

24 - 26 June 2009. Oslo, Norway. Bristol Hotel, downtown Oslo.

# Welcome to Oslo and pHealth 2009!

The 6th edition of the International Workshop  
on Wearable Micro and Nano Technologies for Personalised Health

## "Facing future health care needs"

The pHealth Workshop is a forum for discussions and presentations of cutting-edge of technology. The workshop focuses on user centered development and the successful implementation of technologies; creating the solutions for tomorrow's personalised health systems

## Programme



## Welcome to pHealth 2009 International Workshop in Oslo

Dear Friends and Colleagues,

It is an honour to welcome you to the sixth edition of the pHealth International Workshop. The pHealth workshop has proven to be a valuable forum for debate and a good place to get an overview of the state-of-the-art and future of nano and micro technologies, wearable and implantable sensors and ICT for personal health systems. Once again we are able to bring together experts and researchers from academia and industry, despite hard financial times for many. This year we are in Oslo, trying to live up to the legacy of previous editions of pHealth in Luca 2003, Belfast 2004, Luzern 2006, Thessaloniki 2007 and Valencia 2008.

pHealth 2009 is the result of a collaboration between three organisations, SINTEF, The Norwegian Centre for Integrated Care and Telemedicine - NST (University Hospital of North Norway), and The Intervention Centre - IVS (University Hospital of Oslo).

This years programme starts off Wednesday, June 24, with a day of practical demos and presentations of sensors and systems in actual use and in experimental use in the research lab at IVS and at the HP Health Centre of Excellence. Thursday and Friday we run a more usual programme with plenary presentations and discussions. On Friday we have opened up for a few special topics to be addressed in parallel seminars for the morning session. We hope that the progression of the programme will take us from the details of sensors and sensor systems, through to the final session focusing on the future and how to get research results from the lab through to innovations and implementations.

In addition to the detailed programme for the pHealth 2009 workshop, you will find abstracts from the presenters as well as the posters and demos in this booklet. We will plan to publish the presentations on our web site ([www.phealth2009.com](http://www.phealth2009.com)) as they become available to us, and we will publish a proceeding with IEEE IMBS approval after the workshop.

One of the most important aspects of any conference or workshop is to meet colleagues and peers, so we hope you will participate in the social events and use the lunch breaks and coffee breaks to network and create new relationships. The main social event takes place outdoors, on the beautiful Oslo-fjord. The fjords and the landscape is one of the main reasons why people come to Norway and we hope to be able to give you an impression of why this is so. However, any outdoor arrangement presents certain risks related to weather and we hope that you have brought some warm clothes, just in case.

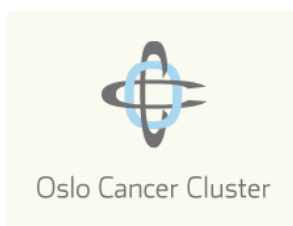
We wish you all a pleasant stay in Oslo and thank you for participating in the event. We value your time and participation and hope that you will find this year's pHealth useful and enriching.

Workshop Chairpersons

Dag Ausen  
SINTEF

Per Hasvold  
The Norwegian Centre for Integrated Care and Telemedicine

## Sponsors, exhibitors and collaborating partners



## Programme overview

Wednesday, June 24		
09:00	Bus transport HP HCoE	Hotel Bristol
09:00 – 10:00	Registration	HP HCoE
10:00 – 10:30	<b>pHealth 2009 Opening</b>	HP HCoE
09:00	Bus transport Rikshospitalet	HP HCoE
10:30 – 13:00	<b>Personalised Health at the hospital</b>	HP HCoE
13:00 – 14:00	Registration	Rikshospitalet
14:00 – 18:00	<b>Biomedical in-vivo sensors in action</b>	Rikshospitalet
18:00	Bus transport to city centre	Rikshospitalet
10:00 – 18:00	<b>Smart Textiles network meeting</b>	Hotel Bristol

Thursday, June 25		
08:30 –	Registration	Hotel Bristol
09:30 – 11:00	<b>pHealth 2009 Keynote presentations</b>	Bristol Hall
11:00 – 11:30	Coffee break	Exhibition Area
11:30 – 13:00	<b>Session 1 – Medical Sensors and Sensor Systems</b>	Bristol Hall
13:00 – 14:00	Lunch	Exhibition Area
14:00 – 15:30	<b>Session 2 – Wearable Sensors and Systems</b>	Bristol Hall
15:30 – 16:00	Coffee Break	Exhibition Area
16:00 – 17:30	<b>Session 3 – User Interaction and Personal Health Systems</b>	Bristol Hall
18:00	Reception at Oslo Town Hall	
19:30 – 22:30	Boat trip on the Oslo Fjord including dinner	

Friday, June 26			
08:00 –	Registration		Bristol Hotel
08:30 – 10:30	Seminars (in parallel)		
	Personal Portable Devices and Sensor Networks	Cancer Diagnostics	EU-US pHealth Experiences
10:30 – 11:00	Coffee Break		Exhibition Area
11:00 – 12:30	Session 4 – System Integration		Bristol Hall
12:30 – 13:15	Lunch		Exhibition Area
13:15 – 14:30	Session 5 – From Research to Innovation to Implementation		Bristol Hall
14:30	pHealth 2009 Ends		Bristol Hall

## Organising Committee

Dag Ausen, SINTEF ICT (chairman)  
Berit Sundby Avset, SINTEF ICT (co-chairman)  
Trine Seeberg, SINTEF ICT (chair posters & demos)  
Annebeth Osa, SINTEF ICT  
Per Hasvold, NST  
Ole Jakob Elle, Oslo University Hospital - Rikshospitalet  
Morten Fraas, Oslo Teknopol  
Susanne Werner, Oslo Teknopol / MedCoast Scandinavia

## Programme Committee

Per Hasvold, NST (chairman)  
Dag Ausen, SINTEF ICT  
Liv Furuberg, SINTEF ICT / University of Oslo  
Hilde Færevik, SINTEF Health Research  
Toril N. Hernes, SINTEF Health Research / Norwegian Technical University  
Gustav Bellika, NST  
Rune Fensli, University of Agder  
Ilangko Balasingham, Oslo University Hospital / Norwegian Technical University  
Karl Øyri, Oslo University Hospital - Rikshospitalet  
Laura Slaughter, Norwegian Technical University / Oslo University Hospital  
Gunnar Hartvigsen, University of Tromsø  
Marius Mikalsen, SINTEF ICT  
Frode Strisland, SINTEF ICT  
Morten Borch, SINTEF ICT  
Veslemøy Tysse, Oslo University College

## Scientific Committee

Andreas Lymberis, European Commission, Microsystems  
Loukianos Gatzoulis, European Commission, eHealth  
Danilo De Rossi, UNIPI  
Eric McAdams, NIBEC  
Georges Kotrotsios, CSEM  
Nicos Maglaveras, Univ. Thessaloniki  
Sergio Guillén & Vicente Traver, ITACA  
Brian MacCraith, Biomedical Diagnostics Institute, Dublin City University  
Paolo Bonato, Harvard Medical School  
Jean Luprano, CSEM  
Josep Roca, Hospital Clinic Barcelona

**Technical co-sponsor**



**IEEE**





## The Organisers



[www.sintef.no](http://www.sintef.no)

The SINTEF group is the largest independent research organisation in Scandinavia. We generate new solutions and knowledge for our customers, based on research and development in technology, in natural sciences, medicine and the social sciences.

SINTEF is the leading Norwegian research player in medical technology.

SINTEF adopts a multidisciplinary approach, ranging from health informatics and information security to communication systems and applications involving instrumentation, microfluidics and micro sensor systems. This includes integration of Micro Electro Mechanical Systems (MEMS), as made in silicon, with polymer microfluidic devices and functionalized surfaces into complete platforms. Through long-term collaboration with health care providers, SINTEF identifies user demands and performs interdisciplinary translational research in true clinical environments. SINTEF is hence a complete supplier of all the most relevant technologies for design and development of medical devices and services.

Our experience includes:

- Lab-on-a-chip in vitro diagnostic platforms for point of care and home testing
- Ambulatory sensor systems for physiological vital signs monitoring
- Instrumentation and integration of medical devices
- Smart textiles and clothing involving sensors, electronics and multifunctional materials
- Radiation sensors for medical imaging, micro-optical detection systems, gas and liquid sensors, chemical micro-reactors
- In vivo, in situ and implant sensor systems
- Drug delivery and tissue sampling systems
- Technology for image guided, minimally invasive and computer assisted therapy/surgery
- Work physiology and validation of sensors and protective equipment
- Computer supported collaborative care and services

### SINTEF ICT



SINTEF ICT offers integrated research-based knowledge through access to a broad competence and technology platform within ICT.

### SINTEF



#### Technology and society

SINTEF Technology and society is a multidisciplinary research institute within the main areas of health, transport, technology management, safety and applied economics.



## NST | Norwegian Centre for Telemedicine

UNIVERSITY HOSPITAL OF NORTH NORWAY

WHO Collaborating Centre for Telemedicine

[www.telemed.no](http://www.telemed.no)

The Norwegian Centre for Integrated Care and Telemedicine is a centre for research and expertise that gathers, produces and disseminates knowledge about telemedicine services, both in Norway and internationally.

This knowledge is built through research, development, and innovation projects and activities, based on our values openness, courage, and reliability.

Our goal is to serve the healthcare services to improve integrated care and provision of healthcare services at the most efficient level through the use of telemedicine and eHealth.

NST is organised as a division at the University Hospital of North Norway in Tromsø, with satellite offices in all the other health regions of Norway. NST is an internationally known organization and was chosen as a World Health Organization Collaborating Centre for Telemedicine in 2002.

The Norwegian Centre for Integrated Care and Telemedicine is together with several partners building a scientific environment within telemedicine and eHealth. Tromsø Telemedicine Laboratory was established in 2006 as a Centre for Research-Based Innovation and is combining human caring with new technologies, in order to provide better health care and reduce the growing burden on the health care system.



[www.ivs.no](http://www.ivs.no)

The **Interventional Centre** is a research and development centre for image guided and minimally invasive therapy at Rikshospitalet University Hospital in Oslo, Norway and Faculty of Medicine at University of Oslo. The centre was established in 1996 to create a link between clinical practice, applied-, and basic research in the fields pertaining to minimally invasive and image guided therapy.

The Centre has the following deliverables:

1. Develop new procedures
2. Develop new treatment strategies
3. Compare new and existing strategies
4. Study the social, economic, and organisational consequences of new procedures on health care

### Strategy

- The Interventional Centre is a research and development resource for all the clinical and laboratory departments at Rikshospitalet.
- The Centre shall actively offer similar services to the health care community in Norway outside the hospital.
- The Interventional Centre shall work as a link between technology institutions (commercial and academic) and the clinical medical environment in the hospitals.
- The Interventional Centre shall promote and work actively to protect new knowledge and facilitate commercial exploitation.

### Focus

- MR guided intervention and surgery
- X-ray, CT, ultrasound, video-guided interventions and surgery
- Robotics and simulators
- Biosensors, data management and communication

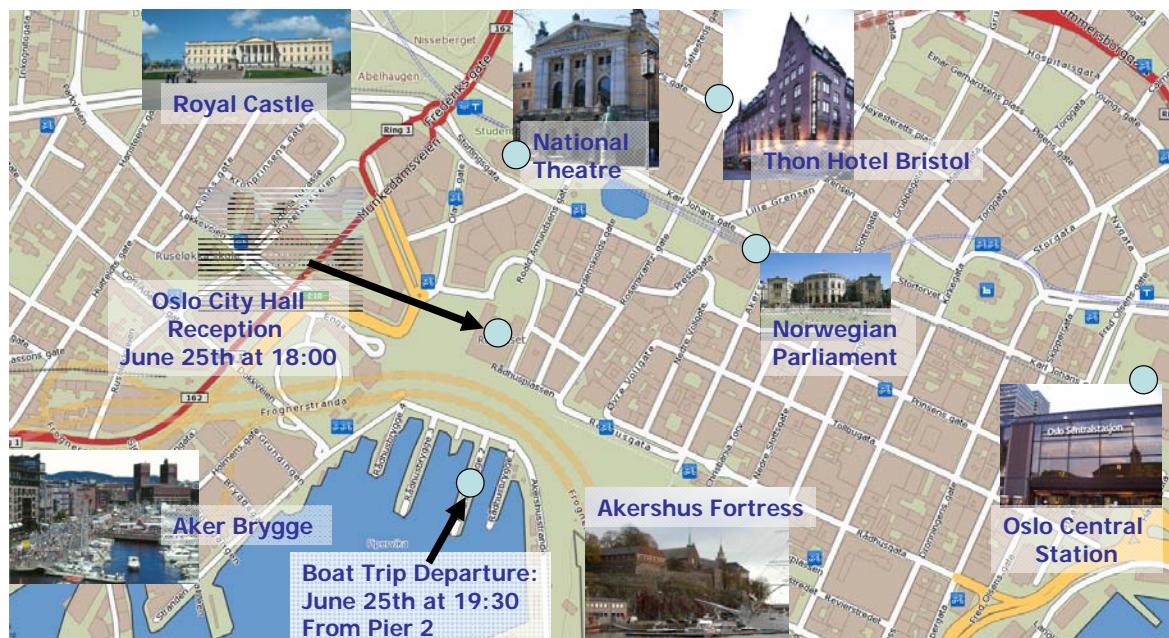
### Facilities

The Centre has a unique architectural structure. In the three suites advanced imaging equipment was integrated in an operation room environment. In 2007 all advanced imaging equipment was renewed. In the combined surgical and radiological suite, the conventional angiographic equipment was substituted by the Siemens Zeego system, based on robotic technology and containing new advances in imaging and functionality. Our MRI suite was completely rebuilt into a dual room suite where a 3 T was installed in one room beside a state of the art OR. The two rooms were separated by a sliding door, allowing surgery with standard equipment and intermittent MRI imaging. In the videoscapy room all systems were replaced by Olympus HD equipment.

