

A photograph of the Château de Chillon, a large stone castle with multiple towers and conical roofs, situated on a rocky island in the middle of a lake. The sky is overcast and grey. The water is a deep blue-green color. In the foreground, there is a large, dark rock formation. The text is overlaid on the top right and bottom of the image.

ISMICT
2011

Montreux

March 27-30

**5th International Symposium on
Medical Information and
Communication Technology**

Program Guide

WELCOME

CSEM (Swiss Center for Electronics and Microtechnique) and EPFL (Ecole Polytechnique Fédérale de Lausanne) are very pleased to host ISMICT 2011 here in Montreux, Switzerland.

ISMICT 2011 is the 5th International Symposium on Medical Information and Communication Technology. The purpose of ISMICT is to bring together leading researchers and experts from the medical and hospital community with those from the information and communication technology (ICT) domains in order to exchange experiences and share new ideas. The focus of ISMICT 2011 is on “Medical Body Area Networks Technology and Services for Personalized Medicine”.

Message from the organizers

Sharing knowledge and building collaborations is vitally important to foster technological, industrial, and societal innovations. ISMICT brings together international experts in Information Communication Technologies (ICT) with Medical, Clinical and hospital professionals. It provides a forum for the exchange of ideas across disciplines encouraging multidisciplinary research collaborations and the development of new concepts in the important and growing domain of Medical ICT.



Prof. Dr. Christian Enz
Vice President
Integrated and Wireless Systems



Dr. John Farserotu
Head of Wireless Program
Integrated and Wireless Systems

CONFERENCE AT A GLANCE

Time	Sunday 27 March	Monday 28 March	
8:30-8:45	No Sessions	Opening and Welcome	
8:45-9:30		Keynote Speaker Prof. Dr. Ohno-Machado, MD	
9:30-10:15		Keynote Speaker Prof. Dr. Kondoh, MD	
10:15-10:30		Coffee	
10:30-12:15		BAN Panel Chair: Dr. Li	
12:15-13:30		Lunch	
13:30-15:30		Tutorial 1 Chair: Dr.Carrara	Session 1
15:30-15:45	Coffee		Coffee
15:45-18:00	Session 2		Session 4
	Open evening		

Tutorials	Invited and Keynote Speakers	Sessions
Tutorial 1: Medical BAN technology and devices	Prof. Dr. Ohno-Machado, MD , <i>University of San Diego Chief Division of Biomedical Informatics</i> , “ Medical Informatics and BAN for Future Personalized Medicine ” Prof. Dr. Kondoh, MD , <i>Shimane University Hospital</i> , “ Server based computing as an infrastructure of hospital-wide EPR and the regional healthcare information system ”	Session 1: MAC and Security Session 2: Medical BAN and eHealth Applications Session 3: Modeling, Miniaturization, EMI & Physical Parameters Session 4: Antenna, Propagation & Ranging

Tuesday 29 March		Wednesday 30 March		Thursday 31 March
No Sessions				
Keynote Speaker Dr. Rogier Reerveur Keynote Speaker Prof. Dr. Degoulet, MD		Keynote Speaker Mr. Bron Keynote Speaker Mr. Schmid		Workshop 2 Chair: Dr. Niemegeers
Coffee		Coffee		
Invited Speakers Prof. Dr. Kohno Prof. Dr. Enz		Nano-Tera Special Session Chair: Prof. Dr. De Micheli		
Lunch		Closing speech by Chair		Lunch
		Lunch		
Session 5	Session 7	Workshop 1 Chair: Dr. Dehollain	Workshop 2 Chair: Dr. Niemegeers	No Sessions
Coffee	Coffee			
Session 6	Session 8			
19:30 Dinner speech with Dr. van Hoof Banquet dinner		Open evening		

Invited and Keynote Speakers	Sessions
Dr. Rogier Reerveur , <i>Technology Manager Medtronic Bakken Research Center</i> , “Communication strategies for brain interfacing”	Session 5: Wireless BAN Technology
Prof. Dr. Degoulet, MD , <i>Professor of Medical Informatics at Paris Descartes University</i> , “Clinical Information Systems: the thin line between success and failure”	Session 6: Telemonitoring, Wireless Healthcare & Homecare
Prof. Dr. Kohno , <i>Division of Physics Yokohama National University and NICT, Japan</i> , “Dependable Wireless for Medicine and Other Reliable Systems”	Session 7: Medical Imaging & Patient Diagnostic System
Prof. Dr. Enz , <i>CSEM Vice President Integrated and Wireless Systems</i> , “Ultralow-power MEMS-based Radio for WBAN”	Session 8: Medical & Diagnostic Systems, Rehabilitation & eHealth
Mr. Bron , <i>Deputy Secretary General Health Department Canton of Geneva</i> , “The e-toile experience: from the eHealth vision to a political necessity”	
Mr. Schmid , <i>Head of the Swiss Coordination Office for eHealth</i> , “The Swiss eHealth Strategy – a model for international cooperation?”	
Dr. van Hoof , <i>Head of Department of the Clinical Chemistry University Hospital Antwerp, Belgium</i>	

BAN PANEL

Body Area Network for Medical Treatment and Healthcare – Technologies and Challenges

Time: Monday, March 28, 2011, 10:30 - 12:15

Place: Main Conference Room

Chair: Dr. Huan-Bang Li, *Senior Researcher, National Institute of Information and Communications Technology (NICT), Japan and Visiting Professor, the University of Electro-Communications, Japan*

1 UWB Technology for Medical Applications

Panelist: Ilanko Balasingham, Professor, The Interventional Center, Oslo University Hospital, Norway & Institute of Clinical Medicine University of Oslo, Norway & Department of Electronics and Telecommunications Norwegian University of Science and Technology (NTNU), Norway

2 Challenges of Interference Mitigation in Medical Body Area Networks

Panelist: Eryk Dutkiewicz, Professor, Wireless Communications and Networking Lab., Macquarie University Australia

