Chapter 1: Introduction

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1.1 The Role of Computers in Modern Society

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Embedded System

- Importance of desktops, servers, and laptops is unmistakable.
- But, we often overlook another facet of computers – embedded systems!
- Embedded systems are designed to perform one or a few dedicated functions, and more importantly, are embedded as a part of a complete device that often includes hardware and other mechanical parts.
- The meaning of embedded system has evolved - any system with a computer that is not a desktop or laptop!

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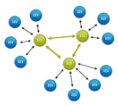
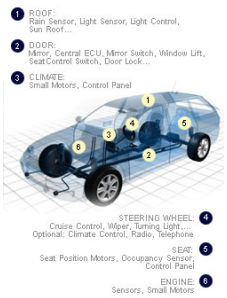
Example Embedded Systems

802.15.4/ZigBee
LR-WPAN Devices



Wireless Sensor Networks

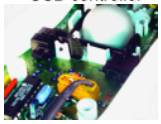
Automotive Applications



RFID

Motor Control

USB controller



Remote Access Controller

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Why Focus on Embedded System?

- More than 95% of devices with computers are embedded systems.
  - They account for the most of the world's production of microprocessors!
- Therefore, understanding how they are programmed and how their internal structure is organized are essential for future engineers and computer scientists.

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1.2 Spectrum of Computers and Their Processors

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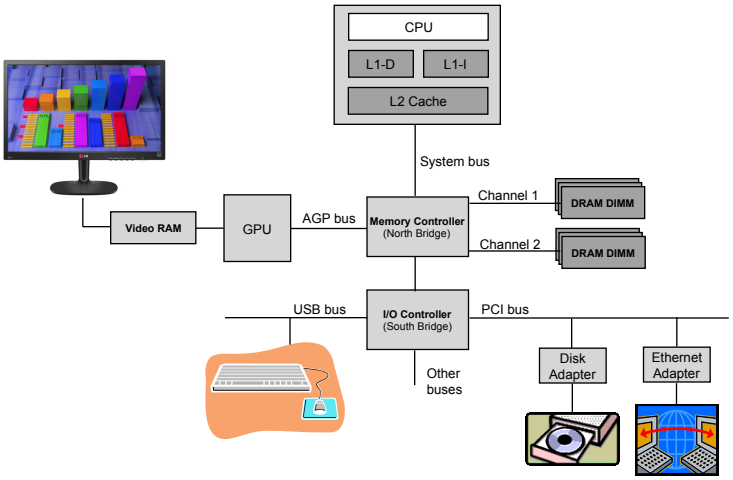
Desktop System



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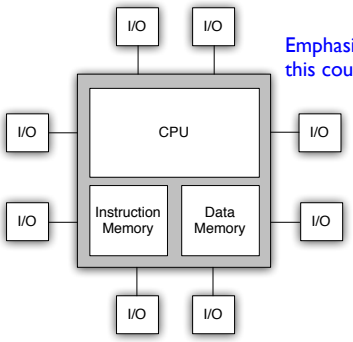
Embedded System

System on Chip (SOC)



Designed to control I/O devices.

Emphasis of this course

- Lower performance, complexity, power, and cost.
- Low-end embedded system:
  - 8-bit or 16-bit processor @ few to tens of MHz.
  - Memories of tens to hundreds of Kilobytes (KB).
- High-end embedded systems:
  - 32-bit processors clocked at several hundred MHz.
  - Memories in the order of Megabytes (MB)
  - e.g., Portable Media players, GPS, car infotainment systems, feature phones, etc.

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Embedded or General-Purpose?

- Recently, a new class of mobile devices have emerged that saddle between embedded systems and general-purpose computers:
  - Smartphones and pad/tablet devices with large memories, OS, graphics processor, and multi-cores.
- Thus, the line between general-purpose and embedded systems has become blurred!

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1.3 Objectives of this Course

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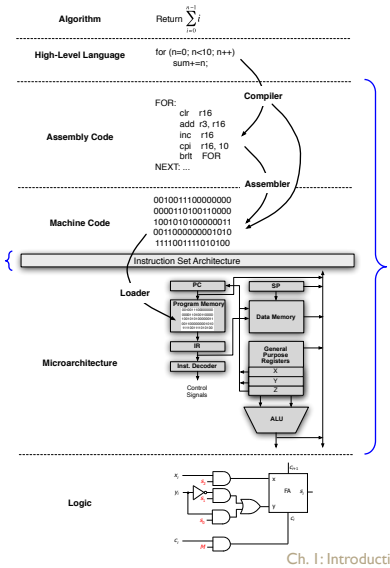
Computing System Hierarchy

Interface between software and hardware



Emphasis of this course

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Objectives of the Course

- Understand the interrelationship between hardware and software:
  - These two topics are not distinct.
  - This is the course where ECE and CS disciplines merge.
- Understanding the essence of these concepts makes both software and hardware designers better at what they do:
  - Programmers can write better programs by understanding how processor execute their programs.
  - Hardware designers can design better processors by understanding the operational requirements of programs.

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Course Logistics

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Logistics

Instructor:	Prof. Ben Lee
Office:	1048 Kelley Engineering Center
Tel:	7-3148
E-mail:	benl@eecs.orst.edu
Web:	http://www.eecs.orst.edu/~benl/Courses/ECE375_w22.html
Textbook:	- *Computer Organization and Assembly Language: Embedded Systems Perspective*, by Ben Lee (will be provided)
	- ATmega 128 Datasheet, ATmega32U4 Datasheet
Office Hours:	TR 3-4pm and by Appt.
TAs:	TBA
Labs:	Section 010: Thursday 12:00pm - 1:50pm
(Dearborn 222)	Section 012: Thursday 8:00am - 9:50am
	Section 013: Thursday 10:00am - 11:50am
	Section 014: Friday 4:00pm - 5:50pm
	Section 015: Friday 12:00pm - 1:50pm

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Grading Policy

- Midterm 25%
- Quizzes (2) 10%
- Laboratory (7) 30%
- Assignments (4) 10%
- Final Exam 25%

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Course Outline (1)

Chapter 1: Introduction

Chapter 2: Assembly Language Fundamentals
- Introduction
- How Do We Speak the Language of the Machine
- Instruction Set Architecture
- Instruction Format
- A Pseudo-ISA

Chapter 3: Computer Organization Fundamentals
- Introduction
- Memory
- Microoperations
- Organization of the Pseudo-CPU

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Course Outline (2)

Chapter 4: Atmel's AVR 8-bit Microcontroller, Part 1 - Assembly Programming
- Introduction
- General Characteristics
- Addressing Modes
- Instructions
- Assembly to Machine Instruction Mapping
- Assembler Directives
- Expressions
- Assembly Coding Techniques
- Mapping Between Assembly and High-Level Language
- Anatomy of an Assembly Program

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Course Outline (3)

Chapter 5: AVR 8-bit Microcontroller, Part 2 - Input/Output
- I/O Ports
- Interrupts
- Timers/Counters
- USART

Chapter 7: Digital Components
- Introduction
- Multiplexers
- Decoders
- Memory Elements
- Registers
- Memory
- Register File
- ALU

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Course Outline (4)

Chapter 8: AVR 8-bit Microcontroller, Part 3 – Microarchitecture
- Microarchitecture
- Instruction Format
- Basic Datapath Components
- Multicycle Implementation
- Execution of More Complex Instructions
- Control Unit Design
- Pipeline Implementation

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Questions?