Architecture, Design and Implementation of Embedded Systems for Real-Time Applications

CpE-450 Spring 05

Class 1

Bruce McNair

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Course Introduction

- Logistics:
  - Instructor: Bruce McNair
    - Office: Burchard 206
    - Phone: 201-216-5549
    - email: bmcnair@stevens.edu
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    - **No assignment will require massive printout. Limit your results to a few pages**
  - Grading – all submissions are to be an individual effort
    - Homework: 20%
    - Project: 30%
    - Midterm: 25%
    - Final: 25%

    - Detailed grades will be posted on WebCT

Reference Materials

- Two optional texts, not required:
  - John Catsoulis, “Designing Embedded Hardware,” O’Reilly, 2003, ISBN 0-596-00362-5
  - Michael Barr, “Programming Embedded Systems in C and C++,” O’Reilly, 1999, ISBN 1-56592-354-5

- Reference material I’ll supply:
  - Circuit Cellar Magazine

Syllabus - by week

1. Introduction
   - Definition of embedded system
   - Constraints on embedded vs. standalone systems
   - Concept of real-time design
   - Time scales for real-time systems
   - Applications
2. Hardware/software functional partitioning
   - Relevant hardware technologies:
     - Discrete logic
     - CPLDs, FPGAs, ASICs
   - Software environments
     - HLL vs. assembly coding
     - DSP vs. general purpose vs. RISC
3. Development environments, course project definition
4. System architectures
5. Pipelining, interrupt service routines

Syllabus

6. Software structures
    - ISRs
    - Polling
    - Semaphore
7. Midterm
8. Evaluating system performance
    - Correctness
    - Speed
9. More on system performance evaluation
10. Profiling system performance
11. More on performance profiling
12. Performance optimization
    - Hand-optimization
    - Optimizing compilers
    - Pareto principle
13. Future directions, course project due
14. Final Exam

What's in a Name?

Architecture, Design and Implementation of Embedded Systems for Real-Time Applications

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~~Architecture, Design and Implementation~~

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Definition of Terms

- Embedded System – a computing system that is *embedded* within a larger system. The embedded system may or may not be visible to the end user, but it's function is not the intended end application of the user-perceived system.

- Real-time Application – an application that has specific time-bound performance requirements

Typical Constraints on an Embedded System vs. Standalone System

Constraint	Embedded System	Standalone System
Cost	$3	$2000
Power	1 mW	500 W
Size	1 in^3	1 ft^3
Processing complexity	1-10 MIPS	500 – 1000 Mflops
Interfaces	8-16 bits	RS-232, Parallel, IDE, SCSI, USB, IEEE1394, WiFi, Bluetooth
O/S	Minimal or none	Windows XP
RAM	10^3 – 10^6 bytes	10^8 – 10^9 bytes
Programming	1-time load, programmed in advance	Flexible applications, user programmable, wide variety of languages

Typical Real-time System Constraints

- Input data is streaming at S samples/second. B samples must be processed in a batch within B/S seconds to keep up with the input stream
- An external input requires a decision within T seconds

Assignment 1

- Identify at least 5 embedded systems that you might encounter in your room, your car or some other environment that you interact with on a regular basis.
- Identify whether these systems have any real-time performance requirements. If they do, identify the real-time requirements that exist for the system. What might happen if the real-time requirements were not met?
- Pick one system and research how it is or has been typically implemented.

Embedded system	Are there any real-time requirements?	What are they?	Implications of failure to meet real-time requirements
1.			
2.			
3.			
4.			
5.			