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*Editorial*

# Wearable Antennas and Systems

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The topic of wearable antennas and body-centric communication systems has received a great deal of interest over the past few years with many applications in health care and sports science being proposed. These applications have included body area networks (BAN), where an array of devices or sensors, distributed across the body, communicate wirelessly to a body-mounted central hub, to be routed to an off body receiver for medical or sports monitoring. Other applications include RFID tags mounted on body that can be detected, wirelessly, for health care or security monitoring systems.

Naively, one may imagine that these systems are merely developmental with no need for further research; however, there are a number of challenges that engineers face in designing antennas and communication systems on body that are not present in a conventional system. Firstly, in body-centric systems, the antenna is necessarily mounted in close proximity to human tissue. Human tissue has a large dielectric constant compared to conventional RF substrate materials and a significant conductivity; as such, the body can have a great effect on an antenna's characteristics. This problem is compounded by the need to mount the antenna on a textile substrate, as part of an everyday garment, with the associated problems in maintaining the antenna's performance when the fabric is flexed or bent. For on-body networks, where communication between devices is necessary, the effect the body has on the channel must be characterised. This is particularly challenging due to the variability in human body shape and the dynamic nature of the channel—with movement of the body greatly affecting the channel characteristics, blocking, and scattering the signal in a complicated manner.

A large number of submissions were received for this special issue and the papers with relevant technical content were selected after review by experts. Brief synopses of some of the selected papers are given below.

"*Effect of earth ground and environment on body-centric communications in the MHz band,*" by K. Fujii and Y. Okumura, studies the effect the physical ground has on a body centric system. The authors model the human body shunted to earth ground in a radio anechoic chamber to analyze the electric field strength around it and clarify the effect of earth ground during BAN run time. The results suggest that earth ground has little influence on the human body and wearable devices. Only when the human body is directly grounded, the electric field near the feet area will decrease. The input impedance of the transmitter is approximately the same, and the received open-circuit voltage and current of the receiver are also the same. In addition, the authors also suggest that stable communications can be established by developing a closed circuit using earth ground as return path.

The problems of antennas on textile substrates are addressed in "*Metamaterial embedded wearable rectangular microstrip patch antenna,*" by J. G. Joshi, S. S. Pattnaik, and S. Devi. Here, the authors propose a modified patch antenna embedded with a metamaterial square SRR, on a fabric substrate, that maintains its characteristics even when flexed. The bending effect on the performance of wearable antenna is shown to be reduced by making slots in the radiating patch but it leads to mismatching at the desired lower resonance frequency. The authors report that embedding a metamaterial SRR is an advantageous approach to obtain better impedance matching at the desired resonant frequency as this SRR introduces additional inductance, capacitance, and mutual inductance to match the impedance at the required frequency.

The topic of ultrawideband (UWB) communications on body is studied in "*Improved successive interference cancellation for MIMO/UWB-based wireless body area network,*" by M. Jayasheela and A. Rajeswari where cancellation schemes to improve the problems of interference in BANs are presented. An improved successive interference cancellation scheme for MIMO/UWB-based wireless body area network is proposed here. To mitigate interdevice interference in body area network successive interference cancellation with optimal ordering is used. TH PPM modulation followed by MMSE equalization is employed in this paper.

Applications of on-body systems are covered in "*Design of a wearable, low-cost, through-wall Doppler radar system,*" by S. Agneessens, P. V. Torre, F. Declercq, B. Spinnewyn, G.-J. Stockman, H. Rogier, and D. V. Ginste. In this paper, an on-body radar system is presented with applications for motion detection in difficult terrains and disaster areas. The system operates at 2.35 GHz and is integrable into garments. The main individual components of the radar system, that is, the transmit array and active receive antenna, as well as the system itself, have been reported to be thoroughly tested, validating the proposed design.

"*Performance of ultrawideband wireless tags for on-body radio channel characterisation,*" by M. M. Khan, Q. H. Abbasi, A. Alomainy, and Y. Hao studies path loss models for UWB on body channels. Experimental characterisation of an on-body radio channel for ultrawideband (UWB) wireless active tags is reported. UWB on-body radio propagation channel measurements are performed in the chamber and indoor environments. Nine different UWB on-body radio channels are investigated for static and movement scenarios. Results demonstrate that lognormal distribution provides the best fits for on-body propagation channels path loss model.

The effects that bending has on the polarisation and radiation pattern of a conventional patch antenna is covered in "*Analysis of circular polarization of cylindrically bent microstrip antennas,*" by T. Kellomäki. The authors present a simplified model of a bent circularly polarised patch antenna and predict the frequency shift of the axial ratio band. Uncontrolled bending is a problem associated especially with flexible textile antennas, so the authors present some guidelines for wearable antenna design and its placement as well.

It is hoped that this special issue goes some way in addressing the challenges associated with wearable antennas and systems, adding to the state-of-the-art in this exciting field.

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