PhD Position

Project Title: 5G AT MILLIMETER WAVES: NOVEL APPROACH FOR ACCURATE AND REALISTIC EXPERIMENTAL NEAR-FIELD DOSIMETRY IN THE 60-GHz BAND

Research Fields: millimeter waves, microwave modeling and systems, electromagnetic dosimetry, antennas and probes, tissue-equivalent models

Research Laboratory: Institute of Electronics and Telecommunications of Rennes (IETR), UMR CNRS 6164, University of Rennes 1, Rennes, France.

Offer Type: PhD position (36 months scholarship)

Hiring Institution: University of Rennes 1

Application Deadline: May 20, 2019

Expected Starting Date: October 01, 2019

PhD project

Context

Continuous development of mobile terminals, such as smart phones, tablets, body-worn devices, has increased the wireless data traffic, which will keep growing due to video streaming applications and cloud computing. The increasing need in high-performance mobile communications leads to a fast development of next-generation heterogeneous 5G cellular mobile networks. The upper limit of the spectrum used for 5G has shifted towards the millimeter-wave (MMW) band. In coming years, MMW mobile broadband systems will be integrated in 5G networks, in particular for the user access and backhaul / fronthaul links. In particular, transceivers operating in the 60–GHz band are expected to be integrated in user terminals; this allows for a larger channel bandwidth, higher data rates (beyond several Gb/s), high level of security for short-range communications, and low interference with adjacent cells.

The new usages and services will involve interaction of radiating devices with the human body, both in terms of body impact on wireless device performance as well as in terms of user exposure to electromagnetic fields. This includes near-field exposure by wearable and mobile devices operating in vicinity of the human body. Radiated powers of the user terminals may result in locally very high exposure levels under near-field exposure conditions due to localized absorption at MMW. Proposing solutions for accurate dosimetry in the near-field 60 GHz scenarios is of uppermost importance to anticipate the forthcoming deployment of 5G networks.

Objectives

This PhD project will deal with the design, optimization and experimental characterization of a MMW dosimetry system and associated methodology for near-field exposure assessment accounting for a potential increase of exposure levels due to presence of the human body.

Work description

Existing experimental MMW dosimetry techniques are limited to electromagnetic field measurements using free-space probes in vicinity of wireless devices. These solutions do not account for a potential increase of exposure levels due to the presence of human body and may result in an underestimation of exposure levels. To overcome these limitations, we propose a fundamentally new approach. It is based on a solid skin-equivalent model recently introduced by our research team in the 60-GHz band [1]. This model consists of a lossy 1.3 mm-thick dielectric layer (PDMS saturated with the carbon powder) and a metallic ground plane. The properties of the lossy dielectric (thickness, composition) are optimized to reproduce the reflection coefficient from human skin. This solid tissue-equivalent model will be used as a starting point to design a MMW dosimetry system for measurements of incident power density (IPD) accounting for perturbation of the field radiated by a MMW wireless device due to presence of the human body. The proposed system will integrate two key functionalities: (1) it will accurately reproduce the reflection coefficient of human skin and (2) it will enable retrieval of the IPD distribution based on the field measurements inside the lossy dielectric. To this end, an array of sensors will be integrated into the phantom and coupled to transmission lines printed on a low loss MMW dielectric substrate through coupling slots etched in the ground plane. The main parameters of the system architecture will be optimized (lattice type and size of the antenna array) to maximize the field measurement accuracy and spatial resolution, while minimizing the complexity of the system.

References

[1] A. R. Guraliuc, M. Zhadobov, O. De Sagazan, R. Sauleau. Solid phantom for body-centric propagation measurements at 60 GHz. *IEEE Transactions on Microwave Theory and Techniques*, 62(6), pp. 1373–1380, Mai 2014.

[2] A. Guraliuc, M. Zhadobov, R. Sauleau, L. Marnat, L. Dussopt. Near-field user exposure in forthcoming 5G scenarios in the 60-GHz band. *IEEE Transactions on Antennas and Propagation*, 65(12), pp. 6606–6615, Dec. 2017.

[3] M. Zhadobov, C. Leduc, A. Guraliuc, N. Chahat, R. Sauleau. Antenna / human body interactions in the 60 GHz band: state of knowledge and recent advances. *State-of-the-Art in Body-Centric Wireless Communications and Associated Applications*, IET, pp. 97–142, Jun. 2016.

Research environment

The PhD student will join Electromagnetic Waves in Complex Media Team (WAVES, www.ietr.fr/WAVES.html) of the IETR. Our research activities in biomedical electromagnetics cover a wide spectrum of fundamental and applied research spreading from multi-physics and multi-scale modeling to advanced technologies for body-centric wireless communications. The team was at the origin of pioneering innovations in biomedical electromagnetics, including the first mm-wave tissue-equivalent phantoms, novel reflectivity based surface phantom concept, new broadband multi-physics characterization technique for Debye-type materials, innovative mm-wave textile antennas for smart clothing, ultra-robust miniature implantable UHF antennas, first mm-wave reverberation chamber.

Candidate

Education: MS or equivalent.

Background: excellent skills in electromagnetics, microwave design / measurements, numerical modeling. Knowledge in electronics is welcome but not mandatory.

How to apply

To apply please send your CV, transcripts, motivation letter, and reference letters (optional) to:

- ⇒ Dr. Maxim ZHADOBOV, CNRS (maxim.zhadobov@univ-rennes1.fr)
- ⇒ Prof. Ronan SAULEAU, University of Rennes 1 (ronan.sauleau@univ-rennes1.fr)