Imaging in Scattering Media

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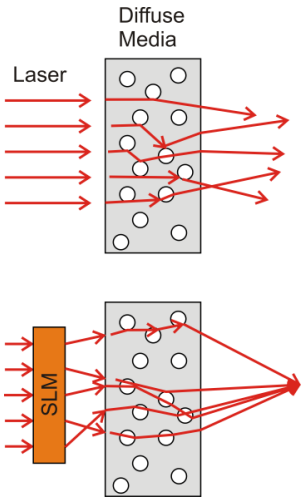
Imaging in biological and other scattering media has been one of the great remaining challenges in optics. If a light beam is incident onto scattering media, it gets diffused by single scattering particles included in the medium as sketched in the figure (top). As a consequence, an additional random phase is added to the light field which varies locally. This leads to a random light field and to focusing through the medium and, thus, imaging is usually impossible.

There have been attempts in recent years to overcome this limitation by gaining information on the particular phase change induced by the scattering medium and compensate for the latter. The compensation is achieved by actively altering the phase of a light beam before it enters the scattering medium as sketched in the figure (bottom). Typical optical setups include spatial light modulators (SLM) based on liquid crystals to add the required phase distribution to the light beam. In this way, the random phase introduced by the scattering medium is reversed and focusing becomes possible. However, a remaining problem is to acquire the phase distribution and existing techniques require fluorescent marker dots, for instance, which are located close to the focal spot. The aim of this PhD project is to employ already existing methods to obtain the phase changes induced by such scattering media and develop new methods to compensate for those. In addition, an optical setup has to be realized including SLM to evaluate the performance of the developed methods.



Focusing in scattering media: no focusing is possible due to scattering (top), phase modifications to the incident laser beam leads to focusing (bottom)

Furthermore, we aim at practical applications of such methods such as in imaging in biological tissue using optical coherence tomography (OCT). Prospective PhD candidates will develop theoretical models to transfer properties of biological tissues and deduce new methods for phase compensation. In addition, experimental work will be carried out including the development of the optical setup and sample preparation. We expect prospective PhD student to have a strong background in optics with an emphasis on light propagation modeling as well as experience in experimental optics.

This is a PhD-project of Tailored Light. Tailored Light is a coordinated PhD-programme of the Hanover Centre for Optical Technologies from the Leibniz Universität Hannover together with the Hochschule Hannover, the Laser Zentrum Hannover, the HAWK Hildesheim/ Holzminden/ Göttingen, the TU Braunschweig and the TU Clausthal.

Students interested in this or another project of Tailored Light can apply for fellowships. Have a look at www.tailored-light.uni-hannover.de for details.