Einblicke in die Forschungsarbeit

MASTERARBEIT

„Contact-free, optical technology for faster and more reliable medical tissue diagnostics“

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Contact-free, optical technology for faster and more reliable medical tissue diagnostics

Lucas Kreiß is an alumnus of the Elite Graduate Program “Advanced Optical Technologies” (MAOT) at the University of Erlangen. There and at the Institute of Medical Biotechnology (MBT), the researcher worked on the combination of multiphoton imaging with Raman spectroscopy in the scope of his master thesis. Currently, he continues his research within the Graduate School of Advanced Optical Technologies (SAOT) and FAU to the Dr.-Ing level.

Diagnosis of colo-rectral cancer – tissue biopsies and conventional colonoscopy

Colorectal cancer is the third most common type of cancer worldwide, and it is especially widely spread in industrial countries. The mortality is indicated with 10.5 deaths per 100,000 men and 9.2 deaths per 100,000 women making it rank five among all cancer-related deaths worldwide. The key to combat this deadly disease more efficiently is a successful diagnosis at the earliest stages possible. Until the present day, the gold standard for cancer diagnostics still relies on cutting biopsies, followed by a time-consuming procedure of fixation, wax embedding, staining, cutting and image analysis by pathologists. In contrast to that, optical endoscopes have been proven to be most effective while allowing a direct in vivo investigation. There are many different configurations of optical endoscopes, using numerous techniques such as wide-field imaging, endo-microscopy or spectroscopic methods for diagnosis. However, all of them share the common feature of a fast, direct and non-invasive procedure that is specific to optical technologies. Nevertheless, there are some limitations remaining in state-of-the-art clinical endoscopes. Modern endo-microscopes are based on fluorescence of dye molecules and still require immune-staining of the tissue. Spectroscopic devices, on the other hand, are mostly designed for ex vivo applications, and there are only very few examples of endo-spectroscopy in clinical routine.

Combining advanced optical imaging with advanced optical spectroscopy for a possible diagnostic tool of the future

Two of the most promising technologies that might enable successful diagnostics at pre-cancerous conditions and overcome these limitations are multiphoton microscopy and Raman spectroscopy. Both of them are label-free methods that do not require immuno-staining and have already been widely used for several disease models ex vivo as well as in vivo, making those perfect candidates for endoscopic applications. While multiphoton microscopy shows structural information in histology-like optical sectioning, Raman spectroscopy provides access to the fingerprint-like biochemical composition of a sample. Due to the elementary physical difference in the detection mechanisms, the separation of the signals from both techniques would be relatively simple. At the same time, the different nature of the signals would have numerous synergistic effects, providing access to structural information complemented by the biochemical composition of the very same structure, without the need of cutting biopsies or processing them with bio-chemical staining. For these reasons, a hybrid system that successfully incorporates both techniques could have an immense impact on any sort of endoscopic diagnostics. The long term aim of the work that started with this thesis is to incorporate Raman spectroscopy into an existing multiphoton endo-microscope designed at the Institute of Medical Biotechnology. The data obtained from such a system could

later be used for (semi-)automatic diagnostics based on artificial intelligence software, accelerating the diagnostic procedure and supporting pathologists.

Mehr zum Elitestudiengang Advanced Optical Technologies:

http://www.aot.uni-erlangen.de/maot/home.html

More information:

https://www.mbt.tf.fau.de/

https://www.saot.fau.de/