

CSCE 436/836: Embedded Systems

Instructor

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Course Info

Spring 2011
Tues and Thurs 11:00am-12:15 in room Business Administration 31, Labs in Schorr Center 117A
Office/Lab hours: Tues, Wed, Thurs 1:00-2:00 and by appointment

Course Description

Embedded Systems are everywhere. Every time you look at your watch, answer the phone, take a picture, or turn on the TV you are interacting with an embedded system. Embedded systems are also found in cars, airplanes, and robots. They far outnumber traditional computers (which also contain embedded processors) and it is estimated that there will be thousands of embedded devices per person by 2015 (Lisa Su, CTO Freescale Semiconductor, 2008). Learning to design and program embedded systems is a critical skill that is necessary for many industry and scientific jobs.

In this course you will build an omni-directional hovercraft robot and develop the low-level controllers and sensor interfaces on the embedded system that control the robot. In this course you will learn the theory and practice of interfacing, configuring, and programming embedded systems through the creation of this robot platform.

At a low-level, you will learn about embedded system design, using digital and analog interfaces, controlling motors, communicating over various protocols, and interfacing with sensors. At a higher-level you will learn about implementing, optimizing, and debugging embedded algorithms to control the covercraft's actions. In addition, you will learn about networking, embedded operating systems, and power management.

The hovercraft platform can control a variety of motors, transport reasonable payloads, and has numerous sensors including gyros and magnetometers. For the final project, you will extend the robot with new sensors and develop algorithms that take advantage of these enhanced capabilities, and by the end of the course you will have a deep understanding of the design, programming, and interfacing of embedded systems. This will prepare you for cutting edge careers in industry and research.

Course Website and email

The website for the course is: <http://cse.unl.edu/~carrick/courses/2011/436/>

You will find the most up-to-date version of the syllabus at that location, as well as information on readings, assignments, and projects. Please make sure to check it regularly. In addition to posting information and assignments on the course website, I will send information over email to the address you gave me at the start of the course. I expect that you will check your email on a daily basis. Please make proper arrangements if you will not be able to check your email or if your email address changes.

Prerequisites and Requirements

CSCE310, senior or graduate standing, or instructor permission.

Textbooks

This course will be supported primarily by readings from the first two textbooks. The third is listed here for reference. In addition, there will be a number of datasheets and online sources that will be used throughout the course.

Wayne Wolf, **Computers as Components, Second Edition: Principles of Embedded Computing System Design**, 2nd ed. Morgan Kaufmann, 2008.

Available in the book store.

David Russell, **Introduction to Embedded Systems**, 2010.

Available for free download when on the UNL campus:

<http://www.morganclaypool.com/doi/pdfplus/10.2200/S00291ED1V01Y201007DCS030>. Good reference for embedded C programming. Do not print out this book, it is less expensive to order a printed copy than to print it yourself.

Edward Lee and Sanjit Seshia, **Introduction to Embedded Systems, A Cyber-Physical Systems Approach**, 2011.

Available as a free download online:

<http://leeseshia.org/> Do not print out this book, it is less expensive to order a printed copy than to print it yourself. There are no specific readings from this book, but it is a good reference for those interested in exploring some subjects further.

Topics Covered

Topics covered will include basic circuit and schematic reading skills, datasheet reading skills, embedded C programming, embedded system design, embedded software design, register and memory access, digital I/O, bus communication, serial communication interfaces, PWM, analog to digital converters, interrupts, debugging embedded systems, designing embedded algorithms, sensors, sensor fusion, program optimization, networking, process scheduling, multitasking, operating system design and organization, power management, and more!

See the course website for a detailed course schedule.

Assignments and Grading

All assignments are due via email to carrick_at_cse.unl.edu. Please include CSCE 436 or CSCE 836 at the beginning of the subject line. I will respond to you to acknowledge that I received the assignment. If you do not receive a response from me within 24 hours, assume I did not receive your assignment and try to contact me again. Unless otherwise noted, all assignments are due before the beginning of class on the day they are due. Assignment due dates are announced in class.

Your final grade will be composed of a number of components. These are:

Percentage	Assignment
15%	Class and Lab Participation
15%	Homework
40%	Labs
30%	Final Project

Homework

There will be at least two homeworks over the course of the semester. These are **individual** assignments. It is ok to discuss concepts behind the problems in the homeworks with classmates, however, you cannot do them together. If you do discuss problems with classmates or other people, you must acknowledge this on the assignment (this will not lead to any grade reduction). As a metric for what level of discussion is allowed, it is ok to meet and talk over coffee about the assignment. It is not ok to show someone your solution or to work on the details of the problems together. In general any discussions should be limited to discussion and you should not be taking significant notes on the problems. If in doubt, ask me questions about assignments.

