Master in Photonics – "PHOTONICS BCN"
Master ERASMUS Mundus "EuroPhotonics"

MASTER THESIS PROPOSAL

Dates: April - September 2022

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

Title of the master thesis: *Photonics and image processing tools for the automatic characterization of the canopy in vineyards*

Name of the master thesis supervisor and co-supervisor: Fernando Díaz, 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: photonics, image processing, canopy characterization, precision agriculture

Summary of the subject (maximum 1 page):

One of the biggest challenges that humanity will have to face in the coming century relates to ensuring food security and healthy food access for an increasing population, while maintaining a sustainable environment. In this way, there is an urgent need for optimizing the agricultural production processes so as to achieve higher yields and, at the same time, being more respectful with the environment. In this context, precision agriculture, which is nothing more than the consequence of the landing of new technologies in agriculture, plays a key role. In particular, in the so-called specialty crops (such as vineyard, olive, or other fruit-trees), great efforts have been dedicated in the last years to developing systems for the automatic characterization of the canopy (height, width, leaf density, …). Such systems will allow the optimization of the applied pesticide dose based on the actual vegetation structure at each point of the plots, reducing in this way both the impact on the environment and the production costs, while still ensuring the correct protection of the crops against pests. Several technological approaches have been proposed and tested with this aim in research works (ultrasound sensing, LIDAR, analysis of satellite or unmanned aerial vehicle images, …), in some cases with great success. However, none of them has been transferred into common agricultural practice, mainly due to their high

cost or the need for heavy post-processing after data acquisition. In these regards, CD6 is developing a new photonics-based system using machine vision and time-of-flight imaging, aiming at providing a low-cost and fast tool for canopy characterization in vineyard and olive groves. To fully exploit the potential of this new system, eventually allowing its use in real time during the pesticide application process, it will benefit from the implementation of faster image processing algorithms, including the use machine learning (ML) and deep learning (DL) strategies. For this purpose, we look for a motivated and enthusiastic student with good team working skills.

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

1. Look for bibliographic information to propose new fast image processing strategies to be applied to our datasets, in particular those from vineyard.
2. Implementation of data fusion and image processing tools for the correct segmentation of the images and the identification of the evaluated grapevines from the rest of the scene.
3. Develop new fast algorithms for the extraction of geometrical parameters describing the vegetation structure (height, width) from the segmented images.
4. Investigate the possibility of adapting existing ML and DL classification algorithms in the state of the art, such as convolutional neural networks (CNN), in order to classify the vineyard vegetation in terms of density.
5. Train and test the developed algorithms with our datasets, comparing the results with ground truth values and those obtained with other techniques (ultrasound).
6. Participate in experimental measurements for validation of the system.
7. Discuss the results with other works in the state of the art.

Additional information:

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

- Python and Matlab programming.
- Image processing.
- Machine and Deep learning background.