DEVELOPMENT OF RIGID POLARIMETRIC ENDOSCOPE FOR EARLY DETECTION OF CANCER IN VIVO

Keywords: Optical imaging for biomedical applications; Mueller polarimetric imaging; polarimetric endoscopy; signal processing; early cancer detection and cancer staging.

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Early diagnosis of a cancerous lesion and complete surgical resection of the diseased areas are both crucial points in order to greatly improve the chances for recovery of a patient. However, early detection of cancer is a very difficult task. It relies on random biopsies of suspicious areas which are not easy to identify at this stage of the disease using conventional imaging techniques (visible imaging, ultrasound, magnetic resonance, X-ray scanner, positron emission tomography). In addition, the correct evaluation of surgical resection margins remains often very difficult or even impossible in some cases.

Polarimetric imaging is a promising technique for the early detection of cancerous lesions on the surface of the organs and for a better definition of the resection limits during surgery. Biomedical research activity, conducted within the “Applied Optics and Polarimetry” team of the LPICM, focuses on the development of Mueller polarimetric imaging systems for improving the management of epithelial cancers, also known as carcinomas, which represent 80-90% of all cancers. In this regard the LPICM leads a project funded by the “Institut National du Cancer (INCa)”, on the use of Mueller polarimetric imaging for improving the management of cervical cancer at different stages of its evolution. At present an extensive series of ex vivo measurements is in progress in three different hospitals of Paris (Institut Gustave Roussy, Kremlin Bicêtre and Institut Mutualiste Montsouris). The final goal of this study is to evaluate the performance of Mueller polarimetric imaging technique in terms of sensitivity and specificity, while using an interpretation of corresponding histology slides by pathologists as a “golden standard” of cancer diagnostics. Ex vivo measurements provide a precise knowledge of the systematic effects which can negatively affect image quality. Hence, the results of this study represent a good starting point for in vivo applications of polarimetric imaging technique. Within the frame of INCa project the analysis of uterine cervix in vivo is planned, using a classical colposcope modified to obtain polarimetric Mueller images.

The endoscope is another medical instrument used also to detect cancerous or precancerous lesions in the internal cavities of human body (esophagus, colon, rectum, etc.). The proposed thesis subject consists in developing a Mueller polarimetric rigid endoscope and evaluating its performance in terms of sensitivity and specificity. The work of PhD student will be concerned with instrumentation in optics, acquisition of data, signal processing and statistical evaluation of the performance of technique. Thus, the subject of this thesis is on the interface between physics and medical diagnostics and it shows a strong potential for industrial development with a significant societal impact.
Desired profile or skills: optics, optical instrumentation, optical measurements and signal processing.
A very strong motivation in a continuous interaction with the medical world is required.

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