Homeworks are due via email before the start of class on the day that they are due. Note that late homeworks are not accepted.

Labs

There will be four labs, each worth 10% of your final grade, during the semester. Each lab group only needs to submit one lab report. The lab report should be well written with complete sentences and paragraphs and be readable on its own. It must contain an introduction, discussion, conclusion, as well as the answers to specific questions asked. Supporting materials such as pictures, code examples, etc. are encouraged.

Each lab group will appoint a group member at the start of each lab that will be primarily responsible for collecting and organizing the lab report. Each person must do this for at least one lab during the semester. Everyone in the group must still contribute fully to doing and writing the lab, the person in charge of the lab just has the added responsibility of organizing and submitting the lab writeup.

Labs are due via email before the start of class on the day that they are due. Late labs will receive a 10 point deduction for each 24 hours they are late. That means that if you turn it in after class, instead of before, your group will start with a 90% as the highest possible grade.

Lab groups will be assigned at the start of the semester and will remain the same throughout the semester for the labs and final project. If you are experiencing any problems with the dynamics of your group, please let me know early so that we can address them quickly before they get out of hand.

Final Project

The final group project will consist of picking, interfacing, and designing algorithms to utilize a new sensor on the hovercraft. Some potential ideas are:

Sensor/Actuator	Algorithm Ideas
accelerometer	compensate for bumps, learn thruster configurations
range finders	wall following, obstacle avoidance
bump sensors	obstacle avoidance, roomba-like behavior
gripper	transport objects
camera	follow objects
IR Comms/range finder	multi vehicle communication/ranging/localization

Overall the final project is worth 30% of your grade. The breakdown of the grading for the project is roughly:

Percentage	Component
5%	Proposal
5%	Pre-Presentation
10%	Presentation
10%	Project report

The proposal is a short paper (2-4 pages) describing the sensor you plan to interface to the hovercraft and the algorithms sensor enables that you plan to implement. The project report is a final report describing your project and outcome. The presentation will show your system, sensor, and algorithms in action to the class and the broader UNL community. A short pre-presentation before the final presentation will also be given to ensure system functionality before the final presentation. Further details on the final project will be given in class.

Class and Lab Participation

Participation and lab is critical in this class and counts for 15% of your grade. You are expected to be prepared for class and lab, do assigned readings, and ask questions during class and lab. Simply coming to class and lab is not sufficient for obtaining full marks for participation; you should actively participate in discussions.

It is acceptable to use computers to read papers and take notes. However, I expect that their use will not be a distraction. Texting, tweeting, facebooking, etc. can wait until after class. Do not use your cell phone during class. It is obvious and is a distraction not only for you, but for me and your classmates as well.

Absences

Students are allowed two absences during the semester. Any absences beyond this will lead to a reduction in your class participation grade. There is no exception to this, so it is best to save these days for times when you are sick and cannot come to class. You do not need to notify me if you will be absent, although it is appreciated. Not showing up for class is not an excuse for not turning in an assignment.

The **exception** to the “free” absences is if you are scheduled to present or give a demonstration. If you do not give your presentation on your scheduled day you will receive a zero for the presentation. An absence for your presentation may be excused in the case of an illness or family emergency if acceptable written evidence is given and you notify me as soon as possible. Even if you are sick or leaving town on short notice you should be able to have a friend notify me that you will be missing your presentation. Please do so as soon as possible so that I can plan accordingly so you do not waste the time of the other students in the class.

University Writing Center

The University of Nebraska-Lincoln Writing Center can provide you with meaningful support as you write for this class as well as for every course in which you enroll. Trained peer consultants are available to talk with you as you plan, draft, and revise your writing. Please check the Writing Center website (<http://www.unl.edu/writing/>) for locations, hours, and information about scheduling appointments.

CSE and UNL Policies

You must abide by the Computer Science and Engineering academic integrity policy:

http://cse.unl.edu/ugrad/resources/academic_integrity.php

In particular, for this course, do not plagiarize (writing or code) and make sure to properly cite any sources you use. Any cheating or plagiarism will be reported to the Chair of your department and your Dean, and will result in an F for the course.

Disabilities

Students with disabilities are encouraged to contact the instructor for a confidential discussion of their individual needs for academic accommodation. It is the policy of the University of Nebraska-Lincoln to provide flexible and individualized accommodation to students with documented disabilities that may affect their ability to fully participate in course activities or to meet course requirements. To receive accommodation services, students must be registered with the Services for Students with Disabilities (SSD) office, 132 Canfield Administration, 472-3787 voice or TTY.