

18-748: Wireless Sensor Networks

Course Overview

Lecture #1

Prof. Raj Rajkumar

Outline

- Course Objectives
- Course Personnel
- Grading Criteria
- Course Elements
- Course Logistics

About The Course

- **Lecture hours:**
 - Mondays and Wednesdays, 3:30pm - 5:20pm, PH-126A
- **Pre-requisites:**
 - 15-213: Introduction to Computer Systems
 - 18-349: Embedded Real-Time Systems (or)
 - 15-410/412: Operating Systems
 - or 18-648: Embedded Real-Time Systems
 - A course on networks and network programming
 - In-depth knowledge of C
 - Extensive programming experience (esp. debugging)

Course Instructor

Prof. Raj Rajkumar

George Westinghouse Professor of ECE and RI
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Teaching Assistants

- **Name:** Sandeep D'Souza
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Course Objectives

1. Obtain a broad understanding of the underlying principles, technologies and applications for the exciting domain of wireless sensor networks, an integral piece of the Internet of Things.
2. Get in-depth hands-on experience in designing and developing an operational wireless sensor network.

Internet of Things (IoT)

- Also, known as Internet of **E**verything (IoE)
- Any and all physical objects are connected to the rest of the world
 - Control things independent of space
 - “Virtual teleporting”
 - Add “smarts” to anything
 - Considerations:
 - Power
 - Latency
 - Cost
 - Configurability
 - Security/Privacy



Content of Lectures

Wireless Sensor Networks

- Introduction
- Applications

Component Technologies

- Sensors
- Physical Layer
- Sensor Platforms
- Low-Power WANs

Network Technologies

- Medium Access Control
- Routing

Infrastructure & Development

- Clock Synchronization
- Sensor Operating Systems
- Power Management
- Security
- Topology Control
- Programming Abstractions
- Storage

Applications

- Localization
- Data Dissemination
- Mobility & Distributed Control

Future Directions

Students

- ECE
- Other departments

Tentative Lecture Schedule (1 of 2)

Date	Day	#	Class Activity	Notes
January				
18	Wed.	1	Course Overview	
23	Mon.	2	WSNs and Applications	
25	Wed.	3	Labs and CMU FireFly Platform	Lab #1 Out
30	Mon.	4	Project List and Descriptions	
February				
1	Wed.	5	Sensor Platforms and Tools	
6	Mon.	6	Sensors	Lab #1 Due; Lab #2 Out
8	Wed.	7	Physical Layer - 1	
13	Mon.	8	Physical Layer - 2	Lab #2 Due; Lab #3 Out
15	Wed.	9	Medium Access Control	Quiz #1
20	Mon.	10	Routing	Lab #3 Due;
22	Wed.	11	Clock Synchronization	
27	Mon.	12	Power Management	
March				
1	Wed.	13	Sensor Operating Systems	Quiz #2
6	Mon.	14	Initial Project Presentations – 1	
8	Wed.	15	Initial Project Presentations – 2	
13	Mon.	16	Security I	

Tentative Lecture Schedule (2 of 2)

Date	Day	Slot	Class Activity	Notes
15	Wed.	17	Security II	
20	Mon.		* Spring Break *	No Class
22	Wed.		* Spring Break *	No Class
27	Mon.	18	Topology Control	
29	Wed.	19	Programming Abstractions	Quiz #3
3	Mon.	20	Localization I	Intermediate project demos this week
5	Wed.	21	Localization II	
April				
10	Mon.	22	Data Dissemination in WSN	
12	Wed.	23	Storage in WSN	
17	Mon.	24	Mobility and Distributed Control	
19	Wed.	25	Sensor Network Simulation	
24	Mon.	26	TBA	
26	Wed.	27	Future Directions & Course Summary	Quiz #4
May				
1	Mon.	28	Final Project Presentations – 1	Final project demos this week
3	Wed.	29	Final Project Presentations – 2	

Readings

- Soft and/or hardcopies of papers and chapters assigned as **required and optional readings** will be made available.
- A long list of **miscellaneous readings** will also be given.

