Editorial: Special Issue on "Wireless Robotics—Research and Standardization"

Selected Topics from the Strategic Workshop, May 25–27, 2011, Saint-Paul De Vence, France

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The 13th Edition of the closed-door Strategic Workshop was held in Saint-Paul De Vence, France. The focus during the active two-day discussions of the participating major stakeholders, was on wireless robotics research and standardization.

Wireless robotics is a rapidly growing area with the potential to significantly affect mobile telecommunication networks. The recent interest of both the research and standardization community in wireless robotics is motivated by the fast increase in smart personal communication devices and in demand for data intensive applications running on such devices, on one side, and the potential of using multi-robot systems for a variety of applications in space, military, undersea, service, and industry.

This Special Issue features nine selected papers on the above topic and related enabling technologies. The collection of papers addresses a number of challenges related to communication, networking and performance aspects, as well as the importance of standardization effort in this area. Sets of wireless robots are, in essence, complex spatially distributed sensor-actuator networks with a high variability in bandwidth and service types moving about in dynamically changing environments in ever-changing network structures and topologies. Moreover, these systems are used in environments that are characterized by potentially massive electromagnetic disturbances. This puts stringent requirements on the reliable communication and networking capabilities for wireless robotic systems.

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Software defined radio (SDR) is one enabler of reliable wireless robotic communications. The paper "*Software Defined Radio Technology for Highly Reliable Wireless Communications*" by Hiroyasu Ishikawa explains the features and advantages of SDR technologies and proposes advanced applications of SDR for telerobotic control, which require highly reliable wireless communications, and for multi-mode wireless sensor networks (MM-WSN), as potential markets for wireless robotics and machine to machine (M2M) communication.

The physical layer(s) of wireless robotics may take advantage of current standards, like Bluetooth, Wifi, etc., each of them addressing a specific segment of wireless robotics. However, wireless robotics has a wide range of needs, comprising low power, robustness and high data rate when video is used as well as the opportunity to use a large number of transceivers. The paper '*Continuous Phase Modulation and Space-Time Coding : A Candidate for Wireless Robotics*," by Luc Deneire and Jerome Lebrun, proposes a new physical layer, based on Continuous Phase Modulation (CPM) and Space-Time Coding as a means to cover those needs and opportunities. Both are complementary to each other, with space-time coding yielding a higher spectral efficiency as well as enhanced robustness against the wireless channel.

Wireless robotic networks are expected to operate in a distributed and parallel manner in order to achieve a common goal. It is expected that ad hoc networks will be formed based on a given context resulting in unpredictable and varying network topologies. The paper "*Adoption of Vehicular Ad Hoc Networking Protocols by Networked Robots,*" by Wim Vandenberghe, Ingrid Moerman, and Piet Demeester focuses on the utilization of wireless networking in the robotics domain, and in particular on novel Robotic Ad Hoc Network (RANET) protocols. The paper provides a thorough overview of the related work in the domain of robotic and vehicular ad hoc networks and defines an exhaustive list of requirements is defined for both types.

Security is another very important issue in the dynamic network environment of wireless robotic networks. The paper "*Performance Related Security Modelling and Evaluation of RANETs,*" by Demetres Kouvatsos analyzes security aspects that may affect RANET performance.

A number of papers are directly focused on application-related challenges and possibilities of wireless robotics. The paper "*Wireless Underwater Communications,*" by J. Poncela, P. Otero, and M.C. Aguayo focuses on use of wireless robotics underwater and describes the characteristics of the acoustic underwater channel and how it impacts the mechanisms at the link and network layers.

The paper "*Understanding link behavior of non-intrusive wireless body sensor networks,*" by Rune Hylsberg Jacobsen, Kim Kortermand, Qi Zhang, and Thomas Skjødeberg Toftegaard focuses on medical applications and related challenges. The paper presents a study of the link layer behavior of wireless body sensor networks operating at 2.45 GHz and reports on a wearable body-centric network operation in realistic environments from which a wireless channel characterization based on a novel test framework is given.

The significance of wireless robotics in the communication world and the variety of applications possible brings forward the importance of standardizing the various technological aspects. The paper "*Wireless Communication in Mobile Robotics: A Case for Standardization*" by Henrik Schijøler and Thomas Skjødeberg Toftegaard discusses the relevant issues and concerns accompanying the efforts in creating a standard for wireless communication in mobile robotics. The application areas of mobile robotics exhibit immense diversity and that may make standardization across the entire set of application areas. The paper "*Wireless Robotics: A History, an Overview, and the Need for Standardization,*" by Sanil Pruthi continues the thoughts by assessing the background of wireless robotics and the challenges

faces for its adoption. Finally, the paper "*Wireless Robotics—a Highly Promising Case for Standardization*," by Alois Knoll, and Ramjee Prasad, Center for TeleInfrastruktur, focuses on the benefits of having wireless robotics standards and on the strategies that need to be developed for this field.

We are confident that this Special Issue will give you incentives and research ideas for the unexplored and promising area of wireless robotics.

