ART OF TECHNOLOGY

NEWSLETTER

electronic system design

March 2008

This newsletter is brought to you courtesy of Art of Technology, a leading European specialist for customer specific electronic system design and development in hardware, software and electronic miniaturization.

Art of Technology will be exhibiting at **Medtec** in Stuttgart. Please visit us from March 11th to March 13th at our **booth 1337** in **hall 6.0**
If you need a free guest ticket please do not hesitate to contact us at info@aotag.ch.

MEDTEC

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Content

Art of Technology AG

Art of Technology offers the whole spectrum of services for electronics design and development in hardware and software. We work together with our customers and support their team with exactly the processes they need, or take over a whole system as turn-key project.
Especially Art of Technology's expert know-how in medical technologies and sensors combined with High Density Packaging (HDP) technologies for a cost optimized system miniaturization of electronic systems is nearly unique. This allows us to realize innovative solutions together with our customers.
Art of Technology is ISO9001:2000 and ISO13485:2003 certified.

Please visit our new homepage on www.aotag.ch and learn about the services and support Art of Technology can offer you.

Yours sincerely
Rolf Schmid
Managing Director, Art of Technology AG

Technologies

New ready-to-wear sensor devices: the new vogue for disease management

from Rolf Schmid and Dr. Thomas Gillen, Art of Technology AG

Medicine and the management and co-ordination of the public health system currently undergo a tremendous change. Everything, from first aid to inpatient hospitalisation, is due to transform. The focus is on prevention, early risk detection, general wellbeing, patient education and new ways of empowering individuals to influence their own health.

Changes in healthcare are driven by society and extraordinary research and technology improvements. Social factors include an ageing society, increasing numbers of chronic diseases and the rising costs of public healthcare. When talking about technology - the main contenders include micro and nano technologies, mobile communication, information and biomedical technologies. Combining cost-effective telemedicine platforms with intelligent, wearable systems that provide personal and early feedback to the patient through continuous measurement of vital functions, can significantly reduce sickness and increase early detection, diagnosis, treatment and therapy of diseases and rehabilitation at home.

Future interdisciplinary research is important in developing powerful, user-friendly, cost-effective, wearable and implantable health systems. Such electronic devices play a crucial role in collecting patients' physiological parameters or supporting vital human functions.

Miniaturization of medical devices

Thanks to microelectronics miniaturisation, new sensor concepts, more powerful signal processing and compact communication capabilities, many new medical devices have emerged. These include devices such as mobile phones with integrated electrocardiogram. But when planning new groundbreaking wearable devices, a developer has to take into account more user requirements than those needed to create stationary equipment. The considerations and challenges should include the following.

Small and lightweight The device should be unobtrusive in order to be worn as a daily accessory and not necessarily look like a medical device. Meeting these restrictions requires mechanical and electrical co-design throughout the entire development phase.

Low power A stand-alone power supply of at least one working day without recharging is mandatory. Apart from low-power electronic components, the duty cycle should also be minimised in order to optimise the power consumption of permanently operated equipment. Biological parameters do not necessarily have to be measured continuously, instead, a "quasi-continuous" measurement can be employed depending on the measured parameters (eg, blood oxygen saturation can be measured every two minutes and skin temperature every five minutes).

Life cycle High reliability and a minimum of four years of field life will make devices eligible for possible reimbursement by health insurances.

Housing The device should be shockproof, at least IP65 (dust tight, protected against water jets), complying with the IEC529 standard, and must be biocompatible where exposed to the user.

Input/output interconnection If a plug/socket option is selected, this adds mechanical issues and (comparably) large, expensive hardware. In comparison, wireless connections such as Bluetooth, ZigBee, GSM or infrared require a larger power budget.

Sensors Novel applications demand new sensor concepts, which are often not easily integrated into standard electronics or housings. Also, when direct physical contact to the patient/user is required, biocompatibility issues may influence the sensor principles and signal post processing.

Well established and known wearable medical devices that use sensors are the pace maker, implantable defibrillator, pulse measurement devices and data logger for continuous ECG monitoring. Currently, companies worldwide are developing new sensors and systems for better and easier surveillance and improved patient support.