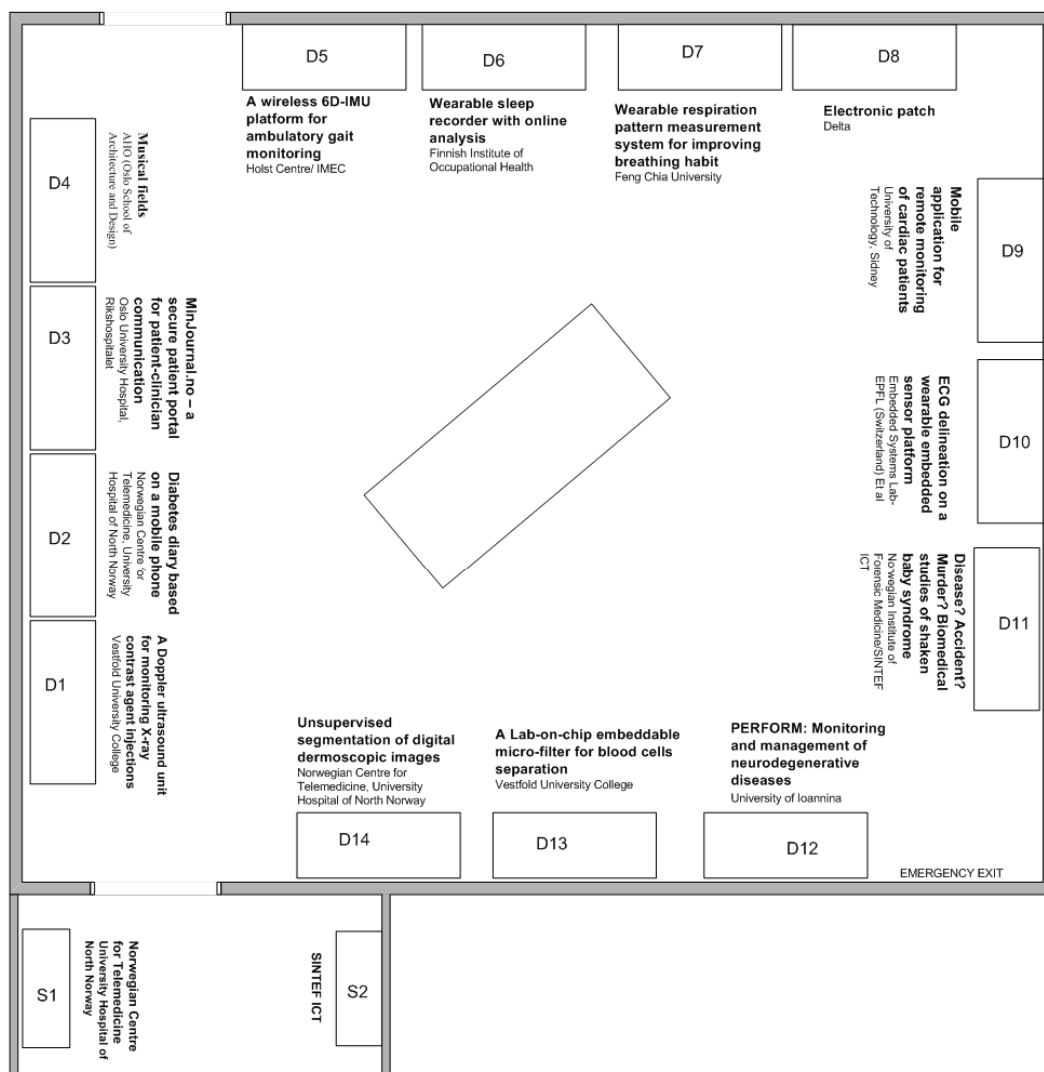


## Venue and Maps

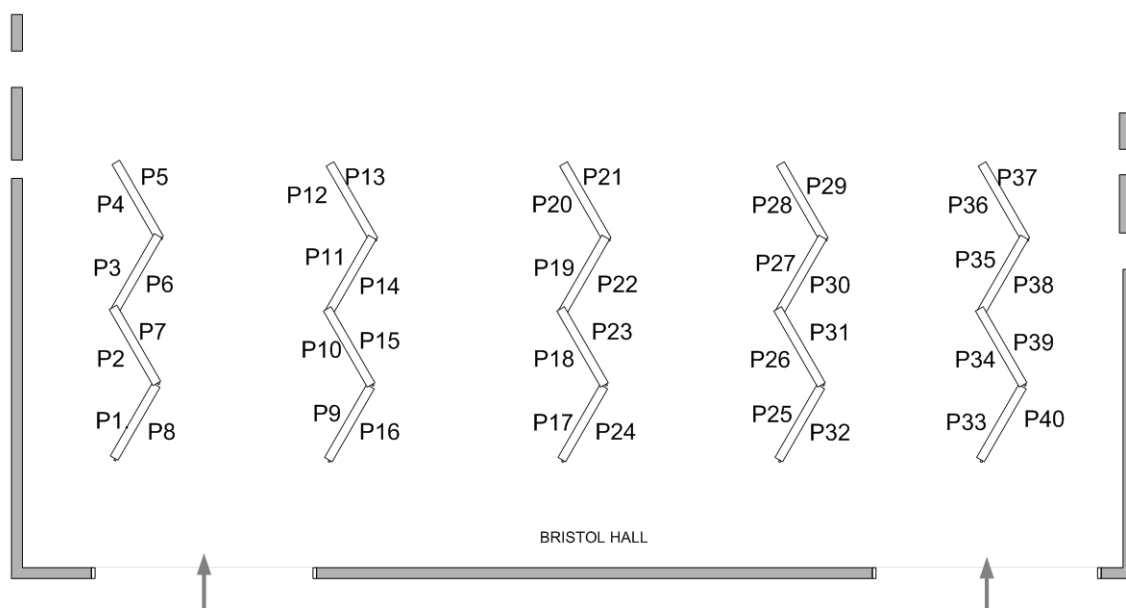
The main location for pHHealth is Bristol Hotel, see location on map. Oslo City Hall and departure location for the boat trip Thursday are also shown.



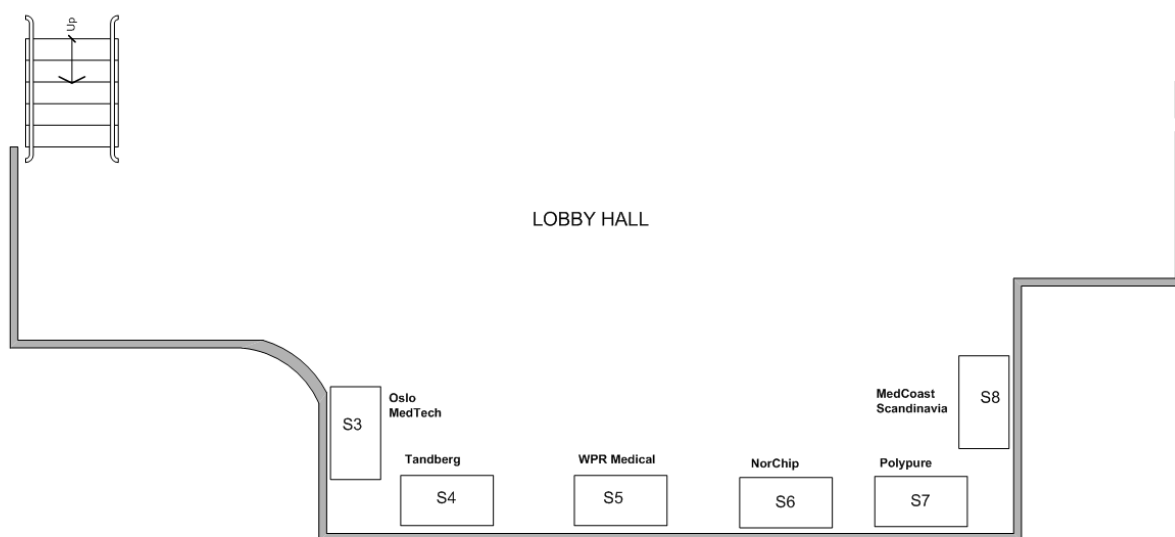
## Demos location and Organisers stand at Hotel Bristol



## Poster location map



## Exhibitors location at Hotel Bristol



## Overview poster participants

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P04	Rune Fensli	University of Agder	Norway	Signal quality of wearable sensors, methods for comparing recordings from a wireless ECG sensor to established clinical standards	45
P05	Matthias Struck, Christoph Dinh	Fraunhofer Institute for Integrated Circuits	Germany	A new real-time fall detection approach using fuzzy logic and a neural network	45
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P09	Jeon, Hyo-Seon	Graduate Program in Bioengineering, Seoul National University	South Korea	Multiclass SVM Application for Parkinsonian Gait Recognition using Wearable Plantar Pressure System	47
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P20	Lars Vognild	Northern Research Institute (Norut)	Norway	Off-the-shelf devices and open source for low cost personalized home-based telemedicine	51
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P40	Knut Grythe Ilangko Balasingham	SINTEF ICT The Interventional Centre, Rikshospitalet	Norway	Interactive system design and end-to-end optimization in sensor network	60

## Overview demo participants

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D03	Sissel Jor	Oslo university hospital, Rikshospitalet, Norway	MinJournal.no – a secure patient portal for patient-clinician communication	D03	61
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D07	Chen-Yen Lan	Ph. D. Program of Electrical and Communications Engineering, Feng Chia University, Taiwan, R.O.C	Wearable Respiration Pattern Measurement System for Improving Breathing Habit	D07	63
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D10	Francisco Rincon	Embedded Systems Laboratory (ESL)-EPFL, Switzerland	ECG Delineation on a Commercial Wearable Embedded Sensor Platform	D10	64
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D12	Dina Baga	University of Ioannina, Ioannina, Greece	PERFORM: A system for the monitoring and management of patients suffering from neurodegenerative diseases: The Parkinson's disease and Amyotrophic Lateral Sclerosis cases.	D12	65
D13	Tao Dong	Norwegian Center of Expertise on Micro- and Nanotechnology, Norway	A Lab-on-chip Embeddable Anti-clogging Micro-Filter for Blood Cells Separation	D13	65
D14	Kajsa Møllersen	Norwegian Centre for Integrated Care and Telemedicine, University Hospital of North Norway	Unsupervised Segmentation of Digital Dermoscopic Images	D14	66



## **Notes for technology demo at HP Health Centre of Excellence:**

## Wednesday 24 June, 10:00 - 13:00 – HP HCoE

### Technology demo session: Personalized health at the hospital

The pHealth 2009 workshop opens with a visit to HP European Health Centre of Excellence. In this centre, HP and the partners Imatis, Cisco, Telenor and Microsoft present and demonstrate the technology-solutions for the digital hospital. It is unique that so many large companies come together to cooperate and create the best technology for health.

The vision for the HP HCoE is:

*"Deliver state of the art technology to secure meaningful information anytime, anywhere within a hospital environment, and thus improve patient care and technology efficiency".*

### Mini-seminar: From digital hospital to home care solutions

In parallel with the technology demo, the centre will also present experiences from the implementation of the digital hospital infrastructure at St.Olavs Hospital in Trondheim, one of the most advanced hospitals in Europe. The way forward, presenting solutions for home care settings will also be discussed.

#### Speakers:

Morten Andresen, COE, Imatis AS

Hans Christian Haugli, director Telenor R&I

### Digital Hospital demo

The Digital Hospital Infrastructure (DHI) is a framework of products, solutions and services, which enables the construction of a Digital Hospital. DHI lays the foundation for a health service environment that offers a better quality of care, improvements in patient safety, and greater productivity for healthcare professionals.

DHI is based around a single IP connectivity and integration platform that connects different hospital systems together and meets the availability, security and reliability requirements of clinical applications.

In a Digital Hospital, the following critical technologies are integrated to work together, freeing staff to focus on delivering better care:

- Cisco Medical Grade Network Design
- High-availability computing platforms
- HP StorageWorks Medical Archive Solution
- IMATIS Integration Platform
- Data-acquisition technologies
- Messaging and alerts
- Location-based services and asset tracking

The technology demo will be held as a play for small groups of people, explaining and demonstrating the technology.

## Notes for technology demo at Rikshospitalet:

## Wednesday 24 June 14:00 - 18:00 - Rikshospitalet

### Technology demo session: In-vivo sensors in surgery

Technology demo session at Oslo University Hospital, Rikshospitalet

The demo session will demonstrate the use of biomedical sensors during surgery procedures transmitted live to the audience from the operation theatre. Ongoing research activities, both at Rikshospitalet and in European projects, will also be presented.

### Programme

14:00	Welcome and introduction	Morten Reymert, CEO Oslo University Hospital - Rikshospitalet Jacob Bergsland MD, Interventional Centre
14:20	"Best of Luck!" Some unsolicited advice to St. Olav management	Arne Olav Solumsno, Manager of Public Relations, Helsebygg Midt-Norge
14:40	Technical introduction The IscAlert sensor - a miniaturized disposable biosensor providing early warning of ischemia Detection of regional cardiac ischemia by accelerometer technology Live demonstration of sensors and technology transmitted to the auditorium	Prof. Tor Inge Tønnessen MD, Interventional Centre  Dr. Ole Jakob Elle, Interventional Centre Jacob Bergsland MD / Prof. Tor Inge Tønnesen MD / Per Steinar Halvorsen MD / Andreas Espinoza MD/ Søren Pischke MD / Mr. Karl Øyri, The Interventional Centre
	Bio impedance sensors Live demonstration from the Interventional Centre ctd Brain stimulators	Prof. Ørjan G. Martinsen, Department of Biomedical and Clinical Engineering Dr. Jon Ramm-Pettersen, Department of Neurosurgery
16:15	Coffee break	
16:45	VECTOR - Versatile Endoscopic Capsule for gastrointestinal TumOr Recognition and therapy	Prof. Dr. Marc O. Schurr, novineon Healthcare (DE)
17:10	NANOMA - Nano-Actuators and Nano- Sensors for Medical Applications	Prof. Antoine Ferreira, ENSI, Université d'Orleans (FRA)
17:35	ULTRASPONDER - In-vivo ultrasonic transponder system for biomedical applications	Prof. Ilanko Balasingham, The Interventional Centre
18:00	End of session. Transport to city centre	

## Wednesday 24 June 2009, 10:00 - 18:00 – Hotel Bristol

### Smart textiles network meeting

The third Nordic Smart Textiles Network Meeting

This meeting is organised by the Smart Textiles network, a Nordic collaboration stimulating quality development, research, product development, competence development, and professional state-of-the-art skills within the textile industry.

### Programme

10:30	Welcome & introduction	Veslemøy Tysse, Oslo University College Susanne Edström, University College Borås Jean Luprano, CSEM
10:45	Smart textiles for leisure, professional and healthcare applications: an introduction to wearable systems	
11:15	Smart textiles for monitoring professional rescuers and fire fighters: the Proetex Project	AnnaLisa Bonfiglio, University of Cagliari
11:45	Nordic networking Smart Textiles - Short presentations from the participants	
13:00	Lunch	
14:00	Nordic industrial projects	
	Experiences with development and commercial application of smart textiles	Ivar Grøneng, HellyHansen AS (NO)
	Fire-fighter clothing Per Arne Andersson and Jørgen Lilljerot	TST-Sweden (SE)
	How new developments, design and materials can improve athlete's performance	Lena Grimsrud Aarestad, SWIX Sport AS (NO)
15:30	Coffee break	
16:00	Nordic research projects	
	Smart textile research projects at SINTEF	Hilde Færevik, SINTEF Health (NO)
	A Textile Product Concept based on wireless Monitoring of Heart Rate and Electromyographic Signals	Lena Berglin, The Swedish School of Textiles (SE)
	Smart Textiles Technology Lab Nils Krister Persson	University College Borås (SE)
	Wearable technology development in Finland	Jukka Vanhala, Tampere University of Technology (FIN)
17:30	Strengthening the textile industry through cooperation.	Chairs: Hilde Færevik and Susanne Edström
18:00	Conclusions and final remarks	

The network meeting is not an official part of pHealth 2009, but are organised and marketed in collaboration.

## Thursday 25<sup>th</sup> June 2009, 08:30 – 11:30 – Bristol Hall

### Keynote Session

The registration takes place at the Britol Hotel from 08:30 for those that did not register the previous day.

The opening session features three keynote presentations that will provide an overview of the state-of-the-art in the domain of personal health systems.

