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ICFO
The Institute
of Photonic
Sciences



Master in Photonics – “PHOTONICS BCN” Master ERASMUS Mundus “EuroPhotonics”

MASTER THESIS PROPOSAL

Starting full time from April 2024

Presentation at the end of July or beginning of September 2024

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

Institution: Universitat Politècnica de Catalunya

City, Country: Terrassa

Title of the master thesis: Photonics, image processing and deep learning for precision agriculture: pest control

Name of the master thesis supervisor and co-supervisor: Meritxell Vilaseca, Fernando Díaz

Email address: meritxell.vilaseca@upc.edu

Phone number: +34 93739 8767

Keywords: Photonics, DL, precision agriculture

Summary of the subject (maximum 1 page):

Several photonic-based techniques have been developed in the last few decades to analyze biological samples. In parallel to the development of these modalities, the use of deep learning (DL) algorithms (e.g., deep neural networks) has become a popular resource as it allows to improve the outcomes and predictability of such systems. For instance, in the field of precision agriculture, which is nothing more than the consequence of the landing of new technologies in agriculture, color and multispectral imaging systems have started to be used to automatically recognize and count insects in order to adopt more efficient and sustainable production methods. It is to be noted that due the last EU regulations, which aim to achieve a sustainable use of pesticides to reduce their impact on human health and the environment through alternative non-chemical approaches, real-time monitoring of pests has become a crucial task to prevent their development in crops.

In this context, a multispectral imaging system able to make the counting process of number of insects trapped on chromotropic traps across crops automated, and thus providing real-time data, is being developed at the CD6 (see figure). The former system could benefit from the use of DL tools in order to extract features and specific patterns from the images that allow for a



better classification among insects of different species based on morphological and spectroscopic characteristics.

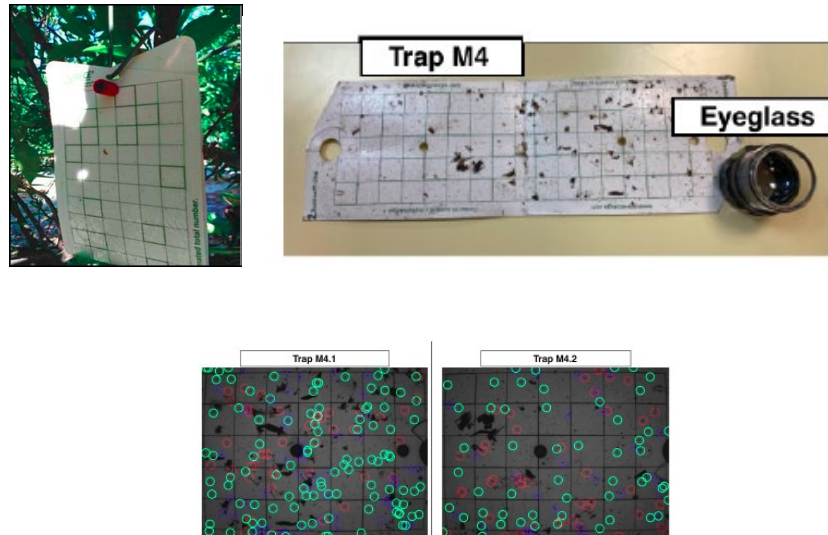


Figure. Chromotropic traps (top) and multispectral images (bottom) with automated detection of individuals of one specific species.

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. Implementation of image processing tools to extract characteristic patterns of the insect species from the images.
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.
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. Participate in experimental measurements for validation of the systems.

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

1. Python and Matlab programming
2. Image processing