CSEE/ENGR-4310: Embedded Robotics (Fall 2014)

Tu-Th 9:30 PM - 10:45 PM in Room 310, Driftmier Engineering Center
College of Engineering – The University of Georgia

Engineering Professionalism Policy & Academic Honesty

Engineers make great contributions to society. Engineering is a very satisfying profession that provides many rewards but is demanding and requires hard work. The engineering profession is governed by a code of ethics. Engineering faculty at UGA expect students to act in a professional manner at all times and develop the work ethics required for a successful engineering career. Engineering students at UGA are responsible for maintaining the highest standards of professionalism and professional practice. All students are responsible for maintaining the highest standards of honesty and integrity in every phase of their academic careers. The penalties for academic dishonesty are severe and ignorance is not an acceptable defense. All academic work must meet the standards contained in the document "A Culture of Honesty." Students are responsible for informing themselves about those standards before performing any academic work. The link to more detailed information about academic honesty can be found at http://www.uga.edu/honesty/ahpd/culture_honesty.htm.

Instructor

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Office hours: appointments via e-mail.

Important Dates:

August 19, 2014	First Day of Class
November 24-28, 2014	Thanksgiving Break
December 4, 2014	Last Day of Class
December 17, 2014	**Project 4 due at 4:00 PM**

Course Description:

The course goal is to provide students with an advanced practicum in Embedded Robotics wherein the students will learn about the programming of embedded controllers, the interfacing of sensors (sound, light, acceleration, pan & tilt color video camera), the actuation of servo motors, inter-computer serial communications (RS-232, ZigBee and BlueTooth), and the control of autonomous as well as remotely piloted systems. The student will be programming using a high-level integrated environment called RoboPlus, and also will be practicing lower-level programming using the C/C++ language with an Arduino-like environment. These concepts and methodologies will be demonstrated in class with sample codes and the students can expand on these ideas further with a series of robotic projects (of increasing complexity) throughout the semester such as car robots, simple bipedal robots (7-8 degrees of freedom) and humanoid robots (16-18 degrees of freedom). Possible projects can be about Master-Slave Robots, Search and Rescue Robot Teams, Mobile Wireless Sensor Networks, Humanoid Robot Balance Control, Intruder (motion) Detection, Image Recognition and Object Tracking, Humanoid Robot Negotiating Stairs with Varying Tread Depths depending on skills and motivations of students.
Upon completion of this course, students should have an integrated hardware/software understanding of embedded robotic systems whether they would be autonomous or remotely piloted. **This course syllabus is a general plan for the course; deviations announced to the class by the instructors may be necessary.** This course can serve as an optional elective for the BSCSE degree and also for the Mechanical Systems or Electrical & Electronics emphasis areas of the BSAE degree.

Offered	Credits	Level	Weekly Class & Meeting Pattern
Fall	3	Undergrad	2 - 75 m. mixed lecture/laboratory session

Prerequisites: ENGR-1140 (Java Programming) or CSCI-1301 are pre-requisites **and** senior standing. We will be actually programming in C/C++ which are very similar to Java. A background in Sensors and Transducers and/or Microcontrollers will be helpful for the more advanced projects.

Class Materials

- Customized class notes will be provided to students.

Additional References

- "The Robotics Primer" by Maja J. Mataric (Science Library).
- "Embedded Robotics" by Thomas Braunl (Science Library and on-line access via GIL).
- "Computational Principles of Mobile Robotics" by G. Dudek and M. Jenkin (Science Library).

Schedule of Topics & Course Grading:

1. Description of the main functional blocks for typical robotic systems and of the Robotis Bioloid systems in particular (hardware & software tools).
2. Using a carbot platform, review embedded controller programming concepts: basic logic structures, internal timer, sensor interface and motor control.
3. **Project 1** using car-bot platform and RoboPlus' Manager & Task tools:
    a. Task programming and motor control (endless turn mode). Sensor interfacing (sound & NIR – active/passive) - Reactive Control & Behavior Control.
    b. Wireless (Zig100 device) remote control of car-bot with automatic obstacle avoidance (***15% of course grade***).
4. **Project 2** using 3 types of simple bipedal bots platform (from 4 to 8 servos) and RoboPlus' Manager, Task & Motion tools:
    a. Servo control (position control mode) and Motion Programming.
    b. Bipedal bots negotiating stairs steps while keeping dynamic balance (***15% of course grade***).
    c. **OR** create your own walking bot needing only 3 servos ***(15% of course grade).***
5. **Project 3** using multiple robots in Master-Slave(s) control mode:
    Option 1 (Group Project) - using 3 car-bots and PC acting as base station develop a Wireless Sensor Network using C/C++ programming on the PC side or LabView and TASK programming on the robots side or,
    Option 2 – using a Quadruped robot with dual controllers:
    a. RS-232 communications programming.
    b. ZigBee communications programming via Zig2Serial device (1 to 1 and broadcast modes, packet shaping).
    c. Master & Slave robots (open and closed loop systems).
    PC wireless (Zig2Serial device) communications to multiple robots to create a Mobile Wireless Sensor Network (**25% of course grade**) or a Master-Slave Quadruped robot (**20% of course grade**).
6. **Project 4** using Humanoid or Bipedal robots equipped with balance sensors or color video cameras:
    - *Option 1* - using a Bipedal robot equipped with Foot Pressure Sensors for 1-leg balancing **(20% of course grade)**.
    - *Option 2* – using a Bipedal robot equipped with color video cameras to track and kick a ball **(25% of course grade)**.
    - *Option 3 (Group Project)* – Humanoid robot making 2 steps and throw a ball – grades based motion design and on actual distance thrown **(25% of course grades)**.
    Example codes for a Humanoid robot platform with 3-D IMU sensor and/or Foot Pressure Sensors to provide 1-leg balance on a platform with varying tilt angles will be provided
7. Various homework assignments throughout the semester using the RoboPlus environment and Embedded or PC-side C/C++ applications will be worth **15% of course grades**.

