EE-733

Design and Optimization of Internet-of-Things Systems

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Cursus	Sem.	Type
Electrical Engineering		Obl.

Language of teaching	English
Credits	4
Session	
Exam	Oral presentation
Workload	120h
Hours	**56**
Courses	24
Exercises	24
TP	8
Number of positions	**40**

Frequency

Every 2 years

Remark

Every 2 years. Next time: Fall 2020

Summary

This course provides an overview of the relevant technologies and approaches for the design and optimization of Internet-of-Things (IoT) systems. It covers architectures of edge computing platforms, wireless communication options, cloud computing backend and different machine learning applications.

Content

The goal of the proposed course is to provide a complete overview of the most relevant subfields related to the design and optimization of complete IoT systems. 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 into three different modules: Internet-of-Things (Iot) platforms and cloud computing backend, communication, and signal processing and applications.
The first part of the course is titled "IoT architectures" and will be dedicated to cover the different design of ultra-low power and smart edge computing platforms, as well as the existing options of cloud computing infrastructures for IoT backend platforms, with sub#topics ranging from components of different IoT paltform architectures and power/performance optimization principles. There will be a number of development tools and IoT sensors (TI SensorTag, Huawei Watch 2, etc.) 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 IoT 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 design options to design the related IoT cloud computing infrastructure to store and process the data coming from the IoT platforms. The hands#on lab of this module is focused on showing how to define a secure communication between the IoT edge platforms and the cloud computing backend.
The main topic of the second module is entitled “communication”: lectures will cover the main issues and challenges

related to new IoT wireless communication protocols, management and optimization of communication for IoT 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 and future 5G based IoT communication. Physical layer issues such as the challenges of the propagation environment and modulation and coding for massive IoT as well as key physical and MAC layer design considerations will also be addressed. 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 Lora and other new IoT standards for mid- and large-range IoT communication.
The third module of the course is application-oriented lectures of IoT systems, with focus on the actual needs in smart wearables for 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.

Keywords

Internet of Things (IoT), low power design and optimization, smart wearables, embedded systems, wireless communication, cloud computing.

Learning Prerequisites

Recommended courses

EE-490(g), EE-442.

Learning Outcomes

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

- Expound the basis of IoT sensor nodes and architectures
- Expound low-power design options at system-level design
- Select appropriately the wireless communication protocol based on a required energy and performance requirements
- Expound the basis of wearable architectures and bio-signal processing analysis

Resources

Moodle Link

- https://moodle.epfl.ch/course/view.php?id=15391