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

MASTER THESIS PROPOSAL

Dates: April 2022 - September 2023

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

Title of the master thesis:

INDUSTRY CHALLENGE: Advanced 3D Perception based on 2D Projection and Sensor Fusion for Autonomous Vehicles

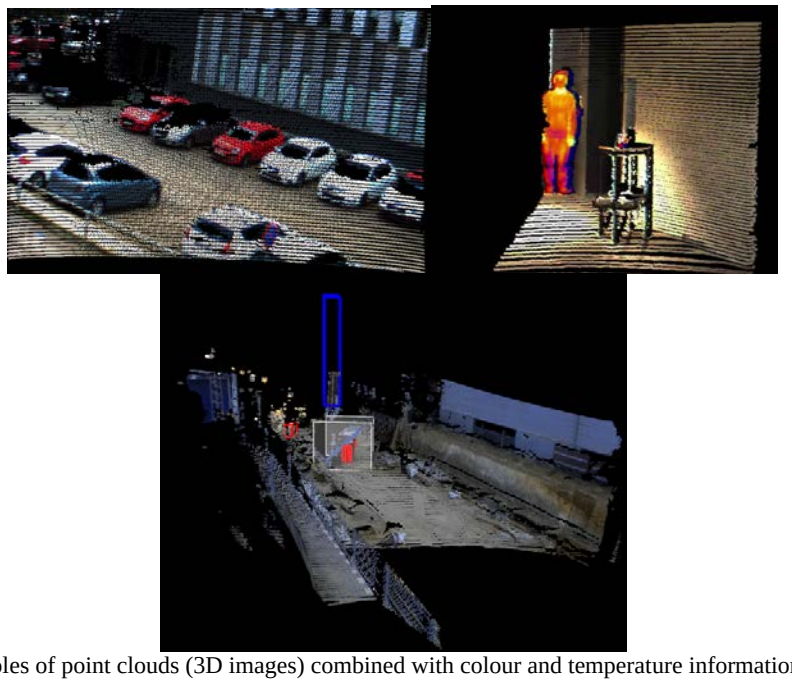

Figure. Some examples of point clouds (3D images) combined with colour and temperature information from our multimodal LiDAR system. Below, you can appreciate our current 3D AI-perception.

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Keywords: Perception, Autonomous Vehicles, LiDAR, Artificial Intelligence

Summary of the subject (maximum 1 page):

With the disruption of autonomous vehicles in recent years, LiDAR (Light Detection And Ranging) devices have aroused lots of interest for becoming the "eyes" of the vehicles for perceiving their environment. They provide the depth information that cameras lack and have larger spatial resolution than radars. The current approach for autonomous vehicles is to combine data from 2D and 3D sensors (sensor fusion) with the LiDAR at its core for avoiding system failures when the environmental conditions are adverse (low illumination, fog, rain, …) and increasing the confidence of the detections.

Nonetheless, 3D detection is not as mature as 2D object detection so most of the current state-of-the-art perception pipelines do not take advantage of the 3D information. Additionally, there are few 3D datasets and most of the state-of-the-art architectures rely on the same dataset: Kitti. Besides, the high computational cost of point cloud processing causes most of the approaches to either exploit 2D detection and back-project to the point cloud or to reduce the point cloud size by means of voxelization. Moreover, most of the researchers do not have access to the full raw data of the sensors, so they are forced to base their perception pipelines in the post-processing stages.

This TFM proposal is linked to the cutting-edge technology developed in the CD6 with the spin-off Beamagine that proposes a multimodal sensor based on 3D LiDAR that outperforms current AI perception systems and provides 2D-3D key advantages that lead to different successful research projects (here you can see our recent results about 2D-3D perception in construction environments). The aim of this TFM is to explore, propose and train a 2D-3D perception pipeline based on our current Deep Neural Networks (DNN) directly applied to the LiDAR information thanks to the access to the raw data.

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 is demonstrating an outstanding performance in AI perception thanks to its accurate range and precise sensor fusion. Moreover, we have the key advantage of having access to the raw LiDAR data, contrary to most of the research today. 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 2D image processing (conventional and AI deep neural networks) focused on perception and the state-of-the-art about 3D perception. Later on, you will have to propose a feasible pipeline capable of using both 2D and 3D information for enhancing the system perception. Once you propose a feasible pipeline or 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?

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.

Additional information:

- Amount of the monthly allowance
- 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 confidential 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.
Early incorporation welcome.