3 Body Area Network: Introduction of Research on a New Generation Tele-health System in NICT

Panelist: Kiyoshi Hamaguchi, Group Leader of Medical ICT Group, National Institute of Information and Communications Technology (NICT), Japan

4 Visualizing RF Propagation in Body Area Networks Using a 3D Immersive Platform

Panelist: Kamran Sayrafian, Program Manager, Information Technology Laboratory, NIST, USA & Adjunct Professor University of Maryland

NANO-TERA SPECIAL SESSION

Time: Wednesday, March 30, 2011, 10:30 - 12:15

Place: Main Conference Room

Chair: Prof. Dr. Giovanni De Micheli, *EPFL/LSI*

- 1 i-Ironic: Implantable/Wearable System for on-line Monitoring of Human Metabolic Conditions**
 Project Leader: Giovanni De Micheli of EPFL/LSI, giovanni.demicheli@epfl.ch
 Presented by **Sandro Carrara**, EPFL
- 2 IsyPeM: Intelligent Integrated Systems for Personalized Medicine**
 Project Leader: Carlotta Guiducci of EPFL/IBI/CLSE, carlotta.guiducci@epfl.ch
 Presented by **Carlotta Guiducci**
- 3 SimOs: Smart Implants for Orthopaedics Surgery**
 Project Leader: Peter Ryser of EPFL/STI/IMT/LPM2, peter.ryser@epfl.ch
 Presented by: **Kamiar Aminian**, EPFL
- 4 TecInTex: Technology Integration into Textiles: Empowering Health and Security**
 Project Leader: Gerhard Tröster of ETHZ/D-ITET/IFE, troester@ife.ee.ethz.ch
 Presented by: **Jean Luprano**, CSEM
- 5 Nexray: Network of integrated miniaturized X-ray systems operating in complex environments**
 Project Leader: Alex Dommann of CSEM, alex.dommann@csem.ch
 Presented by: **Nicolas Blanc**, CSEM
- 6 NutriChip: A technological platform for nutrition analysis to promote healthy food**
 Project Leader: Martinus Gijs of EPFL/LMS2, martin.gijs@epfl.ch
 Presented by: **Martinus Gijs**
- 7 PATLiSci: Probe Array Technology for Life Science Applications**
 Project Leader: Harry Heinzelmann of CSEM SA, harry.heinzelmann@csem.ch
 Presented by: **André Meister**, CSEM
- 8 PlaCiTus: Platform Circuit Technology Underlying Heterogeneous Nano and Tera Systems**
 Project Leader: Qiuting Huang of ETHZ/IIS, huang@iis.ee.ethz.ch
 Presented by: **Qiuting Huang**

TABLE OF CONTENTS

Welcome	i
Conference at a Glance	ii
BAN Panel	iv
Nano-Tera Special Session	v
Table of Contents	vi
Sponsors	vii
Organizing Committees	ix
Organizers	ix
Organizing Chairs	ix
Local Organizing Committee	ix
Technical Program Committee.....	x
Steering Committee.....	xi
International Advisory Board.....	xii

TECHNICAL SESSIONS

Monday, March 28

A1L-A Session 1: MAC and Security	1
A2L-A Session 2: Medical BAN and eHealth Applications	3
A1L-B Session 3: Modeling, Miniaturization, EMI & Physical Parameters.....	5
A2L-B Session 4: Antenna, Propagation & Ranging.....	7

Tuesday, March 29

B1L-A Session 5: Wireless BAN Technology	10
B2L-A Session 6: Telemonitoring, Wireless Healthcare & Homecare	12
B1L-B Session 7: Medical Imaging & Patient Diagnostic System	14
B2L-B Session 8: Medical & Diagnostic Systems, Rehabilitation & eHealth.....	16

AUTHOR INDEX.....	18
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- With the financial support of the SATW www.satw.ch, the Swiss academy of engineering sciences.

We would like to send big thanks to all of our supporters and technical partners who contribute to make this event such a success.

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- **EIC**, the Japanese Institute of Electronics, Information and Communication Engineers. www.ieice.org/eng/index.html
- **Medical Cluster**, a Swiss association supporting the innovation process throughout the value-added chain, from research through production to market. www.medical-cluster.ch
- **ETSI**, the European Telecommunications Standards Institute, a not-for-profit European organization. www.etsi.org

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The local organizer committee CSEM (Swiss Center for Electronics and Microtechnique) and EPFL (Ecole Polytechnique Fédérale de Lausanne) were pleased to host and organize the 5th International Symposium on Medical Information and Communication Technology in Switzerland on the Swiss Riviera in the Swiss Majestic Grand Hotel in Montreux.

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- Dr. Kamran Sayrafian, NIST, USA
- Prof. Lucila Ohno-Machado, M.D., Ph.D., Chief of Division of Biomedical Informatics, University of California, San Diego, USA
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A1L-A Session 1: MAC and Security

Time: Monday, March 28, 2011, 13:30 - 15:30

Place: The 4 Seasons

Chair: Saad Mezzour, *Chair ETSI eHealth, Medtronic, The Netherlands*

A1L-A.1 When Ultra Low Power meets High Performance: The WiseMAC Availability Protocol (INVITED)

Jérôme Rousselot

CSEM SA, Switzerland

A1L-A.2 MAC protocol for BAN (INVITED)

Yuta Fujiura, Ryuji Kohno

Yokohama National University, Japan

A1L-A.3 BATMAC: an Adaptive TDMA MAC for Body Area Networks Performed with a Space-Time Dependent Channel Model

Mickael Maman, Laurent Ouvry

CEA, Leti, Minatec, France

Wireless communications for body area network (BAN) applications require an adaptable, dynamic and flexible medium access control (MAC) to cope with a variety of application requirements. The key requirements in BAN applications are low power consumption, high reliability of intra-BAN communication and low latency. As body posture highly affects the performance of MAC protocols, we evaluate the benefits of relaying purpose to reinforce links. However, since radio links are not stationary, the scheduling of the relaying should quickly adapt to BAN changes. We instead propose a BAN Adaptive TDMA MAC (BATMAC) which automatically detects the shadowing effect and adjusts its communication protocols and the parameters of the IEEE 802.15.4 superframe. Finally, we evaluate BATMAC from latency outage and energy consumption points of view depending on the redundancy of the monitoring information.