Chair persons: Dag Ausen, SINTEF and Per Hasvold, NST

### Programme

09:30 – 11:00	<i>Empowering citizens through pHealth - the European agenda</i> , Roberto Giampieretti, European Commission - eHealth <i>Personal Health Systems – roadmap towards 2020</i> , Cristiano Codagnone, Milan State University <i>Digital Soldiers: Transforming Personalized Health in Challenging and Changing Environments</i> , Karl Friedl, Telemedicine and Advanced Technology Research Centre	Bristol Hall
11:00 – 11:30	<i>Coffee break</i>	Exhibition Area

### Notes for Keynote session:



## Notes for Session 1:

## Thursday 25<sup>th</sup> June 2009, 11:30 – 13:00 – Bristol Hall

### Session 1 – Medical Sensors

This session will focus on biomedical diagnostics, with a particular emphasis on point-of-care or near-patient testing. Such systems typically rely on lab-on-a-chip platforms in which the concentration of selected biomarkers is measured in a small ( $\mu\text{L}$ ) sample of physiological fluid. In this context, the selection of appropriate multiplexed assay formats plays an important role in achieving the balance between cost and performance (e.g. sensitivity; limit of quantitation, precision). The convergence of microfluidics, nanotechnology, photonics, and sensor technology is critical to the development of the required platforms. In addition, the combination of information and communications technology (ICT) with such platforms enhances the remote delivery of appropriate healthcare and facilitates the integration of integration of point-of-care diagnostics in the broader e-Health environment.

Chairman: Prof. Brian MacCraith, Biomedical Diagnostics Institute, Dublin City University

Co-chair: Dag Ausen, SINTEF ICT

11:30 – 13:00	<ul style="list-style-type: none"> <li>- Lars-Olof Hansson, Uppsala University: <i>pHealthLab, a need for effective pHealthCare</i></li> <li>- Clifford C. Dacso, Abramson Center for the Future of Health: <i>The new personalised medicine: low cost sensors, robust analytics, ubiquitous computing</i></li> <li>- Stig Morten Borch, SINTEF: <i>In vitro diagnostic platforms of the future. Technological possibilities and challenges.</i></li> <li>- Frank Karlsen, NorChip: <i>Business case POCNAD</i></li> </ul> <p>Roundtable discussion chaired by prof. MacCraith.</p>	Bristol Hall
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## Notes for Session 2:

**Thursday 25<sup>th</sup> June 2009, 14:00 – 15:30 – Bristol Hall**

**Session 2 – Wearable Sensors and Systems: Integrating Technology for Clinical Applications**

When designing wearable systems to be used in clinical practice, it is important to adopt a user-centred design approach. Wearable sensors should be easy to use, comfortable to wear, and minimally obtrusive. Sensors should be easy to clean and should be water-proof as subjects need to be able to shower or take a bath without having to remove the sensors. Remote access to the data should be fully integrated into the system design, thus addressing data flow management and performance of analysis of the physiological information gathered using wearable systems. The adoption of wearable technology to monitor health status in individuals at the point of care (including, for instance, the office of the general practitioner) would likely lead to early diagnosis of medical conditions with great benefit to the patient. Besides, the healthcare system would witness a reduction in medical costs due to enhanced ability that the adoption of wearable technology provide allow practitioners with. Trials aimed at demonstrating clinical validity of these technologies should be pursued in order to facilitate adoption of wearable systems. We anticipate that providers (e.g. physicians) would accept the diagnostic quality of the recordings performed using wearable sensors only if extensive clinical studies are performed using such technology. Evaluation procedures comparing new sensor technologies to conventional equipment should be established to facilitate the validation of wearable systems. This process is challenging. For instance, if one had developed a new wireless ECG sensor, comparison with traditional technologies would be problematic because, for instance, the recordings may not be directly comparable to traditional methods relying on standardized ECG leads. Finally, one has to face the challenge of obtaining certification of the equipment for medical application.

Chairman: Paolo Bonato, Harvard Medical School

Co-chairman: Rune Fensli, University of Agder

14:00 – 15:30	<ul style="list-style-type: none"> <li>- Rune Fensli: <i>Wearable Sensors and Systems: Integrating Technology for Clinical Applications</i></li> <li>- Dr. Emil Jovanov, University of Alabama: <i>System Architecture of Wireless Body Sensor Networks</i></li> <li>- Venere Ferraro, Politecnico di Milano: <i>Designing a Sensorized Glove for Post-Stroke Rehabilitation</i></li> <li>- Juan Jacobo Estrada, Universidad Politécnica de Madrid: <i>Monitoring of motor status in Parkinson's disease</i></li> <li>- Roundtable discussion chaired by Dr. Bonato</li> </ul>	Bristol Hall
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## Notes for Session 3:

## Thursday 25<sup>th</sup> June 2009, 16:00 – 17:30 – Bristol Hall

### Session 3 - User interaction and personal health systems

Personal health systems are constructed from a number of underlying technologies and services. In this session we focus on the components of personal health systems that provide a platform for computation, storage, acquisition and retrieval of data, and an interface to those data. This will include wearable computers and smart textiles, implants and actuators, as well as multi-modal user interfaces.

The targeted issues are: chronic diseases, continuity of care, efficacy of medical decisions and interventions, citizen empowerment for managing and controlling their health.

Chairman: Jean Luprano, CSEM

Co-chairman: Per Hasvold, NST

16:00 – 17:30	<ul style="list-style-type: none"> <li>- Elina Mattila, VTT: <i>Personal Health Systems for Health and Wellness Management</i></li> <li>- Geir Østengen, NST: <i>Diabetes digital management - while waiting for the cure</i></li> <li>- Sergio Guillen, ITACA Institute UPV: <i>Personalisation of health in Heart Failure and Coronary Artery Disease patients via closed loop systems. The Heart Cycle approach</i></li> </ul> <p>Roundtable discussion chaired by Dr. Luprano</p>	Bristol Hall
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## **Notes for seminar: The Transition from Cards to Portable Devices and Sensor Networks for Wireless Personalized Health Services**

**Friday 26<sup>th</sup> June 2009, 08:30 – 10:30 – Bristol Hall - I**

**Seminar: The Transition from Cards to Portable Devices and Sensor Networks for Wireless Personalized Health Services**

Modern healthcare in the 21st century aims at involving citizen and health professionals alike entitling especially citizens to take over responsibility for their own health status. New technologies (Internet, mobile phones, sensors, etc.) enable patients to actively participate in healthcare processes. It's not any longer just health data storage data cards; it's an ongoing personalization of health services including application of portable devices and sensors/actors stipulating the personalized health approach which offers a real chance for practicing high quality wireless personalized shared care. The workshop jointly organized by EFMI WG "Personal Portable Devices (PPD)" and ISO/IEC JTC 1 "Study Group on Sensor Networks (SGSN)" will therefore aim at identifying a set of criteria/factors determining the application of personalized portable devices, sensors, and actors in a wireless healthcare and welfare, the paradigm change from health cards to wireless health devices, and the citizen's confidence in, and acceptance of, the underlying technologies and methods. The presentations are based on experience from different national, European and international projects and standardization activities as well as existing and emerging routine implementations in the domain.

The workshop is jointly organized by EFMI Working Group Personal Portable Devices (PPD) and ISO/IEC JTC 1 "Study Group on Sensor Networks (SGSN). It aims at analyzing the topics related to portable devices, sensor networks, and the personalization of the devices and from the groups' own perspective allowing a comprehensive view on the application of sensors and devices as such.

Co-chairs: Peter Pharow, formerly eHealth Competence Center, Regensburg University Hospital and Asbjorn Hovsto, ITS Norway

Followed by a concluding and summarizing discussion with the audience, the invited speakers and their presentations are:

From chip cards to personalized portable devices and sensor networks	Peter Pharow (DE)
Intelligent chips – an adviser towards health support for the wireless patient	Pekka Ruotsalainen (FIN)
NFC – Near Field Communication mobile phones as enabler for wireless health services	Tomas Trpisovsky (CZ)
Standard for Personalized eHealth Services	Françoise Petersen (FRA)
Intelligent transport including support for sensor networks	Asbjorn Hovsto (NO)
Sensor networks for optimization of blood bag logistics in hospitals	Fritz Meier (DE)
Collaborative Information Processing in Sensor Networks	Qiang Pan (China)

## **Notes for seminar: Latest Technology Developments and Future Needs in Cancer Diagnostics**

## Friday 26<sup>th</sup> June 2009, 08:30 – 10:30 – Bristol Hall - II

### Seminar: Latest Technology Developments and Future Needs in Cancer Diagnostics

In addressing the high economic burden of the healthcare sector, prevention, early diagnosis and informed therapeutics are indispensable. Tests must be highly accurate and well integrated into medical management to avoid unnecessary treatment and stress to users. This seminar will focus on latest research in intelligent technologies for cancer diagnostics, future needs and discuss a roadmap on “how to get there”.

The seminar theme is “What are the future needs in point-of-care cancer diagnostics and how can new techniques/methodologies add value to the patient/doctor/nurse/health service?” It will elaborate on these needs and challenges by presenting state-of-art advances and projected future possibilities and needs.

Co-chairs: Prof. Calum McNeil, The Medical School, Newcastle University and Patric Salomon, 4M2C

Welcome & introduction	Prof. Calum McNeil, The Medical School, Newcastle University (UK)
A new microarray design used as a universal cancer diagnostic tool for detection of fusion genes	Dr. Rolf Skotheim, Oslo University Hospital (NO)
Microfluidic chip-based detection of cervical cancer	Dr. Liv Furuberg, SINTEF ICT (NO)
Electrochemical Sensor Arrays for Breast Cancer Monitoring	Dr Ciara K. O' Sullivan, Universitat Rovira i Virgili (ES)
"Smarter" biodiagnostic devices: Intelligent device communication and data interpretation	Stephan Kiefer, Fraunhofer-IBMT (DE)
How can point-of-care diagnostics add value to the patient/doctor/nurse/health service in cancer diagnostics	Open discussion with speakers and seminar audience, animated by Patric Salomon, 4M2C, and Henne van Heeren, Nexus Microsystems Association

The seminar session is organised by the SmarthHealth consortium in collaboration with Oslo Cancer Cluster.

## Notes for seminar: EU-US pHealth experiences

## Friday 26<sup>th</sup> June 2009, 08:30 – 10:30 – Hotel Bristol

### Seminar: EU-US pHealth experiences

The establishment of the emerging Personalized Healthcare Informatics (PHI) area looks to be driven by several factors. Some of them are Country independent. Some others highly depend from the way the specific Country organizes its healthcare system. As we know that such systems are significantly different between EU and US, we have to foresee differences in the PHI applications and overall impact between the two environments. Nevertheless, several architectural visions and practical applications may take positive inputs from the view cared on each other side of the ocean.

The workshop is jointly organized by the eHealth Lab at the Department of Bioengineering at the Politecnico di Milano, Italy and the College of Health Sciences at Old Dominion University, Norfolk VA, USA. The workshop will start by presenting the results and the recommendations collected at the EU-US PHealth Conference organized last year. Then novel PHI approaches and projects, both in EU and US, will be outlined. Finally, together with the inputs from the audience, the speakers will propose new PHI research directions and collaborations between EU-US.

Co-chairs: Francesco Pincioli, eHealth Lab - Politecnico di Milano / London City University and Andrew Balas, Old Dominion University – Norfolk, VA

Deputy Chairs: Stefano Bonacina, Politecnico di Milano and Gianluca De Leo, Old Dominion University

The invited speakers and their presentations are:

Forecasting the Impact of Personalized Health Informatics	Francesco Pincioli, Politecnico di Milano (IT)
Result and recommendations from the 2008 EU-US pHealth	Gianluca De Leo, Old Dominion University (US)
Characterizations of the Family Medical Lexicon and Some Technical Experiments	Stefano Bonacina, Politecnico di Milano (IT)
Educating Healthcare Providers to Deliver Equitable Care through Learning with Simulations	Beth Garzon, Old Dominion University (US)
Standards in the Personalized Medical Data Domains	Mauro Giacomini, Università Statale degli Studi di Genova (IT)



## Notes for Session 4:

## Friday 26<sup>th</sup> June 2009, 11:00 – 12:30 – Bristol Hall

### Session 4: Topic – Systems integration

There is a clear need to reduce the societal burden of chronic disorders and ageing. There is a need for successful deployment of innovative and integrated care services supporting healthier and independent living. Many health record suppliers of today are offering pre-Internet era software that is costly and locked to proprietary technology standards that make it difficult to change vendors. The government role should be to set the rules that allow for care services that are based on open software platforms and open standards. This would allow for innovators to write services that are well integrated into an ecosystem of systems. On the organisational and political side, the experiences from the use of such care services are quintessential to ensure uptake. Clear clinical and economical evidence need to be presented. This session will bring together an international group of experts in their fields that will highlight these topics.

Chairman: Josep Roca, Hospital Clinic Barcelona

Co-chair: Marius Mikalsen, SINTEF ICT

11:00 – 12:30	<ul style="list-style-type: none"> <li>- Dr. Josep Roca: <i>Setting the scene – the Catalanian experience</i></li> <li>- Prof. Dr. Milan Petković, Cluster Leader Information Security, Philips Research Europe: <i>Standardisation and security in personal health systems (Continua work)</i></li> <li>- Stefan Ohlsson, IBM Nordic: <i>IBM + Google – a collaboration to empower the patients and personal health records</i></li> <li>- Aase Kari Haugeto, The Norwegian Technology Advisory Board: <i>The future of senior care</i></li> </ul> <p>Roundtable discussion chaired by Dr. Roca</p>	Bristol Hall
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## Notes for Session 5:

## Friday 26<sup>th</sup> June 2009, 13:15 – 14:30 – Bristol Hall

### Session 5: Topic – From research to innovation to implementation

Marked analysis, opportunities for innovation, EU and other funding opportunities, future trends, emerging markets

Chairman: Andreas Lymberis, European Commission

13:15 – 14:30	<ul style="list-style-type: none"> <li>- Andreas Lymberis: <i>Microsystems and pHealth: Relevant activities under EC-ICT program and forthcoming call for proposals</i></li> <li>- Sverre Flateby, Forefront Innovation: <i>Why is real implementation and adoption of innovative product and solutions in healthcare so hard</i></li> </ul>	Bristol Hall
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## **In-vivo session Abstracts**

### **Bioimpedance based sensors**

Ørjan G. Martinsen, University of Oslo, Norway

Bioimpedance deals with the passive electrical properties of biomaterials. These properties change with virtually any changes in the physiology or anatomy of the studied tissue. Hence, bioimpedance can be used as a transducer mechanism for a wide range of physiological parameters. A basic introduction and two examples will be presented. The examples are from needle positioning for blood vessel detection during emergency cardiopulmonary bypass and from measurement of sweat activity.

### **New Frontiers in Capsule Endoscopy: Active Locomotion and Wireless Therapeutic Intervention**

Schurr, M. O.; MenciAssi, A.; Dario, P.

Capsule Endoscopy has become a clinical reality since a number of years for the inspection of the small bowel. It has revolutionized the way small-bowel disease is diagnosed. Given its little impact on patient comfort and the missing pain associated with the examination “capsule endoscopy” can also be of great value in the upper and lower GI tract. For that purpose, however, capsule endoscopes have to provide a similar diagnostic quality as conventional endoscopic procedures. The two biggest limitations of today’s capsule endoscopes are the missing capability of active locomotion inside the organ and of missing therapeutic options.

