

Review of doctoral thesis

Diffraction effects in transmitted optical beam

written by **Juraj Poliak**

Presented doctoral thesis is scoped to theory, modelling, study and design of Free-Space Optical links as a technique where signals are distributed from a transmitter to a receiver through the atmospheric media. Main effort of the research was oriented to theoretical investigation with modeling followed by pilot experimental tests.

The work explored behavior of Gaussians beams transmitting signals in a non-stationary and inhomogeneous media. The study and theoretical analysis were oriented mainly to an influence of unstable refractive index of the media to losses of propagated beams in the atmosphere. The Fraunhofer and Fresnel diffraction effects in FSO communication systems were simulated, and analyzed on two mathematical models. Models took into account diffraction of a circular Gaussian beam on a circular aperture and diffraction of the elliptical beam on a circular lens socket. Their influences on the optical intensity distribution in the receiver plane were assessed in the complex form. The thesis also introduced the derivation of the expressions describing the influence of the geometrical and misalignment (pointing) loss in FSO links. This part presented some unique mathematical expressions helpful in the next experimental design of an all-optical FSO link. Next, the work includes theoretical design and experimental test of a smart dual wavelength transceiver where the optical carrier 1550 nm for data transmission and 850 nm as the tracking are used. In this section, main stress was put on a fiber optic design of coupling two far wavelengths to one FSO link transceiver. The following design and calculation of bulk optics and fiber-coupling elements belong to very interesting part of the thesis. The usage of dual-core fiber is smart and useful in the next design of FSO systems.

Presented doctoral thesis and short-form thesis are written in English. The form of mentioned documents fulfils all of criteria which are placed to such a work. Author presents all of achieved results clearly and with a very detailed description. The formal structure of the work is also clear and it corresponds with requirements generally placed to such kind of scientific work.

State of reviewer to the doctoral thesis

1) Relevance and scientific importance of the work

The presented work covers the fundamental and experimental research of interesting area of optics communication in free space, mainly in the atmosphere with unstable conditions. It is scoped to branch of interaction between the propagating light and different effects in the atmosphere. They have essential contribution in the future for next generation of all-optical FSO systems. The research presented in the work also contributes to the theory of optical wave propagation in the atmospheric medium where Gaussians beams are delivered with the link from the transmitter to the receiver, and within kilometers distances.

2) Originality of the work, main original contribution

The work includes a lot of original ideas which author theoretically proposed and experimentally verified. The main and original contribution is in the complex mathematical description of behaviors of the unstable atmosphere to optical losses and misalignment of the FSO link between the transmitter and receiver. I would like to remind the contribution in derived models of the first part of the thesis and the complex design of two wavelengths all-optical transceiver. Presented models and design of the transceiver give to optical wireless technique community very unique matter for next generation design of FSO links.

3) Publication of the main ideas of the doctoral thesis

My point of view is the author published all of ideas and important parts of the work in peer-reviewed journals, international conferences and workshops as is presented in the appendix – list of publications and reprints. It's clear the author has respected position at the science community of the optical wireless communication research.

4) Scientific level of the author, his scientific results, publications, quality and rating

The author achieved high-level scientific results with respect on enclosed the list of publication. He published more than 10 original scientific contributions as the first author and he is co-author in total 24 papers. He demonstrated excellent contribution in the FSO link theoretical design and experimental proof-of-concepts. On basis of author's evaluation tables, his quality is very high and potential impact of his scientific results is internationally comparable.

5) Questions for the author during doctoral thesis defense

- a) Which effects introduce main intensity losses in all-optical transceivers and FSO links in general?
- b) It could be used a multimode fiber instead the dual-core one for coupling of two far wavelengths in all-optical FSO link?
- c) The all-optical FSO links are very promising thanks to recent advance development of all-photonics fiber-link networks, mainly long-haul. What are main factors which limits the distance a point-to-point connection when a free-space transmission of a broad spectrum of DWDM communication can be realized?

I consider presented doctoral thesis of Juraj Poliak as original and with high level of scientific results. I recommend this for the doctoral thesis defense. In case of successful defense I recommend to grant title "doctor".



Ing. Ondřej Číp, Ph.D.
Senior scientist

Department of Coherence Optics
ÚPT AV ČR, v.v.i.

Brno, 9th October, 2014