A1L-A.4 A Lightweight Security Protocol for Ultra-Low Power ASIC Implementation for Wireless Implantable Medical Devices

Saied Hosseini-Khayat

Ferdowsi University of Mashhad, Iran

The newest generation of Implantable Medical Devices (IMDs) employs wireless communication with a nearby base station in order to provide better treatment and monitoring of the patients. However, a wireless connection opens a host of potential security threats to the privacy and safety of patients. This paper proposes a lightweight security protocol providing authentication and confidentiality to wireless energy-limited IMDs that operate on small energy sources such as a battery for many years. Adding security features to these devices can impose an

unacceptable overhead. The protocol presented here employs lightweight encryption and is suitable for implementation on ultra-low power ASIC chips.

A11-A.5 A Survey on Dependability in Body Area Networks

Yasmin Hovakeemian², Kshirasagar Naik², Amiya Nayak¹

¹*University of Ottawa, Canada;* ²*University of Waterloo, Canada*

This paper begins by introducing a working definition of dependability in Body Area Networks (BANs). Since they are widely used in e-healthcare applications, having reliable, secure, and available connectivity to a destination database, workstation or smartphone is imperative for healthcare treatment and management. Using a generic, divided system model (intra-BAN and extra-BAN), we identify potential areas of failure. The paper discusses and classifies issues and schemes proposed to increase dependability. Finally, upcoming challenges and new directions of research for improving the dependability of BANs are presented.

A2L-A Session 2: Medical BAN and eHealth Applications

Time: Monday, March 28, 2011, 15:45 - 17:45

Place: The 4 Seasons

Chair: Lucila Ohno-Machado, *Professor, University of San Diego, Chief Division of Biomedical Informatics, USA*

A2L-A.1 ETSI, European Telecommunications Standards Institute, eHealth project (INVITED)

Saad Mezzour

Chair ETSI eHealth, Medtronic, The Netherlands

A2L-A.2 Sound Aided Interface of a Pervasive Pain Monitoring System

Ismo Alakärppä², Jukka Riekkö³, Sofia Larsson¹, Elisa Jaakkola²

¹*Interactive institute, Sweden;* ²*University of Lapland, Finland;*

³*University of Oulu, Finland*

The main goal of this study was to evaluate user experience of the pain monitoring system and the sounds we designed for the user interface. The system was tested in four sessions with 23 test users from Finland and Sweden. We tested four sound options; spoken, synthetic, xylophone and mute. The material was collected through group discussions and questionnaires. In general, sounds were perceived as very functional. This study strongly implies that the context of use has to be taken into account as a primary design driver in the sound design process of the health care applications.

A2L-A.3 P-Rake Receivers in Different Measured WBAN Hospital Channels

Ville Niemelä, Matti Hämäläinen, Jari Iinatti, Attaphongse

Taparugssanagorn

University of Oulu, Finland

In wireless applications, power consumption is one of important characteristics. The endurance of battery is inversely proportional to complexity of device, and complexity is proportional to performance. The best performance is achieved with the most complex devices which has high power consumption. Rake receivers offer trade-off between complexity and performance. In the near future, due to the aging of population, personal medical applications are most likely increasing in number and gaining more attention in industry. This paper presents simulation results of IEEE 802.15.4a ultra wideband (UWB) rake receivers in measured real hospital environment at Oulu University Hospital Oulu, Finland.

A2L-A.4 Operation Scheduling Method by Efficient Anesthetist Assignment Using Genetic AlgorithmChika Sugimoto¹, Ryuji Kohno²*¹Yokohama National University, Japan; ²Yokohama National University & NICT, Japan*

This paper proposes an operation scheduling method to assign an anesthetist efficiently. The work of anesthetist is divided into some anesthesia procedures for an operation and the other. The degree of urgency and busyness is different among the work. Anesthetist's behaviors during work are learned and recognized using wearable sensors and the work could be ranked based on the degree. A genetic algorithm was applied to solve the operation scheduling problem. The results of the simulation showed that the GA approach appears to be useful for scheduling so as to make anesthetist's work more efficient bringing the risk under control.

A2L-A.5 Healthcare Integration PlatformJerzy Brzezinski, Stanislaw Czajka, Jacek Kobusinski, Maciej Piernik
Poznan University of Technology, Poland

In this paper we tackle the issue of exchanging and integrating medical information originating from different health care information systems. We propose a solution which utilises some of the concepts contained in the IHE profiles combined with the existing EHR standards in order to maintain a high level of interoperability. We confirm the value of our solution by presenting a working prototype based on our concepts. The prototype relies on the Service Oriented Architecture paradigm using RESTful web services. The article also contains a brief overview and a comparative analysis of standards for storage and exchange of medical information.

A2L-A.6 Developments in International Standards and Regulations for Medical Device Communications

Peter Chadwick

Zarlink Semiconductor, United Kingdom

Many of the European standards in the field of medical communications have achieved wide international acceptance, so that the standards and regulatory production processes in Europe are of some importance in the global sense. This paper reviews the bodies involved in European standardisation and radio regulation for medical device communications, and the recent developments therein.

