

PROPOSITION DE STAGE EN COURS D'ETUDES

Référence : **DOTA-2024-39**
(à rappeler dans toute correspondance)

Lieu : Châtillon/Palaiseau

Département/Dir./Serv. : DOTA/HRA, DOTA/SLS

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DESCRIPTION DU STAGE

Thématique(s) : Analyse de surface d'onde, Optique adaptative, Holographie numérique, Télécommunications optiques en espace libre

Type de stage : Fin d'études bac+5 Master 2 Bac+2 à bac+4 Autres

Intitulé : Exploring the temporal behavior of atmospheric fog with LiDAR techniques for wavefront shaping

Sujet :

Free space optical (FSO) communication in the infrared with quantum cascade lasers operating in the chaotic regime represents an attractive technology for secure terrestrial communication or ground-satellite communications in presence of atmospheric perturbations [1][2]. However in presence of atmospheric disturbances such as fog or clouds, the encoded information can be lost due to multiple scattering. The signal undergoes temporal and spatial distortions, and becomes unreadable as the distance increases.

Fortunately a new generation of fast spatial light modulators integrating a high number of actuators allows now to address turbid media and paves the way for wavefront shaping techniques which partially correct scattering due to propagation through complex media [3]. These approaches which allows focusing and imaging of light through opaque medium could be applied to FSO communications.

Recent works carried out by ONERA and the Laboratoire Kastler Brossel (LKB) show that the decorrelation time of the speckles that characterizes a fog can be compatible with the bandwidth of actuator mirrors available on the market. This means that it should be possible to implement a phase conjugation (time reversal) method for FSO through fog, a relevant technique to determine the optimal correcting field and avoid long calibration process of the channel.

The goal of this internship will be to characterize the temporal behavior of a beam after propagation through fog using LiDAR measurements. Indeed LiDAR technique can provide high resolution position of the scatterers and thus give access to temporal measurements. Furthermore LiDAR is a very advanced technique since it allows easily deployable measurements thanks to the use of a fast single-pixel sensor compared to the use of a camera. ONERA has developed a unique expertise on LiDAR for various applications [4].

During his internship, the applicant will adapt the configuration of a LiDAR available in laboratory to perform experimental measurements in an optical set-up developed by ONERA. Temporal measurements will then be undertaken with a small green house representative of an atmospheric fog in various conditions. These measurements will be carried out in pairs. The applicant will process the data obtained with the Lidar to estimate the temporal statistical behavior of the droplets. First empirical modelizations will be made according to the droplets concentration.

We are looking for an applicant with skills and interests in experimental work, as well as a taste for data processing.

Bibliography :

[1] O. Spitz, A. Herdt, J. Wu, G. Maisons, M. Carras, C.-W. Wong, W. Elsässer & F. Grillot, « Private communication with quantum cascade laser photonic chaos », *Nature Communication*.

[2] C. Sauvage, C. Robert, B. Sorrente, F. Grillot, et D. Erasme, « Study of short and mid-wavelength infrared telecom links performance for different climatic conditions », *SPIE Remote Sensing, Strasbourg*,

Septembre 2019.

[3] S. Gigan, O. Katz, H. B. de Aguiar et al, « Roadmap on wavefront shaping and deep imaging in complex media », *Journal of Physics : Photonics*, Volume 4, Number 4, 2022

[4] B Augere, B Besson, D Fleury, D Goular, C Planchat and M Valla; « [1.5 μm lidar anemometer for true air speed, angle of sideslip, and angle of attack measurements on-board Piaggio P180 aircraft](#) », *Measurement Science and Technology*

Est-il possible d'envisager un travail en binôme ? **Non**

Méthodes à mettre en oeuvre :

- | | |
|---|---|
| <input checked="" type="checkbox"/> Recherche théorique | <input type="checkbox"/> Travail de synthèse |
| <input type="checkbox"/> Recherche appliquée | <input type="checkbox"/> Travail de documentation |
| <input checked="" type="checkbox"/> Recherche expérimentale | <input checked="" type="checkbox"/> Participation à une réalisation |

Possibilité de prolongation en thèse : **Non**

Durée du stage : Minimum : 5 mois Maximum : 5 mois (6 mois uniquement sur dérogation)

Période souhaitée : février-septembre 2024

PROFIL DU STAGIAIRE

Connaissances et niveau requis :
Optique, physique, modélisation

Ecoles ou établissements souhaités :
Ecole d'ingénieur ou master 2 avec spécialisation en optique/physique