



HR EXCELLENCE IN RESEARCH

Post doc subject: High secured optical free-space communication network

Post doc Advisors:

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Context of the study:

To date, wireless communications are mainly provided by radio frequency (RF) band across different technologies such as WiFi, Bluetooth, Zigbee,... offering a bitrate not exceeding the hundreds of Mbps. RF communications suffer from several problems including the security of the transmitted data, the limited channel bandwidth and then the limited bitrate, the electromagnetic interference between different transmission systems and the various electronic modules that may exist in the communications area.

Generally, the RF transmission uses diffuse antennas that cover a large area, then, the interception of the signal is possible by a large number of detector inside this covered area.

Optical wireless communications overcome some of these problems such as the bitrate, the security of transmitted data, mainly when the link is line-of-sight, and the absence of electromagnetic interference. This solution becomes very interesting when a point-to-point communication is required.

Optical wireless communication is a solution to transmit data between a network of sensors or robots, especially when high secured data have to be transmitted. Optical wavelength multiplexed data transmitted in free-space between systems are developed in the last years at Roberval Laboratory within the Labex MS2T. This post-doc will be focused on the development of high secured optical free-space communications network.

Post doc description:

This post doc fellowship aims at developing a high secured optical free-space communication network in order to ensure the transmission of data between two nodes of the network through intermediate nodes. The first level to secure the transmitted data will be to multiplex the data on different wavelengths at the emitter and to demultiplex it at the receiver node. The second level is to split signals corresponding to different used wavelengths in two (or more) parts at the emitter node and to send them using two (or more) different ways and different intermediate nodes. Each intermediate node can do a passive or active transmission depending on the quality (Amplitude, signal to noise ratio, ...) of the signal on this node.

A passive transmission can be ensured by a reflection on a mirror, however an active transmission will be performed by the regeneration of the signal after an optical detection using a photodiode and an optical emitter (Laser or LED based). These passive and active nodes are mechatronics systems that include, a set of actuators (for instance, a pan-tilt actuation systems or a 360° range rotation system) to make possible the orientation of the emitter of the intermediate node to the next passive node in the network.

Some optimization issues are raised when dealing with data transmission in such networks. In particular, the routing paths used to deliver the data should be carefully selected in order to achieve correct demultiplexing. Other concerns are stability, security and lower energy consumption of such routing as well as node/replica placement. In terms of optimization theory all above gives raise to the problem of multimetric weights multipath computation, which, in its general form, is NP-hard.



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The applicant will have to accomplish the following tasks:

- 1/ Review of the literature on optical free-space communication
- 2/ Development of an optical free-space link between a mesh of the network (3 nodes): i) using one wavelength ii) using a free-space multiplexed wavelength (2 or 4)
- 3/ Proof of concept of an optical free-space optical network including passive and active nodes.
- 4/ Theoretical study on the optimization of the trajectory of the split signals between the emitter node and receiver node taking into account the passive and active transmission on intermediate nodes
- 5/ Experimental tests of the trajectories optimization on the developed network

Candidate's profile:

- The candidate must have a PhD degree in the domain of optical communications,
- Skills in the optimization of network transmission will be appreciated,
- Candidates must have excellent scientific and organizational skills, open minded, teamwork experienced. A good English language skill for presentations and writing scientific papers is mandatory.

Documents required to apply:

Send to hani.al-hajjar@utc.fr & dritan.nace@hds.utc.fr

- Curriculum vitae
- Motivation letter
- At least two references and/or recommendation letters
- A statement of research experience and interests

Location:

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References:

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- [2] Hani Al Hajjar, Bruno Fracasso and Dominique Leroux, "Indoor distributed optical wireless Gbps link dimensioning", Optical Fiber Communications (OFC) conference, Anaheim, CA, USA, Mars 2013
- [3] C. Lim, K. Wang and A. Nirmalathas, "High-speed optical wireless communications for in-building personal area networks," 2016 IEEE 6th International Conference on Photonics (ICP), Kuching, 2016, pp. 1-3.
- [4] Ziwei Yan, Amrit Mukherjee, Lixia Yang, Sidheswar Routray, G. Palai, "Energy-efficient node positioning in optical wireless sensor networks", Optik, Volume 178, 2019, Pages 461-466,
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