What is an Embedded System?
What is an Embedded System?

• Computing system with a non-standard interface (often no keyboard or screen)
• Often involved in sensing and control (and may not even talk to a human)
• Typically a custom system for a very specific application
What is an Embedded System? (cont)

• Limited processing capabilities:
  – Can be extremely small
  – Can require a small amount of power

• Can have significant real-time constraints
  – Act on inputs very quickly
  – Generate high-frequency outputs

• Often a higher expectation of reliability
Examples of Embedded Systems
Robotics

Mark Tilden
Los Alamos National Labs
and Wowwee

picture from Robosapiens
Humanoid Robotics

NASA/JSC Robonaut

UMass Torso
Real-Time Robotic Control

Hula-Hoop Juggling
UMass Torso
Dual-Limb Coordination
Personal Satellite Assistants

NASA Ames Research Center

picture from *Robosapiens*
Wearable Computing
Intelligent Prosthetics

Hugh Herr
MIT Leg Lab

dpicture from Robosapiens
Autonomous Flying Vehicle
USC Robotics
RC Heli Example
RC Heli Example II
Sensor Networks

1000 sensor nodes
Embedded Systems Challenges
Embedded Systems Challenges

• Sensing the environment:
  – Sensors are typically far from ideal (noise, nonlinearities, etc.)
  – Sensors fail
  – Hard to get a ‘complete’ view of the environment

• Affecting the environment through “actuators”
  – Application can require fast, precise responses
Embedded Systems Challenges (cont)

• Testing/debugging can be very difficult:
  – Hard to identify and replicate all possible situations
  – Often involves the interaction of many different components
  – Often no standard user interface
  – Limited on-board resources with which to record system state

• Competing requirements of cost, complexity, design time, size, power…
Embedded Systems Challenges (cont)

• Lack of reliability can be a killer ….. literally
My Assumptions About You

• Circuits and sensors class (or equivalent): basic analog circuits

• Some background in programming
  – We will be using C for all four projects

• Everyone has a laptop that can be used for the projects
Course Goals

• Gain an understanding of:
  – Basics of computer architecture
  – Theory of embedded system design
  – Practical issues in embedded system implementation
• Gain hands-on experience with embedded systems
• Learn communication and team-oriented skills within and outside of your field
Sources of Information

• Textbooks:

• Class web page: [www.cs.ou.edu/~fagg/classes/ame3623_s08/](http://www.cs.ou.edu/~fagg/classes/ame3623_s08/)

• Desire2Learn: learn.ou.edu

You are responsible for making sure that you have access to all of these resources
Class Schedule

www.cs.ou.edu/~fagg/classes/ame3623_s08/schedule.html

- Lecture plans
- Required reading

As changes are made, they will be posted here
Channels of Communication

- Lecture
- Class email list: time-critical messages to the class
- Desire2Learn announcements
- Desire2Learn discussion group: you may post questions (and answers)
- Private email or office hours for non-public questions/discussions
Grading

• Components of your grade:
  – Midterm exam: 10%
  – Final exam: 20%
  – Five homework assignments and several pop quizzes: 30%
  – Four projects: 35%
  – In-class participation: 5%

• Grades will be posted on the Desire2Learn

• Final grades boundaries will be selected based on the overall class distribution
Exams

• Closed book/closed notes
  – Exception: you are allowed 1 page of your own notes

• Assigned seating

• No electronic devices

• Grading questions must be addressed before the returned exams leave the classroom
Homework Assignments

• Individual work

• Hand-in:
  – Through the digital dropbox of Desire2Learn or hardcopy
  – By 5:00 on the due date (no exceptions)

• Grading questions must be addressed within one week of being returned
Group Projects

• Four group projects will focus on sensor processing and design of robot control circuits
  – Control of an X-UFO

• Project Topics:
  – Inter-processor communication
  – Finite-state machines and microcontrollers
  – Sensor interface and processing
Group Projects (cont)

• Groups will be of size ~4 and will be assigned
• Be ready to demonstrate project by the due date
• Projects require more than a day to complete
• Project reports in pdf or postscript format
• Projects may be late (but I do not recommend this):
  – 0-24 hrs: 10% penalty
  – 24-48 hrs: 20% penalty
  – 48+ hrs: 100% penalty
Laboratory Details

• Location: FH 100/101

• Times: the TAs and I will hold our office hours in the lab
  – Once projects are assigned, we will have the lab open for ~20-24 hrs/week

• Laboratory policies are discussed in the syllabus
Classroom Conduct

• Ask plenty of questions
• Contribute to the discussions

• No: cell phone use (including texting)
• No: laptop use (except for classroom exercises)
Academic Conduct/Misconduct

Homework assignments:

• All work must be your own: no looking at or copying solutions from other students or from the net

• General discussion is OK (e.g., the fundamental skills that we are learning)

• When in doubt: ask
Academic Conduct/Misconduct

Projects:
• All work must be that of your group: no looking at or copying solutions from other groups or from the net
• General discussion is (again) OK

Secure your data
Next Time

- Analog circuits review
- Readings: Designing Embedded Hardware (DEH)
  - pp. 65-86 (through RC circuits)
  - pp. 90-93 (Diodes)