Guest Editorial

Special Issue on "In-and-off Body-Centric Nano-scale Wireless Communication and Networks"

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Recent advances in body-centric wireless communications from UHF to mm-wave bands, in-vivo channel modelling and characterization, cooperative body-worn sensor networks and material characterization including human tissues are highly relevant to the significant increase in technological adaptation of original and novel techniques specifically in the medical domain. There still exist several research challenges from the communication and radio engineering perspectives. One of the main challenges is imposed by the very high path loss at the THz band frequencies, which poses a major constraint on the communication distance. Due of the strict limitation in the transmission distance, the communication distance of the in-vivo nano-networks in the THz band is limited, which motivates the utilization of hierarchical/cooperative networking concepts and hybrid communication techniques using molecular and electromagnetic methods for future body-centric nano-networks. This special issue provides a collection of novel and original contributions by researchers, scientists, engineers and innovators around the world related to nano-scale body-centric wireless networks and communication.

The issue has three research papers covering a range of novel and original contributions in the field of nanoantennas and nanonetworks with emphasis on future body-centric communication mainly targeted for healthcare and biomedical applications. Real-time monitoring of medical test parameters as well as biological and chemical substances inside the human body to facilitate the control of pathologies and create better effectiveness in diagnostics and treatments is explored in this special issue with the focus on in-human-hand scenarios. A hierarchical Body Area Nano-Network (BANN) architecture consisting of two types of nanodevices, namely, nanonodes and a nanorouter, which are conceptually designed using technologically available electronic components are analyzed and numerically investigated. Informed conclusions are made to suggest the usefulness of fluids and small kinetic energy in the body in powering such devices for long term operations. In order to explore further the role of high frequency spectrums (Terahertz and beyond) for applications within body-centric nanonetworks, the issue also presents an analytical model of the THz communication channel (0.1 - 10 THz) for in-vivo nano-networks by considering the effect of noise on link quality and information rate. The molecular absorption noise model for in-vivo nano-networks is developed based on the physical mechanisms of the noise present in the medium, which takes into account both the radiation of the medium and the molecular absorption from the transmitted signal. Based on the studies on channel performance, it is concluded that the achievable transmission distance of in-vivo THz nanonetworks should be restrained to approximately 2 mm maximum, while the operation band of in-vivo THz nanonetworks should be limited to the lower band of the THz band.

While it is important to understand and research the communication channel behavior and also power requirements and constraints, it is vital to appreciate the contirbutions made in antennas and EM devices. From that prospective, the special issue presents a design of a tri-band slotted patch antenna suitable for millimetre wave with scalability to lower THz bands for body-centric networks. The proposed antenna operates at millimeter-wave frequencies of 28 GHz, 38 GHz and 61 GHz. The antenna was tested in stand-alone and wearable configurations with excellent impedance matching, bandwidth and gain performance. These

features, in addition to size compactness, make it a good candidate for current and future applications of Body-centric Networks.

The issue provided comprehensive reference of theoretical, analytical and experimental activities undertaken to tackle the challenges within the field of nano-scale EM-based communication. It represents a platform for demonstrating and exchanging state-of-the-art in the field and also encourages future expansion of ideas and work conducted and to delve beyond the current status of advances.