Interactive and Wearable Computing and Devices (IWCD)

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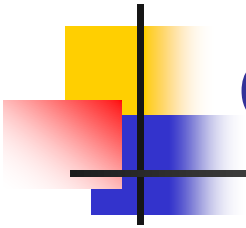


Outline

- IWCD's Pre-History: 1990's
- IWCD's Eve: 2000's
- IWCD Emergence: 2010's
- A Brief Introduction to Wearable Computing, Wearable Devices and Body Sensor Networks
- IWCD Today
- IWCD Tomorrow
- Challenges and Opportunities

IWCD's Pre-History: 1900's

- **IWCD:**
  - First trials in developing wearable devices similar to wearable computers and computer peripherals:
    - Private Eye head-mounted display
    - Wrist Computer, University of Toronto
    - Belt Computer, IBM
  - Foundation of new academic conferences on wearable computing, e.g. IEEE International Symposium on Wearables Computers (ISWC).

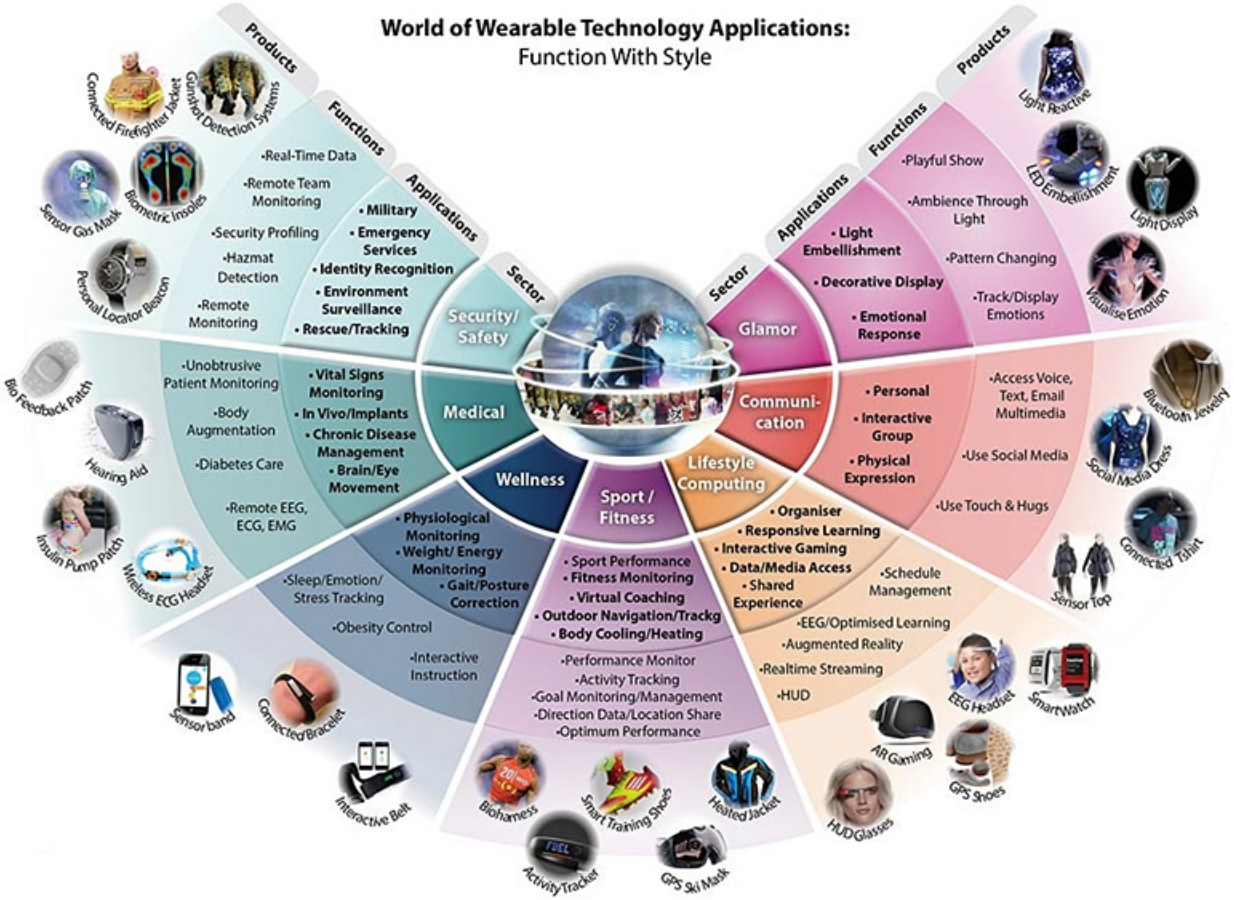
IWCD's Eve: 2000's

- **IWCD:**
  - Using wearable devices (smart watches, smartphones, sensors) as the basis for novel interactive applications supporting humans in their life: at home, at work, outdoor, etc. Thus wearable computing was thought as an enabler of a new technology wave in pervasive computing, human-machine interfaces, affective computing, etc.
- **Body Sensor Networks (BSNs):**
  - Personal Networks of Wearable Sensors
  - Foundation of new conferences on BSNs (e.g. Bodynets)
- **Interactivity & Multimediality**

