Dipartimento di Elettronica, Informazione e Bioingegneria

Politecnico di Milano

20133 Milano (Italia)
Piazza Leonardo da Vinci, 32

Review of the PhD thesis by Peter Barcik

OPTIMAL INTENSITY DISTRIBUTION IN A LASER BEAM FOR FSO COMMUNICATIONS

The thesis presents a comprehensive study directed to the identification, testing through simulations, and generation of the optimal intensity distribution in a laser beam of a Free Space Optical (FSO) link aimed at counteracting the impairing effects due to atmospheric turbulence. The use of FSO links for telecommunication point-to-point connections to complement the standard microwave links, nowadays in use, is actually a hot topic. The rationale is, among the others, the possibility to use a smart technology able to provide, at low cost, an extremely wide bandwidth for multimedia applications. In this framework, beside the presence of fog along the path that can easily cause the link outage, atmospheric turbulence is one of the phenomena that definitely impair an optical link.
The proposal of a fully photonic link making use of the output of the first part of the PhD work from its design to the construction and testing concludes the thesis. This equipment is of extreme interest for future experimental campaigns aimed at identifying and modelling the atmospheric channel, which plays a substantial role on the applicability of the FSO technology in future communications applications.

General comments:

The theoretical background together with the output of the simulator (original aspect in the thesis) purposely developed to study the propagation of a Flattened Gaussian shaped laser beam through weak and moderate turbulent atmosphere is well described and documented. The results of the simulations are very interesting and point out some specific peculiarities that must be taken in due account for the identification of the optimal parameters of the beam shape.

As for the beam shaping technique, different solutions to convert a Gaussian beam distribution into a Flattened Gaussian one have been analysed and discussed in terms of pros and cons. The analysis is exhaustive and optimally documented (original aspect in the thesis). The solution making use of a plastic optical fiber with large core diameter in order to generate thousand of modes is very appealing in its simplicity and effectiveness.

The design of the fully photonic terminals of a FSO link (original aspect in the thesis) concludes the study described in the thesis. All the different critical aspects, with specific emphasis to the receiving terminal, has been considered in the design The practical construction of the terminals and the testing activity aimed at verifying the theoretical predictions have been particularly appreciated. Few very concise pages introduce the link budget and possible applications of the equipment.

The main results and original aspects obtained during the PhD activity by Peter Barcik are well documented through different publications on journals and high-quality conferences of the optical sector. The publication activity is large, continuous and of high-level. It begun since 2012 when the candidate got the master degree.

Specific comments:

The state of the art of the propagation of an optical wave in the atmosphere is described in Chapter 1. While the effect of atmospheric turbulence is well introduced and discussed, the part related to the atmospheric attenuation because of gases and particulates is only sketched and some statements, as they are given, could generate misinterpretation. In particular, I suggest being more detailed when introducing the attenuation due to particulates in the part where is stated that these impairments can be minimized by the correct wavelength selection and by increasing the power of the transmitter.

When introducing the simulator (chapter 3) some more details are needed to better describe the technique used to generate the phase screens and to clarify how to set the parameters of the simulations (number of runs, number of phase screens and number of grid points)

When presenting the results obtained by the simulator (chapter 4) it would be nice to have some physical explanation to support the behaviour shown in the figures as

well as some more details to help in understanding the probability of fade and of the expected number of fades in sect. 4.4

To better conclude the thesis work I suggest adding some few sentences describing any other issue that should be considered in view of the experiment with the fully photonic link over a distance of 850 meters. (Example: what about the need to add an automatic tracking system?)

Conclusions

I consider the doctoral thesis presented by Peter Barcik to face a key aspect of a very innovative technology, to be original and to have provided a high level of scientific results. I recommend this for the doctoral thesis defense. In case of successful defense I recommend to grant the candidate with the title of "doctor".

Prof. Carlo Capsoni

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