A STUDY ON IMAGE QUALITY IN POLARIZATION-RESOLVED SECOND HARMONIC GENERATION MICROSCOPY

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Second Harmonic Generation (SHG) microscopy is regarded nowadays as a very useful and powerful tool for characterizing biological tissues. Its potential originates from the ability to image in a label-free manner non-centrosymmetric molecules, such as type-I collagen, the most abundant protein in the human body. Polarization-resolved SHG (PSHG) microscopy extends the potential of SHG, by exploiting the fact that non-linear signals generated by means of this phenomenon are sensitive to the polarization state of the incident beam. The additional dimension available in PSHG data sets can be used to analyze the optical anisotropy and hence to better probe the molecular organization of collagen-based tissues [1, 2]. In our experiment we investigate how different polarization states of the incident light impact the quality of the collected PSHG images. In this regard, two sets of polarization states are considered: linear (covering the equatorial plane of the Poincaré sphere) and elliptical (located along the vertical meridian). The polarization states are generated using the optical setup previously introduced in [3], based on a fixed horizontal linear polarizer (PL), a rotatory half-wave plate ($\lambda/2$) and a removable quarter-wave plate ($\lambda/4$). While in typical PSHG experiments image quality is mainly correlated to the average intensity of a collected instance, our experiment extends this approach by adding to the evaluation framework a variety of full-reference image quality measures. We consider both simple metrics, such as Peak-Signal to Noise Ratio (PSNR) or the Mean Squared Error (MSE), but also more recent methods that take into consideration known characteristics of the human visual system, such as the Structural Similarity Index (SSIM), Visual Information Fidelity (VIF), Noise Quality Measure (NQM) or Universal Quality Index (UQI), among others. Understanding in more detail the relationships that take place between the polarization state, collagen organization and image quality has the potential to enable the development of optimized PSHG image acquisition protocols, novel adaptive optics strategies and associated image fusion methods.

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