IWCD Emergence: 2010's

- New Smart Wearables (glasses, watches, etc.)
- Smart Textiles
- Smart Objects in the Internet of Things
- Personal Area Networks based on Body Sensor Networks
- Multimedia Wearable Sensors
- Interactive Sensor-based Videogame Consoles
- Pervasive and Ubiquitous Computing
- Novel Application domains: m-Health, e-Entertainment, e-Factory, e-Tourism, e-Defense, e-Emergency, etc.

Needs for IWCD



Source: Beecham Research

Brief Introduction to Wearable Computing

- Wearable Computing is the study or practice of inventing, designing, building, or using miniature body-borne computational and sensory devices. Wearable computers may be worn under, over, or in clothing, or may also be themselves clothes.
- Wearable computing is a relatively new area of research and development that aims at supporting people in different application domains: health-care (monitoring assisted livings), fitness (monitoring athletes), social interactions (enabling multi-user activity recognition, e.g. handshake), videogames (enabling joystick-less interactions), factory (monitoring employees in their activity), etc.
- Wearable computing has been recently boosted by the introduction of body sensor networks (BSNs) and commercial wearable devices.

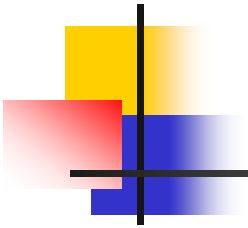
Brief Introduction to Wearable Devices

- Wearable computing is based on wearable computing devices such as sensor nodes (e.g. to measure heart rate, temperature, blood oxygen, etc) , common life objects (e.g. watch, belt, etc), smartphones/PDA.

Brief Introduction to Body Sensor Networks

- Body Sensor Networks (BSN) involve wireless wearable physiological sensors applied to the human body for medical and non-medical purposes. In particular, they allow for the continuous measurement of body movements and physiological parameters, such as heart rate, muscular tension, skin conductivity, breathing rate and volume, during the daily life of a user.
- BSNs are networks of wireless wearable sensor nodes coordinated by more capable coordinators (smartphones, tablets, PCs).
- Although the basic elements (sensors, protocols, coordinators) of a BSN are available (even from a commercial point of view), developing BSN systems/applications is a complex task that requires design methods based on effective and efficient programming frameworks*.

*Giancarlo Fortino, Roberta Giannantonio, Raffaele Gravina, Philip Kuryloski, Roozbeh Jafari: Enabling Effective Programming and Flexible Management of Efficient Body Sensor Network Applications. IEEE T. Human-Machine Systems 43(1): 115-133 (2013)

