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Guest Editorial

Body Area Networking: Technology and Applications

Recent advances in the domain of personal gadgets, sensing and monitoring technology for in-body and near-body use, miniaturization, and energy-efficient wireless and sensor networks have recently come together under the rubric of Body Area Networks (BAN). Body Area Networks, as the name suggests, is a network of computing entities around a person that is used to provide important services. BANs can be utilized in diverse applications such as physiological and medical monitoring, human computer interaction, education and entertainment. The last decade has seen a dramatic increase in the number of computing devices surrounding an average person. Apart from the more macro platforms such as cell phones and laptops, computing devices are now being worn or even implanted into patients and used to monitor various aspects of wearer's physiology and ambient environment. Examples include heart-rate monitors, glucose-monitors, accelerometers, medical implants and so on. These entities are often wearable, forming part of a person's existing apparel of a person such as a watch, ring, bracelet or piece of clothing. This has led to a change in way we perceive computing and computers. Computers are no longer solely stand-alone special purpose entities, or networked entities embedded in our extended environments. Rather, they are becoming a part of the intimate zone of the human body enhancing our capabilities to monitor, perform, improve and entertain ourselves.

In comparison to traditional wireless sensor and ad hoc networks, BANs present several new and unique research challenges due to signal propagation characteristics in and around a human body and the need for safe, secure, and dependable operation with ability to operate for long periods of time. Recently, many research groups in the industry and academia have proposed several solutions toward improving the state of the art in BANs. There are many initiatives to investigate, including issues such as communication protocols, usability issues, security and privacy maintenance, in-body and near-body signal propagation and signal processing. The purpose of this special issue is to bring together researchers and practitioners working on diverse aspects of this important emerging area in order to identify current status, fundamental issues, future problems, and applications. Here we present six articles selected from the 26 papers that were submitted. Certainly, we could not cover all aspects of BANs in this special issue; accordingly we have classified the selected articles into three categories: Antennas and propagation, Communication protocols, and Context processing.

ANTENNAS AND PROPAGATION

The first article titled "Cooperative Communications in Ultra-Wideband Wireless Body Area Networks: Channel Modeling and System Diversity Analysis" by Chen et al. explores the application of cooperative communications between two BANs. It addresses channel propagation issues in BANs which utilize ultra-wide band (UWB) based communication.

The second article in this category titled "Performance of UWB Receivers with Partial CSI Using a Simple Body Area Network Channel Model" by Zasowski et al. investigates the impact of partial channel state information at the receiver on the detection performance. The article derives symbol-wise maximum-likelihood detectors for pulse position modulation and transmitted-reference pulse amplitude modulation along with evaluating their performance.

The third article in this category titled "An Antennas and Propagation Approach to Improving Physical Layer Performance in Wireless Body Area Networks" by Conway et al. investigates techniques to improve the link conditions in BANs. In this regard, the article introduces a novel wearable antenna based upon an innovative design which is suitable for integration with BAN nodes and evaluates its performance.

COMMUNICATION PROTOCOLS

The article in this category titled "Transmission Power Control in Body Area Sensor Networks for Healthcare Monitoring" by Xiao et al. investigates the opportunities and challenges in the use of dynamic radio transmit power control for prolonging the lifetime of health monitoring BANs. The article presents the advantages of dynamic transmission power control by illustrating its efficiency over using static transmission power control methods, along with developing a class of practical on-line schemes that adapt transmission power dynamically based on feedback from the receiver.

CONTEXT PROCESSING

The first article in this category titled "Modeling Service-Oriented Context Processing in Dynamic Body Area Networks" by Lombriser et al. explores real-time context processing in BANs taking into account the dynamic topological and contextual changes, and heterogeneous processing capabilities and energy constraints present on the available devices. The article proposes a service-oriented framework for the execution of context recognition algorithms. It also theoretically analyzes the performance of various components of the framework, including the sensor network organization, service discovery, service graph construction, service distribution and mapping.

The second and final article in this category titled “Energy-Efficient Information-Driven Coverage for Physical Movement Monitoring in Body Sensor Networks” by Ghasemzadeh et al. investigates energy-efficient sensor coverage techniques for movement monitoring in BANs utilizing inertial sensors. The article presents theoretical models allowing it to consider the sensing coverage from a collaborative signal processing perspective, while eliminating redundant sensor nodes and yet maintaining the quality of service.

