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A portable high-resolution microscope based on combination of fiber-optic array and pre-amplification lens

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Abstract. A portable high-resolution microscope based on combination of fiber-optic array (FOA) and pre-amplification lens, which can overcome the magnification limit of FOA, was developed. By employing the amplification lens at the small-end of the FOA, the resolution was improved from 4.4 μm to 1.0 μm over a field of view (FOV) of 140 μm ×100 μm without using any algorithm processing, and the distortion only slightly increases from 0.13% to 0.19%. The distortion is still lower than that of normal lens-based microscopy. Moreover, the combination methods of the amplification lens and FOA were investigated, which including only FOA, the pre-amplification lens at the small-end of the FOA (termed **preAL-FOA**) and the post-amplification lens at the big-end of FOA (termed **postAL-FOA**). The result proved the best resolution was achieved by using the preAL-FOA. This microscopy is suitable for real-time monitoring of cells in microfluidic systems.

Keywords: portable microscope, FOA, preAL-FOA, postAL-FOA, high-resolution.

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1 Introduction

Portable, high-resolution and cost-effective microscopy has been widely used in telemedicine, point-of-care diagnosis and personal health monitoring^[1-3]. Currently, there are mainly two kinds of portable microscopy: (1) lens-based imaging (based on micro-lens arrays^[4], droplets^[5], ball lens^[6, 7] and optical lens^[8]), and (2) lens-free imaging (based on contact imaging^[9-14], fiber optic array^[15, 16] and holographic microscopy^[12, 17-21]). For lens-based imaging, it suffers from limited field-of-view (FOV), large distortion, and relative low resolution (>1.2 μm)^[6, 8, 22, 23], which is limited by Abbe diffraction (due to the loss of high frequency details)^[6, 7, 22]. As for the lens-free imaging, it has advantages of low distortion and large FOV^[11, 14, 15, 24, 25], but the resolution is limited by the pixel size of Complementary Metal Oxide Semiconductor (CMOS) sensor and complex computation algorithm was normally required to process the captured image for improving the resolution^[11, 13].

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