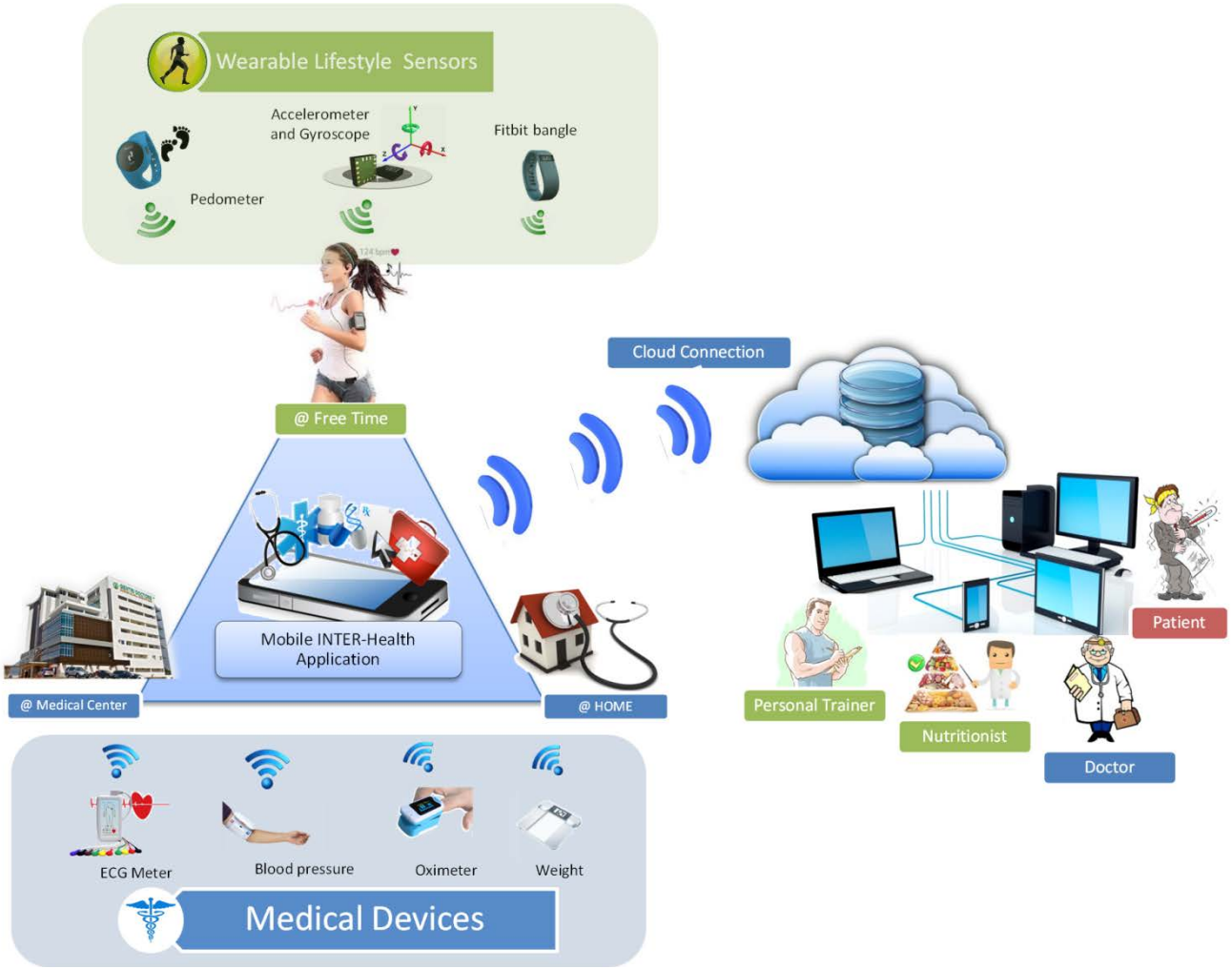


IWCD Applications

- Human Health and Lifestyle Monitoring
- Emergency response team: search and rescue
- Activity detection, recognition, and prediction
- Smart City navigation devices and systems
- RFID devices and tracking

Application Example 1: Human Health and Lifestyle Monitoring

Devices: Medical portable devices (e.g. blood pressure, oximeter), Wearable sensors (e.g. ECG, accelerometers/gyros), Smartphones.
Communication: IEEE 802.15.4, BT, ANT+
Computing Systems: Cloud Computing, Data Centers
Wearable Computing: Programming and Management Framework, e.g. the SPINE framework, http://spine.deis.unical.it

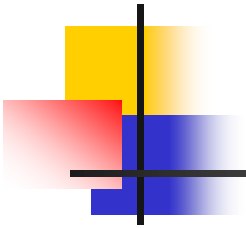


Application Example 2: Emergency response team: search and rescue

Devices: Medical portable devices (e.g. blood pressure, oximeter), wearable sensors (e.g. ECG, accelerometers/gyros), Smartphones/Tablets
Communication: IEEE 802.15.4, BT, ANT+
Computing Systems: Cloud Computing, Data Centers
Wearable Computing: Programming and Management Framework, e.g. the SPINE framework, http://spine.deis.unical.it

IWCD Today

- Research Perspective
  - Design of Small and Low-power Wearable Devices
  - Programming and Management of Body Area Networks
  - Energy-aware Wearable Computing
  - Application-specific Algorithms Distributed over BSNs
  - Application-specific Algorithms over Mobile Smart Devices
  - Human-Device Interfaces
- Technology Perspective
  - Commercial Wearable Sensors and Devices (Shimmer sensors, IWatch, Google Glasses, etc.)
  - Communication Protocols for Wearables Interconnection (IEEE 802.15.4/6, (Low Power)Bluetooth, Ant++, 6LowPAN, TCP/IP, CoAP, REST, etc.)
  - BSN-based Systems and Wearable Applications



IWCD Systems of Tomorrow (1)

- Cloud-assisted Body Area Networks
- VR-oriented wearable devices
- Opportunistic wearable computing
- Large-scale Ecosystems of Wearables
- Augmented Humans through Wearables
- Energy Scavenging based on Wearables
- New Communications Technology for Wearables

Challenges and Opportunities

- Ministration
- Power management and battery life time of sensors
- Big data handling and processing
- Real-time decision support for medical environment
- Security solutions
- Human-device interfaces
- Efficient and flexible Operating Systems (OS)
- Smart and lightweight sensor design
- Coexistence with other wireless technologies
- Low-power medium access control protocols
- Impact on human health