A1L-B Session 3: Modeling, Miniaturization, EMI & Physical Parameters

Time: Monday, March 28, 2011, 13:30 - 15:30

Place: The Riviera

Chair: Alan Wong, *Toumaz Ltd., England*

A1L-B.1 Cost-Effective and Miniaturized System-on-Chip Based Solutions for Portable Medical & Ban Applications

Dragan Manic², Daniel Severac¹, Erwan Le Roux¹, Vincent Peiris¹

¹*CSEM, Switzerland*; ²*Swiss Center for Electronics and Microtechnology, Switzerland*

A System-on-Chip (SoC) offers an optimal implementation of electronics for portable medical systems and in particular for Body Area Network (BAN) applications. It integrates as much functionality as possible in a single chip thereby allowing miniaturization of the system, while optimizing performance and power consumption. Using present day mature and cost effective semiconductor process CMOS technology platforms, the SoC based solutions also optimize the cost and reliability of the overall system by reducing the bill of materials (BOM).

A1L-B.2 Coupled RF Inductive Sensors for Monitoring the Conductivity of Electrolyte Solutions

Siavash Saremi-Yarahmadi, Kristel Fobelets, Chris Toumazou
Imperial College London, United Kingdom

The use of closely coupled inductors, operating in the region of 10 MHz to 1 GHz, for detection of change in the concentration of ionic species present in a liquid sample, is reported here. The S-parameters were measured for the coupled inductors with liquid samples under varying pH conditions. The results from this study show that coupled inductors can be employed in simple sensing systems to monitor electrolyte solutions without the need for direct physical contact to the sensor itself.

A1L-B.3 Electromagnetic Interference and Safety in Wireless Networks: a Statistical Approach

Sergey Loyka², Vladimir Mordachev¹

¹*Belorussian State University of Informatics and Radioelectronics, Belarus*; ²*University of Ottawa, Canada*

Statistical properties of electromagnetic environment in wireless networks affecting its performance and safety are studied. A statistical method to evaluate risks to the general public due to electromagnetic radiation in wireless networks is proposed. The analysis is based on the standard propagation channel model, a Poisson model of random spatial distribution of transmitters, and a threshold-based

model of the victim receptor behaviour (radio receiver or human body). The distribution of dominant interference level is derived and analysed under various network and system configurations. The aggregate interference is dominated by the nearest one. The outage probability is used as a measure of not only the wireless link quality-of-service, but also of environmental risks induced by electromagnetic radiation. The maximum acceptable interference levels for reliable link performance and for low environmental risks are surprisingly similar.

A1L-B.4 Modeling of Printed Spiral Inductors for Remote Powering of Implantable Biosensors

Jacopo Olivo, Sandro Carrara, Giovanni De Micheli
École Polytechnique Fédérale de Lausanne, Switzerland

Fully implantable biosensors require small size to be minimally invasive. To avoid embedded batteries, power can be supplied by means of printed spiral inductors located on the skin, close to the implanted devices. Reliable models are required to optimize the design of such inductors. In this paper, a RLC model to describe the electrical properties of printed spiral inductors is proposed. The model is based on the geometrical and physical characteristics of the inductors. The accuracy of the model is finally compared with the experimental measurements.

A1L-B.5 Estimation of Maximum Communication Distance Between in-Vivo Miniature Electronic Implants

Dmitriy Penkin, Gerard Janssen, Alexander Yarovoy
Delft University of Technology, Netherlands

The known three-layered model of a human body (skin- fat-muscle) is applied to estimate maximum distances feasible for the communication between two in-vivo miniature electronic devices. It is notable that dimensions of these implants are assumed not to extend the thickness of the human fat layer. The effect of guided wave propagation in the selected 3-layered model is investigated and the gain coming from this effect is numerically analysed.

A2L-B Session 4: Antenna, Propagation & Ranging

Time: Monday, March 28, 2011, 15:45 - 17:45

Place: The Riviera

Chair(s): Matti Hämäläinen, *University of Oulu, Finland*

Paul Stadnik, *Micro Systems Engineering, Inc., USA*

A2L-B.1 Impedance-Matched Sensor-Tag Antenna Design Using Genetic Algorithm Optimization

Onur Kazanc¹, Catherine Dehollain¹, Franco Maloberti²

¹*École Polytechnique Fédérale de Lausanne, Switzerland;* ²*Università degli studi di Pavia, Italy*

Optimal matching between tag antenna and integrated circuit is crucial for maximizing delivered power in remotely-powered sensor systems. The method maximizes conjugate matching between antenna with inductive reactive impedance and an integrated circuit with capacitive reactive impedance. Obtaining the desired conjugate impedance by the intrinsic antenna impedance excludes the need of an impedance matching network. This enables fully integrated sensor systems with further miniaturization. In this study the design of a meandered slot antenna with genetic algorithm optimization for an operation frequency of 2.45 GHz is proposed. Investigations on constraints limiting the power link efficiency between reader and tag antenna at system level outline possible design actions and give rise to the design flow of the antenna. Simulation results on the proposed architecture verify the performance of the designed miniaturized antenna.

A2L-B.2 Numerical Simulations for Dynamic WBAN Propagation Channel During Various Human Movements

Takahiro Aoyagi², Minseok Kim², Jun-Ichi Takada², Kiyoshi Hamaguchi¹, Ryuji Kohno³

¹*National Institute of Information and Communications Technology, Japan;* ²*Tokyo Institute of Technology, Japan;* ³*Yokohama National University & NICT, Japan*

In this report, we performed six human movement simulation by a commercial software (Poser7). We performed FDTD simulations for body area network propagation with one transmitter and six receivers. Received amplitudes were calculated for every time frame of 1/30 s interval. We also demonstrated a polarization diversity effectiveness for dynamic wearable body area network propagation.

A2L-B.3 Very Small UWB Antenna for WBAN Applications

Kamya Yekeh Yazdandoost, Kiyoshi Hamaguchi
*National Institute of Information and Communications Technology,
 Japan*

The increasing demand for lightweight and miniature size of Ultra-Wideband (UWB) applications in wireless communications such as Body Area Network (BAN), requires the design of very small UWB antennas. One of the main element of wireless body area network is an antenna, and there are numerous concerns to consider while designing an on-body antenna, including power consumption, size, frequency, required bandwidth, and the unique RF transmission challenges posed by the human body tissues. This paper presents a tiny and very small UWB antenna for BAN applications. The antenna is made on silicon substrate with thickness of 0.6 mm. The antenna's operating frequency is in the lower band of UWB frequency range of 3.1- 5.1 GHz. The small size of antenna makes it suitable for different applications, in particular for body area network. The use of single side metal on substrate is advantageous for integrating the antenna into UWB system.

