Post-Doctoral Fellowship

Smartphone assisted flow imaging for research and education

Research Center : Center for Energy and Environment

Lab Head : Pr. Patrice CODDEVILLE

Contract type : Fixed term (CDD), 14 months

Location : IMT Lille Douai research center, 764 Boulevard Lahure, 59500 Douai France

Context:

Created by the merger of Mines Douai and Telecom Lille on January 1st, 2017, **IMT Lille Douai** is the largest graduate school of engineering in the north of Paris. It aims at teaching the general engineers and digital experts of the future. Located at the crossroads of Europe, between Paris, London, Brussels and Amsterdam, IMT Lille Douai intends to become a major player in industrial and digital transformation of the society by combining engineering science and digital technologies.

Based on two sites dedicated to research and education in Douai and Lille, IMT Lille Douai has research facilities of almost 20,000m² devoted to high-level scientific activities in the following areas:
- Digital sciences
- Process for industries and services
- Energy and Environment,
- Materials and Process engineering applied to polymers, composites and civil engineering.

For further details , please visit www.imt-lille-douai.fr. The successful applicant will be affiliated to the enter for Energy and Environment and the research team on Fluids and components, that conducts research on complex fluids complex flows, and their role in transfer intensification. He/she will be involved in a multidisciplinary project team with members belonging to Numerical sciences and Materials research centres, and working closely with the Educational innovation team. Details on the project are provided in what follows.

Scientific context / Mission / Tasks:

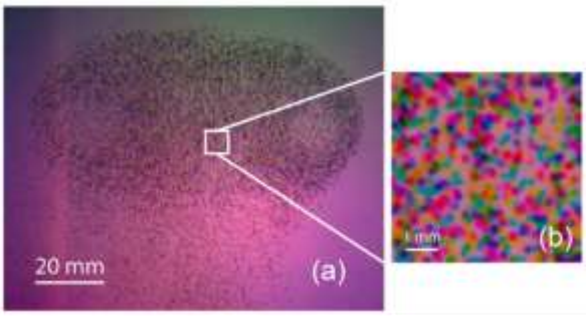

Figure 1: Rainbow PIV by Aguirre-Pablo et al. [4]

Optical methods are an ever-developing tool of experimental mechanics and provide information on various types of flows (multiphase, granular, non-Newtonian, turbulent…)[1]–[3]. Lately frugal developments of optical methods have been proposed, based on the use of smartphones[4], [5]. Camera performances of the latter have indeed become comparable, to some extent, to those of scientific cameras commonly used for flow imaging, while staying relatively cheaper. Smartphone assisted flow imaging thus shows great potential for research by making some advanced methods affordable, and eventually offering an integration of the data acquisition and image processing chain to a single tool. Without seeking to replace advanced optical metrology, it provides fast, inexpensive, and flexible screening of physical phenomena, and quickly and easily identify key features. Using numerical science and advanced data processing, smartphone eventually offer new opportunities of flow imaging, in research projects for which conventional methods would not have been easily implemented. Beyond the metrological considerations, smartphone assisted imaging also provides great educational opportunities, bringing together physical and numerical sciences, and being at the same time visual, intuitive, relatively inexpensive to implement. It opens the door to virtual, remote and adaptable practical works at all stages of study, the relevance of which has been emphasized by the COVID19 pandemic [6].

The aim of this project is to develop an experimental tool for Smartphone Assisted Flow Imaging for Research and Education (SAFIRE), synthetizing recent advances in the fields of optical methods for flow measurement and image analysis, and applicable for both frugal research and educational innovation.

The tasks of the research fellow will be to identify the potential of measurement techniques, develop the hardware and software for data acquisition and processing, and apply the designed system to research and teaching scenarios. Those include (but are not limited to): tomographic flow velocimetry and density measurement in complex flows, study of multiphase and granular flows, development of remote teaching methods and practical works. The method will contribute to research projects in energy efficiency, environmental flows and civil engineering.

Person specification:

We are looking for an enthusiast candidate willing to conduct multidisciplinary cutting-edge research (and potentially engage in educational innovation projects). The ideal candidate is expected to have a PhD in physical or numerical sciences, engineering, or any related fields, (graduation complete at the project starting date). Strong analytical, organisation and communication skills, proven aptitude for experimental work are required, along with experience in one or several of the followings: Image analysis, optics, experimental (fluid) mechanics, programming (Matlab, C++, Python …). Knowledge in optical methods for fluid mechanics (PIV, PLIF...) and experience with LabView and/or mobile app development would be a plus. This position is open to early career researchers (no prior postdoc experience required). The recruited candidate is expected to contribute to international scientific publications and communication, and can be asked to involve in teaching and supervision activities from graduate to post-graduate levels (supervision of lab courses, undergraduate and MSc student projects, PhD students). Eligibility to live and work in the EU is required.

Conditions: ***Recruitment conditional to funding allocation through internal competition, on the basis of candidate profile and project quality. Answer expected in the week beginning on 22/03/2021.***

Starting date: 31/05/2021 at the latest
Salary (raw): 25-35 k€/yr

How to apply: Please send detailed CV, cover letter, and any document supporting your application at **Tom LACASSAGNE** tom.lacassagne@imt-lille-douai.fr. Use the same contact for enquiries about the position.

Application deadline: 05/03/2021

References:

[1] T. Lacassagne, S. Simoëns, M. E. Hajem, et J.-Y. Champagne, « Ratiometric, single-dye, pH-sensitive inhibited laser-induced fluorescence for the characterization of mixing and mass transfer », *Exp. Fluids*, vol. 59, nº 1, p. 21, janv. 2018, doi: 10.1007/s00348-017-2475-y.

[2] J. Westerweel, G. E. Elsinga, et R. J. Adrian, « Particle Image Velocimetry for Complex and Turbulent Flows », *Annu. Rev. Fluid Mech.*, vol. 45, nº 1, p. 409-436, 2013, doi: 10.1146/annurev-fluid-120710-101204.

[3] S. Hamidouche, J. V. Simo Tala, et S. Russeil, « Analysis of flow characteristics downstream delta-winglet vortex generator using stereoscopic particle image velocimetry for laminar, transitional, and turbulent channel flow regimes », *Phys. Fluids*, vol. 32, nº 5, p. 054105, mai 2020, doi: 10.1063/5.0005788.

[4] A. A. Aguirre-Pablo, M. K. Alarfaj, E. Q. Li, J. F. Hernández-Sánchez, et S. T. Thoroddsen, « Tomographic Particle Image Velocimetry using Smartphones and Colored Shadows », *Sci. Rep.*, vol. 7, nº 1, p. 1-18, juin 2017, doi: 10.1038/s41598-017-03722-9.

[5] K. Hayasaka et Y. Tagawa, « Mobile visualization of density fields using smartphone background-oriented schlieren », *Exp. Fluids*, vol. 60, nº 11, p. 171, oct. 2019, doi: 10.1007/s00348-019-2817-z.

[6] « Smartphonique.fr – Utilisation du smartphone en sciences. » https://smartphonique.fr/?lang=fr (consulté le janv. 12, 2021).