The VECTOR Project, funded by the European Union in FP6, is aiming at overcoming these limitations by the developing actively driven diagnostic and therapeutic capsule endoscopes. The VECTOR Project Consortium has developed a number of different locomotion options such as on-board-locomotion actuators (eg. legs) and external magnetic forces to be used for moving capsules inside the GI tract. These technologies are currently at a prototype level and are assessed in ex-vivo and in-vivo experiments. The first preliminary results show that active propulsion and positioning of capsules can be achieved in all sectors of GI tract including the esophagus, the stomach, the small and large bowel. The clinical focus of VECTOR is on developing painless endoscopic procedures that enhance screening and early diagnosis for the prevention of gastrointestinal cancers.

A further hallmark of the VECTOR Project is actuators and devices for therapeutic interaction with pathologies. This includes the release of endoscopic clips or taking biopsies with wireless capsules. The ability to deliver an effective haemeostatic clip to a desired location inside the GI tract has been shown on an experimental basis.

## **Keynote session Abstracts**

### **Empowering Citizens through pHealth – the EU Agenda**

R. Giampieretti, European Commission, Information Society and Media Directorate-General, ICT for Health Unit

In an ageing Europe, where more and more citizens live with chronic diseases, telemedicine can help to make the difference in facing the global challenge posed to health systems by an increasingly heavy burden of demand for service. The European

Commission (EC) realises this potential and intends to exercise leadership in fostering the deployment of telemedicine applications on a large scale. Acting in the structured framework of several policy initiatives started in 2004 with the eHealth Action Plan (COM 356), the EC has recently addressed in its Communication on Telemedicine (2008, COM 689) the main barriers that need to be overcome in order to facilitate greater deployment, highlighting three key issues: 1) increasing confidence and acceptance of telemedicine services; 2) gaining legal clarity; 3) overcoming unsolved technical issues and supporting market development. This speech focuses on Personal Health Systems (PHS) and Remote Patient Monitoring (RPM) as novel methods ("pHealth") for increasing the effectiveness of chronic disease management while using scarce human resources to maximum effect. The Community agenda on the subject is presented, with a special focus on the upcoming large scale pilot on telemedicine, which is expected to build up the largest multi-centre clinical trial ever deployed in Europe to provide high-profile scientific evidence of the impact of adopting pHealth on a large scale.

\* The views presented are those of the authors and do not necessarily represent the official view of the European Commission on the subject.

## Personal Health Systems 2020 roadmap

Cristiano Codagnone, Department of Social and Political Studies, Milan State University

This keynote presents the main findings of the project PHS 2020, a roadmapping of future research themes in the field of ICT supported Personal Health Systems (PHS). The project was realized through the organization of 10 consultation events involving stakeholders and experts from across Europe. The article, after providing a consensual definition of PHS supporting the vision of its future development, illustrates the current state of the art, identifies the key gaps and proposes five research roadmaps with themes needing further efforts and funding to fill the identified gaps. The broad areas of further research proposed include: a) research to make PHS informed by biomedical knowledge and practice suggesting their convergence with other fields such as Biomedical Informatics and Virtual Physiological Human; b) research to increase the intelligence embedded into PHS data processing to support truly personalized and individualized services, going beyond monitoring and making possible diagnosis, treatment, prevention; c) research to develop of third generation PHS sensors with improved self-calibration, on board processing, actuation capabilities, less invasive and more energy efficient; d) research to achieve more inclusive and user friendly interfaces and interaction channels; e) research on Lab on Chip to advance Point of Care diagnostic capabilities.

## Digital Soldiers: Transforming Personalized Health in Challenging and Changing Environments

COL Karl Friedl, TATRC, USA

This talk provides a perspective of how one military organization (TATRC) predicts, reacts, and responds to challenging and changing needs of the military for advancing personalized health for both military and civilian benefits. Specifically, it will highlight:

- both the need and advances for creating personalized health (to include EMR, WPSM, PIC, longitudinal studies, etc) for deployment record, OCONUS, and CONUS operations - a continuum of cost effective and efficient care through advances in personalized health as a response to changing environment as one impetus;

- how TATRC accomplishes advances in medical technology research in personalized health to give new opportunities in health care from both military and to civilian markets through examples of programs (e.g. implantable sensors, home monitoring for rehab, VR for rehab, neural controlled prosthesis, biocomputational modeling, etc) and its potential impact to both military and civilian populations; and
- how TATRC directed research contributes to "face the future needs" through couple of case studies illustrating the importance of predicting and recognizing both the needs and opportunities, in particular civilian benefits to be derived from overcoming the implementation challenges in military environments (i.e. from austere environment to stricter security issues will lead to novel advances in communication/sensor technologies as well as in policy development that will have a positive impact on civilian personal healthcare).

Some of the main challenges and obstacles that "make or break" with the new advances are discussed through these examples and case scenarios.

## Session 1 Abstracts

### Next-generation Diagnostic Platforms through Integration of Convergent Sciences and Technologies

Brian D. MacCraith, Biomedical Diagnostics Institute, Dublin City University, Ireland

The future of healthcare in both the developed and developing world will be altered dramatically by the advent of innovative diagnostic devices targeting the early detection of disease. In the developed world, these devices will lead to a healthcare approach which is more personalised, predictive and preventative, thereby leading to a better quality of life and greater life expectancy. Similarly, the deployment of such devices, appropriate to low-resource environments, in the developing world could yield dramatic benefits in the efforts to deal with rampant diseases such as HIV/AIDS, malaria and tuberculosis.

These devices will draw on remarkable recent developments in a range of sciences and technologies, such as nanotechnology, microfluidics (lab-on-a-chip), photonics, genomics and proteomics. Many of the new devices will also incorporate communication technologies (e.g. mobile phones, bluetooth) to enable the provision of expert medical monitoring remotely from the patient. The integration of these disparate developments into working platforms represents a key scientific challenge in itself. The availability of innovative, inexpensive diagnostic devices and health-monitoring systems will allow for life-threatening events to be detected long before a critical stage is reached, and enable chronic diseases to be controlled more effectively in the home and elsewhere. Patients will also be empowered to take control over the management of their own health and to remain in their own homes (especially important for the ageing population), thereby improving the quality of life for many, reducing hospital stays and saving lives.

The Biomedical Diagnostics Institute (BDI) is focussed on the development of such devices. The BDI is an academic-industrial-clinical partnership that operates at the interface of many sciences and technologies. We are developing a range of diagnostic platforms that are informed by the vision of our clinical and industrial partners.

This presentation will highlight trends in Point-of-Care diagnostics and will be illustrated by examples of developments at the BDI.

## **The new personalised medicine: low cost sensors, robust analytics, ubiquitous computing**

Clifford C. Dacso, MD, MPH, MBA, Abramson Center for the Future of Health

Patient-based decision making is the newest opportunity granted by the ubiquity of information. Using low cost sensors, communications technology, and decision analytics, patients (and people trying to avoid being patients) are able to access real-time information about their personal physiology and homeostatic mechanisms and convert that into meaningful decisions with measurable outcomes. Chronic diseases are particularly vulnerable to this sort of management, fragments of which have been unequivocally proven in the past. Biosensors for home and distributed health venues require innovation in algorithms, power management, communications, and signal processing.

## **In vitro diagnostic platforms of the future, technological possibilities and challenges**

Stig Morten Borch and Liv Furuberg, Microsystems and Nanotechnology, SINTEF ICT, Oslo, Norway

Point of care in vitro diagnostic (PoC IVD) tests are becoming more and more important tools both for placing early and correct diagnosis and for decentralized monitoring of chronic diseases. PoC IVD platforms as available today do have various limitations linked to reliability, accuracy, sensitivity, robustness, compactness, speed, the panel of parameters available, cost or ease of use. The use of new concepts of controlled microfluidics combined with advanced chemistries, detection principles and compact instrumentation do open new possibilities in improving all these features considerably.

Lab-on-a-chip formats include closed disposable microfluidic devices holding all reagents and elements necessary for analyzing a sample for one or multiple parameters at the time. These small devices may within a few minutes be automatically operated by compact instruments allowing processing of both the sample and subsequent advanced quantitative bioanalytical assays. Microfluidics implies that very small volumes of both samples and reagents may be used, but still allowing high analytical accuracy and reliability.

Typically, in SINTEF's Lab-on-a-chip prototype platform, a defined volume (0.4 to 1  $\mu\text{L}$ ) of plasma is isolated from 10  $\mu\text{L}$  (finger prick) of whole blood within 30 seconds and then the exactly metered plasma fractions are allowed to be further processed in advanced assays, all within the same chip. The reagents need to be stored as stable formulations (liquid and / or dry) at defined locations within the chip. This requires unique knowledge as to reagent formulation, device design and materials used. In order to design very fast immunometric assays the analytes should be forced to interact with an excess of capturing antibodies immobilized on defined surfaces. Further, for multianalyte platforms the detection systems need both to be accurate and to cover wide sensitivity ranges. SINTEF is a leading player within Lab-on-a-chip and MEMS design as well as in combining these technologies with advanced surface chemistries, detection systems, smart instrument design and communication systems. Through the microBUILDER consortium a network of manufacturing partners for such platforms is established. Key challenges and some possibilities within designing complete Lab-on-a-chip platforms for the future will be presented.

## **pHealthLab, a need for effective pHealthCare!**

Lars Olof Artur Hansson, Karolinska Institution, Stockholm, Sweden



The focus in the presentation will be on routine lab logistics: from request to response on lab results, pre-analytical factors, where and by whom shall lab-test be done, is there an unmet need for POCT and pHealthLab tests, why easier in Sweden to decentralize Lab-tests: No reimbursement system; Certified lab-staff in primary health care labs, which lab-tests? Acute diseases; Chronic diseases; Health care and future risk reduction, Demands on POCT and pHealthLab tests.

## Session 2 Abstracts

### System Architecture of Wireless Body Sensor Networks

Dr. Emil Jovanov, The University of Alabama in Huntsville, U.S.A.

Wireless Body Sensor Networks (WBSNs) emerged as a design solution of choice for a number of wearable and ubiquitous monitoring applications. Although useful as stand alone monitoring systems, full potential of WBSNs might be explored by integrating individual on-body systems into hierarchical real-time systems to support unobtrusive ubiquitous applications with intermittent communication. However, resource constraints of the lowest levels of the system architecture demand careful system design and specific trade offs in the WBSN design space. Typical issues include proper design of the wireless communication system, buffering, and real-time latency. These issues are application dependent and critically influence system performance and user acceptance. This paper presents system architecture of the hierarchical wireless body sensor networks and design issues in the WBSN design space.

### Designing a Sensorized Glove for Post-Stroke Rehabilitation

Venere Ferraro, Maria Pacelli, Marita Canina, Rita Paradiso, Danilo De Rossi, Paolo Bonato

Every year more than 700,000 individuals suffer a stroke in the US alone. Approximately 60% of the individuals who survive a stroke are left with long-term impairment of the arm, which causes significant functional limitations and has a profound impact on the ability of individuals to perform activities of daily living such as eating, grooming, and dressing. The rehabilitation of stroke survivors is largely focused on recovering the ability of performing upper extremity motor tasks. The recovery of hand functions is of paramount importance. Recent research has shown that significant motor gains can be achieved via repetition of movements such as reaching, grasping, and manipulating objects. Motivated by the above-summarized considerations, a number of researchers and clinicians have turned their attention to robotics as a means to achieve a large number of repetitions of movements relevant to rehabilitation. In previous work, we reported results from a sensorized glove designed to track movements of the hand in subjects with intact hand functions. In this paper, we present our work toward redesigning such sensorized glove to make it fully suitable for implementing rehabilitation protocols in individuals post stroke. We combined the glove technology with a robotic system (Armeo, Hocoma AG) for upper extremity rehabilitation. Patients post stroke were interviewed to gather data concerning usability of the original design of the glove and improve its wearability. Major problems were identified in donning and doffing the glove. Furthermore, patients reported altered sensation and excessive perspiration when wearing the glove. On the basis of these considerations, we modified the design of the glove to improve comfort and wearability. We removed the fabric on the palmar side of the hand, added clip components around the digits to avoid migration of the glove and redesigned the mask utilized to print the sensing elements (made using a conductive elastomer) on the dorsal side of the glove. The design of the new mask aims at reducing the number of sensors and tracks and detecting the movements relevant to rehabilitation with the minimal mechanical discomfort. In view of a mass production a serigraphic industrial process was used to print the sensors. To increase thermal comfort textile substrates with different weight and fiber compositions were selected and tested. Preliminary results suggest that the design approach we adopted improves the usability of the glove and provides good tracking of hand movements.

## **A soPhisticatEd multi-paRametric system FOR the continuous effective assessment and Monitoring of motor status in Parkinson's disease and other neurodegenerative diseases**

Arredondo MT, Baga D, Chaloglou D, Estrada JJ, Fotiadis D, Garcia-Robledo M, Greenlaw R, Konitsiotis S, Maziewski, Pansera M, P, Pastor MA.

PERFORM aims to provide an innovative and reliable tool that is able to monitor and evaluate motor neurodegenerative disease patients, advice their doctors and caregivers, and overall ease the patients' management process. Parkinson's disease, mainly, and Amyotrophic Lateral Sclerosis will be the model diseases. PERFORM will implement a multi-sensor wearable system and a testing kit to obtain the data and it will keep track of the medication and meal times and compositions. Symptoms, medication and meal intakes will be considered by a decision support system that intends to provide: 1) a proposal of medication schedules to the clinician (aimed at slowing wear-offs) 2) a UPDRS based assessment of whether the condition of the patient is stable or worsening and 3) sets of both rules (new medical knowledge) and population/demographic correlations. A demo can currently be provided on acquiring and transmitting signals with our own system, detecting falls and trunk inclination, assessing the severity of the cardinal symptoms and LID, recognizing basic activities, modelling the symptoms in a patient personalized profile and obtaining medical rules through existing medical databases to generate the knowledge PERFORM requires to accomplish its ultimate objectives.

## **Session 3 Abstracts**

### **Personal Health Systems for Health and Wellness Management**

Elina Mattila, VTT

The health risks and chronic conditions today are largely the result of suboptimal behaviour and lifestyles, such as physical inactivity, excess energy intake, and stress. The risk factors cluster and interact in individuals, and thus need to be managed together.

Behavioural change towards healthy lifestyles is the key to managing health and chronic illnesses. However, changing behaviours permanently is a difficult and long-term process, requiring practice and long-term support, which cannot be provided through the current healthcare system.

Personal Health Systems (PHS), including Web, mobile and monitoring technologies, offer cost-efficient and personalized tools for personal long-term health management. They can be used independently or as a part of a health promotion intervention or chronic disease management program. We have developed and tested a multifactor PHS approach in occupational health promotion and management of psychophysiological wellbeing. Our findings outline the success factors and user requirements for future PHS.

### **Diabetes digital management - while waiting for the cure**

Geir Østengen, NST

"Medical miracles do not happen simply by accident," said President Obama, as he signed an executive order lifting the ban on federally funded embryonic stem cell research. This is celebrated in the diabetes world, because it is the general opinion that this is where the cure for Diabetes will come from. Difficult, controversial, long-term

scientific struggle while Diabetes have an epidemic grow. The cure will arrive but it may easily take another ten to fifteen years. Today 246 million People worldwide have diabetes, The World Health Organization (WHO) fear that we during that time will have near twice as many with Diabetes, 330 millions in 2025. That is an epidemic increase that will have astronomic costs and enormous suffering.