A2L-B.4 Scalable Conformal Array for Multi-Gigabit Body Centric Wireless Communication

Alexander Vasylychenko¹, John Farserotu¹, Steven Brebels³, Walter De Raedt³, Montserrat Fernández-Bolaños², Adrian Ionescu², Guy Vandenbosch⁴

¹*CSEM, Switzerland*; ²*École Polytechnique Fédérale de Lausanne, Switzerland*; ³*IMEC vzw., Belgium*; ⁴*Katholieke Universiteit Leuven, Belgium*

In this work a conceptual design of a conformal antenna array is presented for a millimeter-wave antenna system, optimized for low-cost mass production in PCB technology. The conformal array is constituted by four cube faces with two antennas realized on each face. A printed circuit board (PCB) laminate material was chosen for developing this integrated 60 GHz antenna solution. The beamforming capabilities of the 1 x 8 antenna array were validated using similar array topology but at frequency of 17.2 GHz. The proposed array enables the formation of a steerable high gain beam, significantly compensating the channel loss or shadowing in body area network (BAN), thus offering more robust, higher speed performance. The array topology is easily scalable and the antenna gain up till 12.2 dB is reachable. On one side such high gain combined with an agile beam steering is a significant power saving solution for RF front-end. On the other side a use of 60 GHz frequency band makes the antenna array extremely small and thus easily embeddable into wearable medical or commercial devices.

A2L-B.5 High Accuracy TOA Positioning Algorithm Using UWB Under NLOS Environment for Medical NetworkKoji Enda¹, Ryuji Kohn²¹*Yokohama National University, Japan;* ²*Yokohama National University & NICT, Japan*

The present paper considers how to improve prediction accuracy in a time of arrival (TOA) localization system using UWB in a non-line-of-sight (NLOS) environment for medical network. This method consists of step-by-step compensation on the basis of two approaches considering a reference position that is estimated from data affected by NLOS delay. The first consideration consists of determining NLOS delays for each node, performing compensation to alleviate the effect on line of sight (LOS) nodes through a step-by-step compensation for the NLOS delay. The second consideration consists of compensating the effect of NLOS delay on the position determined on the basis of node distribution and geometrical relations of the estimated positions. Using these considerations, we show that the proposed method outperforms the conventional NEWTON method in terms of estimation accuracy. Under certain conditions, it also exhibits better characteristics than the maximum likelihood estimation method, where environmental parameters such as NLOS delays are known.

A2L-B.6 Impact of an Aortic Valve Implant on Body Surface UWB Propagation: a Preliminary StudyWen-Bin Yang¹, Kamran Sayrafian-Pour¹, John Hagedorn¹, Judith Terrill¹, Kamyā Yekheh Yazdandoost², Attaphongse Taparugssanagorn², Matti Hämäläinen², Jari Iinatti²¹*National Institute of Standards and Technology, United States;*²*University of Oulu, Finland*

In this paper, we use a 3D immersive visualization environment to study and observe the impact of an aortic implant on body surface propagation. Specifically, we focus on the UWB impulse response of the channel between nodes located around the upper body. The difference in the obtained impulse responses (for scenarios with and without the implant) both in measurement and simulation points to the possible impact that such medical implants could have on body surface RF propagation.

B1L-A Session 5: Wireless BAN Technology

Time: Tuesday, March 29, 2011, 13:30 - 15:30

Place: The 4 Seasons

Chair: Shinsuke Hara, *Osaka City Univ., Japan*

B1L-A.1 Physical Layer Security and Privacy with UWB (INVITED)

Wayne Burleson

Professor, Electrical and Computer Engineering, University of Massachusetts, Amherst, USA

B1L-A.2 Preamble Structure and Synchronization for IEEE 802.15.6 Impulse-Radio Ultra-Wideband Physical Layer

Igor Dotlic¹, Ryuji Kohno²

¹National Institute of Information and Communications Technology, Japan; ²Yokohama National University & NICT, Japan

The paper develops a method of synchronization for synchronization header (SHR) structure described in the draft of IEEE 802.15.6 standard for body area network (BAN) and its Impulse--Radio Ultra--Wideband (IR-UWB) physical layer (PHY) with differential phase modulation. Uniqueness of this PHY is that transmitted waveform shape is not known to the receiver at the time of synchronization and therefore classic synchronization methods based on correlation cannot be employed. Based on the developed synchronization method, synchronization performances with the different SHR structures are evaluated and solutions are suggested for the SHR structure described in the standard.

B1L-A.3 Performance Analysis of Hybrid ARQ Error-Controlling Scheme for UWB BAN

Haruka Suzuki¹, Ryuji Kohno²

¹Yokohama National University, Japan; ²Yokohama National University & NICT, Japan

This paper presents hybrid type-II automatic repeat request (H-ARQ) for wireless wearable body area networks (BANs) based on ultra wideband (UWB) technology. It is shown that the improvement in performance in terms of throughput and error protection robustness is very significant. Thus, the proposed H-ARQ schemes can be employed and optimized to suit medical and non-medical applications. We show the effectiveness of the error control method from the definition of the amount of the message transmission delay.

