PhD Position

Project Title: 5G AT MILLIMETER WAVES: NEAR-FIELD EXPOSURE ASSESSMENT IN EMERGING SCENARIOS

Research Fields: microwave modeling, numerical dosimetry, millimeter-wave antennas, tissue modeling, bioelectromagnetics

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 applications. In particular, the 60–GHz transceivers (i.e. 57–66 GHz in Europe) are expected to be integrated in the 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. 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 address open challenges related to numerical and experimental near-field dosimetry around 60 GHz, both for adults and children, contributing to environmental safety of emerging 5G systems.

Work description

The PhD research project will mainly deal with:

1. *Modelling the electromagnetic field and power dissipation induced inside the human body by near-field MMW exposure*. A numerical dosimetry study will be performed using tissue models of increasing

complexity and generic 60-GHz antenna modules in representative 5G scenarios. Parametric studies will be performed to assess the exposure levels depending on the positioning of the antennas modules in respect to the human body.

2. *Assessment of exposure taking into account morphological differences and age-dependent electromagnetic properties of biological tissues*. The age-dependent body models will be developed for the first time in the MMW range to assess the exposure in terms of the specific absorption rate (SAR) and incident power density (IPD). The results will clarify whether the exposure levels in children can exceed those in adults, in particular due to the changing with age electromagnetic properties.

3. *Analysis of resulting heating induced by local exposure to MMW*. Due to the increasing power transmission at skin / air interface at MMW compared to lower microwave frequencies and local power absorption in the near-surface body regions, significant local heating may appear even for relatively low IPD. We will numerically analyze induced local temperature rise depending on the size of exposed area, power density, exposure duration, etc.

References

[1] 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.

[2] C. Leduc and M. Zhadobov. Impact of antenna topology and feeding technique on coupling with human body: Application to 60-GHz antenna arrays. *IEEE Transactions on Antennas and Propagation,* 65(12), pp. 6779-6787*,* 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, numerical modeling, microwave theory and measurements. Knowledge in biophysics / thermal modeling 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)