These facts are starting to get noticed in the political environment, in the health society and by the man in the street. The people that get the disease are now more and more inspired to take it seriously. But that is not an easy task. It's a difficult task at times for anyone and a too heavy burden for some. The Norwegian Centre for Integrated care and Telemedicine have developed unique mobile everyday tools that may have the potential to make the diabetes challenge easier to cope with for many people. This session will present you for some of the research results and development NST has done in this area of personalized self-help systems. The goal is to trigger the patient's curiosity about personal reactions to food, to physical activity and learn more while living well with diabetes, thus motivating a healthier lifestyle, and/or improving self management of their disease. The developed systems illustrate the importance of keeping the patient or user in the loop, as diabetes regulation is very much about knowledge.

## Session 4 Abstracts

### IBM + Google - a collaboration to empower the patients and personal health records

Stefan Ohlsson, IBM Nordic

The presentation will describe the collaboration with Google and the Continua Health Alliance where we have introduced new software, advancing the use and value of Personal Health Record (PHR) technology. IBM developed the software based on guidelines from Continua Health Alliance, a globally recognized organization dedicated to the production of interoperable healthcare products and solutions. The solution is based in part on key open-source software available now from Eclipse and Open Health Tools, which are open-source communities dedicated to supporting advancements in Healthcare.

## Poster session Abstracts

### P01, Surface modification and fabrication technology for lab-on-a-chip devices in polymer materials

Per M. Stenstad, T.Tofteberg and E.Andreassen SINTEF Materials and Chemistry

Some of SINTEF's chemistry- and polymer-related competence will be presented, focusing on technology enabling the development of new devices. Two different aspects of surface modification will be addressed: 1) Surface modification of polymer surfaces to prevent non-specific binding of proteins to channel walls. This can e.g. be implemented by plasma treatment and silanisation, or by photoinduced grafting. 2) Introduction of receptor molecules (e.g. antibodies or other binding proteins, DNA single chain) to sensor surfaces. These molecules will specifically capture the actual analyte molecules from the solution. Regarding fabrication technology, the poster will address the injection moulding process for making chips in polymer materials. Chips with intricate microfluidics structures (channels, mixers etc) can be mass-produced in a cost-effective way with this process. Polymer materials have a number of favourable properties for such applications. Note that polymers are a large and versatile group of materials, which

is in continuous development. Hence, selecting the right polymer type and grade is important.

### **P02, Novel Osmotic Sensor for a Continuous Implantable Blood-Sugar Reader**

Olga Krushinitskaya<sup>1</sup>, Philipp Häfliger<sup>2</sup>, Tormod Vinsand<sup>1</sup>, Tor Inge Tønnessen<sup>3</sup>, Henrik Jakobsen<sup>1</sup> and Erik Johannessen<sup>4</sup>

<sup>1</sup> Institute for Microsystems Technology, Vestfold University College

<sup>2</sup> Department of Informatics, University of Oslo

<sup>3</sup> Rikshospitalet, University of Oslo

<sup>4</sup> Lifecare AS

Current research within the field of diabetes focus on improving existing measurement methods, insulin formulations and transplantation of insulin producing cells and tissues. This project focus on the development of a new revolutionary blood glucose sensor based on detecting osmotic pressure as a function of glucose inside the body (in vivo). The sensor incorporates a nanoporous membrane with selectivity at the molecular level, and the unit will permit insertion under the skin by injection, offering lifetimes of up to 2 years. Work focusing on the interaction between different molecular components in blood and osmotic pressure is presented as well as the development of a novel biochemical assay seeking to identify glucose from other constituents in blood.

### **P03, Biocompatibility and in vivo sensors**

Ingelin Clausen, Andreas Vogl, Trine M. Seeberg, Codin Gheroghe, Frøydis Oldervoll, SINTEF ICT, Ola Sveen, Ellaheh Barzegar, Dep. of Physics, University of Oslo

Small-sized, lightweight, and less power-consuming Micro Electro Mechanical Systems (MEMS) are attractive as sensors for continuous monitoring of physiological parameters in the human body. Such in vivo sensors are now being used during surgery or for a short period after surgery. For permanent or long-term implantation in the human body, however, biocompatibility, i.e. the body's reaction to the implanted sensor as well as the sensor's reaction to the body, is one major obstacle for the success. Corrosion as well as the accumulation of proteins, cells and other biological material on the sensor surface may alter the sensor characteristics and at worst cause the sensor to fail. In this project we focus on how these mechanisms influence the sensor characteristics and stability. Can we control or predict the changes on sensor behavior caused by the biological response? Can we reduce unwanted accumulation of proteins/cells by coating the sensor surface by protective films? How will these films affect the sensor sensitivity? During the project period in vitro as well as in vivo tests in fishes will be carried out. The results from the first in vitro laboratory tests on coated sensors will be presented.

### **P04, Signal quality of wearable sensors, methods for comparing recordings from a wireless ECG sensor to established clinical standards**

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Wireless sensor systems and new fabric sensors will be able to record ECG signals for diagnostic purposes. However, the recordings may not be comparable to a standard Lead I recording because the location of electrodes at the chest can be in different positions. In a clinical study, a novel wireless electrocardiogram (ECG) recorder has been evaluated with regard to its ability to perform arrhythmia diagnostics. It has been necessary to compare those signals to "standard" ECG recording signals in order to

evaluate the arrhythmia detection performance of the new system. Simultaneous recording of ECG signals from both the new wireless ECG recorder and a conventional Holter recorder were evaluated with regard to signal quality for performing arrhythmia diagnosis, defined by two independent cardiology specialists as a “golden standard”. In addition calculated R-R intervals from the two systems were correlated. A total number of 16 patients have participated in the study during their arrhythmia investigation. It has been necessary to develop a reliable method for comparing the ECG recordings from the two different types of equipment, and the clinical experience shows that this method probably can be used as a general method for wearable ECG recording sensors.

### **P05, A new real-time fall detection approach using fuzzy logic and a neural network**

Christoph Dinh, Matthias Struck, Institute of Biomedical Engineering and Informatics, Ilmenau University of Technology

A real-time fall detection system monitors the daily activity of especially elderly people to enlist someone's help as fast as possible in case of emergency. This paper presents a new real-time fall detection algorithm using a single commercial accelerometer. After transforming the acceleration data from Cartesian coordinates to spherical coordinates, the main part of the algorithm is based on a fuzzy logic inference system and a neural network. These methods allow both the integration of specific expert knowledge about typical falls as well as generalization ability. In order to compare the achieved performance of the method to those of literature, four fall scenarios (forward, backward, sideward and collapse) were performed and evaluated in a laboratory trial with, in the first instance, five test subjects. The average sensitivity of those four fall scenarios reached 94% and the false positive rate was about 0.35%. These results show that one single accelerometer is completely sufficient to implement a reliable fall detection system and, furthermore, that knowledge based methods are a suitable alternative to standard pattern recognition methods.

### **P06, Monitoring and therapy of sleep-related breathing disorders**

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<sup>2</sup> Sense Inside GmbH im Innovationszentrum Medizinische Elektronik

The problem of snoring increases as a result of an older and more overweight population. This project aims at helping those who are troubled by snoring or mild to moderate obstructive sleep apnea (OSA) by offering a long-term miniaturized monitoring system in combination with biofeedback therapy for use at home. By using a miniaturized sensor system in a removable head band (i.e. fixed to the skull), head position, snoring, breathing frequency and heart rate was successfully recorded. The sensor system is small enough to be built into implants, which allow innovative new ways of home monitoring with minimum annoyance to the snorer. For example, it can be used to evaluate the compliance and efficacy of therapy methods over a longer period of time. A biofeedback signal was implemented in the head band in order to perform positional therapy, since many snorers have the problem only in the supine position. The first trials has shown promising results and further studies will be conducted to verify the effect.

### **P07, Wireless Gait Monitoring System Using Zigbee**

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Physical activity assessment has an important role in determining both physical and mental health. There have been several techniques to measure physical activity such as direct observations, subjective reports, metabolic measurements and portable physical activity monitors. In order to monitor human's activity objectively without consciousness of a subject, a portable activity monitor was designed and developed using a Zigbee protocol in this study. The system consists of a three-dimensional accelerometer and CC2431 which is a System-On-Chip (SOC) including a Zigbee module and microprocessor. It was integrated into a shoe and measured three dimensional acceleration of the foot. The data were transferred to a personal computer in real-time via a receiver system which also consists of CC2431. Heel contact and toe-off event were detected automatically, and stance and swing phases were discriminated. The proposed system provided a gait signal steadily in the indoor environment. This result shows a promise to continuously assess gait characteristics or disturbance without subject's consciousness.

### **P08, Advanced Systems and Methods of Unconstrained Blood Pressure Monitoring for Personal Healthcare**

Hyun Jae Baek, Jung Soo Kim, Ko Keun Kim and Kwang Suk Park, Seoul National University, Republic of Korea

Blood pressure is one of the vital signs that reflects autonomous activities as well as cardiovascular abnormalities and should be monitored for personal healthcare. In this paper, systems and methods for unconstrained BP monitoring with pulse arrival time (PAT) and two confounding factors were introduced for long-term, everyday BP monitoring. For this, electrocardiogram (ECG) and photoplethysmogram (PPG) sensors were installed in everyday equipments and their signal was non-intrusively obtained in computer desk environment as well as toilet seat and steering wheel in the car. Unconstrainedly measured PAT and systolic BP showed significant correlation and systolic BP was successfully estimated using single linear regression analysis. Additionally, multiple regression analysis with PAT and two confounding factors that include information about heart cycle and arterial stiffness enhanced not only systolic BP but also diastolic BP estimation ability. This study shows the feasibility of using the presented ECG and PPG measurement and signal processing methods for unconstrained BP monitoring in the personalized healthcare.

### **P09, Multiclass SVM Application for Parkinsonian Gait Recognition using Wearable Plantar Pressure System**

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In this paper, we investigated the application of multi class Support Vector Machine (SVM) to the classification of normal and two groups of pathological gait – mild and moderate – in Parkinson's disease (PD) according to UPDRS gait score. We obtained plantar pressure data from 15 healthy elderly and 21 Parkinson's disease patients. Foot pressure was recorded during their comfortable walking and then we extracted three features – peak pressure, pressure time integral and instant time of peak pressure – at ten anatomical area of right foot. To classify normal, mild and moderate gait, we constructed three SVM classifiers. The classification task in three SVM was conducted

by means of a RBF kernel using ten-fold cross validation. As a consequence, we achieved about 98% accuracy on test set. This result demonstrates that the multi class SVM could effectively identify normal, mild and moderate gait in PD and have potential clinical applications.

### **P10, Portable intensity guidance system for fitness training**

Mia Folke, School of Innovation, Design and Engineering, Mälardalen University

Daily moderate activity reduces markedly the population diseases. Although a lot of persons do not perform regular physical activity. Many persons are quitting because they exercise at a too low intensity that does not give result or at a too heavy intensity that is not comfortable. By exercising at an established adequate workload, optimal for the individual, the person can see result of the training and the quitting behavior can be changed. In sport at top level lactate threshold is used as guideline for adequate workload and to see changes in fitness. The lactate threshold is generally established by blood tests. The aim of this project has been to evaluate a new method and a low cost sensor system, LACTA, which can identify the lactate threshold by analysing the amount of Carbon dioxide in respiratory air. LACTA is based on an electro acoustic sensor and needs no calibration by the user. The threshold found using LACTA correlates to the threshold established by blood analyses. LACTA is easy to use and each person can perform the test without help. The aim of the present study is to evaluate a new LACTA prototype without humidity and temperature diluting filter.

### **P11, Diagnosis and biofeedback system for stress**

Shahina Begum, Mobyen Uddin Ahmed, Peter Funk, Ning Xiong, Bo von Schéele, Maria Lindén, Mia Folke, School of Innovation, Design and Engineering, Mälardalen University

Today, everyday life for many people contain many situations that may trigger stress or result in an individual living on an increased stress level under long time. High level of stress may cause serious health problems. It is known that respiratory rate is an important factor and can be used in diagnosis and biofeedback training, but available measurement of respiratory rate are not especially suitable for home and office use. The aim of this project is to develop a portable sensor system that can measure the stress level, during everyday situations e.g. at home and in work environment and can help the person to change the behavior and decrease the stress level. The sensor explored is a finger temperature sensor. Clinical studies show that finger temperature, in general, decreases with stress; however this change pattern shows large individual variations. Diagnosing stress level from the finger temperature is difficult even for clinical experts. Therefore a computer-based stress diagnosis system is important. In this system, case-based reasoning and fuzzy logic have been applied to assists in stress diagnosis and biofeedback treatment utilizing the finger temperature sensor signal. An evaluation of the system with an expert in stress diagnosis shows promising result.

### **P12, Designing new scenarios of wearables through biodesign methods**

Marita Canina, Venere Ferraro, Politecnico di Milano, Facoltà di Design, Italy

The relation between the human body and new technologies (micro and nano) is continually changing. It is essential to emphasize the need to develop an interdisciplinary approach among the different areas, and to figure out their point of contact and their interest in the human being as a unique entity. The design should drive these changes. In spite of the large number of projects, the consideration of industrial design in such research areas is absent. The contribution of industrial design, in order to be innovative, will have to develop an instrument that is able to support and guide the design process to structure and analyze several intervention levels. Through microtechnologies, it is possible project new devices around the human body, wearable.



This paper highlights a new methodological approach for the estimation and satisfaction of wearability criteria (ability to wear) developed at the Biodesign Lab at Politecnico of Milano. In this paper, biodesign methods will be defined through the BABYmotion project, a research project developed in cooperation with Politecnico of Milan and the Paediatrics Dept. University Hospital. The BABYmotion project, a Newborn Motion Dysfunction Evaluation System, is a device for early comparative diagnosis of neurological disease in children affected by critical or pathological birth conditions.

### **P13, VPH2 concept**

Dimitris Gatsios, Evanthia Tripoliti, Theodora Chrisanthakopoulou, Computer Technology Institute (CTI), Greece

Virtual Pathological Heart of the Virtual Physiological Human or VPH2 project (EU funded, under ICT programme – FP7) aims to develop a patient-specific computational modelling and simulation of the human heart to assist the cardiologist and the cardiac surgeon in defining the severity and extent of disease in patients with post-ischemic Left Ventricular Dysfunction (LVD), with or without ischemic mitral regurgitation (IMR). Specific computational methods developed during the project will allow clinical decision making (based on data mining methodologies) and planning of the optimal treatment for left ventricle-valve repair (based on data coming from cardiac MRI processing, which is constantly gaining experts attention, and specific predictive models of left ventricle and mitral valve). The main technological aim of the project is to deliver an advanced software application framework for the development of computer-aided medicine in cardiology and cardiac surgery going beyond current state of the art. The poster will present VPH2 overall concept.

