The Evolution of Wearable Mobile-Health Applications

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Introduction and Definitions
Objective of Presentation

- Define wearable systems as a key area in mobile health evolution
- Present some examples of products and research projects introduced in recent years
- Explain market drivers and challenges
What is a Wearable Mobile Health System

Wearable health systems enable multi-parameter remote monitoring of human physiology and environmental conditions, by integrating

- embedded non-invasive sensors,
- intelligent processing, and
- wireless communications,
Key Features of Wearable Health Systems

- Wearable health monitoring systems can be useful for *early detection* of abnormal conditions and for *prevention* of serious consequences.
- Wearable systems can be part of a garment or worn as an accessory.
- Sensors can be embedded and/or external.
- They can monitor not only physiological parameters but also environmental conditions, such as humidity, temperature.
- Actuators can influence various properties of worn systems.
  - For example, the system may change its thermal properties as a wearer starts to sweat or dehydrate.
Key Technology 1: Body Area Networks

- Body Area Networks (BAN) or Personal Area Networks (PANs) are miniaturized sensor networks worn on the body.
- BANs consist of lightweight, ultra low-power, sensors.
- Sensors continuously or periodically monitor various physiological and/or environmental parameters.
- Data can be sent wirelessly to remote medical center.
- BANs allow long-term monitoring, without affecting user mobility and comfort.
Key Technology 2: Smart Garments

- Combining sensors with smart garments or intelligent textiles enables creation of a new category of products.
- Smart clothing incorporates an array of conducting wires interwoven within the textile, which enables it to become sensitive.
- A smart garment is an ideal interface medium between humans and electronics due to its mobility and natural feel.
Case Studies
WEALTHY (EU-Funded R&D Project) (2002-2005)

- WEALTHY, the Wearable Health Care System.
- A European consortium designed a garment that senses temperature, respiration, and movement, and uses a mobile phone to transmit the data or alert emergency services.
- The basic building block includes “smart” sensors, which provide direct sensing capabilities to textile materials.

http://www.wealthy-ist.com/
Dep. of Electrical and Computer Engineering at UAH developed wireless body area network of intelligent sensors for ambulatory health monitoring
Aerotel (IL) - MDKeeper™ (2006)

- Wristop vital signs monitor
- Wireless, anytime, anywhere monitoring
- Pulse (heart rate), ECG, Blood Pressure, Pulse Oximetry (SpO2)...
- Two-way voice/data communication
- Integrated with Karolinska Hospital (Sweden) IT network
MDKeeper™

- LCD Display
- Emergency button
- Connection to external sensors
- Speaker-phone
- Multi-function push buttons
- Internal GPRS modem
- Rechargeable battery
- Built-in processor
- Wrist strap
- Biosensors
Texas Instruments (2009)

- TI eZ430-Chronos Wireless Watch Reference Platform can be paired wirelessly with external sensors, such as heart monitor, pedometer and others.
- It may be used as part of a personal area network, or as a wireless sensor node for remote data collection.
A student developed a concept for combining wireless sensors and wearable technology to help people affected by epilepsy.

An earpiece monitors the wearer’s brainwaves, communicating with an accelerometer-equipped necklace.

The necklace alerts doctors and family members when a seizure is triggered.

Additionally, it provides guidance to bystanders through an embedded speaker.

Marubeni (Japan) - Wearable Wireless Sensor (2010)

- The HRS-I collects information through a small sensor attached to the chest, which measures electrocardiograph signals, body surface temperature, as well as human movements.
- The device can detect stress levels and heartbeat fluctuations as well.
- The information is transmitted wirelessly to a mobile phone or PC and be forwarded to health professionals or family members in a remote location.
- Running on a CR2032 battery the HRS-I can last for as long as 3-4 days.
- With dimensions of 1.2 x 1.2 x 0.2 inches (30 x 30 x 5mm) it can be attached comfortably to the body
Hitachi (Japan) - Life Microscope (2010)

