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EDITORIAL

IEEE ACCESS SPECIAL SECTION EDITORIAL: WIRELESS BODY AREA NETWORKS

Wearable devices and wireless communications, combined with personalized health management, are future trends that healthcare practices and procedures are heading toward. To facilitate this progress, new technologies and methods are required to provide reliable measurements, end-to-end communications, and data analysis mechanisms from the data source to medical health records. The wireless body area network (WBAN) is the major element in this process. This Special Section is not only limited to on-body WBAN devices but also focuses on benefitting technologies which can distribute vital information inside a human body or allow control of implantable gadgets. Dependable wireless communications combined with versatile application areas, such as accurate localization or behavior analysis techniques, remote monitoring, adoption of vital sensors, and actuators, can benefit the increased use of new WBAN technologies in various healthcare-related studies. In the end, this will make healthcare processes more effective and user friendly, and simultaneously increase the safety of (out)patients. This Special Section focuses on various theoretical and experimental views on WBAN applications, technologies, implementations, and utilizations based on invited, extended versions of the best-evaluated articles from BodyNets 2018, held at Oulu, Finland, in October 2018, as well as quality articles submitted from the Open Call. This Special Section includes 16 accepted articles which have undergone a rigorous peer-review process. Three of the accepted articles were invited extensions of the articles presented at the BodyNets 2018 conference. The total number of submissions we received for this Special Section was 45; thus, the acceptance rate was 36%.

The invited article ''Throughput and channel aware MAC scheduling for SmartBAN standard,'' by Khan *et al.*, discusses a throughput- and channel-aware (TCA) medium access control (MAC) scheduling scheme, which utilizes the European Telecommunication Standard Institute's (ETSI) new standard targeted for smart body area network (SmartBAN). The algorithm performance is analyzed in terms of four key performance indicators: packet reception rate, latency, energy consumption per successful transmission, and throughput. The results obtained are compared with the reference SmartBAN MAC.

The invited article ''Comprehensive study on the impact of sternotomy wires on UWB WBAN channel characteristics on the human chest area,'' by Särestöniemi *et al.*, deals with the impact of sternotomy wires on the characteristics of ultra wideband (UWB) radio propagation channel in the human chest area. A simulation-based study was carried out using a planar layer model and a 3-D elliptical layer model to model the human torso and related tissues.

In the invited article, ''Secrecy capacity and secure distance for diffusion-based molecular communication systems,'' by Mucchi *et al.*, the authors discuss preliminary elements of a systematic approach to quantifying information security in a molecular communications context. The numerical results achieved show that a secrecy capacity depends on the average thermodynamic transmit power, the eavesdropper's distance, the transmitted signal bandwidth, and the receiver radius.

In the article, ''An individual differentiated coexisting mechanism for multiple wireless body area networks based on game theory,'' by Zhang and Zhang, the authors discuss a novel coexisting mechanism that deals with coexisting multi-WBANs, which can provide differentiated communication QoS for different WBANs according to their own priority conditions. The proposed mechanism consists of four parts: time slot allocation, access control, active part interleaving, and power control.

The article by Turbic *et al.*, ''A mobility model for wearable antennas on dynamic users,'' presents a mobility model for the variations in position and orientation of wearable antennas on dynamic users. In the studies, walking and running motions were considered. The proposed model can be used with a variety of propagation channels, including deterministic ray-tracing and stochastic geometry-based ones. In addition, the model also enables the use of analytical inference in simplified scenarios.

In the article by Asif *et al.*, ''A wide-band tissue numerical model for deeply implantable antennas for RF-powered leadless pacemakers,'' the design and the validation of a novel wideband numerical model (WBNM) are proposed for deeply implantable antennas. The model can be enabled to RF-powered leadless pacing. The design was carried out using the finite-element method and the method of moments, and it was verified both analytically and experimentally.

In the article, ''InnoHAR: A deep neural network for complex human activity recognition,'' by Xu *et al.*, a model is proposed for wearable sensor-based human activity recognition applications by concatenating convolution kernels of

different scales and slicing with max-pooling layers. The conceptual work is also experimentally evaluated.

The article by Fornes-Leal *et al.*, ''Dielectric characterization of *in vivo* abdominal and thoracic tissues in the 0.5–26.5 GHz frequency band for wireless body area networks,'' provides a new database of dielectric properties of biological tissues. The study focuses on the tissues of the thoracic and abdominal regions. The properties are obtained by *in vivo* measurements using porcine tissues in the 0.5–26.5 GHz frequency band.