Sensors

Sensors make up the basic parts of wearable measurement devices. They measure a person's vital parameters using physical parameters: temperature and pressure (for pulse), electronic potentials (ECG), gyro sensors (movement), etc. The following subsections provide an overview of the approaches and sensors on the market or in research for measuring vital parameters.

Pulse – state-of-the-art pulse measure methods

- ECG type sensors that measure heart activity continuously are usually built into a belt worn around the chest or integrated into a shirt. They send information to a control and display unit in a wrist-worn device.

- Transmissive photoplethysmography (PPG) on the ear or finger and reflective PPG worn on the forehead are commercially available. Wrist PPG devices are still at the research stage. Commercially available devices require either optical measurement at the ear, a finger clip or a finger ring.
- Pulse detection during oscillometric blood pressure measurement. These devices are intended for periodic use and not continuous use. A lot of battery power is required to pump up the cuff for blood pressure measurement.

In order to integrate a pulse measurement into a wrist device using minimum power, the most promising approaches include:

- Piezoelectric pressure sensors.
- Capacitive pulse sensors that is quite similar to a pressure sensor.

Skin temperature Temperature sensors are available up to accuracies of fractions of one °C and can be used for skin temperature measurement. But skin temperature is different from body core temperature. Thus, this value is not really useful unless for recognition if, for example, a device is worn. An algorithm can only be applied when trained on the patient.

Skin humidity A galvanic skin response value can be used in metabolic disorders or calibration purposes of other sensors.

Blood pressure It's mostly measured using cuffs with air pump. New approaches deal with Pulse Wave Velocity (PWV). The pressure pulse travels much faster than the blood itself. PWV describes how quickly a blood pressure pulse travels from one point to another in the human body. The time difference between these two locations is known as the pulse transit time (PTT). PWV is typically measured between the carotid and the femoral artery. Atherosclerosis causes the arterial wall to thicken and harden, and narrows the arterial lumen. The increased inflexibility of the arterial wall serves to increase PWV, because the energy of the blood pressure pulse cannot be stored in an inflexible wall. PWV can be used as an index of arterial distensibility. In terms of medical diagnosis, PWV is a highly interesting subject, because it estimates the extent of the cardiovascular condition based on a large area of the human body.

Furthermore, as the pulse wave velocity is essentially sensitive to the blood pressure, the velocity pulse and the arterial diameter, blood pressure can be calculated from PWV after an individual initial calibration by means of a standard blood pressure meter.

In principle, three methods can determine PTT:

- ECG pulse to laser doppler flow pulse on arm or leg.
- ECG pulse to PPG pulse on arm or leg.
- Time between two PPG pulses or laser doppler flow measured at least 100 mm apart on arm or leg.

Blood oxygen saturation The technology is well known but not easy to implement. For reliable measurements a transmissive measurement device shall be used as described in Pulse/PPG. They are available as commercial devices.

ECG For reliable and medical useful measurements mostly glued electrodes are required. Other approaches use a belt for the support of the electrodes. New systems deal with intelligent clothing - shirts with woven electrodes and electronic connections.

Philips Research and others have developed wearable, wireless monitoring systems that can warn patients with underlying health problems. However, for constant supervision of people with cardiovascular problems, for example, the key technology required are dryelectrodes that can be integrated into common items of clothing such as bras, shorts or waist belts. These systems are currently at the research stage.

Thoracic impedance Impedance cardiography is used to measure and calculate haemodynamic parameters. Haemodynamics are the forces affecting the flow of blood throughout the body. Four dual sensors on the neck and chest are used to transmit and detect electrical and impedance changes in the thorax. The sensors consist of glued electrodes that are not intended for continuous supervision and are not very handy for mobile applications.

Posture Posture supervision uses textile sensors. An application is posture training in order to improve a patient's body posture in daily life and for orthopedic patients who have to avoid certain postures and body movements. Also movement training can also be supported. Various sensors as well as computational and communication abilities in a textile is used. There are different approaches in research. A mesh of measurement nodes distributed over the body or meandric woven electronic wires in the textile that act as a changing capacity are only two of them.

