Supplemental document accompanying submission to *Optica*

Title: Coded-aperture broadband light field imaging using digital micromirror devices

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Coded-aperture broadband light field imaging using digital micromirror devices: supplement document

Details on the design of the DECALF imaging system

Figure S1(a) shows the ray-tracing result of the dispersion-eliminated coded-aperture light field (DECALF) imaging system using Zemax. The model of the lenses (detailed in the caption of Fig. 1 in Main Text) used in the setup was directly downloaded from an online resource [1]. Five points in the field of view (FOV) with the (x, y) coordinates of (–2.5 mm, 0 mm), (0 mm, 0 mm), (2.5 mm, 0 mm), (0 mm, –2.5 mm), and (0 mm, 2.5 mm) were ray-traced for five wavelengths in the 400 nm–700 nm spectral range. Figure S1(b) shows the simulated results of these five points on the intermediate image plane (left panel) and the final image plane (right panel), respectively. This result proves the DECALF imaging system's dispersion compensation ability. Finally, the spot diagrams on the final image plane [Fig. S1(c)] show a mean spot radius of 14.57 μm over the FOV.

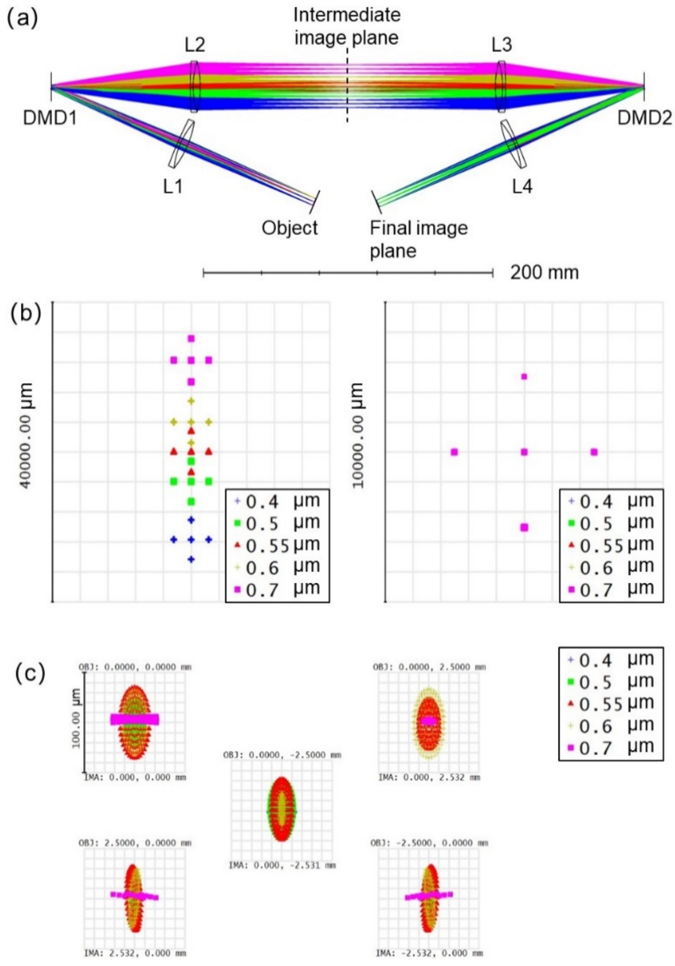

Fig. S1. Zemax simulation of the DECALF imaging system. (a) Ray-tracing result in the design of the DECALF imaging system. (b) Images of the five points in the field of view on the intermediate image plane (left panel) and the final image plane (right panel). (c) Spot diagrams of the five points in the field of view.

Unsuccessful attempts for dispersion compensation

During the construction of the DECALF imaging system, we had two unsuccessful attempts for dispersion compensation. First, we used a 300 lp/mm one-dimension (1D) transmission grating with a single-lens imaging system. Because of the different densities between the DMD and this 1D grating, the compensation was extremely sensitive to the lens position. Moreover, we found that the dispersion in the visible spectral range (i.e., 400 nm–700 nm) could not be completely compensated over the entire FOV. This unsuccessful attempt led to the implementation of the second identical DMD. In particular, we used an unpowered 0.7” XGA DMD chip. This attempt resulted in improved dispersion compensation. However, because the micromirrors could not be set to either “ON” or “OFF” state, the diffraction efficiency of the DMD was extremely low (<1%). Finally, we implemented a DMD development module (Texas Instrument, Discovery 1100) and loaded an all-“OFF” pattern. In addition, we implemented a 4*f* imaging system for easier alignment. This method led to full dispersion compensation with a good light throughput.

Additional results for zebrafish imaging using the DECALF imaging system

The DECALF imaging system was used for observation of the development of the zebrafish. Figure S2 shows depth-coded images of two zebrafish at four different stages of development [i.e. 1 day post-fertilization (dpf), 2 dpf, 3 dpf, and 6 dpf]. Zebrafish started hatching out of their chorion as of 2 dpf. Its length increased from ~2.3 mm (2 dpf) to ~4.0 mm (6 dpf).

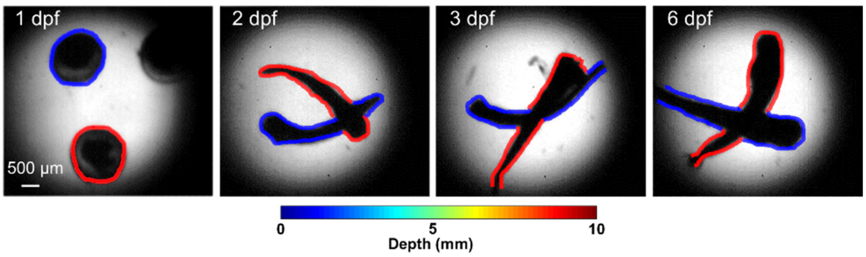

Fig. S2. Observation of the zebrafish’s development using DECALF imaging.

References

1. Thorlabs Inc. Zemax file of AC254-100-A. Accessed on 12/13/2020. URL: https://www.thorlabs.com/_sd.cfm?fileName=20529-S03.zmx&partNumber=AC254-100-A