References

- Edgar H. Callaway Jr. and Edgar H. Callaway, "**Wireless Sensor Networks: Architectures and Protocols**", Auerbach, ISBN 0849318238, 360 pages, 2003.
- Jose A. Gutierrez, Edgar H. Callaway and Raymond Barrett, "**IEEE 802.15.4 Low-Rate Wireless Personal Area Networks: Enabling Wireless Sensor Networks**", IEEE, ISBN 0738135577, 155 pages, 2003.
- Holger Karl and Andreas Willig, "**Protocols and Architectures for Wireless Sensor Networks**", John Wiley & Sons, ISBN 0470095105, 526 pages, 2005.
- Cauligi S. Raghavendra, Krishna M. Sivalingam and Taieb Znati (editors), "**Wireless Sensor Networks**", Springer, ISBN 1402078838, 442 pages, 2005.
- Ian Sinclair, "**Sensors and Transducers**", 3rd Edition, Newnes, ISBN 0750649321, 306 pages, 2001.
- Jon S. Wilson, "**Sensor Technology Handbook**", Newnes, ISBN 0750677295, 704 pages, 2004.
- Feng Zhao and Leonidas Guibas, "**Wireless Sensor Networks: An Information Processing Approach**", The Morgan Kaufmann Series in Networking, Morgan Kaufmann, ISBN 1558609148, 376 pp, 2004.

Grading Criteria

- Project: 60%
- Lab Assignments (3): 15%
- Quizzes (4): 20%
- Class participation: 5%

$\geq 90\% \rightarrow$ guaranteed 'A'

$\geq 80\% \rightarrow$ guaranteed 'B'

$\geq 70\% \rightarrow$ guaranteed 'C'

$\geq 60\% \rightarrow$ guaranteed 'D'

Project

- Carried out in **groups of 3 students**
- A project list will be presented
 - please see course schedule.
 - Initial and final in-class presentations of project
 - Intermediate and final demos of each project
- The TA will act as ‘mentor’ for each project.
- Read all cautionary notes in ‘Syllabus’ handout.
- **Each group will get 5~6 sensor nodes**
 - Take good care of them.
- Program in a place of convenience
 - Recommend Linux host
 - Windows and Mac *may* be usable (assignment handouts will have the information later)

Lab Assignments

- **Three lab assignments** at the beginning of the semester
 - Less than 2 weeks each to get done
- Get familiar with the programming of individual sensor nodes, OS interfaces and protocol stack
 1. “Hello World” + SNR measurements
 2. Distributed “Whack-a-Mole”
 3. Multi-hop communications

Quizzes

- **Four in-class, closed-book quizzes**
- Spread throughout the semester
- Simple quizzes to ensure that you are caught up on all required readings assigned until the date of the quiz.

Lectures

- If travel becomes necessary for instructor,
 - Some schedule changes may be made.
 - A TA may give the lecture.

Computer Failures

- “afs died I couldn't complete development”
whose problem is that?
 - Backup in multiple machines as you go
- “the machine ate my code” so?
 - Backup as you go
- “the disk died with my code”
 - Keep multiple copies on different media

Readings for Monday

1. Chee-Yee Chong; Kumar, S.P., “Sensor networks: Evolution, Opportunities and Challenges”, *Proceedings of the IEEE*, August 2003.
 - http://www-net.cs.umass.edu/cs791_sensornets/papers/chong.pdf
2. Deborah Estrin, David Culler, and Kris Pister, “Connecting the Physical World with Pervasive Networks”, *IEEE Pervasive Computing*, 1,1 (Jan.-March 2002).
 - http://www-net.cs.umass.edu/cs791_sensornets/papers/estrin2002a.pdf

Course and Lecture Summary

- Learn a lot

... and have fun doing it!