B1L-A.4 Short Integration Time for Inter-Pulse Interference Mitigation in UWB Communications

Stephane Mebaley Ekome¹, Geneviève Baudoin¹, Jean Schwoerer²,
Martine Villegas¹

¹*ESYCOM, France*; ²*Orange Labs / Folsom Technology Group, France*

The nature of the UWB channel leads to the spread of the signal energy through the numerous paths, what can create inter-pulse interference (IPI) that degrades the receiver performances. The work presented thereafter aims at evaluating the choice of the integration window of an energy detection receiver, in a dense inter-pulse interference context. The analysis presented shows the way a short integration period could improve the receiver performances by mitigating the negative impact of IPI in UWB communications.

B1L-A.5 UWB on-Off Waveform Coded Modulation for Body Area Networks

Marco Hernandez¹, Ryuji Kohno²

¹*National Institute of Information and Communications Technology, Japan*; ²*Yokohama National University & NICT, Japan*

The paper considers bit-interleaved coded modulation with on-off signaling constellations based on the IEEE 802.15.6 Standard for future body area networks (BANs) with a wideband PHY. The transmitter of BANs is constrained by the IEEE 802.15.6 Standard to have a conventional BCH(63,51) encoder and finite interleaving. The paper presents a proposal of a simple receiver architecture targeting low power consumption, although sub-optimal respect to the BICM decoder.

B2L-A Session 6: Telemonitoring, Wireless Healthcare & Homecare

Time: Tuesday, March 29, 2011, 15:45 - 17:45

Place: The 4 Seasons

Chair: Volker M. Koch, *Bern University of Applied Sciences, Switzerland*

B2L-A.1 Monitoring Physiological and Behavioral Signals to Detect Mood Changes of Bipolar Patients

Olaf Schleusing¹, Ph. Renevey¹, M. Bertschi¹, St. Dasen¹, J.-M. Koller¹, R. Paradiso²

¹*CSEM, Switzerland*; ²*SMARTEX s.r.l., Italy*

In this paper we present a personal, cost-effective, multi-parametric monitoring system based on textile platforms and portable sensing devices for the long term and short term acquisition of data from bipolar patients affected by mood disorders. The system allows the early indication and prevention of bipolar state relapse situations. The bipolar mood state of the patients is estimated from several physiological and physical cues such as biochemical markers, voice analysis and a behavioural index correlated to patient state.

B2L-A.2 A Mobile Wearable Wireless Fetal Heart Monitoring System

Masoud Roham, Enrique Saldivar, Srinivas Raghavan, Mark Zurcher, Jonathan Mack, Mehran Mehregany

West Wireless Health Institute, United States

A wireless and mobile system for concurrent non-invasive monitoring of fetal heart rate and uterine contractions is described. The end-to-end system consists of a wearable Doppler ultrasound and pressure sensing front-end equipped with short range radio, mobile cellular gateway for wide area communication, web server, and browser based user interface for remote monitoring and diagnostics. The system has been fully implemented, tested and characterized in benchtop tests. It has also been used to monitor pregnant women during feasibility trials in a clinical setup. In vivo experiments measuring heart rate and contraction using Sense4Baby in parallel with a standard fetal monitoring device yielded concordance correlation coefficients of 88% and 94%, respectively.

B2L-A.3 A Flexible Home Gateway System for Telecare of Patients Affected by Chronic Heart Failure

Tony Bacchillone², Massimiliano Donati², Sergio Saponara¹, Luca Fanucci¹

¹*Consorzio Pisa Ricerche, Italy*; ²*Università di Pisa, Italy*

Among chronic disease, Chronic Heart Failure (CHF) is recently attracting the attention of physicians and administrators, as it represents one of the most frequent

cause of hospitalization, with a consequent considerable impact on patient quality of life and healthcare costs. This paper presents an integrated ICT solution to improve the management of CHF patients through the monitoring of vital signs at patient home. After a brief introduction of the overall system requirements and architecture, the paper will focus on the flexible home gateway. This represents the central node of the system, being responsible of data flow from the sensors to the server and the hospital information system and representing also the home patient's interface. Hardware/Software architecture and implementation trade-offs will be presented. Home Gateway prototype features will be described and compared with respect to state-of-the-art solutions.

B2L-A.4 The Use of the “Healthwear” Wearable System in Chronic Patients’ Early Hospital Discharge Control Randomized Clinical Trial

Theodoros Katsaras, Alexios Milsis, Maria Rizikari, Nikos Saoulis,
Evita Varoutaki, Angelos Vontetsianos
Sotiria Hospital of Athens, Greece

Forty eight hospitalized patients, due to Chronic Obstructive Pulmonary Disease (COPD) exacerbation, were included in this study with a randomization ratio 1:1. The study group patients were early discharged and monitored at home through the wearable "Healthwear" system, while control group patients underwent conventional care. Patients' intensive monitoring included ECG, heart and respiratory rate, oxygen saturation, activity and body position, combined with 3G mobile video sessions. There was a significant reduction in study group patients' hospital length of stay, outpatient clinic and emergency room visits, as well as in readmission rates.

B2L-A.5 Bidirectional Medication Support System for Medical Staff and Home Care Patients

Shiori Suzuki, Takehiro Yokoishi, Hisakazu Hada, Jin Mitsugi, Osamu Nakamura, Jun Murai
Auto-ID Laboratory, Keio University, Japan

We have been examining this system for more than three months with three subjects and found that a simple open/close sensing of an off- the-shelf pill box can provide a valuable medication history, and that bidirectional communication between medical staff and patients is essential to motivate patients' medication. We have been examining this system for more than three months with three subjects and found that a simple open/close sensing of an off- the-shelf pill box can provide a valuable medication history, and that bidirectional communication between medical staff and patients can motivate patients' medication.

