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PHOTONICS - EUROPHOTONICS MASTER COURSE

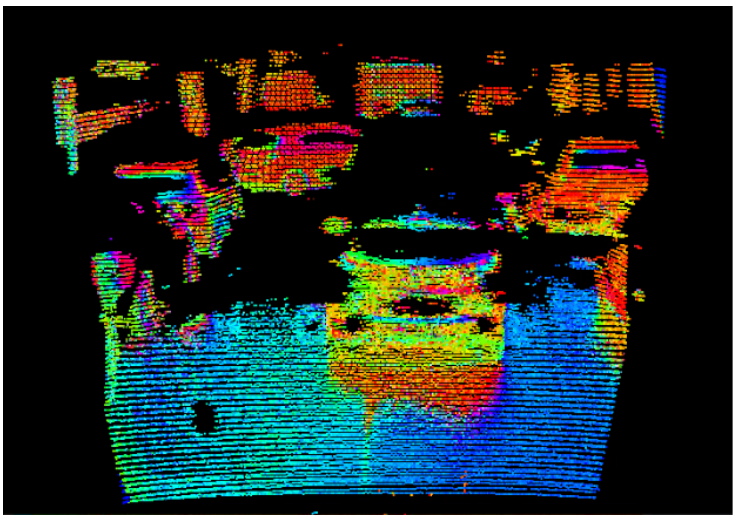
PROPOSAL FOR A MASTER THESIS

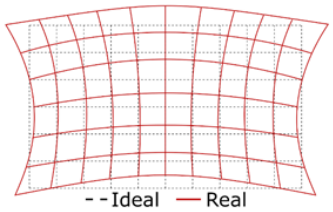
Dates: February 1st, 2020 – September 31st, 2020

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

Title of the master thesis:

Multi-capture 3D camera calibration for data fusion in autonomous driving





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

Summary of the subject:

Which is the problem?

LiDAR imaging is a powerful measurement technique where a laser pulse is shone onto an object and the beam reflected back is recovered at some solid-state detector. The time elapsed is counted so an automated measurement of the distance to the target is obtained, without any further calculation. By scanning the scenario, a whole set of 3D points known as Point Cloud is obtained. The concept is also known as LADAR or time-of-flight imaging.

The current disruption of autonomous driving and robotics has forced this technology to move a step forward for meeting demanding specifications. As a result, many different scanning techniques have emerged but solid-state LiDAR systems are showing greater features than mechanically rotatory ones. Due to fast acquisitions rates, scanning presents a certain amount of distortion which cannot be described by the conventional optical model. Thus, the scanning Field-of-View must be characterized and corrected so precise and accurate measurements are provided. Such correction s critical for high-tech applications such as autonomous driving, where congruent data fusion with imaging sensors is required.

This TFM proposal is linked to a recently proposed and validated calibration procedure resulting from a PhD thesis between CD6 and industrial company. However, the current procedure is based on a single 3D capture, and is considerably as far as since the LiDAR must be constrained to a fixed position and orientation. The aim of this TFM is to improve the procedure by using multiple captures with different positions and orientations of the system, adapting the conventional calibration methods used in conventional imagers.

See https://es.mathworks.com/help/vision/ug/single-camera-calibrator-app.html http://www.vision.caltech.edu/bouguetj/calib_doc/ for examples of state of the art camera calibration methods.

What will you do?

In your first weeks, you will learn and discuss the basics and tools of the problem, and the current optical procedure the team related to the project, which will support you throughout your project. Once the algorithm and the different functions are understood, you will formulate the multi-capture calibration problem on the basis of the already developed single capture one. This means, mainly, including the position and orientation of the LiDAR in the current minimization function and carefully selecting the solver and its constraints. 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, either on the coding or on the optomechanical and lidar side.

Is this TFM for you?

This is an applied thesis work with unsolved technical challenges and with controlled risk. This Thesis is for you if you are willing to work with state-of-the-art tech-challenges in the middle ground of sensor development and computer vision, and you enjoy seeing your talent applied to a real-world problem, whilst working with a good and enriching environment.

Additional information:

* A monthly allowance is possible depending on the value of the candidate. In any case allowance requires full-time dedication and early incorporation, even part-time in the first months. Contact for details.

* Recommended skills:
Programming (C++, MatLab) and use of scientific software packages (Labview) recommended.
Interest in application-driven experimental work for solving real-world problems.
Search of resources, both scientific and technical.
Self-motivated, objective-driven, capable of autonomous working within a multidisciplinary team.
Basic concepts in optical metrology and optical engineering.

* Miscellaneous :
This thesis contents will be considered confidential due to its closeness to market.
Consolidated research team with several years of experience in the topic.
Multidisciplinary environment with electronics and mechanics workshops, and specialists and technicians in metrology, optics, mechatronics, and electronics.
Possibility of joining CD6 for a PhD/Project Manager career in case of common interest.
Early incorporation welcome.