Communicating using spatial modes of light through the desert

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Abstract

Free space optics is a license free wireless communication that has recently received a great attention for a variety of applications. FSO is an attractive solution for last mile connectivity problems in communication networks particularly when fiber optics installation is costly or non-existing [1]. FSO can be also used to establish inter-buildings/cities secure communication and can be deployed as a backup to optical fiber networks. Wireless optical communication can guarantee a high bit rate line of sight (LoS) transmission over long distances and up to several kilometres. Importantly, FSO technology is considered as a potential technique to scale down bandwidth challenges in future 5G networks [2]. It is possible to establish multiple-wavelength FSO which can guarantee better transmission capacities than single channel communications. Data can be mapped on advanced modulation formats such as quadrature phase-shift keying (QPSK) and quadrature amplitude modulation (QAM) to achieve higher spectral efficiency levels. Multiple-input and multiple-output (MIMO) FSO has been also suggested, where multiple lasers are placed to transmit Gaussian beams to multiple receiving apertures.

It has been proven recently that it is possible to convey information over spatial modes of light which is considered as an additional degree of freedom in optical communication. Indeed, each spatial mode can be viewed as an independent information-bearing carrier scaling the transmission capacity by several orders of magnitude. The choice of orthogonal spatial modes can be done from various orthogonal basis in particular the Laguerre Gaussian (LG) and Hermite Gaussian modes that have been used to demonstrate beyond 1 Tbit/s transmission capacity [3,4]. In this context, we aim to move beyond laboratory test benches and establish outdoor FSO communication links based on LG and HG modes. A potential outcome of our research is to provide connectivity solutions in desert areas. Before it is widely deployment, spatial mode-based FSO requires further research efforts to overcome several major technical challenges mainly associated with atmospheric turbulence and beam divergence. To establish a communication using multiple modes ensuring a communication beyond 100 Gbit/s over 1 km distance at humid and possibly sandy weathers in Thuwal in Jeddah, we incorporate two turbulence mitigation strategies through adaptive optics and digital signal processing techniques. We further propose the use of relay nodes suitable for LG and HG modes to increase the communication reach and reduce the divergence effects. We are also developing the theoretical framework of the propagation of LG and HG modes through turbulent atmosphere which could provide optimal mode selection rules without resorting to time consuming experimental trials.

In this talk we will present our ongoing results on communication using LG and HG beams through the desert.

References

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