PHOTONICS - EUROPHOTONICS MASTER COURSE

PROPOSAL FOR A MASTER THESIS

Dates: February 1st, 2022 – September 31st, 2022

Laboratory: Centre for Sensors, Instrumentation and systems Development (UPC-CD6)
City, Country: Terrassa, Spain

Title of the master thesis:

Multimodal Imaging fog Removal for Autonomous vehicles in turbid media using deep neural networks

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Summary of the subject:

Which is the problem?
Turbid media scatter light in many directions, damping the visibility through them. Consequently, the performance of imaging sensors such as cameras and LiDAR (Light Detection And Ranging) devices is severely harmed, even to the extent of failing to provide reliable data because of veiling or hazing artefacts on images and false alarms.

The current disruption of autonomous driving and robotics has led Computer Vision (CV) researchers to focus on minimizing these damaging effects of imaging through turbid media or adverse weather conditions. Traditionally, the Dark Channel Prior (DCP) has been commonly used for single image defogging but, nowadays, Deep Neural Networks (DNN) seem to outperform them. This is the case of Generative Adversarial Networks (GAN) whose main ability is to create fake images. Hence, they can be trained for creating defogged images from raw inputs. (Some examples here: 1 , 2 , 3 , 4). Moreover, data fusion of multiple imaging modes aims to increase the global performance of the sensors being combined.

This TFM proposal is linked to a cutting-edge research project carried in the CD6 with the spin-off Beamagine that proposes a multimodal sensor based on 3D LiDAR in conjunction with active polarization imaging (you can get access to our recent article under request) for improving the imaging performance through turbid media. The aim of this TFM is to explore and train a DNN for reducing the turbid media haze effect and increasing the detection performance by using the available imaging modes.

Why are we interested?
Due to the direct relation between CD6 environment and the development of novel photonic products, we are used to deal with this kind of technical challenge. Currently, our 3D multimodal LiDAR system with active polarization imaging is being tested in advanced facilities under the framework of an international project. We are in the industry race, getting specialized know-how and participating in the designing of the tomorrow's technology in collaboration with manufacturers.

What will you do?
During the first weeks, you will be introduced to the multimodal sensor fusion device with technical staff of CD6 (teammates) whilst you will explore and learn about DNN focused on defogging. Once you propose a feasible DNN architecture, you will have access to our developing environment for creating the dataset, training the DNN and evaluating its performance.
You will have to make decisions on different technical aspects such as code performance, generated output, efficiency, … getting confidence and experience in working in real-world applications and getting involved in technical teams. It must be highlighted that you will be co-working with the team so you can get support from them when needed.

Is this TFM for you?
This is a Thesis mostly related to programming. If you are willing to work with state-of-the-art tech-challenges and seeing your progress applied in a real-world application whilst working with a good and enriching environment, this TFM is for you.

Keywords: LiDAR, 3D imaging, LiDAR calibration, Image processing

Additional information:

* Amount of the monthly allowance. Depending on value of candidate

* Recommended skills:
Interest in application-driven experimental work for solving real-world problems.
Basic concepts in image processing and neural networks
Programming (MatLab, Python and the DNN packages, C++ appreciated)
Search of resources, both scientific and technical.
Self-motivated, objective-driven, capable of autonomous working within a multidisciplinary team.

* Miscellaneous :
This thesis contents will be considered <u>confidential</u> due to its closeness to market.
A solid research project with several PhDs related.
International team with several years of experience in the topic proposed.
Multidisciplinary environment with electronics and mechanics workshops, and specialists and technicians in metrology, optics, mechatronics, and electronics.
Possibility of joining the Centre for a PhD/Project Manager career in case of common interest.
<u>Early incorporation welcome</u>.