Chromatic dispersion based wide-band, fiber-coupled, tunable light source for hyperspectral imaging

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Abstract: Hyperspectral-imaging is label-free imaging technique. We designed hyperspectral source based on chromatic dispersion property of off-the-shelf lenses, that can be incorporated into standard endoscope/microscope to perform hyperspectral-imaging.

Hyperspectral imaging (HSI) has emerged as a unique technique that not only allows one to obtain topological information but also provides spectroscopic information of the sample by utilizing the inherent chromophores in a biological sample and has become a useful label-free imaging technique. Usually, HSI has been realized by utilizing small wavelength bands of a broadband light source through different wavelength filtering mechanisms such as series of bandpass filters [1], liquid crystal tunable filters [2], or acousto-optic tunable filters [3]. In this work, we have developed a fiber-coupled, tunable HSI source based on the chromatic dispersion property of the off-the-shelf lens combination.

For the design of chromatic dispersion based HSI source, we utilized a supercontinuum laser source (SCLS) as our primary light source because of its broadband emission from 400 nm to 2300 nm. Since naturally occurring chromophores provide higher contrast in the visible-near infrared spectrum, we designed our source to cover a wavelength range of 490 nm to 900 nm only. The spatial separation between different wavelength components was achieved by introducing the chromatic dispersion of two commercially available aspheric lenses. We achieved a total spectral separation of 8 mm for the wavelengths from 490 nm to 900 nm. We could easily couple these axially separated wavelength bands in a multimode optical fiber for imaging purposes.

Using our source, we imaged fast green stained lily ovary and hematoxylin and eosin stained dense connective tissue and measured their spectral signatures. Figure 1 shows the spectral response of the two samples between wavelength range of 490 nm and 900 nm.

Figure 1. Normalized absorption plotted as a function wavelength using our HSI source for (a) stained cell nucleus in the lily ovary, and (b) stained cell nucleus and surrounding tissue for dense connective tissue.
References

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