### **P14, An Open, Ubiquitous and Adaptive Chronic Disease Management Platform**

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Among the initiatives aiming to improve the health status monitoring technologies, the European Commission promotes CHRONIOUS, a 42 months project, started on February 1st 2008, which involves 19 partners from several countries. The CHRONIOUS project works on an innovative system with intelligent sensors and decision support system for patients and healthcare professionals in the area of chronic diseases. The CHRONIOUS system will monitor patients' vital body parameters, context and environmental variables and patient motion and other activities such as drug intake and dietary habits. The system will assist health care experts and patients by providing tools for health status monitoring and decision support. This paper presents a description of the goal of the project and its background the system architecture and a first prototype with preliminary results and the expected impact.

### **P15, Sensor Networks for Personalized Mobile Health Service Provision**

Peter Pharow, eHCC Regensburg

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Tomas Trpisovsky, Institut mikroelektronických aplikací (IMA) s.r.o., Czech Republic

Françoise Petersen, Apica / ETSI Sophia-Antipolis, France

Asbjørn Hovsto, ITS Norway

Fritz Meier, Zentrum für intelligente Objekte, Fraunhofer IIS-ATL, Germany

Qiang Panok, Shanghai Institute of Microsystems and Information Technology, China

Modern 21st century healthcare aims at involving citizen and health professionals entitling citizens to take over more responsibility for their own health status. Mainly new technologies (Internet, mobile phones, sensors, networks,) enable citizens to become active partners in healthcare processes. It's no longer just tokens like health data cards; it is ongoing personalization of mobile health services including the application of portable devices and sensors/actuators stipulating a personalized health approach offering real chances for providing/practicing high quality wireless personalized shared care. Solutions like investigating holes and flow-stops, localization of bottle necks in oil pipelines could be transferred into the field of medical investigations inside humans finding blood-stop in vessels. It's far from being just science fiction; it's becoming reality. Current developments therefore aim at identifying criteria/factors determining the application of personalized portable devices and sensors/actuators in a wireless healthcare, the paradigm change from plastic cards to wireless health devices, and the citizen's confidence in, and acceptance of, underlying technologies. EFMI WG "Personalized Portable Devices (PPD)" and ISO/IEC JTC 1 "Study Group on Sensor Networks (SGSN)" are actively supporting and jointly promoting this paradigm change towards sensor-based personalized portable and mobile health service provision.

#### **P16, RareICT – digital resources for collaborative knowledge construction supporting self-care**

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As health care migrates from organized care settings, e.g., hospitals, care-centers or doctor's offices, to the home dwelling, requirements for timely access to health related knowledge and experiences of daily living surface. In this picture, social software and Web 2.0 technology provide interesting opportunities for creation, collection and accumulation of information and knowledge to support self-care and activities of daily living. We are involved in development of a web-based resource RareICT. The aim is to provide new approaches to collect and accumulate experiences and knowledge for everyday living. With new, networked opportunities RareICT complements and augments traditional approaches to patient learning, support group participation and peer work. As community members different stakeholders, e.g., patients, family and health providers, can contribute and accumulate knowledge and experiences in new patterns of interactions. RareICT will be available to users in the secure environment provided by MinJournal.no. In the poster we will focus on co-design experiences from a series of participatory design workshops with stakeholders in the agile approach to design of RareICT. Acronym "ICT based information and communication resources for patients, their families, and health care providers dealing with rare disorders"

#### **P17, Autonomic Computing Systems Acting as Patient Self-Management Support in Early and Quick Medical Assistance**

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Designing personalized health care programs based on information from people's wearable sensors and daily use devices and integrating health monitoring systems in people activity is a way to obtain health status everywhere people moves. Modern

medicine can obtain benefits of such information using the user's health information profile to offering support to people, for example in early assistance, a quick response when symptomatic diseases are detected by local and remote monitoring analysis and also in the support for monitoring progress of diseases as well as intervention and therapeutic post intervention procedures. This complete personalized medical support and assistance scenario demands in one hand computing applications to locally process information and in the other hand computing systems (information and communications – ICT's) able to react in real-time to variations in the remotely information being collected about patient's health levels. This article presents research and technological efforts under the framework of personalized health systems serving society. This research is being conducted into the HEA Future Communications project. The main objective in this research project track is investigate both the pHealth systems requirements providing end-user applications and the necessary ICT support to interconnect in secure and reliable form device-based health care applications with distributed information data systems. An advantage arising when using the proposed pHealth system is to assist medical professionals with historical health status about patients and then as result patients can receive more accurate and earliest possible medical assistance before diseases are apparent. Collaborative and interdisciplinary research activities between members of the project consortium are conducted to provide this technological ICT support.

### **P18, Portable sensor system for rehabilitation of WAD patients**

Christer Gerdman<sup>1</sup>, Mia Folke<sup>1</sup>, Catharina Bexander<sup>2</sup>, Anita Brodd<sup>3</sup>, Maria Lindén<sup>1</sup>

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Whiplash Associated Disorders (WAD) are several remaining symptoms after an acceleration-/deceleration injury of the neck, often due to a road accident. Common symptoms are neck pain, headache, stiffness, loss of sensation, memory impairment and concentration difficulties. The whiplash-related injuries were estimated to cost Sweden more than SEK 4 billion 2005, the main part of these costs takes the form of compensation for loss of income, as a result of incapacity for work. The aim of this project has been to develop a training and rehabilitation system for patients suffering from WAD. The portable system is based on a 2-axis gyroscopic sensor with a computer interface. The sensor system is placed on the head of the patient and movements of the head are mirrored on the computer screen. The patient is supposed to follow a visible track on the screen. This enables interactive training facilities for patients, who can use the system unsupervised in their home environment.

### **P19, Web Technologies for personalized health services, MyHealthService towards the Web 2.0**

Luis Fernandez Luque<sup>1</sup>, Lars K. Vognild<sup>1</sup>, Tatjana M. Burkow<sup>2</sup>, Elin Johnsen<sup>2</sup>, Salvador Romero<sup>1</sup>, Juan M. Cruz Dominguez<sup>1</sup>, Trine Krogstad<sup>2</sup>, Astrid Bratvold<sup>2</sup>, Marijke J. Risberg<sup>2</sup>, Eva Henriksen<sup>2</sup>, Salvador J. Romero Castellano<sup>1</sup>, Borja A. Drake<sup>1</sup>, and Anders Baardsgaard<sup>3</sup>

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This poster will present how the usage of web technologies has been the core enabling factor for making flexible integrated solution for personalized e-Health services. In the project MyHealthService of the Tromsø Telemedicine Laboratory we used Web 1.0 technology for building and to field-trial an integrated solution for home-based

rehabilitation and education for chronically ill patients. The Web 1.0 components we used were videoplayer, videoconferencing, web servers and browser, application servers and several open source libraries. Currently we are experimenting with incorporating Web 2.0 technologies in our approaches for new personalized health services. We are investigating the use of Virtual Worlds combined with wireless sensors for physical rehabilitation and patient education, we exploit personalization based on the analysis of the Patient's social network and Personal Health Records, and we do analysis of Patient Generated Content in order to tailor our service to the patient. This poster will present our transition of MyHealthService from Web 1.0 to Web 2.0, and highlight the opportunities and challenges of Medicine 2.0 for p-Health.

## **P20, Off-the-shelf devices and open source for low cost personalized home-based telemedicine**

Lars K. Vognild<sup>1</sup>, Tatjana M. Burkow<sup>2</sup>, Luis Fernandez Luque<sup>1</sup>, Elin Johnsen<sup>2</sup>, Juan M. Cruz Dominguez<sup>1</sup>, Trine Krogstad<sup>2</sup>, Astrid Bratvold<sup>2</sup>, Marijke J. Risberg<sup>2</sup>, Eva Henriksen<sup>2</sup>, Salvador J. Romero Castellano<sup>1</sup>, Borja A. Drake<sup>1</sup>, and Anders Baardsgaard<sup>3</sup>

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Due to the limited resources of our health care systems one of the main challenges of personal health applications is affordability. In this poster we present our approach to this; combining affordable consumer PC's and health and fitness devices with Free Open Source Software. The personalized eHealth platform MyHealthService currently provides an integrated solution for personalized home-based rehabilitation and following-up of elderly patients with chronic obstructive pulmonary diseases (COPD). We integrate applications for home based rehabilitation, physical activity, individual following up, - and group-based exercising and education using videoconferencing, a personal health diary, activity monitoring, and multimedia educational material. The core component of the platform is a Residential Patient Device. It is a low-cost small PC (e.g. Asus Eee Box) and uses a remote control and the TV as a interface for the patient. Additionally, the system comprises other patient terminals such as Touch-screen PC (e.g. Asus Eee Top), a Ultra-Mobile PC (e.g. Nokia Internet Tablet) and a notebook (e.g. Asus Eee). These devices are integrated with OEM vital sign sensors with Bluetooth, such as a wearable PS02 sensor for continuous monitoring (4100 Bluetooth® Oximeter) and PS02 fingertip sensor (Onyx® II 9560) and inertial sensors (e.g. Wii-remote).

## **P21, Cancer care for patients and their next of kins today and tomorrow**

Per Loua, National Cancer Society, Sissel Jor and Per Tømmer, Oslo University hospital

The Norwegian Cancer Society and Oslo university hospital are establishing a centre for cancer patients and their next-in-kins at the new patient hotel at the Radium hospital (part of Oslo University hospital). The ambition is to advance life quality, well-being and empowerment, before, during and after cancer treatments. The center will utilize the possibilities that ICT offers to demonstrate the cancer care of the future. To support the ambitions the centre will establish a patient-centered portal adjusted to different ages, cultures and languages, online community, patient networks, sharing patient experiences, knowledge and patient education, counselling / tools to support a healthier lifestyle and much more. There will be new functionality in addition to the services offered by both the Norwegian Cancer Society and Oslo University hospital today, all designed to meet the patient and their next-in-kins needs. In this poster we will illustrate the work that is being done to establish a comprehensive cancer patient service, and what kind of services that will be offered, focusing on participatory design with stakeholders from a multitude of disciplines.

## **P22, The Paradigm Shift: The Roles of Patient 2.0 in Today's Healthcare Systems**

Vicente Traver<sup>1</sup>, Luis Fernandez Luque<sup>2</sup>, Francisco J Grajales III<sup>3</sup>, and Randi Karlsen<sup>2</sup>

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Nowadays, the 2.0 wave is everywhere. From concepts to Internet productivity, new technologies have paved the way for the emergence of personalized eHealth services and applications. Issues like information, tools, content production, type of content, focus, relationship or roles are moving towards a new paradigm where patients produce, share, review, and comment through blogs, wikis, podcasting, and forums. Video, audio, images, and texts are produced by everybody in a holistic patient centered approach. Therefore, the patient's role and environment is changing rapidly due to the incidence and accessibility of Web 2.0 platforms and the raise of the patient empowerment. Unfortunately, patient empowerment within Web 2.0 has yet to be understood by public and private healthcare providers, medical staff, and governmental organizations in order to redefine healthcare processes and services towards a patient-centric care. The paradigm-shift of patient's roles in today's healthcare systems within the Web 2.0 is presented in this poster. Some of the most prominent new roles are: content provider, content reviewer, community builder, adviser, communal patient support, exchange of best practices, and Personal Health Records manager. The poster will contain a patient in the centre and different examples of how he could use different Web 2.0 applications.

## **P23, Development of a Hydration Sensor Integrated on Fabric**

Gilles Marchand, Alain Bourgerette, Michel Antonakios, Yvon Colletta, Nadine David, Françoise Vinet and Coralie Gallis, CEA/LETI-Minatec- Department of Technology for Biology and Health, France

The main purpose of the European project ProeTEX is to develop equipment to improve safety, coordination and efficiency of emergency disaster intervention personnel like fire-fighters or civil protection rescuers. The equipment consists of a new generation of "smart" garments, integrating wearable sensors which will allow monitoring position and activity of the user, as well as environmental variables of the operating field in which rescuers are working and physiological parameters among whom there is the dehydration. The dehydration of emergency disaster personnel can lead to severe physiological consequences being able to go until the death. The follow-up of the sodium ions concentration in the sweat allows to evaluate this dehydration state in real time by a non invasive method and to react quickly in the event of problem. This paper deals with the development of an Ionic Selective Electrode sensor and its transfer on fabrics. The performances were evaluated in terms of sensitivity, selectivity and reproducibility initially in model solution and then in natural sweat. A portable electronic board connected to the sensing part is described too. This board drives the electrochemical and temperature sensors for analog acquisition and converts measurement data to digital value. Signal processing is implemented on the electronic board in order to correct raw data (gain, offset) and to convert them to ion concentrations.

## **P24, A Wireless Sensor Network for Fat and Hydration Monitoring by Bioimpedance Analysis**

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In this work, a ZigBee-based wireless system for monitoring and assessing body fat distribution by bioelectrical impedance (BI) analysis is presented. The measurement of the BI of defined body segments is strongly correlated to the body composition. Conventional BI measurement systems are wired monitoring systems and, hence, they are not the best option for remote monitoring of patients under their natural physiological states even when they move. Furthermore, measuring visceral fat has been difficult so far because of the low resolution of BI methods. In order to overcome the above mentioned drawbacks, we have developed a wireless sensor network (WSN) based on the ZigBee communication standard, which allows integration into a wireless biomedical sensor network. The WSN consists of spatially distributed autonomous devices containing a BI measurement integrated circuit that has been designed in a 0.35- $\mu\text{m}$  CMOS technology and a transceiver circuit that provides reliable wireless communication. Since body patient temperature can affect the BI measurement, a temperature sensor is also included. The WSN coordinator collects data from all sensors and transmits them to the end-user's device, such as a PDA, for signal processing and remote body composition monitoring.

### **P25, Textile Electrodes for Electrical Bioimpedance Measurements**

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The use of textile based electrodes for recording of biopotentials has been investigated in some depth and there are various commercially available products for different applications of personal health monitoring, e.g. Adistar T-shirt, Polar chest strap and Numetrex Cardioshirt. In all these products the textile electrodes are used for recording the electrical activity of the heart, the ECG, for which textile technology seems to perform adequately. Electrical Bioimpedance (EBI) spectroscopy is another area of application that could benefit from the application of functional textile, but the performance of the textiles electrodes in EBI measurements has not yet been thoroughly investigated. In this work the performance of textile electrodes has been compared with conventional electrodes for EBI spectroscopy measurements. The electrodes tested were Adistar knitted textile electrodes, Red-Dot Repositionable electrodes, and Impedimed electrodes. Measurements were done with an Impedimed spectrometer SFB7. The impedance spectrum was analyzed from 3 kHz to 1MHz and the results show that textile electrodes produce reliable and repeatable measurements provided that electrolytic gel is used to reduce the skin-electrode interface impedance. Thus, textile technology may have the potential of playing a critical role in personal and healthcare monitoring based on Electrical Bioimpedance Spectroscopy measurements.

### **P26, ECG Measurement using Flexible Capacitive Coupled Active Electrode**

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Although capacitive-coupled ECG electrode has many merits, still it is suffering from motion artifact. To reduce artifact, optimal site of the torso for measuring ECGs using capacitivecoupled electrode is investigated with acceleration meter and found that motion artifact on waist are smallest compared with the other sites. Although installing capacitive-coupled electrode on the waist belt is very suitable to apply for daily life ECG monitoring as point of motion artifact noise, increased cloth thickness worsens SNR. To raise SNR, flexible and extremely thin capacitive-coupled ECG electrode is developed overcoming enormously increased stray capacitance with driving guarding feedback.

