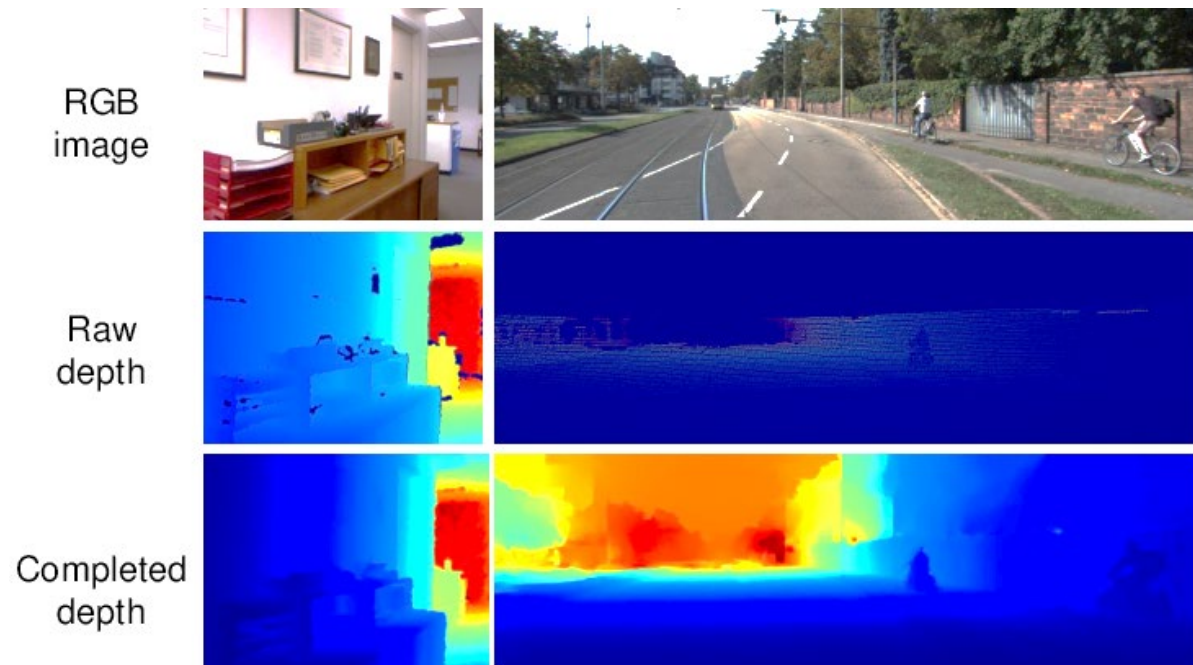# PROPOSAL FOR A MASTER THESIS

Dates: February 1st, 2025 – September 30th, 2025

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

Title of the master thesis:

AI-DENSE DEPTH IMAGE RECONSTRUCTION BASED ON LIDAR DATA FUSION

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Summary of the subject (maximum 1 page):

Robust detection, localization, classification, and tracking of objects are the fundamental tasks for autonomous driving. While computer vision has significantly advanced in recent years through camera sensors, 3D localization from images still remains challenging. LiDAR point clouds provide accurate localization in 3D by measurin distance and geometric information, but 3D processing is computationally much more expensive than 2D. Therefore, depth images are used to provide the distance information in a handy 2D image form. However, LiDAR resolution is limited and yields sparse depth images. Hence, there are completion strategies to generate complete depth images by filling the depth information where no direct measurements are available, resulting in a denser and more continuous depth map.

The project is therefore focused on implementing a depth completion algorithm based on accurate data fusion between a LiDAR and a camera that are enclosed in a unique multimodal device currently available at the research center. We have expertise about RaDAR+camera.

You will join our research group, where you'll have support on the use of scanning lidars, computer vision, optical design and modelling, software and AI development, etc.

This thesis aims to develop the depth completion algorithm exploiting the benefits of the congruent data fusion between a LiDAR and a camera. The focus will be on four key areas:

1) **Technology background:** Understanding the proprietary multimodal technology that combines the 3D data with the 2D information using the camera projection model.

2) **State-of-the-Art Review:** Exploring the current state-of-the art about depth completion and data fusion to establish a benchmark and to determine the possible parameters and trade-offs of the development.

3) **Dataset generation:** Acquiring the necessary data to train the algorithm, validate it and test it. Within this context, the research group has a vehicle equipped with different sensors including the abovementioned LiDAR+camera device to acquire datasets.

4) **Software development and deployment:** Developing the algortihm with the goal of being deployed in the multimodal LiDAR devices.

This project will provide the current multimodal LiDAR devices with a powerful feature of high interest and impact to real-world applications like autonomous mobility. Exploiting the benefits of 2D+3D data fusion is a key value in our roadmap. Basic programming skills (fluent Matlab or Python) and basic knowledge of electronics and optical system design are desirable, but not strictly required.

Keywords: LiDAR, metrology, autonomous vehicles, data fusion, AI, Python, deep learning

Additional information :
* Amount of the monthly allowance (if it is the case):
To be discussed depending on the value of candidate.

* Required skills:
Interest in application-driven experimental work for solving real-world problems.
Basic concepts in optical metrology and optical engineering
Programming (C++ desirable, Python or Matlab minimum) and use of scientific software packages.
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.
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>.