Wearables and implantables for personalized and preventive healthcare

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Summary

This multidisciplinary course presents, from both engineering and medical perspectives, the state-of-the-art, applications and impact of wearable and implantable technologies, with focus on cardiovascular healthcare shift from intervention-based to personalized and preventive medical strategies.

Content

The course will be organized in two main interactive parts, going from technology to medical and life style applications:

Part I (14 hours): Wearable and implantable technologies:
- Edge of the cloud sensing and computing and Internet of Humans
- Physical and physiological biosensors:
  - Motion sensors: accelerometers, magnetometers, gyroscopes (focus on low power MEMS solutions)
  - Biosignals and biosensors: ECG, EEG, EMG, EOG, ENG, blood pressure, pulse wave velocity, SpO2, pH, glucose, ions
  - Environmental sensors
  - Gas and particle sensors for air and breath monitoring
  - Temperature sensors: body core and skin temperature
  - Implantable micro/nanosensors and challenges for in-body sensing, communication and energy harvesting
  - Wireless autonomous sensors for multiparameter sensing as components of a the healthcare cycle
  - Standards for Body Area Networks (BAN) wireless communications with their merits and demerits as well as future standardization according tIEEE (Medradio, ISM, UWB, etc.)
  - Ultra-low power radio front-ends and antennas for wearables
  - Context driven wearable systems and the new industry ecosystem: wrist-based devices, smart glasses, smart patches
  - Big and deep data analytics for healthcare: requirements for privacy and security
  - Interoperability challenges for wearables and internet-of-things nodes

Part II (14 hours): Medical applications with focus on cardiovascular, metabolic and life style engineering: from prevention to intervention
- Cardiovascular System
  - Anatomy, Physiology, Metabolism: from a cell to a pump
  - Cardiovascular diseases:
    - Epidemiology, economical burden
    - Prevention and lifestyle monitoring: from 7 to 77 y.o: the Tintin rules.
- Treatment: overview of past, current and future interventions in cardiovascular medicine:
  1. part I: Open heart surgery: from vessel to heart transplant (recorded intervention/live cases)
  2. part II: Endovascular heart and vessels intervention: from stent to the cell (recorded intervention/live cases)
  3. part III: Peri- and post-procedural monitoring, Cardiovascular reabilitaion
• Unmet needs in Cardiovascular Medicine
  - Integration of new technologies in the management of Cardiovascular patients
  - Patients acceptance, Ethical and regulatory aspects

Note
PhD students will receive in advance a full set of handouts (slides).
By the end of the course, the student will:
  1. be sensitized to the ultimate use and impact of technological development in a practical field.
  2. be familiarized to the opportunities but also limitations of introducing new wearable & implantable technologies in the medical field.
The examination will be under the form of a written QCM.

Keywords
wearable and implantable devices, internet-of-things, biosensors, health, personalized medicine, prevention, translational medicine, cardiovascular system, metabolic diseases.

Learning Prerequisites
Required courses
None.

Assessment methods
Written examination.

Resources
Websites
  • http://nanolab.epfl.ch