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

MASTER THESIS PROPOSAL

Dates: February 2024 - September 2024

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:

Smart FOV LIDAR based on MEMS scanner technology

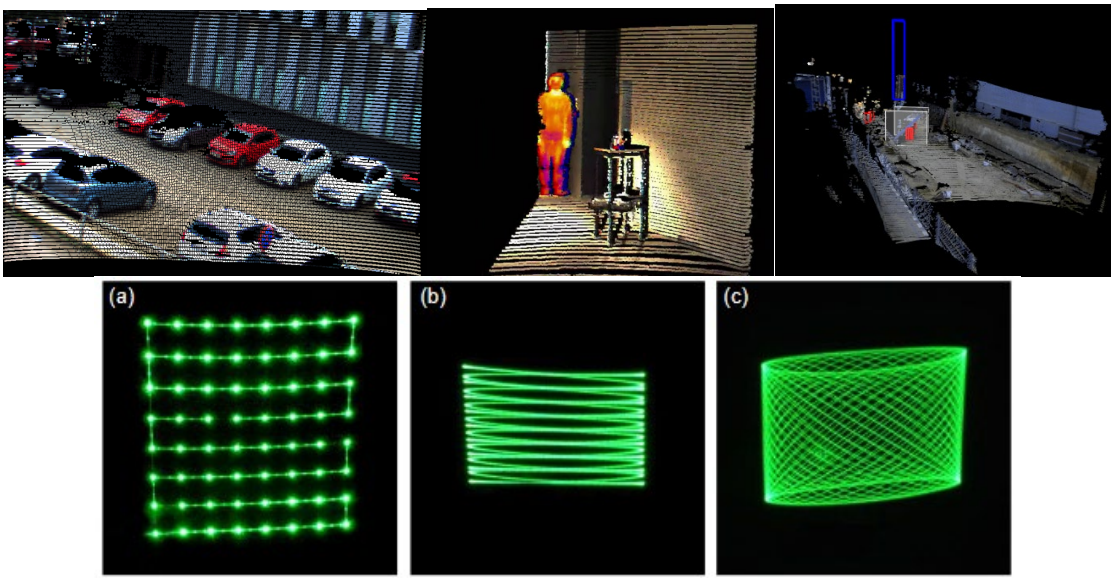

Figure. (Top) Some examples of point clouds (3D images) combined with colour and temperature information from our multimodal LiDAR system and our current 3D AI-perception. (Bottom) Light patterns produced by a MEMS mirror.

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Keywords: Autonomous Vehicles, MEMS, LiDAR, Artificial Intelligence

Summary of the subject (maximum 1 page):

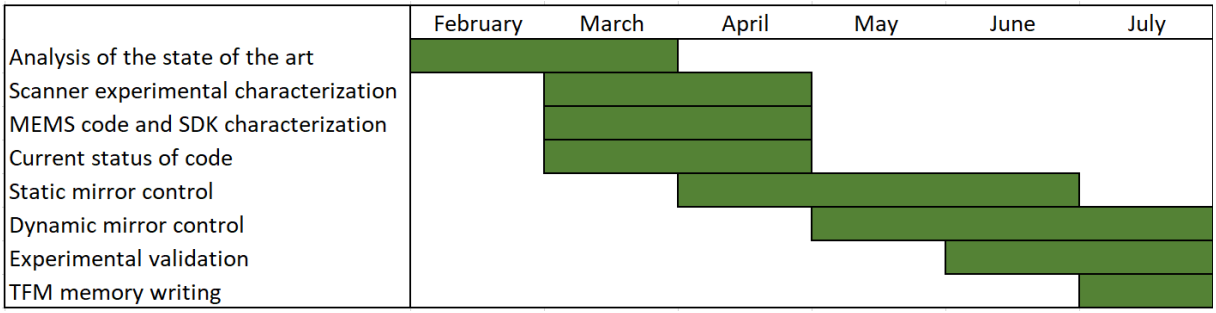
With the disruption of autonomous vehicles in recent years, LiDAR (Light Detection And Ranging) devices have aroused lots of interest for becoming the "eyes" of the vehicles for perceiving their environment. They provide the depth information that cameras lack and have larger spatial resolution than 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. As a result, many different scanning techniques have emerged but solid-state LiDAR systems are showing greater features than rotatory ones. Particularly, Microelectromechanical Systems (MEMS) mirrors present unrivalled advantages for scanning the environment with a given Field-Of-View (FOV) at high speeds by means of steering the laser beam. Hence, the imaging properties of the LiDAR (FOV and resolution) are determined by the MEMS steering capabilities and its control.

The aim of this TFM is to improve our current MEMS-based scanning technologies to target the laser beam towards a target with precision and accuracy. Actively controlling the MEMS will enable future LiDAR devices to adjust their FOV and resolution depending on the scenario to focus on certain Regions-Of-Interest (ROI) building a new concept of Smart LiDAR devices.

This TFM proposal is linked to the technology developed in the CD6 in the last years in collaboration with the SME Beamagine S.L that proposes a multimodal sensor based on 3D LiDAR that outperforms current AI perception systems and provides advantages fomr the combination of 2D and 3D technologies. You can see some of our recent results about 2D-3D perception in construction environments and our work related to see through fog using a polarized LiDAR.in the associated links.

Work plan

During the first weeks, you will be introduced to the multimodal LiDAR device with technical staff of CD6 assigned to support you in your project for proper progress. From there, you will explore about LiDAR imaging, revise the state-of-the-art about imaging (cameras) and MEMS mirror scanners. Later on, you will get your hands on our calibration lab, and understand the surrent mirror control methodology. Further, you will propose and develop a method to detect where the LiDAR MEMS scanner is pointing to its infrared laser beam based on a NIR camera and develop a pointing system based on MEMS. A tentative project development timing is proposed next.



Additional information:

- CD6 offers internship allowances for BSc and MSc students with grants depending on the value of the interns, given full time dedication is granted.
- Interns join a consolidated research team with several PhDs and Postdocs related, involving an international team with several years of experience in the topic proposed.
- CD6 offers a multidisciplinary environment with electronics and mechanics workshops, and specialists and technicians in metrology, optics, mechatronics, and electronics.

- Necessary skills (Must have):
  - Full-time dedication.
  - Proactive attitude to do research in a market-oriented environment.
  - Collaborative work and communication skills.
  - Critical thinking and problem-solving.

- Recommended skills (Nice to have):
  - Interest in application-driven experimental work for solving real-world problems.
  - 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 developed in collaboration with a company and will be considered confidential.
  - Possibility of joining the Centre for a PhD/Project Manager career in case of common interest.
  - Early incorporation recommended.