**University of Maine, School of Computing and Information Science**

# *SIE559 Geosensor Networks*

**Silvia Nittel**

## Contact Information:

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## Course Description

Readily available technology of ubiquitous wireless communication networks, the miniaturization of computing and storage platforms as well as the development of novel microsensors and sensor materials has lead to the technology of wireless geosensor networks (GSN). Geosensor networks have changed the type of dynamic environmental phenomena that can be detected, monitored and reacted to, often in real-time. In this course, we will survey the field of wireless geosensor networks, and explore the state of the art in technology and algorithms to achieve energy-efficient, robust and decentralized spatial computing.

**Credits**: 3
**Prerequisite**: Graduate standing, programming experience in Python, Java, C++, or C

## Topics covered:

- Motivation, history and vision
- Platforms
- Data centric routing in wireless sensor networks
- Data management interfaces for wireless sensor networks using database management systems and the cloud
- Decentralized, in-network, ad-hoc collaboration in geographic space
- Geosensor networks applications
- Testbed project

## Course Goals and Objectives

- Introduce students to novel concepts of wireless geosensor networks.
- Develop an understanding of decentralized, ad-hoc computation and collaboration in geosensor networks
- Develop practical skills to design, set-up, program and run geosensor networks

**Course Texts**

For an introduction to geosensor networks, see this paper.

**Textbooks (optional):**
Wireless Sensor Networks: An Information Processing Approach, Feng Zhao, Leonidas Guibas, Morgan Kaufman
Embedded, Everywhere. National Academy of Engineering, 2001 (free .pdf)

Reading material, powerpoint slides of lecture material and assignments will be available via Umaine/Blackboard.

**Software:**

We will:

- Prototype with Arduinos and Zigbee-based radios
- Postgres database system
- Python
- Amazon cloud
- QGIS

**Office Hours:**
Office hours for this course will be announced at the beginning of the semester. Alternatively, contact me by email to arrange a time to meet.

**Distance Opton for Class:**

The class is offered on campus and as a distance class. Distance student can participate in the live class via zoom or watch recordings of live classes, and participate in once weekly live sessions for distance students.

**Syllabus:**

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| Week 1 | **From Vannevar Bush to Smart Dust**<br><br>Vannevar Bush, As we may think, The Atlantic, 1945<br>Mark Weiser, The Computer for the 21st Century, Scientifican American, 1991<br>D. Estrin et al.: Connecting the Physical World with Pervasive Networks<br>J.M. Kahn, et al: Next Century Challenges: Mobile Networking for Smart Dust |
| Week 2 | **State of the Art in Platforms**<br>tiny computing platforms, communication, batteries, sensors, software<br><br>*Lab: programming with Arduinos* |
| Week 3 | **Characteristics of software for resource constrained operating systems**<br><br>*Lab: programming with Arduinos with sensors* |
| Week 4 | **Communication Protocols in Wireless Sensor Networks**<br>• networking - state of the art (OSI, TCP/IP stack)<br>• communication characteristics of radio based small devices and impact on communication protocols<br><br>*Lab: building an ad-hoc, mesh-based sensor network with Arduinos and radios* |
| Week 5 | **Data-centric Routing in Wireless Sensor Networks**<br>novel communication protocols in WSN (data centric routing, geographic routing, rumor routing<br><br>*Lab: building an ad-hoc, mesh-based sensor network with Arduinos and radios* |
| Week 6 | **Data Management for Wireless Sensor Networks**<br>• streaming data to databases and the cloud<br><br>Lab: streaming sensor network real-time data to a database systems |
| Week 7 | **Geosensor Networks: Spatially-aware Sensor Networks & Applications**<br>Spatially intelligent data collection and processing algorithms<br><br>Lab: final project discussion and assessments |
| Week 8 | **Monitoring Continuous Phenomena in Geosensor Networks**<br>• soil moisture sensor networks for precision farming<br>• air quality monitoring in urban environments<br>• earthquake monitoring in Southern California<br><br>Lab: building a project-oriented geosensor network |
| Week 9 | **Monitoring Events in Geosensor Networks**<br>• wildfire event detection based on continuous phenomena<br><br>Lab: set up cloud-based data management infrastructure with AWS (Amazon cloud) |
| Week 10 | **Mobile Geosensor Networks**<br>• Dynamic Transportation Systems<br>• Dynamic hitch-hiking and the case of Uber<br><br>Lab: prototype a final project geosensor network |
| Week 11 | **Mobile Geosensor Networks**<br>• Situational Awareness Applications |

