Announcement of a PhD fellowship
Clermont-Ferrand, France

Identification by inverse method of optical properties of a participating media submitted to a polarized light
Application to the impact of fog on artificial perception

Doctoral contract 3 years

Deadline for application : August, 31th, 2020
Beginning of the contract : October, 1st, 2020

Subject description

The project "Autonomous VEhicle uNder difficult CondiTions in partially Unknown Road Environment (AVENTURE)" funded by the IMobS^3 LabEx and the I-Site CAP 2025 (https://cap2025.fr/en/) aims to develop navigation tools for an autonomous agricultural or road vehicle, making it possible to move, as a human being can, in complete safety from a point A to a point B without first learning the path followed.
An original methodology is developed in Johann Laconte's thesis (2018-2021) on the optimal and safe traversability for the movement of autonomous vehicles. It is based on a dynamic risk map established during the evolution of the vehicle (taking into account obstacles, etc.), based in particular on perceptive sensors. In order to quantify the impact of fog on perceptive sensors, we propose in this thesis topic to develop a method to identify the optical properties of a participating medium (fog) from experimental data obtained through the PAVIN "Rain Fog" platform of Cerema (France, Clermont-Ferrand).
The scientific objective is to evaluate the robustness of literature models (Mie theory in particular) on experimental data, by setting their parameters by inversion.
The identification will be based on the inversion of the radiative transfer equation governing the propagation of electromagnetic waves in fog. The droplet size distribution of the medium is a key parameter in propagation models, and the inversion will allow to identify this distribution from experimental radiation measurements acquired by a spectroradiometer operating between 300 nm and 2500 nm. Measurements with a 8-14 micron radiometric camera will complete the inversion for the thermal infrared range.
It will be interesting to compare the identified drop size distributions with the distributions measured by the optical granulometer of Cerema.
In addition, to take into account the possible use of polarimetric cameras in autonomous vehicles in the near future, the proposed collaboration with Professor Royo of the University of Catalonia will extend the modelling work to polarized light.

Scientific support

PhD fellowship is proposed at Cerema (Department Laboratory of Clermont-Ferrand) and at the Laboratory of Mathematics of Clermont-Ferrand (University in collaboration with the Centre for Sensors, Instruments and Systems Development (Barcelona, Spain). The scientific support will be led by :

- Dr-Ing. Frederic Bernardin (Researcher, Cerema, Clermont-Ferrand)
- Pr. Arnaud Munch (Full Professor, Laboratory of Mathematics, Clermont-Ferrand University)
- Pr. Santiago Royo (Full Professor, Centre for Sensors, Instruments and Systems Development, Barcelona)

Academic requirements

The applicant must have strong skills in applied mathematics and more particularly in functional analysis, partial differential equation (PDE) theory, numerical analysis, optimal control of PDE's, stochastic simulation. Knowledges in photonics would be appreciated. Good knowledge of code developing (e.g. C/C++) is required and fluency in English (oral and written) is needed.

Application

Applicants are invited to send, before August, 31 2020, a detailed CV, a letter of application, a letter of recommendation and the scores of first and second year (if available) of Master's degree to :
frederic.bernardin@cerema.fr, arnaud.munch@uca.fr and santiago.royo@upc.edu