The article ''Context-enriched regular human behavioral pattern detection from body sensors data,'' by Ismail *et al.*, discusses a new model which is used to explore the challenges associated with mining patterns from body sensor data and their potential use in discovering regular human routines through mining periodic patterns from a nonuniform temporal database. Moreover, the authors examine the context-enriched periodic patterns, which provide more insights about residents' health and correlations between the discovered patterns.

In the article, ''A resilient smart body sensor network through pyramid interconnection,'' by Almajed *et al.*, the authors propose a novel wireless body sensor network architecture through a pyramid interconnection to decrease power consumption and data gathering delay, and to increase the resiliency of the system compared to the state-of-the-art models and topologies, such as star and hypercube topologies. According to the authors, their proposed system increases the system resiliency, scalability, reliability, as well as interoperability.

In the article, ''A new externally worn proxy-based protector for nonsecure wireless implantable medical devices: Security jacket,'' by Kulaç, the author proposes a full-duplex secure communication of wireless implanted medical device system by proposing a new protector that is compatible with existing unsecure systems. By implementing advanced sensors in the jacket, the physical layer security is improved. The proposed system also has low power consumption, thus increasing the lifetime of the sensors.

The article ''Body sensor network-based gait quality assessment for clinical decision-support via multisensor fusion,'' by Qiu *et al.*, proposes a versatile multisensor fusion method and decision-making algorithm for ambulatory and continuous patient monitoring purposes using a body sensor network. The proposed system is initially targeted for gait analysis and could provide an easy and low-cost method for measuring various gait-related parameters using a WBAN.

In the article, ''Modeling mental stress using a deep learning framework,'' by Masood and Al Ghamdi, the authors discuss stress severity, which is modeled using a deep learning framework, to determine the level of mental stress. Using a WBAN, the authors measured various physiological signals such as heart rate variation, skin conductance, and breathing pattern irregularities. To identify stressed activities and their severity, the authors used a convolutional neural network framework to employ training and validate the input data sets. According to the results obtained, the neural signals improve the efficiency of the proposed classification model when computing mental stress.

The article ''Pedestrian dead reckoning using pocket-worn smartphone,'' by Zhao *et al.*, presents a self-contained indoor pedestrian dead reckoning (PDR) system, which is based on a pocket-worn smartphone, by using the inertial sensor and magnetometer embedded in the smartphone.

In the article, ''Reliability of strip line method for determination of conductivity for lossy conductive materials,'' by Abd Rahman *et al.*, the authors discuss the validity of the technique for lossless, low-loss, and high-loss materials for 2.45–GHz wearable applications. The article describes a practical equation to calculate the bulk conductivity of electro-textiles. They present the accuracy and reliability range of the equation through comprehensive electromagnetic simulation. Through analysis, the correlation between conductivity, dielectric loss, and attenuation loss is shown.

Finally, in the article, ''Self-sustainable smart ring for long-term monitoring of blood oxygenation,'' by Magno *et al.*, the authors present a wearable pulse oximeter, which is assembled in a 3-D ring-like geometry that achieves self-sustainability by exploiting efficient power management, solar energy harvesting, and ultra-low-power processing in a multicore microcontroller. The wireless connectivity is based on Bluetooth low energy. The presented system is self-sustainable with just 64 min of sunlight per day or 12 h of indoor home light.

As the number of submitted articles indicates, wireless body area networks are an interesting and important topic in research related to the development of healthcare practices. The Guest Editors hope that this Special Section will benefit the scientific community and contribute to the knowledge base and would like to take this opportunity to applaud all the authors who contributed to this Special Section. The efforts made by the reviewers to enhance the quality of the manuscripts are also much appreciated. They highly appreciate the contributions of the reviewers for their constructive comments and suggestions. It should also be highlighted that all the invited articles passed a review process equal to the articles submitted from the Open Call. They would also like to acknowledge the guidance from the Editor-in-Chief and staff members of IEEE ACCESS.

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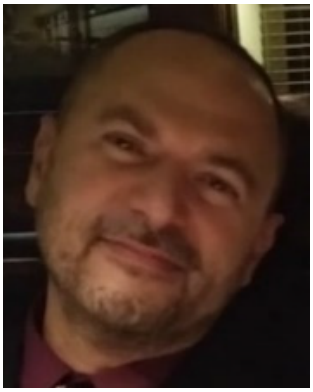

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