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| | Lab: prototype a final project geosensor network |
| Week 12 | ***Thanksgiving***, break |
| Week 13 | **People as Sensor Networks**<br>• Citizen Science and geosensor networks<br>• Tracking and integrating social media updates to map natural disasters in real-time<br>• Collective Sensing<br><br>Lab: prototype a final project geosensor network |
| Week 14 | **Outlook, Vision and Review** |
| Week 15 | Student final project presentations |

- Develop hands-on skills in programming state of the art geosensor networks.
- Design and program an application project related to geosensor networks
- Practice skills to communicate your ideas to an audience in a presentation or a scientific discussion.

## Grading, Class Policies and Course Expectations

As a graduate level course, you are expected to exhibit high quality work that demonstrates sound understanding of the concepts and their complexity. Earning an "A" represents oral and written work that is of exceptionally high quality and demonstrates superb understanding of the course material. A "B" grade represents oral and written work that is of good quality and demonstrates a sound understanding of course material. A "C" grade represents a minimally adequate completion of assignments and participation demonstrating a limited understanding of course material.

*Grading criteria:*

Homework assignments (programming, reading papers, presentations) – 50%

Class participation– 10%

Final Project (programming project and presentation)– 40%

## Academic honesty

Academic honesty is expected. Plagiarism—one form of academic dishonesty—is the handing in of work not substantially the student's own. It is usually done without

reference, but is unacceptable even in the guise of acknowledged copying. It is not cheating, however, to discuss ideas and approaches to a problem, nor is it cheating to seek or accept help with a program or with writing a paper. Indeed, a moderate form of collaboration is encouraged as a useful part of any educational process. Nevertheless, good judgment must be used, and students are expected to present the results of their own thinking and writing. Plagiarism is unacceptable in this course and will result in a failing grade.

## Students with disabilities:

If you have a disability for which you may be requesting an accommodation, please contact Ann Smith, Coordinator of Services for Students with Disabilities (Onward Building, 581-2319), as early as possible in the term.

## Extended disruption:

In the event of an extended disruption of normal classroom activities, the format for this course may be modified to enable its completion within its programmed time frame. In that event, you will be provided an addendum to the syllabus that will supersede this version.

## UMaine's Sexual Discrimination Reporting:

The University of Maine is committed to making campus a safe place for students. Because of this commitment, if you tell a teacher about an experience of sexual assault, sexual harassment, stalking, relationship abuse (dating violence and domestic violence), sexual misconduct or any form of gender discrimination involving members of the campus, your teacher is required to report this information to the campus Office of Sexual Assault & Violence Prevention or the Office of Equal Opportunity.

If you want to talk in confidence to someone about an experience of sexual discrimination, please contact these resources:

For confidential resources on campus: Counseling Center: 207-581-1392 or Cutler Health Center: 207-581-4000.

- For confidential resources on campus: Rape Response Services: 1-800-310-0000 or Spruce Run: 1-800-863-9909.
- The following resources on campus can offer support but may have to report the incident to others who can help: Office of Sexual Assault & Violence Prevention: 207-581-1406, Office of Community Standards: 207-581-1409, University of Maine Police: 207-581-4040 or 911.

See the OSAVP website for a complete list of services at http://www.umaine.edu/osavp/