric setup needed in off-axis DH microscopy on a commercial LoC [1,2]. Thanks to the inscription of a diffraction grating onto the chip surface, it is possible to split a single incoming wave in an object and reference beam. We have investigated different configurations, positioning the grating parallel and orthogonal to the sample flow inside the channel. We have shown that the amplitude and quantitative phase imaging features of DH, as well as its flexible focusing capabilities, are preserved in the proposed module. Moreover, we have highlighted how the two configurations suit different needs.
The resulting pocket module is well suited to point-of-care diagnostic application, thanks to its improved compactness and portability. As an exemplary case of use, we tested a spatio-temporal scanning acquisition modality to yield high-throughput counting and 3D tracking of Red Blood Cells. We further improve our system portability by using a compact coherent source, namely a laser diode. Our work thus show that it is possible to realize a compact and cost-effective imaging module for high-throughput screening of fluid samples

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