B1L-B Session 7: Medical Imaging & Patient Diagnostic System

Time: Tuesday, March 29, 2011, 13:30 - 15:30

Place: The Riviera

Chair: Prof. Dr. Enrico Staderini, *HEIG-VD, Switzerland***B1L-B.1 BAN and future patient diagnostic systems (INVITED)**

Art Astrin

*Chair IEEE802.15.6 Body Area Networks, USA***B1L-B.2 A Switched Capacitor Fully Differential Correlated Double Sampling Circuit for CMOS Image Sensors**

Gozen Koklu, Yusuf Leblebici, Sandro Carrara

École Polytechnique Fédérale de Lausanne, Switzerland

Complementary metal oxide semiconductor (CMOS) image sensors are more compatible than charge coupled devices (CCDs) for lab-on-a-chip platforms due to their inherited advantages. However, without the noise reduction circuits, CMOS technology wouldn't be able to compete with CCDs. Today, correlated double sampling circuits (CCDs) are used in all CMOS imagers in order to remove the reset noise and the fixed pattern noise. However, these circuits immensely decrease the fill factor of the image sensors because of their large area and their requirement of extra circuitries in order to convert their single ended outputs to differential outputs. In this paper, we propose a CDS architecture convenient for CMOS imagers that uses switched capacitor fully differential configuration which reduces the noise in the same way as the conventional CDS architectures while decreasing the area and increasing the fill factor.

B1L-B.3 Using Fuzzy C-means Index Matrix to Depict for the Focal Cortical Dysplasia Region on T1 Brain MRI ImagesTsu-Wang Shen², Yue-Loong Hsin¹, Tomor Harnod¹¹*Tzu Chi General Hospital, Taiwan;* ²*Tzu Chi University, Taiwan*

Focal cortical dysplasia (FCD) is a common disorder of cortical development that underlies the susceptibility of epileptogenicity of focal cortical region. However, FCD may not be visualized easily in regular MRI images by physicians, especially in the early stage. Hence, video-monitored EEGs are still the diagnosis gold standard in hospital. Based on fuzzy C-means (FCM) segmentation technologies, we proposed a fuzzy C-means index matrix (FCMIM) to depict for the FCD region on brain MRI images to valid the cortical micro-disorganization. The technique can help a practitioner of neurology or neurosurgeon to define the focal lesion when an epilepsy surgery is planned to conduct. The proposed method successfully detected FCD regions in 5 out of 8 patients for this investigation. It is promising

that the proposed method provides blurring junction area detection without using normal brain database (NDB). Our experiment results provided suggestions on invisible information discovery on MRI images for future neuroimaging research to prevent disorders in early stages.

B1L-B.4 Near Infrared Spectrometer Combined with Multichannel EEG for Functional Brain Imaging

Etienne Lareau², Guillaume Simard², Frederic Lesage², Dang Nguyen¹, Mohamad Sawan²

¹*Centre Hospitalier de l'Universite de Montreal, Canada;* ²*École Polytechnique de Montréal, Canada*

Clinical conditions such as epilepsy and stroke could benefit from portable functional brain evaluation systems. The combination of electroencephalography (EEG) and near infrared spectroscopy (NIRS) has the potential to provide useful information towards that task. Their combination in a single device has shown beneficial results but available instruments lack NIRS sensitivity and have low channel number. In this work, a portable EEG-NIRS prototype is developed having a large channel count and a high NIRS sensitivity obtained by the use of avalanche photodiodes. The system is demonstrated to be portable and enables operation over long periods for continuous monitoring.

B1L-B.5 A Literature Review of the Safety of Medical Body Area Network Devices in Magnetic Resonance Imaging

Allen Huang², Bernard Segal¹

¹*McGill University, Canada;* ²*McGill University Health Centre, Canada*

A review of the clinical scientific literature and US FDA adverse event reports (MAUDE) database was done, to ascertain the evidence for safety of wireless devices potentially used in Medical Body Area Networks in Magnetic Resonance Imaging machines. Very little information exists. The authors discuss issues concerning a gap in research into the safety of MBAN devices in MRI machines and EMI fields.

**B2L-B Session 8: Medical & Diagnostic Systems,
Rehabilitation & eHealth**

Time: Tuesday, March 29, 2011, 15:45 - 17:45

Place: The Riviera

Chair(s): Allen R. Huang, *McGill University, Canada*

Jean Luprano, *CSEM SA, Switzerland*

B2L-B.1 A Design of H Infinity Fuzzy Controller for HIV/AIDS Infection System with Dual Drug Dosages

Sasiluk Junhom, Wudhichai Assawinchaichote

King Mongkut's University of Technology Thonburi, Thailand

This paper presents a design of H_∞ fuzzy controller for HIV/AIDS infection system with dual drug dosages. The Tagaki-Sugeno (TS) fuzzy model is applied for fuzzy modeling of the HIV infection dynamic system. Sufficient conditions of the controller for this system is given in term of LMIs. The effectiveness of the proposed controller design methodology is finally demonstrated through simulation results. It has been shown that the anti-HIV vaccines are critically important in reducing the infected cells.

B2L-B.2 Biosignals Separation Method for Medical Diagnostic System

Kenji Hashiodani¹, Tatsuya Onoue¹, Shinichi Takada¹, Yohei Fukumizu¹, Hironori Yamauchi¹, Yoshimasa Kurumi², Tohru Tani²

¹*Ritsumeikan University, Japan;* ²*Shiga University of Medical Science, Japan*

In this paper, we will propose method to separate biosignals such as breath, blood, heart signal from mixed signals in body. As a result, we could get only target signal which is breath, blood and heart signals from actual mixture signals of carotid artery sound that extracted from a healthy human subject in a real environment using our algorithms and microphone sensors.

B2L-B.3 Identification of Chemical Elements Present in Daily Materials in Orthotics and Prosthetics

Juan Carlos Muñoz, Roberto Cassibba, Ruben Corrao, Favio Montane, C. Adatto, Maria Del Mar Vales Flores

Universidad Nacional de General San Martín, Argentina

In this paper we analyze the chemical composition of materials used daily in the field of Orthotics. Prosthetics and Assistive Technology, which act as the interface of contact between the prosthetic / orthotic element and the patient's skin. The methodology is experimental, using the technique of wavelength dispersive X-ray fluorescence, applied to samples of wool and synthetic cloth. To perform these studies, it took and used special equipment belonging to the Management of

Chemistry, National Atomic Energy Commission, and the measurements were made in collaboration with personnel of this institution.

