QUASIOPTICAL BEAM PROPAGATION FOR REMOTE SENSING

S. Zvanovec, P. Pechac, M. Mazanek

Department of Electromagnetic Field, Czech Technical University in Prague
Technicka 2, 116 27, Prague, Czech Republic
xzvanove@fel.cvut.cz, pechac@fel.cvut.cz

I. INTRODUCTION

Similarly to the movement of the current technology to higher frequency bands, a development of millimeter waveband sensors have been found of a great interest, especially for their ability to provide a reliable sensing within complex outdoor and indoor environments [1]. To investigate the propagation aspects for these systems correctly under such conditions, the utilization of spherical or planar waveforms can provide biased results, since transmitted wave is there refocused and diverged. Therefore, it is essential to accompany methods known from free space optical systems based on paraxial approximation of diverging waveforms. The simplest solution is introduced by Gaussian beams of basic and higher orders [2]. Difference between conventional and Gaussian beam based models can be significant especially for remote sensing systems being deployed within a complex environment. The presented paper will highlight advantages and drawback of these simulation approaches, based on analyzing of electromagnetic wave propagation within an indoor environment.

II. GAUSSIAN BEAMS MEASUREMENT AND SIMULATIONS

The interactions of electromagnetic waves with very narrow beams having their transverse widths comparable to ones of wavelengths with their surrounding have been investigated both theoretically and experimentally. A measurement campaign was performed in order to measure properties of Gaussian beams and to provide an appropriate insight on data support for our calculations. An example of a part of measuring system and a measured normalized transmission can be seen in Fig.1.

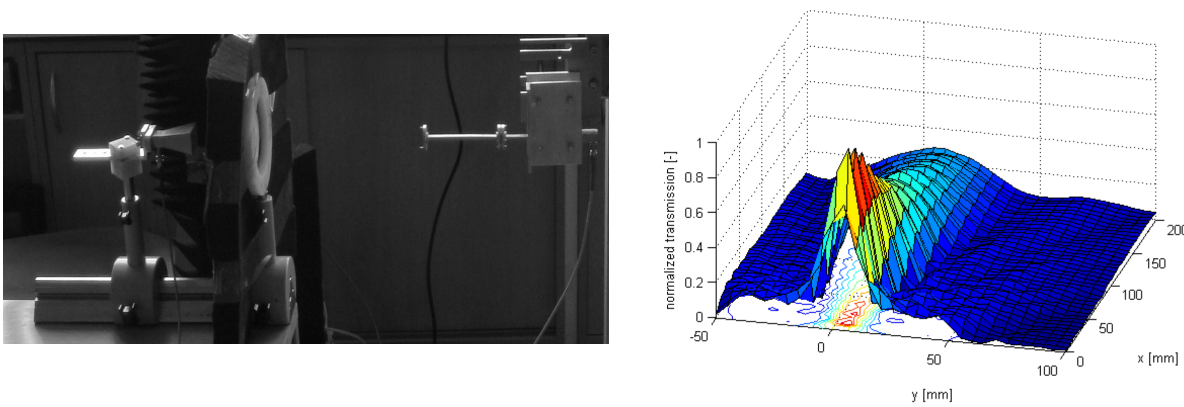

Fig. 1 Example of measurement of Gaussian beam distribution

Measurements of electromagnetic field distributions for particular sensing quasioptical systems were accomplished. The experimental arrangement in an anechoic chamber will be presented in the paper outlining a possibility of undesired errors of measured amplitude as well as phase waveforms. Measured distributions will be fully discussed and compared to theoretical assumptions.

Nevertheless, the main aim of the paper is to show the results from simulations of an entire indoor wireless sensor network working at frequencies of hundreds of gigahertz. It has to be noted that the propagation aspects of submillimeter waves in the indoor scenario since its complexity still remains the challenge for researchers. Indoor scenarios are usually very complicated and represent due to moving people a rapidly changing environment. Since newly emerging wireless systems are expected to use a wideband transmission, the reliability of service will be highly dependent not only on average signal strength in a specific location, but also on fading statistics. Therefore a tool to predict the electromagnetic wave propagation for sensor systems operating in the quasioptical region has been designed.

Results from simulations (see an example of the simulation in Fig.2 - the received power from the two sensor network working within a particular indoor scenario) have shown that the beam propagation approach allows us to more efficiently determine parameters of whole indoor system compared to conventional methods used for systems at lower frequency bands. For example, significant differences between these two approaches can be seen in the enumerated interference level. The paper will discuss the interference aspects experienced by the sensor network and surrounding wireless network as well.

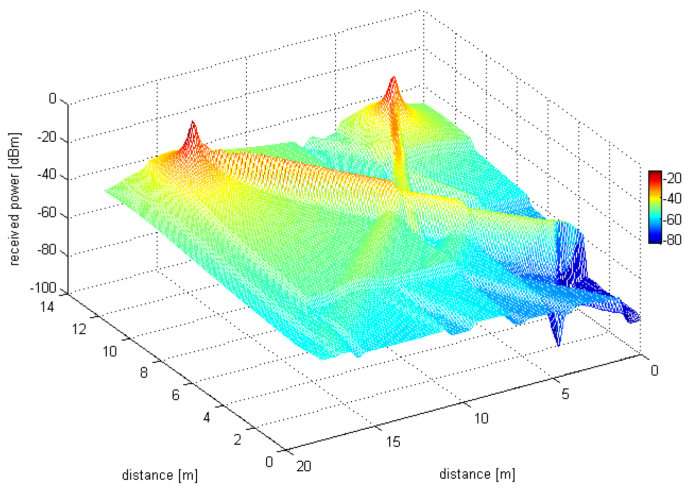

Fig. 2 Example of Gaussian beam simulation of a sensor network within indoor scenario

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