Targeted spectral acquisition in the eye fundus

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INTRODUCTION

Ocular diseases generally involve specific structural and functional changes to the eye fundus. Assessment of these changes is an important factor in understanding and, eventually, diagnosing these diseases.

Here, we describe a system allowing the concurrent imaging of the eye fundus and acquisition of a full visible spectrum at a specific location. The user can select an area of interest within the eye fundus image without requiring any realignment or change of fixation target. The user will then receive continuous spectral information of the targeted area.

TARGETED SPECTROSCOPY

Targeted spectroscopy uses the concept of a LED pointer as a light assistant that projects the orientation of a device onto an object.

In this instance, where the objective is to combine spectroscopy with an imaging device, the pointer is used to visualize where the light entering the spectrometer is coming from; it is a projection of the light coming into the spectrometer. We define this region, from which the diffuse reflection spectra are acquired, as the region of spectral acquisition (ROSA).

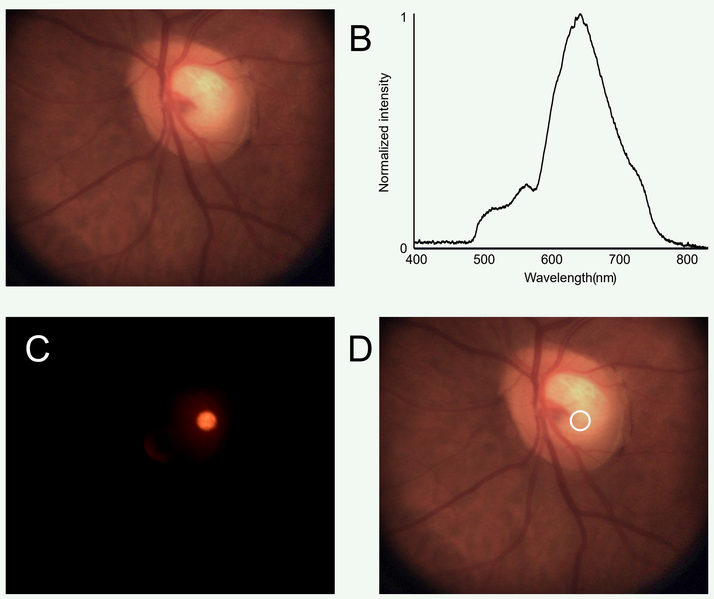

Figure 1. Principle of operation of targeted spectroscopy, enabling continuous, real-time imaging and spectral acquisitions. A) A white LED is used to illuminate the eye fundus to enable imaging by the camera. B) Concurrently, a spectrum of light reflected on the eye fundus is acquired by the spectrometer. C) The camera acquires an image of the pointer LED projected onto the eye fundus, thus enabling the identification of the ROSA. D) An image of the eye fundus overlaid with the location of the ROSA is shown to the user.

RESULTS

REFERENCE TARGET

Data was acquired at 6 different locations of a reference target by moving the LED pointer , the ROSA, on the screen.

The white circles in Figure 2 represent the locations tested.

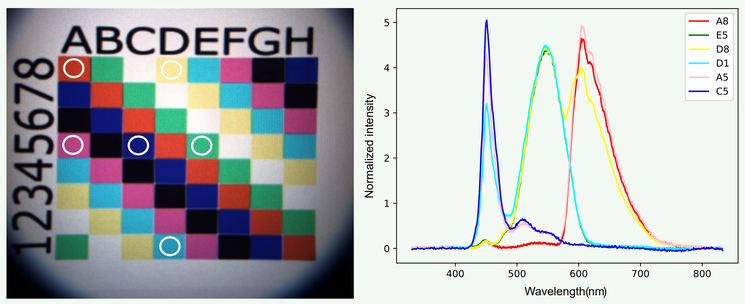

Figure 2. Reference target. On the left, the white circle overlay represents the locations of the ROSA. On the right, the spectra associated with each location are shown.

