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26 | Custom made LED-based system for extended hyperspectral retinal imaging

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In conventional fundus photography, a broadband white light source and a camera are used to acquire color images from the retina. In the last years, hyperspectral imaging has shown to be a powerful tool for the spectral analysis of tissue and in particular for a better understanding and aiding the diagnosis of ocular diseases.

In this regards, a full custom-made hyperspectral system based on Light Emitting Diodes (LEDs) for fundus imaging with extended spectral range (from 400 nm to 1300 nm) is presented in this work. The detection system consists of CMOS (Orca Flash 4.0, Hamamatsu, Japan, 2048x2048 pixels, 16 bits) and InGaAs (C12741-03, Hamamatsu, Japan, 640x512 pixels, 12 bits) imaging detectors with sensitivity from 400 nm to 1000 nm and from 950 nm to 1700 nm, respectively. The illumination consists of LEDs, which allow robust, fast and versatile hyperspectral illumination of the retina through the entire spectral range.

Due to the broad spectral sensitivity, a robust optical system was especially designed (Zemax LLC, USA), tested and coupled to the former cameras and LEDs. This allows the acquisition of images with an angular field of view of 30° and a resolution around 10 µm at different wavelengths. To choose the best illumination strategy in terms of homogeneity, light collection efficiency and efficacy in the elimination of spurious back reflections, which compromise image quality, different LEDs arrangements were analyzed. The performance of the system was firstly evaluated on an artificial eye (OEMI-7, Ocular Instruments, USA) and then on some volunteers' eyes. The final LED-based system shows a good trade-off between back reflection reduction and illumination performance.

Optimal viewing of superficial retinal structures was achieved with short wavelengths, while images in the infrared range, especially those beyond 950 nm, allowed obtaining information from deeper layers.