8. Weekly quizzes will be worth **10% of course grades**.
9. **The procedures and detailed rubrics for the projects will be provided to students separately.**

Method of Grading

The final letter grade will be defined as follows: A for above 93, A- for above 90 to 93, B+ for above 87 to 90, B for above 83 to 87, B- for above 80 to 83, C+ for above 77 to 80, C for above 73 to 77, C- for above 70 to 73 and D for above 60 to 70, F for below 60.

Homework	**15%**
Quizzes	**10%**
Project #1	**15%**
Project #2	**15%**
Project #3	**20-25%**
Project #4	**20-25%**
	95-100%

Quizzes & Homework:

Weekly quizzes will be given on Tuesdays about materials presented during the previous week's lectures and from reading assignments.

Homework will be assigned on Thursdays via UGA eLC and due on the date and time specified in eLC (usually by **9:00 PM the next Thursday**). Neatness and clarity will be important factors in assigning homework grades. Excused late homework will be accepted only under extreme circumstances (e.g., personal crises). **Unexcused late homework submitted after the eLC deadline on Thursday and before 8:00 AM on the next day (Friday) will receive 70% of maximum possible credit. Unexcused late homework submitted after 8:00 AM and before 5:00 PM on Friday will receive 50% of maximum possible credit (you'll have to send in the late homework directly to thai@engr.uga.edu). No late homework will be accepted after 5 PM on Friday.**

Typical homework deductions are defined as follows:		**% deducted**
1.	**Program will not compile or will not run**	**100**
2.	Program produces incorrect results	20 - 100
3.	Insufficient testing (borderline case not tested, prescribed test case results not submitted)	10 - 20
4.	Listing not annotated to show correctness of logic	5
5.	Program solves the wrong problem	5 - 100
6.	**Duplicating someone else's homework**	**100 & Report to Student Judicial**

However, if the student **showed creativeness or added useful features** beyond the basic homework requirements, an additional **10-20%** would be added to the homework grade. You also need to submit all program files & run-time output files, and any other needed data files via eLC to the instructor.

Experiential Learning Environment

All classes meet in Room 310 wherein each student can access their own PC for personal electronic hand-written note taking and also for laboratory exercises. This laboratory also has specialized software and a computer projection system to permit sharing of any software application between teacher and students and among students (under the control of the teacher station). Captured hypermedia files of classroom notes and software demonstrations will be accessible to students for review on eLC after class.

Course Learning Objectives Matrix

Course Learning Objectives	Course Assessment Methods*	Extent of Coverage of Program Outcomes** (ABET Criterion 3)
Upon successful completion of this course, the student will be able to:		
1. Analyze a robotic problem description and conceptualize a solution based on computer systems engineering principles.	A,B,C,E	**a**-xxx **c**-xxx **e**-xxx **k**-xxx
2. Have a good understanding of the functions of embedded robotic controllers and their wired/wireless communication programming.	A,B,C,E	**a**-xxx **c**-xxx **e**-xxx **k**-xxx
3. Interface sound/light/vision/acceleration sensors to embedded controllers.	A,B,C,E	**a**-xxx **c**-xxx **e**-xxx **k**-xxx

* Course Assessment Methods: A- Homework; B – Robotics Projects; C – Quizzes; D – Presentation; E – Student Evaluations

** Extent of Coverage: x – Some; xx – Moderate; xxx – Extensive

ABET EC-2000 Criterion 3 Program Outcomes

a. An ability to apply knowledge of mathematics, science and engineering
b. An ability to design and conduct experiments, as well as analyze and interpret data
c. An ability to design a system, component or process to meet desired needs
d. An ability to function on multi-disciplinary teams
e. An ability to identify, formulate and solve engineering problems
f. An understanding of professional and ethical responsibility
g. An ability to communicate effectively
h. The broad education necessary to understand the impact of engineering solutions in a global and societal context
i. A recognition of the need for, and an ability to engage in life-long learning
j. A knowledge of contemporary issues
k. An ability to use techniques, skills and modern engineering tools necessary for engineering practice

Overall Course Contribution to Program Outcomes

a - extensive
c - extensive
e - extensive
h - moderate
i - extensive
j - extensive
k - extensive

Attendance:

Attendance will be checked at the beginning of each class period, late students must check with the instructor at the end of the class period. Missing **four** lectures of this course will be considered an "excessive absence" and the student involved will be **withdrawn** automatically from the course.