Flexibility and the very thin thickness of developed electrode allowed to increase the electrode face size which is very related to SNR. After installing on the waist belt, enlarged flexible electrode showed very enhanced quality of ECG waveform compared to smaller electrode. Simultaneously, flexible electrodes attached on chest belt and waist belt and ECGs were measured with various motions. As a result ECGs from waist is less affected by artifact in most of motions. In conclusion, developed electrode increased SNR that enables to measure ECGs through thicker clothes so ECGs can be measured even though installed on waist belt where artifact is small.

### **P27, Wearable gas sensors**

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Wearable sensing applications have attracted much attention in recent years. The aim of the FP6 funded Proetex project is improving safety and efficiency of emergency personnel by developing integrated wearable sensor systems. This paper describes recent developments in the integration of sensing platforms into wearables for the continuous monitoring of environmentally harmful gases surrounding emergency personnel. Low-power miniature CO and CO<sub>2</sub> sensors have been successfully integrated in a jacket collar and boot worn by emergency personnel. These sensors need to provide information about the level of gas in the surrounding environment without obstructing the activities of the wearer. This has been achieved by integrating special pockets on the jacket and boot of fire-fighters. Each sensor is attached to a sensing module for signal accommodation and data transfer. The sensor performance has been evaluated by simulation of real-life situations. These wearable gas sensors will dramatically improve personnel awareness of potential hazard and can function as a personal warning system. In this way, fire-fighter's jacket and boot not only protect the wearer, but have a second function of providing valuable information on external hazards. The authors gratefully acknowledge the financial support of the Science Foundation Ireland (07/CE/I1147) and the EU project FP6-2004-IST-4-026987. We also acknowledge contribution of University of Pisa (Italy), Zarlink Semiconductor (UK), and Diadora/Invicta Group (Italy).

### **P28, A holistic approach for patient motivation in a personal health system**

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Vasilios Protopappas, University of Patras, Greece  
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Diego Ardigó, Parma University, Italy

Motivation is a psychological feature and, as such, represents a challenge when being addressed through an ICT system for personal care. Its complexity resides in the fact that extrinsic motivation requires the presence of an intrinsic component within the subjects serving as the primal driving force to use a system to manage their health. The METABO project addresses both faces of motivation from a holistic approach in a three dimension strategy - Overall design of the monitoring system following the ISO definition of usability: effectiveness, efficiency and satisfaction - Provision of features to empower users' knowledge and understanding of their condition and status: reminders, recommendations and educational messages - Provision of a tool to set goals to achieve changes in lifestyle and keep track of the benefits derived from these changes. This strategy leans on the system's capability of evaluating users' compliance to treatment, identifying key points where lack of motivation is a cause for therapy dropping. METABO focuses specifically in the management of diabetes, a disease in which lifestyle plays a crucial role in the metabolic control of patients, demanding often radical changes

in their behaviour, which represents one of the most difficult aspects of this disease treatment.

### **P29, MET3-Asthma – a mobile clinical decision support system for integrative and personalized management of paediatric asthma exacerbations at the point of care**

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Children with asthma exacerbations are one of the most common groups of patients in the emergency department of a pediatric hospital. Management of such patients involves a process that consists of the three following stages: data collection, diagnosis formulation and verification, and finally creation and implementation of a treatment plan. In order to provide integrative (spanning over these three stages) and personalized (patient specific) decision support for this process we developed the MET3-Asthma system. MET3-Asthma is a mobile clinical decision support system that facilitates accessing data stored in external hospital systems and entering new information, provides diagnostic and treatment suggestions for specific patients based on the knowledge embedded in the system and enhances these suggestions with underlying clinical evidence extracted from external repositories. MET3-Asthma has been developed as a distributed multi-agent system and it operates on multiple computing platforms including mobile devices (tablet computers, cell phones, iPhone and iPod Touch), thus it can be used directly at the point of care, where and when necessary.

### **P30, Social Networking Healthcare**

Leigh Griffin, Eamonn de Leastar, Waterford Institute of Technology, Ireland

The world of “Social Networking”, a cultural phenomenon of recent years, has evolved an application paradigm, Instant Messaging (IM), into a feature rich, highly interactive and context sensitive service delivery environment. Terms such as buddy lists, presence and IM-bots have emerged as building blocks for services that significantly enhance the user experience. Mapping this paradigm to healthcare can deliver a highly innovative communication platform for information sharing, monitoring and care plan execution. Buddy lists become care groups, presence becomes patient context (e.g. blood sugar level) and IM-bots become E-healthcare services, capable of delivering appropriate contextual information to the care groups. Consider the following scenario: A pharmacist and a local health nurse are both monitoring the blood sugar level for a diabetes patient - the patient appearing as a “buddy” in one of their care groups. Through an IM application, the health nurse first notices a heightened blood sugar level for one of her patients. The nurse messages the patient immediately to ascertain his general status. The pharmacist is also alerted, and the nurse and the pharmacist discuss medication types and levels. A revised prescription is agreed and the patient collects it on his next visit to the pharmacist.

### **P31, Improving clinical performance through remote home monitoring of cardiology implantable devices**

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The number of cardiology patients with implantable devices is increasing in the developed countries. This involves an escalating workload for proper device follow-up. The new developed internet-based remote follow-up systems allow patients to send device information from home. 37 patients with implantable devices were included in the Medtronic Carelink remote follow-up program. All patients performed scheduled transmissions from home every 3 months. During a mean follow-up of  $260 \pm 88$  days, we received 168 transmissions. 129 (76.8%) didn't show any significant event. Mean time invested in data acquisition, interpretation and subsequent report elaboration of each transmission was by average 4.3 times lower that needed in in-hospital follow-up, also reducing up to 25% the administrative process. 84.8% of the patients did not have any mayor technical problem performing the scheduled transmissions. Patients declared a mean 2.7 hours saving due to the possibility of avoiding hospital visit. Daily life was not disturbed due to transmission in any case. 82.4% of patients positively valued SMS messages received from the clinical team after each transmission. Only one patient asked to return to in-hospital visits. Remote home telemonitoring is a feasible and practical way to avoid unnecessary hospital visits, allowing a cost-efficient follow-up of implantable devices.

### **P32, Wireless Technologies to Improve Patient and Medical Community Well-Being**

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Wiloct is a Real Time Location System platform that integrates different wireless technologies. This platform works over Active RFID (433 MHz), WSN ZigBee and Ultra Wide Band (UWB) but it is possible to easily integrate other wireless communication devices. The core of Wiloct is a powerful location engine that utilizes triangulation algorithms to calculate the position of assets indoor accurately. The algorithm uses Received Signal Strength Indication (RSSI) to determine accurate positioning in the RFID and Zigbee systems and Time Difference of Arrival (TDOA) in the UWB systems. Wiloct solution uses wireless communications as the basis of a single architecture in order to provide several services such as: patient's real-time accuracy location, medical equipment/devices monitoring, inventory tracking applications, alarm management and alert sending via GPRS, ambient parameters control. These services allow to minimize costs and time and to improve medical process management. Cuida-t is a remote medical care platform that improves everyday nursing and medical work and offers better medical care for patients. The use of DTT (Digital Terrestrial Television) and different wireless devices allows patients to monitor vital signs (breathing, blood pressure, ECG, pulse oximetry, etc.) and sends the information to the hospital through the Internet network. It provides a bidirectional communication channel between doctors and patient, thus making easier the remote patient assistance.

### **P33, High frequency broadband ultrasound micromachined transducer**

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High frequency broadband ultrasound transducers for medical applications to get high resolution imaging have been desired recently. We are now developing a miniature ultrasound transducer based on PZT thick film on silicon. The silicon substrate functions as a front face and is micromachined to optimize acoustic transmission into tissue in order to achieve very wide bandwidth whereas air is served as backing. The transducer shall have an outer diameter of 1mm, working in the frequency range of 60-

100 MHz; intended for fitting into a catheter tip for imaging of blood vessel walls. This paper presents the initial design of the transducer, including the necessary fabrication steps, together with analytical and numerical simulations of the performance. Calculation shows that 91% bandwidth can be achieved. Finite element (FE) simulation is also performed and shows good agreement with the calculation.

### **P34, Microsystems for monitoring patients during and after heart surgery**

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Rikshospitalet and Vestfold University College are developing two new sensor systems for monitoring patients during and after heart surgery. The systems have been tested on animals and patients, and the initial results are promising. The first system uses micro accelerometers attached to the heart to measure the motion of the heart surface in 3D. The second system uses small ultrasound transducers sutured to the heart to monitor the contraction pattern of the myocardium. This paper gives an overview of these two methods. Details on system design are given, with emphasis on the acquisition, processing and presentation of the signals from the two different sensors. Example results from the animal and patient trials are presented.

### **P35, Wireless Sensor Network**

Ola Jetlund, Peyman Mirtaheri, Morten Flå and Øystein Auli, Oslo University College, Faculty of Engineering, Norway

In health care institutions it is often tractable to have the opportunity to position users and equipment. As there is no standard technology, there exists an opportunity today to integrate such positioning with state of the art sensors for gathering of medical data. We suggest a wireless system, based upon IEEE 802.15.4, with the ability to connect different types of sensors. The Crossbow TelosB mote has been chosen as a candidate for such a system. The project includes choosing an appropriate network protocol for transmitting data and positioning technique. The system uses positioning to track users and sensors to gather medical data. Early tests show that the RF-based localization system can place the sensors in a room with 75-95% accuracy. We also suggest and show hardware modifications of the system such that it is wearable, and with improved communication and positioning accuracy by antennas designed for this purpose. As an add-on the wearable system can be used to restrict physical access to rooms by working as a wireless key, thus insuring the users of health institutions privacy in their own rooms, and providing the health personnel more control of the users positions and activity.

### **P36, A standard application for Personalized Medical Data**

Mauro Giacomini, Carmelina Ruggiero Department of Communication, Computer and System Science, University of Genova, Italy

Many recent projects base their development on a significant amount of strictly personalized medical data that constitutes a base for data mining algorithms for discovery relevant patterns to found new treatment protocols for serious diseases that need integrated and complex approach. In order to get a relevant impact these studies need to quickly share their results, so the use of standard tools for data management can greatly affect the success of multi center and multi national projects. □ Two examples of these projects are CardioWorkBench (CWB) and EATRIS. Both financed by the European Union with different purposes. CWB aims to define new drugs for cardiovascular disease treatment based on personalized data in order to tune up molecules on the specific needs of people to which usual drugs were not effective. EATRIS aims to design an European Infra-structure to better support translational

medicine. In both cases, people agreed on a data network containing above all high quality clinical data, but also strictly connected to related biological data (that is data revealed on real cell lines obtained from biological samples from patients enrolled into the study), at last genomic and proteomic data (measured on the same set of these biological samples) have also to be considered. Our main contribution to both projects is the definition of a standard structure to share these strictly connected data, based on the Clinical Genomics domain of HL7 – V3.

### **P37, Wireless Body Area Network (WBAN) Monitoring Application System (MASS) for Personal Monitoring**

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This paper describes a WBAN-based prototype system for continuous ambulatory monitoring of human body physical activities via Internet. The system comprises a number of custom-made low-cost ZigBee-powered wireless sensor nodes forming the WBAN, a personal server based on a wearable single-board minicomputer running embedded Linux OS, and a remote monitoring server based on an internet-enabled PC. Using some basic processing on the data collected from the subject useful data such as the position of the subject can be determined. This is taken as a strong indicator that a WBAN based on low-cost components could still relay a considerable amount of useful information.

### **P38, Label-free cell based assays for individualized chemotherapy**

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System solutions for online analysis of living cells were developed at the Heinz Nixdorf-Lehrstuhl für Medizinische Elektronik of Technische Universität München. The cell based assays monitor different parameters directly at living cells. These parameters are extracellular acidification (pH), cellular respiration (pO<sub>2</sub>) and changes in morphology (impedance) of the living cells. The measurement is label-free, parallel, continuous and in real-time. With this cell based assays one can e.g. determine the toxicity of a drug in vitro (without the use of animals). Measurements can be performed over weeks without the use of labels. Determination of cytotoxicity / toxicodynamics can be performed. Fields of applications are alternatives for animal experiments, pharmacology, basic biological research, individualized chemotherapy, environmental monitoring or quality testing of transplant cells. Due to its real-time, label-free measurement the method is especially useful for the field of toxicodynamics. Different cell types (e.g. 3T3, MCF-7, MDA, yeast, algae, primary human cells) and substances (chemotherapeutics, toxins, stimuli) have been tested with the system. The system is conforming to the medical product law for in-vitro diagnostics. With the system unique data from drug / cell interaction can be determined. Advantageous properties of the system are: multiparametric (determination of vitality and morphology), long term measurements, label-free i.e. also determination of dynamics, high sensitivity and an optimized fluidic system. The system has the potential to replace different animal models.

### **P39, Research of Neural Network-Based Blood Glucose Level Forecasting Systems for Insulin-Dependant Diabetes Patients**

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This paper documents the results of the research involving neural network-based blood glucose level forecasting systems for insulin-dependent diabetes patients. Forecast is made for continuous subcutaneous insulin injections and continuous subcutaneous glucose measurements. Elman, layer-recurrent, and NARX network architectures were considered in the research. The influence of the network architecture, the number of neurons, the training algorithm and the tapped delay line on the forecast precision were investigated. The research is part of the optimal insulin dose determination algorithm creation work, which can complement the insulin pump and continuous glucose monitoring system to a closed-loop system that will perform artificial pancreas functions. The research resulted in the determination of the optimal neural network architecture that allowed obtaining the necessary forecast precision for the short-range predictions.

### **P40, Interactive system design and end-to-end optimization in sensor network**

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The presented work concerns the requirement for quality of service (QoS) in wireless medical sensor networks (WMSN) and the use of MPEG-21 for interaction between the medical sensor network and external user(s). The network's applications are signal processing algorithms reporting sensor data to external users and they possibly instructing networked actuators. □ The QoS problem is formulated as the definition and interaction of a set of layered QoS parameters, including both the sensor network and the external networks. The layered QoS model has three layers, which together define the expected QoS experienced by the end user. The upper layer represents the optimum measure defined by the observed process and the implemented signal processing. The next lower level concerns the node interactions within the WMSN while doing signal processing, while the lowest layer concerns the transportation of the consensus results via the WMSN and the external networks. This poster proposes further architecture for WMSNs using the MPEG-21 multimedia framework. It has been envisioned that future hospitals will have networks comprising WMSNs for low rate medical sensors as well as other network nodes supporting high rate audiovisual content. Such increasing collection and variety of media content (multimedia), needs a framework for the interaction with the external users regarding data filtering, meta information tagging, authentication and data rights control. Furthermore due to different user terminals and network resources, media adaptation will become important to provide reliable and robust quality of services. We argue for an extension of the MPEG-21 terminology and incorporate the requirements for use in WMSN applications. The deployment of such a system may become warranted in future healthcare enterprises.