Clearly, the articles in this special issue can only cover a sub-selection of the issues in BAN. We hope, however, that this set of articles gives the reader a broad appreciation of the remaining challenges in BANs and the progress the research community is making in addressing some of them. We wish to thank Prof. D. Lee and Prof. P. Cosman, editors of J-SAC, for their advice, encouragement and patience during the process of putting together this Special Issue. We also thank the various reviewers who greatly helped us in selecting the best articles. We hope you will enjoy this special issue as much as we enjoyed putting it together

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2007 IEEE New Face of Engineering Award and the IEEE Region 1’s 2007 Technological Innovation Award. Dr. Cordeiro was also part of the team that received the 2007 Frost & Sullivan Excellence in Research of the Year Award. He is an Editor of IEEE Transactions on Wireless Communications and has served as Guest Editor of various IEEE JSAC and ACM special issues. He is the author of the textbook Ad Hoc and Sensor Networks: Theory and Applications, and has been an active participant in standardization activities including IEEE 802.11, IEEE 802.15, IEEE 802.22 and ECMA. Dr. Cordeiro delivered several tutorials in the wireless area, has served as Chair and TPC member of various conferences, has published over 75 papers in the wireless area alone, and holds tens of patents.



Romano Fantacci was born in Pistoia, Italy. He graduated from the Engineering School of the Universit di Firenze, Florence, Italy, with a degree in electronics in 1982. He received his Ph.D. degree in telecommunications in 1987. After joining the Dpt. of Elettronica e Telecomunicazioni as an assistant professor, he was appointed associate professor in 1991 and full professor in 1999. His current research

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Joseph Paradiso joined the MIT Media Laboratory in 1994, where he is now an Associate Professor of Media Arts and Sciences directing the Responsive Environments Group, which explores the development and application new sensing modalities and enabling technologies that create new forms of interactive experience and expression. He is an expert on sensing technology for human-computer inter-

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from Tufts University in 1977, and in 1981 completed a Ph.D. in physics from MIT with Prof. Ulrich Becker as a K.T. Compton Fellow in the Nobel Prize-winning group headed by Prof. Samuel C.C. Ting at the Laboratory for Nuclear Science. His dissertation research was based on an experiment measuring high-energy muon pair production at the European Center for Nuclear Research (CERN) in Geneva, Switzerland. From 1981 to 1984 he conducted post-doctoral research at the Swiss Federal Institute of Technology (ETH) in Zurich, where he developed precision drift chambers and fast electronics for the inner tracker of the L3 experiment at CERN/LEP. From 1984–1994 he was a physicist at the Draper Laboratory in Cambridge, Massachusetts, where, as a member of the NASA Systems and Advanced Sensors and Signal Processing Directorates, his research encompassed control algorithms for orbital and re-entry spacecraft, sonar systems for advanced underwater applications, fractal-based image processing, and high-energy physics detectors. From 1992–1994, he directed the development of precision alignment sensors for the GEM muon detector at the Superconducting Supercollider, and was a visiting scientist at ETH-Zurich in 1991 and 1992 to design fast pattern-recognition algorithms for triggering an electromagnetic crystal calorimeter at the CERN Large Hadron Collider (LHC). In addition to his physics career, Paradiso has been designing electronic music synthesizers and composing electronic music since 1975, and long been active in the avant-garde music scene as a producer of electronic music programs for non-commercial radio. He has built (and still uses) one of the world's largest modular synthesizers, and has designed MIDI systems for internationally-known musicians such as Pat Metheny and Lyle Mays. Paradiso has frequently published and internationally lectured in many areas, including high-energy physics, spacecraft control, sensor systems, and interactive media.



Asim Smailagic is a research professor at the Institute for Complex Engineered Systems, the College of Engineering, and the Department of Electrical and Computer Engineering at Carnegie Mellon University (CMU). He is also the director of the Laboratory for Interactive and Wearable Computer Systems at CMU. This lab has designed and constructed more than two dozen generations of

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Mani Srivastava received his B.Tech. in 1985 from I.I.T. Kanpur, and M.S. and Ph.D. in 1987 and 1992 respectively from U.C. Berkeley. After working for five years at Bell Labs Research at Murray Hill, NJ, he joined UCLA's faculty in 1997 where he is currently Professor and Vice Chair (Graduate Affairs) in Electrical Engineering, and Professor of Computer Science. He is also affil-

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