Movement/fall Fall detection is provided by several “commercial” devices by means of movement sensors. The only known approach at the wrist is from ETH Zurich. According to their findings fall detection cannot be 100% warranted. It causes too many false alarms (eg, hits of the arm on a table). Another approach to detect dangerous situations, especially for elderly people, is to detect a person falling and not standing up again.

This is only a summary of some of the most important and promising sensor principles. Biochemical measurements have not been covered since, according our knowledge, most of the principles are still in at very basic research stages.

Devices

The following devices are only a very small selection of wearable medical devices in order to illustrate the possibilities.

AMON The “advanced care & alert portable telemedical monitor” AMON was an EU-funded research project under the fifth framework. The target of the project was to develop a multi-parameter sensor device that can be worn like a watch. The device measures a three lead ECG, skin temperature, blood pressure, pulse frequency and blood oxygen saturation. The sensor data are analyzed on the device and transmitted via GSM to a medical care centre periodically and upon detection of abnormal values. In the medical center the data is further analyzed by medical experts and stored to provide a history. The patient gets real time care at the point, while preventing unneeded hospitalisation.

Auricall The Auricall Home Monitoring System is an ideal solution for short-, medium-, and long-term monitoring of patients at home. Miniaturised sensors for ECG and SpO2 continuously monitor the patient’s state and enable a proactive management of the patient’s health in combination with a mobile phone. The system can be used for recognition of arrhythmias, optimising medication, monitoring patients with congestive heart failure, screening for sleep apnoea, monitoring patients with pneumonia and monitoring patients during ambulatory rehabilitation or within disease management programmes (DMPs).

QBIC The cubic belt integrated computer QBIC can support various applications where computational power, low power, mobile data storage and wireless communication capabilities are the main requirements. Examples are mobile ECG recording and processing and polysomnographic monitoring.

Conclusion

It can be said, that there are already lots of sensors, sensor principles and even medical measurement devices available on the market, for surveilling vital parameters of especially elderly or chronically ill patiens. In order to allow unobtrusive surveillance of healthy people or persons with a certain risk for accidents or sickness, further investigations have to be undertaken within the next 10 to 20 years. Especially the measurements of biochemical parameters and the handling of artifacts are subjects to further investigations and will keep the universities and industry busy. Pushed also by the financing of the EC in the 6th and 7th framework programmes, we can expect not only currently foreseeable but also completely new approaches of security enhancement tools.

Sources

Auricall - www.auricall.com/english.html
BodyMedia - www.bodymedia.com
Europe's Information Society – eHealth
ec.europa.eu/information_society/activities/health/index_en.htm
Philips - www.philips.com
Wearable Computing Lab – ETH Zütich - www.wearable.ethz.ch

EC 6th Framework Research Projects

CAALYX - www.caalyx.eu
DICOEMS - www.dicoems.com
EMERGE - www.emerge-project.eu
INTREPID - Liz.Fay@man.ac.uk
MyHeart - www.hitech-projects.com/euprojects/myheart
OFSETH - www.ofseth.org
OLDES - www.oldes.eu

Application

Please find our new flyers of customer applications under http://www.art-of-technology.ch/english/publications_flyers.html

- OEM GPS Data Logger
- Tracker Box
- EEG-Logger
- Automated Fluid Shunt

For further information visit us at Medtec 2006 in Stuttgart, March 11th – March 13th, 2008, Booth 1337 in hall 6.0 or contact us at: info@aotag.ch

Upcoming Events

Medtec 2008
(AoT will be exhibiting)
March 11th – March 13th 2008
Stuttgart, Germany
http://www.medtecstuttgart.de/

SMT/HYBRID/PACKAGING 2008
June 3rd-5th 2008
Messago, Nürnberg, Germany
www.mesago.de/smt

IFA 2008
August 29th - September 3rd 2008
Messe Berlin, Germany
www.ifa-berlin.de

MID 2008
September 24th-25th 2008
Kongresszentrum Fürth, Germany
http://www.3dmid.de

Electronica 2008
(AoT will be exhibiting)
November 11th-14th 2008
Neue Messe München, Germany
http://www.global-electronics.net/de/ge/electronica/HOME

Compamed 2008
November 19th-21st 2008
Messe Düsseldorf, Germany
http://www.compamed.de/