B2L-B.4 Personal Vibrotactile Stimulator for Rehabilitation of the Hand in Stroke and Parkinson Patients

Enrico Maria Staderini², Stefano Mugnaini¹

¹*Tor Vergata University of Rome, Italy;* ²*Western Switzerland University of Applied Science, Switzerland*

It is already known that electrical or vibratory somatosensory stimulation is useful for the recovery of patients following a stroke event. The presented prototype system has been developed as an aid for the rehabilitation of stroke patients by means of vibrotactile stimulations in a force sensing biofeedback set-up. The system has been specifically designed so to be used in the neuro-lab as well as in the clinic or at home for administering to the patient a series of exercises, tests and bio-feedback training exercises. The system is also useful for basic research and for remote controlling in a telerehabilitation session.

B2L-B.5 Challenges & opportunities of innovation management in the MedTech Industry (INVITED)

Mr. Hofrichter

MedTech Sector Lead, Deloitte Consulting AG, Switzerland

AUTHOR INDEX

A

Adatto, C.16
 Alakärppä, Ismo 3
 Aoyagi, Takahiro..... 7
 Assawinchaichote, Wudhichai.....16
 Astrin, Art14

B

Bacchillone, Tony12
 Baudoin, Geneviève11
 Bertschi, M.12
 Brebels, Steven..... 8
 Brzezinski, Jerzy 4
 Burleson, Wayne10

C

Carrara, Sandro.....6, 14
 Cassibba, Roberto.....16
 Chadwick, Peter 4
 Corrao, Ruben16
 Czajka, Stanislaw 4

D

Dasen, St.12
 De Micheli, Giovanni 6
 De Raedt, Walter 8
 Dehollain, Catherine.....7
 Donati, Massimiliano12
 Dotlic, Igor10

E

Enda, Koji 9

F

Fanucci, Luca12
 Farserotu, John 8
 Fernández-Bolaños, Montserrat..... 8
 Fobelets, Kristel 5
 Fujiura, Yuta.....1

Fukumizu, Yohei.....16

H

Hada, Hisakazu.....13
 Hagedorn, John..... 9
 Hamaguchi, Kiyoshi.....7, 8
 Hämäläinen, Matti3, 7, 9
 Harnod, Tomor14
 Hashiodani, Kenji.....16
 Hernandez, Marco11
 Hofrichter, Mr.17
 Hosseini-Khayat, Saied 1
 Hovakeemian, Yasmin 2
 Hsin, Yue-Loong.....14
 Huang, Allen15

I

Iinatti, Jari3, 9
 Ionescu, Adrian 8

J

Jaakkola, Elisa..... 3
 Janssen, Gerard..... 6
 Junhom, Sasiluk16

K

Katsaras, Theodoros13
 Kazanc, Onur 7
 Kim, Minseok..... 7
 Kobusinski, Jacek..... 4
 Kohno, Ryuji 1, 3, 7, 9, 10, 11
 Koklu, Gozen14
 Koller, J.-M.12
 Kurumi, Yoshimasa.....16

L

Lareau, Etienne.....15
 Larsson, Sofia..... 3
 Le Roux, Erwan..... 5
 Leblebici, Yusuf14

AUTHOR INDEX

Lesage, Frederic15
 Loyka, Sergey..... 5

M

Mack, Jonathan.....12
 Maloberti, Franco 7
 Maman, Mickael..... 1
 Manic, Dragan 5
 Mebaley Ekome, Stephane11
 Mehregany, Mehran12
 Mezzour, Saad.....1, 17
 Milsis, Alexios13
 Mitsugi, Jin.....13
 Montane, Favio.....16
 Mordachev, Vladimir 5
 Mugnaini, Stefano17
 Muñoz, Juan Carlos16
 Murai, Jun13

N

Naik, Kshirasagar 2
 Nakamura, Osamu13
 Nayak, Amiya..... 2
 Nguyen, Dang.....15
 Niemelä, Ville 3

O

Olivo, Jacopo..... 6
 Onoue, Tatsuya.....16
 Ouvry, Laurent 1

P

Paradiso, R.12
 Peiris, Vincent 5
 Penkin, Dmitriy 6
 Piernik, Maciej 4

R

Raghavan, Srinivas12
 Renevey, Ph.....12

Riekki, Jukka 3
 Rizikari, Maria13
 Roham, Masoud12
 Rousselot, Jérôme..... 1

S

Saldivar, Enrique12
 Saoulis, Nikos.....13
 Saponara, Sergio.....12
 Saremi-Yarahmadi, Siavash 5
 Sawan, Mohamad15
 Sayrafian-Pour, Kamran 9
 Schleusing, Olaf12
 Schwoerer, Jean11
 Segal, Bernard15
 Severac, Daniel..... 5
 Shen, Tsu-Wang14
 Simard, Guillaume.....15
 Staderini, Enrico Maria17
 Sugimoto, Chika..... 3
 Suzuki, Haruka10

T

Takada, Jun-Ichi 7
 Takada, Shinichi16
 Tani, Tohru.....16
 Taparugssanagorn, Attaphongse.....3, 9
 Terrill, Judith..... 9
 Toumazou, Chris 5

V

Vales Flores, Maria Del Mar16
 Vandenbosch, Guy 8
 Varoutaki, Evita13
 Vasylichenko, Alexander..... 8
 Villegas, Martine.....11
 Vontetsianos, Angelos.....13

Y

Yamauchi, Hironori.....16
 Yang, Wen-Bin..... 9

AUTHOR INDEX

Yarovoy, Alexander 6
Yazdandoost, Kamyā Yekeh8, 9
Yekeh Yazdandoost, Kamyā8, 9
Yokoishi, Takehiro.....13

Z

Zurcher, Mark.....12

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