- The Life Microscope will measure and record an assortment of data, including motion, pulse and temperature.
- The wearable sensor is much like a wrist watch in appearance, and collects information around the clock, 24 hours a day, continuously for up to 10 days.
- Measuring 1.7 × 1.4 × 0.6 inches (43 × 35 × 15 mm) and weighing in at 1.4 ounces (40 g), it is small and lightweight enough to be worn comfortably all day.
- The device connects wirelessly to a computer

http://www.gizmag.com/hitachi-life-microscope/15941/
Equivital (UK) - Monitoring Belt

- The Equivital monitoring belt features a system of sensors and electrodes.
- Data can be transmitted via RF or GSM.
- Parameters measured:
  - Heart rate
  - 2 lead ECG
  - Respiratory rate and effort
  - Skin temperature
  - Movement and body orientation
Imec /Holst / TASS (BE/NL) – Monitoring Phone

- A mobile heart monitoring system that allows to view an electrocardiogram (ECG) on an Android mobile phone.
- The innovation is a low-power interface that transmits signals from a wireless ECG sensor system to the phone.
- In the phone data are collected, stored, processed, and sent over the internet to make them available for authorized users such as a physician.
- The interface is based on a standard Secure Digital Input Output (SDIO) interface on Android mobile phones.

Dayton Industrial (USA) - Heart Rate Belt (2011)

- The heart-rate belt will turn any Bluetooth 4.0 smartphone into a heart monitor.
- It is so energy-efficient that it will run for over 500 hours of usage (that's 18 months of one-hour-a-day usage) on a CR2032 coin cell.
- The entire belt weighs just 46g.
Intelligent Closing (UK/USA)

- SmartPatch™ continuously monitors the heart, respiration and temperature and radios the data to a Bedside Display Unit (BDU), for onward transmission to doctors.
- The product is being developed for Special Care Baby Units, birthing hospitals, for doctors to monitor their home-based patients remotely.
Aerotel (Israel) - GeoSkeeper™ – Mobile Medical Alert

Text/e-mail alerts are sent to caregivers or call center when panic button pushed or during critical events.

SMS
emails
GSM Cellular Network

Hands free cellphone, with GPS and motion detector

GPS

3 speed-dialing numbers

Panic button

Geofencing

Grandchildren
Caregiver, daughter or son
Primary doctor

911 or medical alert center
Aerotel - WiKeeper™ (under development)

- Mobile Wearable Personal Health System
- Part of a joint project of Aerotel, Karolinska Hospital and TeliaSonera (Sweden)

- Screen Messages
- Measurements
- Hands free phone with preset numbers
- Panic button
- GPS
- Geofence

Devices:
- ECG Monitor
- Blood Glucose Meter
- Blood Pressure Meter
- High Precision Scale
- SpO2 Meter
- Pill Box

Contact:
- 911 or call center
- Grandchildren
- Caregiver, daughter or son
- Primary doctor
Market Drivers and Challenges
Wearable Systems Could be Driver for mHealth growth

- There have been many challenges to using wearable sensor systems, which prevented them from commercial deployment:
  - Size, cost, comfort, power consumption, ...
- Their main implementation so far has been for research.
- But now, a number of new technologies are coming up that promise to make them practical for commercial mHealth applications.
- Recent technology advances include wireless networking, micro-fabrication, and integration of physical sensors, embedded microcontrollers and radio interface.
- This should signal a growing demand from the market.
Fitness will Overpass Healthcare

- **ABI Research** predicts that wearable wireless devices should reach nearly 80 million units in 2016.”
- There is an enormous potential for wearable wireless sensors in remote healthcare monitoring.
- But the stronger uptake is expected by *consumer-driven* sports and fitness applications.
- Consumer devices do not require the same level of complexity and regulation to deploy that healthcare devices do.
- Wellness monitoring wearable devices will be tied to online applications generating recurring revenues.
- Consumer wellness devices will connect data to *cloud applications*.
- They will also support the *social networking*, with participants sharing their results with friends.

Source: ABI Research, June 2011
Key Challenges Must Still be Overcome

- In addition to the “standard” barriers facing telemedicine as an industry, wearable systems must still face its own set of challenges:
  - Reducing weight
  - Maintaining user comfort
  - Filtering and overcoming artifacts during movement
  - Reducing power consumption
  - Keeping RF radiation to a minimum
Thank you for your attention

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