## Demo Abstracts

### D01, A Doppler ultrasound unit for monitoring X-ray contrast agent injections

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During CT investigations, large volumes of X-ray contrast agent are routinely injected into the patients. 100 ml volume at flow rate several ml per second is common. This procedure is normally safe. However, in some rare cases, the vein ruptures, causing an extravasation, or equipment failure prevents the contrast agent from being injected. The company Neorad AS in Oslo, Norway is developing an automated system to monitor such injections. This system uses a dedicated three channel CW Doppler ultrasound unit with specially designed transducers to monitor the blood flow in the arm of the patient. Correct contrast agent injections cause an increase in signal intensity and flow velocity in the system. Equipment failure, such as a faulty pump or blocked tubing, is characterized by a missing response, while an extravasation causes a delayed and weakened response. The first system prototype has been tested on approximately 200 patients. Example results from these trials are presented. The paper also describes the system design, including the transducer, electronics and signal processing, and it is shown how this system can be interfaced to the injection pump for automatic operation.

### D02, Diabetes diary based on a mobile phone – Users' experiences and iterative design process

Naoe Tatara<sup>1,2</sup>, Eirik Årsand<sup>1,2</sup>, Geir Østengen<sup>1</sup>, Thomas Samuelsen<sup>1</sup>, Niklas Andersson<sup>1</sup>, Taridzo Chomutare<sup>1</sup>, Ragnhild Varmedal<sup>1</sup> and Gunnar Hartvigsen<sup>2,1</sup>

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Diabetes is one of the most prevalent chronic diseases and it is very important that the people with diabetes continuously perform self-management in proper manner. Norwegian Centre for Collaboration and Telemedicine developed a mobile phone-based self-help application for people with diabetes. The application was designed to be as easy as possible by employing automatic wireless data transmission from a blood glucose measurement device and a step counter using Bluetooth, and by enabling food habit registration with few touches on a touch-sensitive screen on a mobile phone. Design process of the application has a strong emphasis on involving real patient-users by employing usability engineering methods, and the application was tested by 12 patient-users in real-life settings for 6-month duration. Excerpts from the users' experiences of using the application will be presented, and the application with tested version and an updated version based on the results from the users' experiences and will be demonstrated.

### D03, MinJournal.no – a secure patient portal for patient-clinician communication

Ivar Berge, Marte Rime Bø and Sissel Jor, Oslo University Hospital, Rikshospitalet



[www.minjournal.no](http://www.minjournal.no) patient portal is currently in use by more than 10 patient groups at different hospitals in the South-East health region. The portal is developed in cooperation with patient organizations and clinicians and offers several functionalities.

□ □ Patients with severe haemophilia report their usage of coagulating agent electronically instead of sending paper reports. The clinicians receive the reports into the clinical portal and the hospital can also keep track of a person's use of coagulants at the hospital. Lipidklinikken offer their patients the opportunity to electronically complete a mandatory form about dietary lifestyle issues before they are seen in the outpatient clinic. Another set of services is secure communication between patients and clinicians. This is currently the most used service in the portal. The patients communicate with clinicians, enclose pictures etc. Both patients and clinicians receive a standard email telling them that there are secure messages waiting in the Minjournal mailbox. The latest addition to the services is RareICT, a web 2.0 platform where patients with rare diagnoses, their relatives and health personnel can accumulate and share knowledge and experiences. We will demonstrate how discharge note, personal applications, discussion forums and a booking solution to change or cancel appointments that are available.

#### **D04, Musical Fields for All**

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The health potential of music has been scientifically documented over the last years. Music is a unique language to communicate through, recall memories by and create with. All which affect our health and wellbeing. We have used ubiquitous computing and ambient media technology to create several cross-media interactive music installations to increase health and well-being. Our goal has been to facilitate communication and co-creation on equal terms with music for all, both disabled and non-disabled. In the cross-media user interface we use interactive music, together with gestures and other sensorial stimuli like tactility, dynamic graphics, light, and vibration, to motivate musical co-creation. We call the installations Musical Fields, because of their openness towards many interpretations, interaction forms and activity levels. In this paper we present and argue for some of the design tactics we used to create our Musical Fields. We base our arguments on several user tests with many users and user categories, from children to grownups with severe disabilities, deafness and autism.

#### **D05, A wireless 6D-IMU platform for ambulatory gait monitoring**

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This paper reports the development and evaluation of a wireless six-dimensional inertial measurement platform for ambulatory gait monitoring. Each wireless 6D-IMU module (S-Sense) features a 3D-gyroscope and a 3D-accelerometer, and carries enough processing power to extract relevant information in real-time. The data is wirelessly transmitted to a receiving unit within 10m range, or may be stored in local memory. The module has a total size of 57.5 x 41 x 19.1 mm<sup>3</sup> including battery, and an autonomy of over 24 hours. An algorithm for real-time walking phase detection has been developed and embedded in the processing unit of the wireless module. Validated against a gold standard system on a population of 17 elderly subjects, the algorithm

shows a specificity of 100% and a sensitivity of 93.2%. The proposed wireless platform is evaluated in a clinical gait study involving 20 subjects. Wireless, miniaturized and wearable, the proposed system opens new perspectives for gait monitoring beyond the lab environment.

#### **D06, Wearable sleep recorder with online analysis**

Jussi Virkkala, Sleep Laboratory, Finnish Institute of Occupational Health, Finland

We have recently developed algorithms for estimating sleep stages based on restricted number of facial electrodes. Algorithms have been evaluated offline using mainly laboratory recordings. In this demonstration a single channel modified Alive Heart Monitor (Alive Technologies, Arundel, Australia) is used with online analysis for home application. Device was modified for increased gain to enable use for EEG and EOG instead of ECG. Unit connects using bluetooth to Windows Mobile Smartphone or Netbook running with Windows operating system. Software is based on .NET Framework (Compact with Windows Mobile) with reusable classes between Smartphone and Netbook. Online analysis enables feedback about sleep stages to optimize e.g. wake up time. Reliable automatic and self-applicable sleep staging methods would make large scale field sleep studies more feasible. Method is demonstrated also to provide online information about facial muscle activity, blinks and saccades during wakefulness.

#### **D07, Wearable Respiration Pattern Measurement System for Improving Breathing Habit**

Chen-Yen Lan, Chuang-Chien Chiu, Tien-Wei Shyr, Feng Chia University, Taiwan

Breathing is highly related to our physical as well as our mental and emotional conditions. Healthy and efficient breathing habit or technique can be improved by more awareness of respiration patterns. In this study, we develop a system which can be used to detect the subject's breathing status by a smart shirt with wearable sensors. It makes possible to provide the measurement of the respiratory patterns in the daily life. Lab-made conductive textile webbing woven by elastic fibre is used as the respiration sensor. The length of sensor can be extended to 300%, and the elongation range of 0 to 30% has linear relationship with measured resistances. Moreover, the signal processing circuits are integrated in a portable unit with wireless communication. The results of the system can provide many useful parameters such as the strength of breath, frequency of breath, and the breathing ratio of chest/abdomen. Combine with interactive multimedia biofeedback interface, the developed system is helpful to provide an easy, friendly and comfortable user interface to improve their breathing habit and better health conditions.

#### **D08, Electronic patch**

Jens Branebjerg, Delta, Denmark

The electronic patch is not a conventional patch as we know it today; on the contrary it is a little "telltale", which continuously monitors the body. These measurements are monitoring the heart rate, body temperature, respiration levels, oxygen concentration in the blood and more. Due to the modest size of the patch it enables us to continue with everyday activities such as work, sport etc. while at the same time monitoring and recording vital body functions. If there is a serious change in the state of health, we are informed and/or a message is sent to the doctor who is treating us. In future this means that people who are diagnosed with certain serious illnesses will not necessarily have to be hospitalised, but are able to continue their everyday life as the patch will inform them if and when any changes need to be made to their treatment.

## **D09, A Mobile Rehabilitation Application for the Remote Monitoring of Cardiac Patients after a Heart Attack or a Coronary Bypass**

Valerie Gay and Peter Leijdekkers, University of Technology, Sydney

This demo presents a mobile rehabilitation application using a smart phone and wireless (bio) sensors. It aims at encouraging patients to do their exercises and improve their confidence by constant local monitoring and feedback. The rehabilitation application is personalised for each cardiac patient and provides tailored advice. Sensors transmit data to the mobile phone where it is analysed locally. The patient's biosignals and activities can be instantaneously transmitted to rehabilitation clinics to remotely evaluate the patient's health and progress. Our application can be used by rehabilitation clinics (in-house) but also by outpatients that have not access to rehabilitation services or wish to continue after the in-house sessions. The Personal Health Monitor application is not a replacement for specialist care or multidisciplinary care clinics, but it can complement them and help cardiac patients making long term lifestyle changes. A trial with a rehabilitation centre is in progress in which we investigate whether the personalised rehabilitation application improves the success of the rehabilitation programme in terms of patient compliance with recommended life style changes (such as increase physical activity or lose weight) and whether use of the system brings peace of mind to cardiac patients.

## **D10, ECG Delineation on a Commercial Wearable Embedded Sensor Platform**

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The electrocardiogram (ECG) is widely used for diagnosing cardiac ailments. Since most of the clinically useful information in the ECG is found in its characteristic wave peaks and boundaries, much research effort has been devoted to the development of accurate and robust algorithms for automatic detection of the major ECG characteristic waves, so-called ECG wave delineation. To translate these signal processing advances into automated analysis and diagnosis capability embedded in wearable sensor nodes, careful porting and optimization is necessary to adapt these algorithms to the limited processing and storage resources of these nodes. □ In this demo, we present the implementation of two salient state-of-the-art ECG delineation algorithms, to a commercial wearable sensor node, i.e., SHIMMER<sup>TM</sup>. Originally designed and validated for off-line ECG delineation, both algorithms were transformed and optimized for real-time operation. In addition to highlighting the challenges of this optimization, the demo illustrates the successful operation of our real-time delineation using a standard manually-annotated database, a patient simulator and actual ECG signals. Interestingly, our results show that, despite the limitations of the embedded sensor node, careful optimization enables achieving comparable or even better delineation results than the original off-line algorithms.

## **D11, Disease? Accident? Murder? Biomedical studies of shaken baby syndrome**

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The Shaken baby syndrome (SBS) is characterized by the clinical findings of subdural hematoma, retinal hemorrhages and brain injury, accompanied by an incomplete history of trauma. Whether violent shaking alone may produce the acceleration forces required for such severe injuries have been questioned by previous biomechanical studies. Critics



have argued that the typical injuries in SBS are more likely to be caused by direct impact to the head. We sought to evaluate the biomechanics of violent shaking by a laboratory dummy model experiment. An anthropomorphic crash test dummy (Q0) matching an infant at 3.5 kg having its head interior equipped with accelerometers enabling assessment of three-axial acceleration forces. The dummy experiments show that large acceleration forces may be generated by a few seconds of violent shaking, and the forces are likely to cause head injuries. Biomechanical study findings must be interpreted with caution, but may increase our knowledge of injury mechanisms in child abuse.

### **D12, PERFORM: A system for the monitoring and management of patients suffering from neurodegenerative diseases: The Parkinson's disease and Amyotrophic Lateral Sclerosis cases**

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PERFORM is a system designed to support the remote monitoring and the personalized management of patients suffering from chronic neurodegenerative diseases that exhibit motor disabilities. The PERFORM objectives are: 1) All day patient monitoring inside and outside the home 2) Detection and quantification of all patient symptoms 3) Patient status assessment 4) Disease evolution assessment 5) Treatment adjustments suggestions based on pre-integrated medical knowledge and experts experience.

PERFORM consists of two sub-systems: 1) The patient side sub-system which consists of a limited number of wearable sensors, a touch-screen interface and a home computer processing unit. For the day monitoring, the wearable platform consists of five small and bluetooth enabled accelerometers which are able to support 16 hours continuous patient monitoring. For the night monitoring, two EOG sensors, a SpO<sub>2</sub> sensor and an accelerometer are used and support 8 hours continuous recordings. The touch-screen interface is specially designed for the elderly and is used to declare medication and food intake information. 2) The healthcare center subsystem receives the processed patient data, e.g. identified symptom and features, and based on the available patient history information it recognizes disease progression and suggests appropriate treatment changes based on an intelligent subsystem especially designed for this purpose.

### **D13, A Lab-on-chip Embeddable Anti-clogging Micro-Filter for Blood Cells Separation**

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In order to avoid clogging in microfilter for blood cells separation, an improved cross-flow unit is realized by utilizing the turbine-blade-like micropillars, in which the block-up of cells does not occur theoretically at permeate entrances due to its unusual geometrical profiles and the microfluidic performance. Two practical microfilter configurations based on the improved cross-flow unit are presented respectively. One is characterized by a shrinking cross-section concentrate channel as well as two expanded filtrate channels separated by the turbine blade-like micropillar arrays, which can prevent the filtrate from regorging to the concentrate. And the other compact layout comprises two Archimedes' Spiral microchannels, which hires centrifugal force and has stronger volume processing capacity. Still further, a novel concept of filtrating unit with

the penetrate flow reverse to the main flow completely, nominated as counter-flow, is proposed for the first time. The fractal-theory based honeycomb scheme is explored to configurate the practical counter-flow filtrating units, which may cover the filtration area uniformly and give a considerable yield with much better anti-clogging performance. The simulation works based on filtrating leucocytes cells with the well-defined blood sample information have been executed. It was proved that all aforementioned novel filtrating units and configurations have a satisfied efficiency with expected anti-clogging performance respectively.

#### **D14, Unsupervised Segmentation of Digital Dermoscopic Images**

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Skin cancer is among the most common types of cancer for fair-skinned populations. Melanoma, the most fatal of all skin cancer types, starts in a skin lesion and spreads to inner organs. The only effective treatment is early excision of the lesion. Recognising the melanoma is a challenge both for general physicians and expert dermatologists. A computer-aided diagnostic system that improves the level of diagnostic accuracy would be of great importance. Segmenting the lesion from the skin is the first step in this process. The present segmentation algorithm offers a new approach to histogram analysis. Instead of segmenting by recognising a lesion mode and a skin mode, only the skin mode is found by histogram analysis and then the location of the lesion mode is estimated. The histograms are attained by Gaussian kernel smoothing with several bandwidths. The algorithm provides correct segmentation for both unimodal and multimodal histograms. A new algorithm for hair detection based on morphological operations on binary images is incorporated in the segmentation algorithm. The segmentation is totally unsupervised, with a digital image as only input.

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## MedCoast Scandinavia – a leading Biomedical Region

**MedCoast Scandinavia** is a member organization with the aim to strength the biomedical sector in the Göteborg and Oslo region. **MedCoast Scandinavia** act as a catalyst for collaboration between scientists, companies and the public sector, enhance entrepreneurship and commercialisation of innovations. **MedCoast Scandinavia** works closely together with GöteborgBIO and OsloBIO. **MedCoast Scandinavia** initiate, coordinate and participate in a number of different projects. The regions greatest strength in biomedicine lies in the quality of research in several areas like: Oncology, Regenerative medicin, Metabolic diseases, Biomaterials, Biomarin and Medical technology.

**“Our vision is that Göteborg-Oslo will become a leading biomedical region in Europe”**

### COINCO North, WP 2: Innovation & Business development

**COINCO North** is an EU project with aims to strength sustainable growth and development of the Oslo-Göteborg-Malmö corridor. One work package is lead by **MedCoast Scandinavia** and has focus on new innovation structures, education in entrepreneurship and cooperation between business and R&D within life science and the healthcare sector in the corridor. A goal is to establish new borderless networks within **MedTech/ Biomaterial, Health Care and Marin Innovation (healthcare focus)** across the regions.



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