EPFL

EE-730   **Design of Ultra-low Power Wearable Wireless Systems**

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Cursus	Sem.	Type
Electrical Engineering		Obl.

Language of teaching	English
Credits	4
Session	
Exam	Project report
Workload	120h
Hours	**56**
Courses	28
TP	28
Number of positions	**20**

Frequency

Every 2 years

Remark

Every 2 years. Next time: Fall 2018

Summary

This course presents a coherent view of the subfields related to wearable and wireless systems. It presents the perspectives and the underlying technologies in the areas related to ultra low power electronic circuits, communication architectures, wearable sensors and multi-source signal processing.

Content

The goal of the proposed course is to provide a complete overview of the most relevant subfields related to wearable and wireless systems. It presents the perspectives and the underlying technologies in the areas related to ultra#low#power electronic circuits, communication architectures, wearable sensors, advanced signal processing and features extraction, as well as applications of these technologies in the field of human monitoring. Its aim is to address all issues related to the using of wearable/wireless sensors and to bring together scientists from computing, electronics, new schemes for biosignal analysis in order to present the latest technological developments and applications of body worn sensors. Furthermore, the course will include a clear cross-disciplinary conception in its basis as it will include scientists working on different fields – sensors and actuators, signal processing, software, system architecture, application fields.
The course will last for one full semester and will feature a number of different activities:
- Lectures: each day will feature lectures and discussions around various research themes. Each session will include in#depth talks and theoretical lectures with processors on different aspects of ultra-low power wearable wireless systems and their applications. A Q&A discussion will follow each of these sessions.
- Hands#on labs: the course will integrate each day hands#on with the theoretical classes. Thus, the lab sessions will provide hands#on experience on real devices with the topics covered in the morning lectures
The evaluation will be done through the correction of the exercise sessions and one group project (in pairs of students) that will be developed at the end of the semester.
The course is divided in three different modules: platforms and power management, communication, and sensors, signal processing and applications.
The first part of the course will be dedicated to "platforms" for ultra-low power wearable systems, with sub#topics ranging from design principles and approaches, to the discussion about available platforms and development tools. The development kit proposed for hands#on labs will be presented during this first module of the course. The participants will get familiar with all the instruments that will be using during the following modules of the course. Then, this module will cover how to design complete ultra-low-power wearable platforms that can be powered with minimal energy, and system-level software management for low#power at hardware and OS level. We will also cover the state-of-the-art and the key techniques to design low-power integrated circuits and SoCs for wearable wireless systems. The hands#on lab of this module is focused on software techniques for the aforementioned topics.
The main topic of the second module is entitled "communication": lectures will cover the main issues and challenges related to new protocols, management and optimization of communication for wearable wireless systems and networks. We will describe the essential concepts and transmission schemes behind current standards and introduce the basics of

future emerging communication technologies and signaling schemes relevant to wireless sensor networks. The hands#on exercises related to this module will be focused on the several design trade#offs between high#level (like ZigBee) and low level protocols, as well as communication modeling around the body used as communication channel. The third module of the course is application-oriented lectures with focus on the actual needs in sport and clinics. It includes dedicated body worn sensors and signal processing, feature extraction and machine learning approaches, sensors fusion and data recording in wearable systems. The participants will have the opportunity to learn the state of the art and advances pervasive monitoring in heath and disease. The importance of outcome measures obtained through wearable systems and their validity is emphasized. Field measurement, daily activity recording as well as tools for analyzing long-term monitoring are presented through example in health and disease. The hands-on exercises of this module will cover practical issues about signal acquisition and software tuning and optimizations for physical mobility analyzing using wearable technology.

Note

The evaluation will be based on the correction of the exercises of the different modules and a final group project.

Keywords

Wearable electronics, wireless body sensor networks, body communication, ultra-low power, system-level design, embedded systems, software optimization.

Learning Prerequisites

Recommended courses

- "Co-design of Systems-on-Chip on Reconfigurable Hardware"
- "Microelectronics for Systems on Chips"

Important concepts to start the course

- Architectures of microprogrammed enbedded systems
- Communication protocols
- Signal processing concepts
- Advanced programming

Learning Outcomes

By the end of the course, the student must be able to:

- Implement complex embedded systems for wearable electronics
- Optimize complete wearable systems
- Formulate system level optimization problems
- Assess / Evaluate different choices of communication and processing blocks
- Justify the global system performance

Transversal skills

- Plan and carry out activities in a way which makes optimal use of available time and other resources.
- Assess one's own level of skill acquisition, and plan their on-going learning goals.
- Use a work methodology appropriate to the task.

Teaching methods

Lectures and exposition of theoretical concepts by the instructors (50%) and laboratories and development of a wearable system project in group (50%).

Expected student activities

Solve the laboratory sessions and develop a complete wearable system project in groups of students.

Assessment methods

Correction of exercises during the laboratory sessions (20%) and presentation of final wearable system design project in groups of 2-3 students to the instructors (80%).

Resources

Bibliography

Bibliographic material and hands-on guides will be provided during the course sessions.

Moodle Link

- http://moodle.epfl.ch/course/view.php?id=13921