Sensor-based Systems and Applications

Instructor: Prof. Dario Pompili
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Topic outline of the course

Course Number: 16:332:---

Course Title: Sensor-based Systems and Applications.

Credits: 3.

Term Normally to Be Offered: Fall.

Enrollment and Prerequisites: Students will be expected to have skills in programming and mathematical analysis.

Co-requisites:

Instructor: Prof. Dario Pompili.

Catalogue Description: 16:332:--- – Sensor-based Systems and Applications.

Course Goals: Students will be introduced to the area of sensor-based systems and their applications, among which environmental and health monitoring, surveillance, reconnaissance, and targeting. Sensor-based systems provide a new set of research challenges involving design, programming, and analysis of self-configurable communication protocols and distributed computing algorithms that should be energy efficient, fault tolerant, and scalable. This is a new and rapidly developing application-driven area with many open research problems of crossdisciplinary interest. Students will acquire a deep knowledge of TinyOS, a light operating system tailored for wireless sensor networks, and of TOSSIM, a simulator for TinyOS-based systems. In addition, they will learn how to program sensor motes such as MicaZ, TelosB, Imote2, and Shimmer, which will be made available throughout the course. Finally, students will learn how to design, implement, deploy, and test sensor-based systems tailored for harsh environments such as underwater and underground. Overall, students will develop problem solving and critical thinking ability by rationally and intuitively applying knowledge and comprehension, and by thoroughly analyzing information.

Course Overview: The course will provide students with a comprehensive introduction to the area of sensor-based systems and their applications through readings of several recent research articles on different topics within this field. Besides the weekly readings, critiques, presentations, and discussions, a large component of the course will be a semester-long research project involving

programming, implementation, testing, and performance analysis of wireless sensor networks in different application-specific contexts. The group projects will be closely guided by the instructor on a weekly basis, and will span the full research cycle – from problem formulation to obtaining and analyzing results to paper writing. Students will be required to make one in-class presentation at the end of the semester pertaining to their group project. Lectures will be reinforced with lab exercises that will aim at developing skills in programming networked sensor motes and analyzing their performance.

Textbooks: Homeworks and exams will be based on class notes, which will be made available through the class website. A list of reference books and research articles will be given throughout the lectures. Several textbooks exist already; some of them are listed below (these are optional and are listed in no particular order).

- Handbook of Sensor Networks: Algorithms and Architectures, I. Stojmenovic, John Wiley & Sons, September 2005.
- Protocols and Architectures for Wireless Sensor Networks, H. Karl and A. Willig, John Wiley & Sons, June 2005.
- Ad Hoc & Sensor Networks: Theory and Applications, C. De Morais Condeiro and D. Agrawal, World Scientific Pub, April 2006.
- Networking Wireless Sensors, B. Krishnamachari, Cambridge University Press, January 2006.

Week-by-Week Syllabus:
Week 1 Sensor-based Systems: Introduction and Applications
Week 2 Factors Influencing Sensor-based System Design
Week 3 Application Layer, Queries, and Sensor Network Management
Weeks 4 and 5 Communication Protocols and their Implementation in Sensor-based Systems
Week 6 Cross-layer Communication Protocol Solutions for Sensor-based Systems
Weeks 7 and 8 Group Project Discussions
Week 9 TinyOS: Introduction, Applications, and Hardware
Week 10 TOSSIM, a Simulator for TinyOS Sensor-based Systems
Week 11 Actor and Sensor Networks
Week 12 Wireless Multimedia Sensor Networks
Week 13 Underwater Acoustic Sensor Networks
Week 14 Underground Sensor Networks
Week 15 Final Project

Computer Usage: Simulation tools such as TOSSIM for performance analysis of sensor-based systems will be studied. MATLAB will be used to visualize performance results.

Laboratory Projects: Acquire deep knowledge of TinyOS, a light embedded operating system tailored for sensor-based systems, and learn how to program sensor motes such as MicaZ, TelosB, Imote2, and Shimmer. These motes will be available for the group projects.

Amount of Homework Required or Suggested per Week: 3 hours.

Criteria for Student Grading: Grading will be based on a weighted combination of class participation, reading summaries, project presentation, and project report. The grade distribution is provided in the following: Attendance and Participation (10%), 3 Homeworks (5% each),

Intermediate Group Project (20%), Final Group Project (35%), Individual In-class Presentation (20%).