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PROPOSITION DE STAGE EN COURS D'ETUDES

Référence : **DOTA-2020-44** *(à rappeler dans toute correspondance)*	Lieu : Châtillon
Département/Dir./Serv. : DOTA/HRA	Tél. : 01 46 73 47 48
Responsable(s) du stage : Jean-Marc Conan	Email. : conan@onera.fr

DESCRIPTION DU STAGE

Thématique(s) : Maîtrise du front d'onde et optique adaptative

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

Intitulé : Optimization of adaptive optics assisted optical links for high capacity ground-GEO telecoms

Sujet :

The exponential growth of the needs in data transfer drives an increasing interest for high capacity optical links between the ground and telecommunication satellites. Currently the most appealing configuration relies on bidirectional ground / geostationary satellite optical links, so-called GEO-Feeder links.

The strong requirements in performance of such systems imply innovative developments on each segment of the chain. In particular, the mitigation of atmospheric turbulence effects is essential to reduce mean loss and deep fadings of the detected optical power. The mitigation of these effects relies both on optical and on numerical strategies. On the optical side, adaptive optics is used on the ground to sense and correct the incoming downlink beam, before injection in a single mode fiber, and to pre-compensate the emitted uplink beam. On the numerical side, telecom coding can be optimized to exploit the channel statistical properties including the correlation between up and down link detected power (so-called link reciprocity [Shapiro-2012]). However, it is worth noting that point ahead, induced by the movement of the satellite during the light roundtrip, limits adaptive optics uplink efficiency and link reciprocity due to the effect of anisoplanatism [Robert-2016].

We have studied adaptive optics performance in such a context through extensive numerical simulations and have also performed, under ESA contract, the first experimental demonstration of uplink pre-compensation on a slant line of sight relevant of the ground-GEO scenario: the FEEDELIO project that lead to successful on-site tests in April 2019 in Tenerife (Canary Islands, Spain) [Védrenne-2017].

The main goal of this internship is then to characterize the up and down-channel joint statistical properties of such a bidirectional optical link and to optimize the telecom coding strategies accordingly.

After a short bibliography study, the student will assess the channel statistical properties and will quantify the reciprocity of the link based on available simulation results and possibly on FEEDELIO experimental data. Building on this analysis, he/she will study various numerical means to optimize the Digital Signal Processing (DSP) performance (data rate, latency, and availability) based on the channel model: code rate adaptation (link adaptation) and/or compensation of channel effects through numerical pre-coding.

The student will benefit from ONERA renowned expertise in adaptive optics and optical links (numerical tools, data, and team environment). Besides, this internship will be realized in close collaboration with Ghaya Rekaya (TelecomParisTech) who is expert in digital communication and has also several contributions on DSP for Space-Division Multiplexing Optical fiber communications. The student will also be given the opportunity to pursue his work in the context of a PhD thesis ONERA-TelecomParisTech-CNES.

Bibliography

C. Robert, J.-M. Conan & P. Wolf, "Impact of turbulence on high-precision ground-satellite frequency transfer with two-way coherent optical links," Physical Review A, 93(3), 033860 (2016).

J. H. Shapiro & A. L. Puryear, "Reciprocity-enhanced optical communication through atmospheric turbulence. Part I: Reciprocity proofs and far-field power transfer optimization," Opt. Commun. Netw. 4, 947 (2012).

N. Védrenne, J.-M. Conan, A. Bonnefois, C. Petit, M.-T. Velluet, & V. Michau, “Adaptive optics pre-compensation for GEO feeder links: towards an experimental demonstration,“ ICSOS, IEEE, (2017).

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

Méthodes à mettre en oeuvre :

☒ Recherche théorique	☐ Travail de synthèse
☒ Recherche appliquée	☐ Travail de documentation
☐ Recherche expérimentale	☐ Participation à une réalisation

Possibilité de prolongation en thèse : **Oui**

Durée du stage : Minimum : 5 months Maximum : 5 months (6 months if exemption)

Période souhaitée : start in February or March 2020

PROFIL DU STAGIAIRE

Connaissances et niveau requis :	Ecoles ou établissements souhaités :
Optics, telecoms, physics, signal processing, modeling tools.	Master 2 or Engineering schools with majors in Optics, Telecom, Physics or Signal Processing