Author Biographies

Marina Ruggieri (Naples, Italy, 29/04/61) graduated in Electronics Engineering in 1984 at the University of Roma. She was: with FACE-ITT and GTC-ITT (Roanoke, VA) in the High Frequency Division (1985–1986); Research and Teaching Assistant at the University of Roma Tor Vergata (1986–1991); Associate Professor in Telecommunications at Univ. of L'Aquila (1991–1994) and at Tor Vergata (1994–2000). Since November 2000 she is Full Professor in Telecommunications at Tor Vergata. Since 2003 she directs a Master in "Advanced Satellite Communications and Navigation Systems" at Tor Vergata. Her research focuses on space communications and navigation systems, integrated systems, mobile and multimedia networks. Since 1999 she has been appointed in the Board of Governors of the IEEE Aerospace and Electronic Systems (AES) Society and, since 2005, Director for AESS Operations in Italy and Western Europe. Since January 2008 she is Executive Vice President of the IEEE AESS. In 2004–2006 she was in the Technical-Scientific Committee of the Italian Space Agency (ASI). In 2007–2008 she has been Vice-President of the ASI Technical-Scientific Committee. Since December 2007 she belongs to the Italian *Superior Council of Telecommunications* as Expert.Since December 2006 she il Vice President of the *AFCEA Rome Chapter*. In 2006–2007 she was Italian representative in the Technical Committee *Communications Systems* (TC6) of IFIP (International Federation for Information Processing). She is Director of *CTIF_Italy*, the Italian branch of the *Center for Teleinfrastruktur* (CTIF) in Aalborg (Danimarca), opened on September 28, 2006 at Tor Vergata. She has been P.I. of various national Programs funded by ASI and MIUR, an Internalization Program funded by MIUR, an ESA Ariadna Program and she has coordinated the RTV Unit in various European Projects funded by EU and GALILEO Joint Undertaking. She is Editor of the IEEE Transactions on AES for "Space Systems", Chair of the IEEE AES Space Systems Panel, Assistant Editor of the IEEE Aerospace and Electronic Systems Magazine. Since 2002, she is co-chair of Track 2 "Space Missions, Systems, and Architecture" of the AES Conference. She participates in the organisation of many international events. She was awarded the *1990 Piero Fanti International Prize* and she had a nomination for the *Harry M.Mimmo Award* in 1996 and the *Cristoforo Colombo Award* in 2002. She is author of about 250 papers, on international journals/transactions and proceedings of international conferences, book chapters and books. She is an IEEE Senior Member (S'84-M'85-SM'94), an AFCEA, IIN and AICA Member.

Ole Brun Madsen is born in 1942 in Denmark and received his M.Sc. in Mathematics and Computer Science from the University of Copenhagen. (1962–1972) researcher and from 1968 head of the Computer Science Laboratory at The Royal Danish Academy of Fine Arts in Copenhagen. (1972–1981) head of the Development Department, RECAU, the Regional Computing Centre at Århus University. (1981–1996) Head of the Data Network Section and Head of the Network Infrastructure Strategy section at Jutland Telephone. (1996–1999) Manager for Infrastructure Network Technology and Strategy at TDC, Tele Denmark. (1999–2010) Professor in Distributed real-time Systems, (2004–2010) as Head of NetSec, Networking and Security section, Head of CNP, Center for Network Planning and (2004–2012) Co-director for CTIF, Center for TeleInFrastructur at Aalborg University. He has been project leader for a number of national and international R&D projects and acted in high level advisory tasks within the European Commission on the R&D framework programs in DGXIII and with United Nations UNDP activities. Present research is focused on Infrastructure Architecture and Modeling Tools for Network Analysis and Design.

Ramjee Prasad is a distinguished educator and researcher in the field of wireless information and multimedia communications. Since June 1999, Prof. Prasad has been with Aalborg University, where currently he is Director of Center for Teleinfrastruktur (CTIF), and holds the chair of wireless information and multimedia communications. He has supervised over 60 PhDs and 15 PhDs are currently working with him. He was the coordinator of European Commission Sixth Framework Integrated Project MAGNET (My personal Adaptive Global NET) Beyond. He was involved in the European ACTS project FRAMES (Future Radio Wideband Multiple Access Systems) as a Delft University of Technology project leader. He is a project leader of several international, industrially funded projects. He has published over 700 technical papers, contributed to several books, and has authored, coauthored, and edited 30 books. He has served as a member of the advisory and program committees of several IEEE international conferences. In addition, Dr. Prasad is the coordinating editor and Editor-in-Chief of the *Springer International Journal on Wireless Personal Communications* and a member of the editorial board of other international journals. Prof. Prasad is the Founding Chairman of the European Center of Excellence in Telecommunications, known as HERMES, and now he is the Honorary Chair. He has received several international awards; among others the "Telenor Nordic 2005 Research Prize". He is a fellow of IEEE, a fellow of IETE, and a fellow of IET. He is a member of The Netherlands Electronics and Radio Society (NERG), and a member of IDA (Engineering Society in Denmark). Dr. Prasad is advisor to several multinational companies. Further, Prof. Prasad is the Founding Chairman of "Global ICT Standardization Forum for India (GISFI: http://gisfi.org/).