DEVELOPMENT OF WAVEFRONT SHAPING FOR OPTICAL SPECTROSCOPY

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1. INTRODUCTION

Light scattering is a fundamental physical phenomenon that scrambles light paths and limits the optical imaging resolution considerably. Due to light scattering in biological tissues, light transmission decreases exponentially with thickness. Vellekoop and Mosk conducted experiments showing multi-fold intensity enhancement behind scattering media using feedback based iterative wavefront shaping algorithms [1]. The time taken by these algorithms was limited by the low refreshing rate of spatial light modulators (SLMs). Recently, several numerical approaches based on backscattered intensity analysis using the steepest ascent algorithm was developed for increasing the transmission when focusing through highly scattering media [2]. But it has not been shown experimentally. Moreover, the earlier attempt in Raman spectroscopy [3] demonstrated only marginal improvement, which did not exploit the full power of wavefront shaping.

2. EXPERIMENTS

We first used the optimal steepest ascent algorithm combined with iterative feedback from forward scattered light behind the scattering media to get the optimum wavefronts. Our experimental results showed that the optimal steepest ascent algorithm can achieve an enhancement factor of around 20 in contrast with respect to the background when the number of independently controlled input channels in the SLM was 100, which is comparable to the traditional sequential method. More importantly, the former algorithm was about 3 times faster. Moreover, we demonstrated that a significant enhancement is possible in the measurements of optical spectra from a turbid medium as illustrated in Fig. 1.

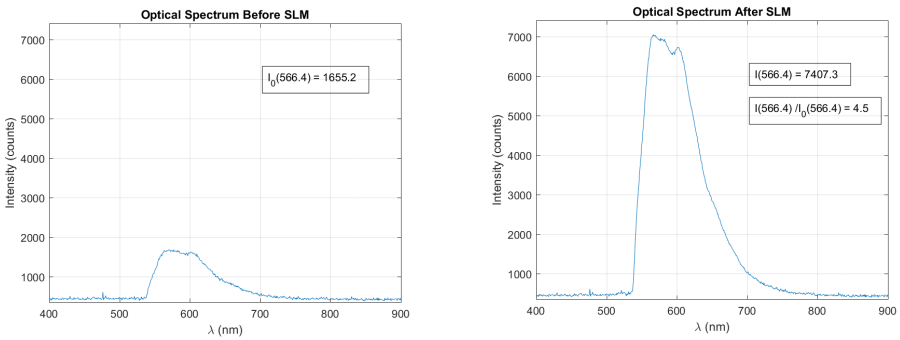

Fig. 1. Optical spectra measured before and after wavefront shaping.

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