EYE FUNDUS

Four different regions, each anatomically different and having different optical properties, were targeted for spectral acquisition in 8 healthy subjects (Figure 3). Light intensity was adjusted to exploit the dynamic range of the spectrometer for every region and patient. Five-second acquisitions were made in each region; corresponding to a total of 13 acquired spectra per region (integration times of 250 ms for the spectrometer and 120 ms for the camera).

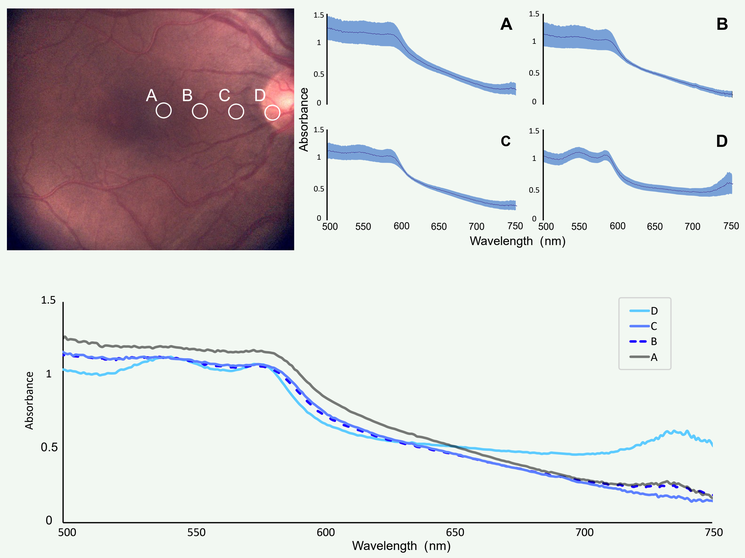

Figure 3. Spectral acquisitions in healthy subjects. Top left: the 4 regions of diffuse reflectance spectral acquisitions. Top right: spectra associated with each region of acquisition. Regions A: Fovea; B: Perifovea; C: Nasal retina; D: Optic nerve head. Bottom: Averaged absorbance spectra of all 8 subjects for the 4 different regions of acquisition.

FLUORESCENCE

Different regions were targeted on an Imaging Eye Model and spectra were acquired. Region A corresponded to a region of high intensity green fluorescence located in the model macula. Region B corresponded to a region located in the model fovea where no fluorescence signal was visible from the wide field image. Region C corresponded to “blood vessels'' located on the simulated retina.

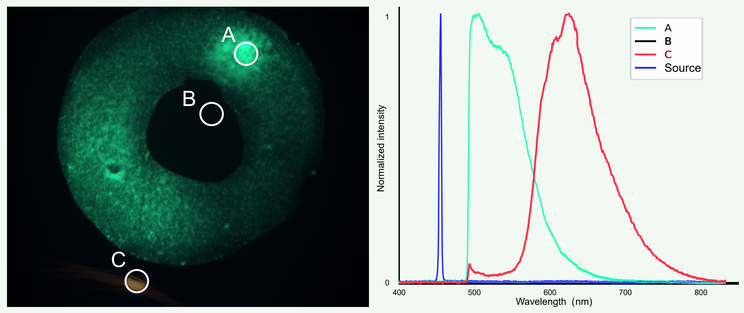

Figure 4. Model eye for fluorescence spectroscopy. On the left, 3 regions of fluorescence spectral acquisitions. On the right, the spectra associated with each region and the source.

CONCLUSIONS

Targeted spectroscopy enables :

- **Fast and continuous acquisitions of diffuse reflectance spectra from targeted locations in the eye fundus**
- **Stress-test response quantification**
- **Easily changeable wavelength range and resolution**
- **Fluorescence imaging and spectral acquisition**

It is common knowledge that many eye diseases can lead to changes in optical properties of the retina. **Enabling analytical diffuse reflectance and fluorescence spectroscopy in the eye fundus opens the door to a whole new range of diagnostic capabilities, from assessment of oxygenation in glaucoma and diabetic retinopathy to photo-oxidation and photo-degradation states in age-related macular degeneration.**

More information

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