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Development and characterization of an optical system for label free ophthalmic Raman spectroscopy: experimental preliminary feasibility study

Ophthalmic spectroscopy has recently opened promising avenues for early and non-invasive diagnosis of pathological brain conditions [1]. Notably, Raman spectroscopy has been explored for traumatic brain injury detection, while hyperspectral imaging has shown potential in the assessment of Alzheimer's disease in humans [2][3]. Although the eye provides an optimal optical window for such investigations, several challenges limit the clinical adoption of these label-free techniques: the intrinsically weak signal, the strict constraints on laser powers and the complexity of biomolecular spectral signatures, all of which are imposed by ocular anatomy.
In this work, we present the development of an experimental compact system for ophthalmic Raman spectroscopy, with the aim of enabling ocular measurements under optimal eye-safe laser power levels. We thus present an experimental preliminary feasibility study aimed at evaluating the performance of a custom opto-mechanical system, with attention to the opto-mechanical layout, to the choice of components, and to the optimization of the signal collection efficiency.
With this study we demonstrate the capability of the setup to provide sufficient spectra quality for identifying Raman bands of interest, showing its potential towards label free retinal spectroscopy.

[1] Stiebing C et al. Nonresonant Raman spectroscopy of isolated human retina samples complying with laser safety regulations for in vivo measurements. Neurophotonics (2019) 6:041106.
[2] Banbury C et al. Window into the mind: Advanced handheld spectroscopic eye-safe technology for point-of-care neurodiagnostic. Science Advances (2023).
[3] Stiebing C. Biochemical characterization of mouse retina of an Alzheimer's disease model by Raman spectroscopy. ACS Chemical Neuroscience (2020) 11:3301–3308.

Biography:
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