MASTER IN PHOTONICS – "PHOTONICS BCN"
ERASMUS+ "EUROPHOTONICS"

MASTER THESIS PROPOSAL

Dates: April - September 2020

Laboratory: Centre for Sensors, Instruments and Systems Development (CD6)
Institution: Universitat Politècnica de Catalunya (UPC)
City, Country: Terrassa, Spain

Title of the master thesis: *Multispectral imaging and machine learning for biomedical applications*

Name of the master thesis supervisor: Laura Rey, Francisco J. Burgos, Meritxell Vilaseca
Email address: meritxell.vilaseca@upc.edu
Phone number: +34 93 7398767
Mail address: CD6-UPC (TR-11), Rambla Sant Nebridi 10, 08222, Terrassa (Barcelona), Spain

Keywords: multispectral imaging, machine learning, skin cancer, blood diseases.

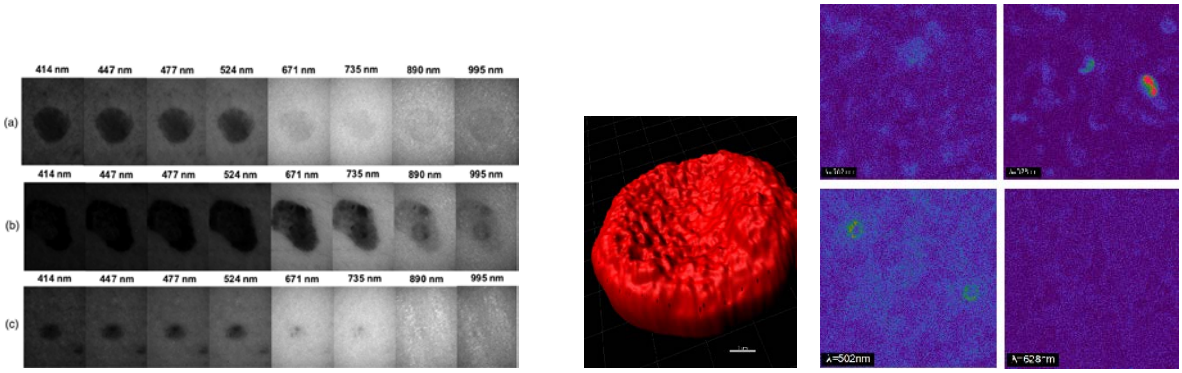
Summary of the subject (maximum 1 page):

In the last years, multispectral imaging has shown to be a powerful tool for the spectral analysis of human tissue and, in particular, for improving the diagnosis of many diseases. In this regards, a custom-made multispectral system for skin cancer analysis was developed at the CD6-UPC. The illumination of the system consists of LEDs, which allow robust, fast and versatile multiplexed illumination of the skin lesions through the visible and near-infrared region. Optimal viewing of skin structures can be achieved with the system: superficial layers are visible through short wavelengths, while images in the infrared range allow obtaining information from deeper layers. The system also includes a 3D head that allows obtaining precise morphological information (3D profile) from the lesion. This system has been recently used to analyze patients with melanomas, carcinomas and benign lesions such as nevi. On the other hand, a confocal laser-scanning microscope (Leica Microsystems GmbH, Mannheim, Germany) equipped with a detection unit that allows spectral discrimination has been used for the analysis of blood samples with red blood cells disorders such as thalassemia, a disease that causes de premature destruction of RBCs and severe anaemia. Blood samples were

excited in this case with a laser diode at 405 nm and the fluorescence emission spectra were collected from 425 to 780 nm with 20 nm bandwidth. Other experiments are currently being designed in order to extract the different spectral traits of RBCs, analyse their morphology and metabolic components.

In this study, we look for a motivated and enthusiastic student with good team working skills to:

1. Process and analyse the multispectral images acquired among several patients with skin cancer lesions (melanomas, carcinomas and nevi) and blood diseases affecting the red blood cells (mainly thalassemia).
2. Look for bibliographic information to be able to offer more ideas in the design of the experiments performed with the confocal laser-scanning microscope, as well as to justify the results that will be obtained after image processing.
3. Apply machine learning and deep learning algorithms to look for specific patterns in the images and develop classification tools to improve the diagnosis of the diseases.



Left: Multispectral images of skin cancer lesions: (a) nevus, (b) melanoma, and (c) basal cell carcinoma. Right: Confocal image of a red blood cell and the corresponding fluorescence emission at several wavelengths.

To this end, the following prior knowledge/skills will be very welcome:

1. Knowledge of machine learning
2. Skills in Matlab programming
3. Ideally, knowledge of TensorFlow and Python programming (but not strictly necessary).