Radiation of USB-WLAN antenna influenced by human tissue and by notebook enclosure

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***Abstract*— A standard WLAN-antenna operating at 2.4 GHz, connected to a PC-notebook has been investigated. In practise, both the presence of human biological tissue and of the notebook casing influence the antenna radiation pattern significantly. For determining the distortion, several numerical investigations have been accomplished. Thereby, more and less favorable polarization directions have been investigated. A dedicated FEM-based as well as a FDTD-based program have been applied and the results have been compared.**

I. Introduction

The recent increase of the use of wireless connections between computers and peripheral equipment enforces a deeper look into the radiation behavior of the appropriate antennas. For short distance communication Bluetooth has become a standard. It operates in the unlicensed, open frequency range between 2.4 and 2.485 GHz.

In general the external USB antennas are manufactured with double-sided printed circuit boards. One side operates as ground whereas the other side contains a special characteristic antenna structure, eg. meander lines, F-forms, etc. Fig. 1 shows the structure of the standard antenna under investigation.

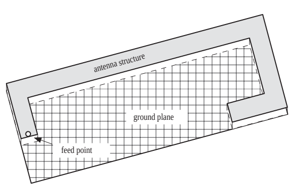

Fig. 1. Geometry of the Bluetooth antenna under investigation.

Such an antenna has a distinct main direction. In our work advantageous and unfavorable orientations of the antenna as well as the interaction with human tissue and with a PC-notebook case have been examined. Thereby, the change in the radiation patterns will be documented.

II. Numerical Model

The electromagnetic field problem has been solved with a FE-code, based on the standard $\vec{A}\,v$ -formulation [1]. With the potentials $\vec{A}$ and v the field intensities follow

$$\vec{E} = -j\omega\vec{A} - j\omega\nabla v, \qquad \vec{H} = [\nu]\nabla\times\vec{A}. \tag{1}$$

The displacement current density is considered completely by treating the conductivity as a complex quantity for the time harmonic case in the Ampere's Law:

$$\nabla\times\vec{H} = \sigma\vec{E} + \epsilon\frac{\partial\vec{E}}{\partial t} = (\sigma + j\omega\epsilon)\vec{E}. \tag{2}$$

The FE-mesh truncation has been realized by applying perfectly matched layers, as recommended, eg. in [2]. To compute the antenna radiation pattern for the various configurations, the vectorial Huygens principle [3] has been used. For the sake of reliability the results have been compared to solutions obtained with a dedicated FDTD-package [4].

III. Numerical results

The simulations have been applied to a standard Bluetooth ground plane dependent antenna at a frequency of 2.4 GHz. In Fig. 2 the displacement current density along the antenna is shown.

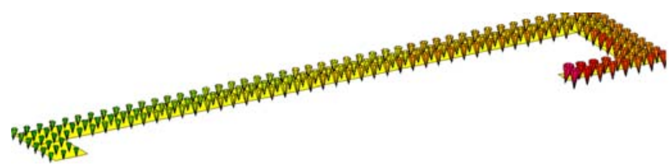

Fig. 2. Current density distribution on the antenna structure.

IV. Conclusion

The influences of a PC-notebook case and of human tissue on the radiation pattern of an external Bluetooth antenna have been investigated. Thereby, the orientation of the antenna has been variied, as well. The changes in the radiation patterns give evidence about the reliability of the wireless LAN connection.

References

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