



MASTER IN PHOTONICS – “PHOTONICS BCN” ERASMUS+ “EUROPHOTONICS”

MASTER THESIS PROPOSAL

Dates: April - September 2021

Laboratory: Centre for Sensors, Instruments and Systems Development (CD6)

Institution: Universitat Politècnica de Catalunya (UPC)

City, Country: Terrassa, Spain

Title of the master thesis: *Evaluation of state-of-the-art deep learning algorithms for multimodal image classification.*

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Keywords: multispectral imaging, confocal laser scanning microscopy, deep learning, skin cancer, blood diseases.

Summary of the subject (maximum 1 page):

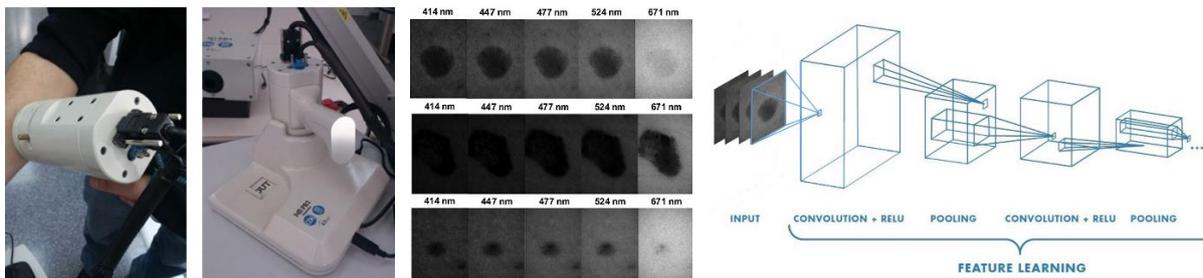
Different imaging techniques such as confocal laser scanning microscopy (CLSM), multispectral (MS) imaging, 3D topography and optical coherence tomography (OCT) have been developed in the last few decades to analyze biological samples quantitatively and non-invasively. In parallel to the development of these modalities, the use of learning algorithms for Computer-Aided Diagnosis (CAD) in the field of medical imaging has become such a popular resource. For instance, in the field of dermatology, deep learning (DL) algorithms have provided physicians with an objective judgement during evaluation of equivocal lesions. DL algorithms are based on neural networks, which are networks of multiple hidden layers of neuronal units, with non-linear connections among them. These connections become accurately weighted when an optimization learning routine is applied. DL can be trained with datasets of diverse nature. This M.Sc. thesis proposal is designed so that the student who enrolls, explores the different DL approaches that exist in the state of the art, and applies them to the different image datasets that have been collected by our research group.

One of the datasets in particular, is the set of multispectral (MS) images of skin lesions acquired in +400 patients. Patients with equivocal lesions were offered to enter the study conducted by hospitals Clínic i Provincial de Barcelona and Università degli Studi di Modena e Reggio Emilia. The images of lesions from different etiologies, benign and malignant were acquired in the visible and near-infrared (VIS-NIR) ranges with a staring MS imaging device, designed at CD6.

Machine learning and other feature extraction algorithms to look for specific patterns in the images were already applied, with average accuracy outcomes. We would like to step forward and apply the existing state-of-the-art DL algorithms, that are proven to retrieve very high accuracy values, and develop an adapted classification tool. For this purpose, we look for a motivated and enthusiastic student with good team working skills.

The main points that will be carried out by the student during the completion of the M.Sc. thesis are the following ones:

1. Look for bibliographic information to be able to offer more ideas in the design of the DL algorithms to be applied to our datasets.
2. Adapt the existing DL algorithms in the state of the art, such as the principal networks used on image classification and their adaptations. Some of the DL convolutional neural networks (CNN) that are being used currently are the LeNet-5, AlexNet, VGGNet, GoogLeNet (Inception) and ResNet.
3. Train and test the adapted DL algorithms with our image datasets, in particular with our set of MS images from +400 patients.
4. Compare the results obtained among the different DL adaptations and study which are the best hyper parameters to be used. The goal will be to obtain higher accuracies and lower loss values on the test data, at each step or adaptation.
5. Discuss the results with other works in the state of the art for similar image datasets. Use the ones collected at the beginning of the M.Sc. thesis.



Left: MS imaging device and images of skin lesions: nevus (up), melanoma (middle), and basal cell carcinoma (down) at 414-671 nm. Right: scheme of deep neural net to be fed with our data.

It is essential that the student has the following knowledge/skills in:

1. Python programming
2. Machine and Deep learning fundamentals
3. Image processing