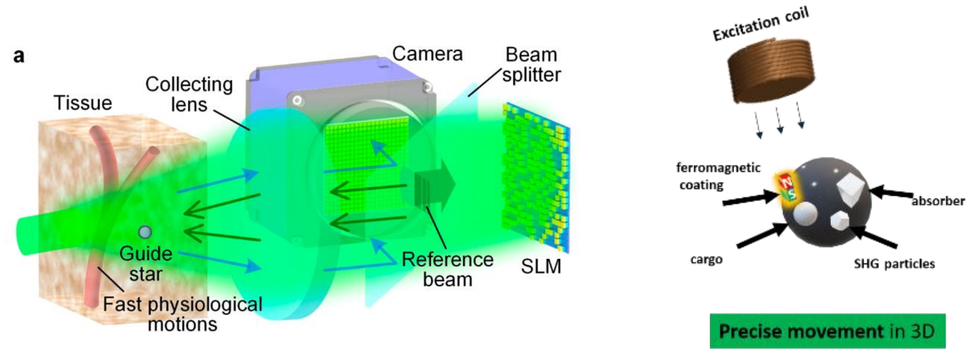
Studien- / Diplom- / Masterarbeit

Deep tissue imaging of micro robots with a second harmonic guide star

Motivation

Background:
Imaging deep inside biological tissue is still a great challenge due to strong scattering. Adaptive optics (AO) can undo the aberrations formed by scattering by doing wave-front shaping. Wave-front shaping requires a mask, which contains the information about the scattering events. One way to acquire this mask is with a coherent guide star, like a second harmonic generation (SHG) crystal. Imaging micro robots equipped with these crystals opens up the way for targeted drug delivery.

Task:
The goal is to successfully create a focus behind phantom tissue with the help of digital optical phase conjugation (DOPC). It should be investigated until which thickness this is possible. In *in vivo* measurements fast perturbations like blood flow would quickly render the phase mask useless. One way to circumvent this problem is by modulating the SHG guide star light, which should also be investigated. Related lectures: Digital Holographie und Bildverarbeitung, Biomedical Laser Systems and Optogenetics



Left: DOPC setup with SHG Guide star inside tissue [1]. Right: Micro robot with SHG nanocrystal

Tasks

- Building the optical setup
- Induce SHG for different phantom tissue thicknesses
- Create focus behind phantom tissue with DOPC
- SHG light modulation to increase the decorrelation time in dynamic tissue
- Using reinforcement learning (RL) to increase imaging depth

Keywords

Second harmonic generation, Guide star, Digital optical phase conjugation, Holography, Deep tissue imaging, Deep learning, Reinforcement learning

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[1] Yang, Jiamiao, et al. "Fighting against fast speckle decorrelation for light focusing inside live tissue by photon frequency shifting." *ACS photonics* 7.3 (2020): 837-844.

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