The University of Texas at Arlington

Class Introduction

CSE 3442/5442

Dr. Gergely Záruba

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Instructor

- Dr. Gergely Záruba – Office: ERB523
- Office Hours: Thursdays 2:00pm –3:00pm other times by appointment only
- Email: zaruba@uta.edu
- Web Page: http://crystal.uta.edu/~zaruba
- Lab Instructor: N. Brent Burns
  nburns@mavs.uta.edu
  - Office hours: during labs and TBA
- Class web site:
  http://crystal.uta.edu/~zaruba/CSE3442/

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Class Mailing List

- Class mailing list: CSE3442-zar@listserv.uta.edu
- Students are strongly encouraged to sign up for the mailing list
- *If you have not been signed up yet, please either request membership via the listserv provided web interface OR send me an email within the first week of classes with the subject:CSE3442 and the body containing your email address (only).*

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Pre-reqs.

- You need to know the information covered in these courses.
  - CSE 2441 (Digital Logic)
  - CSE 2312 (Computer Organization and Assembly Language)

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Text Book

- PIC Microcontroller and Embedded Systems - Mazidi, Mckinlay, and Causey
- Lecture Notes and web links will be provided for most lectures.
- Lab Manual
- Reference materials, if needed, will be placed in Library on reserve and in Lab

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Class Attendance Policy

- Grades are typically directly related to class attendance.
- It's better to come to class late than miss.

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Grades

- Two Exams – 40%
- Homework – 20%
- Lab – 40%

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Papers & Lab Assignments

- Assignments must be turned in by due date or will considered late.
- 20 points (on a 100 point assignment) per day will be deducted from all late home work starting sharp at the deadline.

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Exams

- Exam 1 - Friday, March 27, 2015 (20%)
- Exam 2 - Friday, May 1st, 2015 (20%)
- **A grade of zero will be recorded on any absence from an exam.**

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Labs/Home Work

- When do Labs start?
- Occasionally an ‘in class assignment’ HW may be given. Only those in attendance will receive credit for any ‘in class assignment’.

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Ethics

- **Policy on cheating** --- students who violate University rules on scholastic dishonesty are subject to disciplinary penalties, including the possibility of failure in the course and dismissal from the University. Since dishonesty harms the individual, all students, and the integrity of the University, policies on scholastic dishonesty will be strictly enforced.

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Course Topics

1. **Course Introduction**
2. **Embedded System Concepts & Microcontroller Features**
3. **Lab Introduction and Programming**
4. **PIC Programming in C**
5. **PIC18F Hardware Connections**
6. **PIC Timers & Serial I/O**
7. **Interrupt Concepts**
8. **ADC, DAC, and Sensor Interfacing**
9. **Other concepts and applications**

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Rest of the Syllabus

- Taking Attendance in MyMav
- Accepted file formats
- Grievance
- Drop
- Title IX
- Integrity
- ADA
- Mav mail
- Support
- Feedback
- Final Review Week
- Emergency Procedures

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Questions

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Embedded systems overview

- Computing systems are everywhere
- Most of us think of “desktop” computers
  - PC’s
  - Laptops
  - Mainframes
  - Servers
- But there’s another type of computing system
  - Far more common...

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The Embedded System (Wikipedia Definition)

http://en.wikipedia.org/wiki/Embedded_system_overview

- An **embedded system** is a special-purpose system in which the computer is completely encapsulated by the device it controls. Unlike a general-purpose computer, such as a personal computer, an embedded system performs one or a few pre-defined tasks, usually with very specific requirements. Since the system is dedicated to specific tasks, design engineers can optimize it, reducing the size and cost of the product. Embedded systems are often mass-produced, so the cost savings may be multiplied by millions of items.
- Handheld computers or PDAs are generally considered embedded devices because of the nature of their hardware design, even though they are more expandable in software terms. **This line of definition continues to blur as devices expand.**
- Physically, embedded systems range from portable devices such as MP3 players, to large stationary installations like traffic lights or factory controllers.

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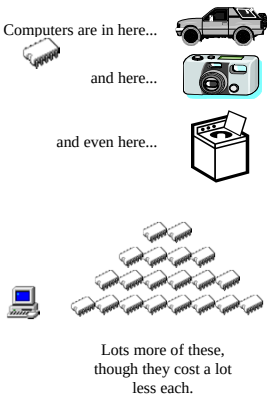
Embedded systems overview

- Embedded computing systems
  - Computing systems embedded within electronic devices.
  - General - Computing systems embedded in a specific application.
  - **Billions** of units produced yearly, versus millions of desktop units
  - Many-many per household and/or automobile



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A "short list" of embedded systems

Anti-lock brakes
Auto-focus cameras
Automatic teller machines
Automatic toll systems
Automatic transmission
Avionic systems
Battery chargers
Camcorders
Cell phones
Cell-phone base stations
Cordless phones
Cruise control
Curbside check-in systems
Digital cameras
Disk drives
Electronic card readers
Electronic instruments
Electronic toys/games
Factory control
Fax machines
Fingerprint identifiers
Home security systems
Life-support systems
Medical testing systems
Modems
MPEG decoders
Network cards
Network switches/routers
On-board navigation
Pagers
Photocopiers
Point-of-sale systems
Portable video games
Printers
Satellite phones
Scanners
Smart ovens/dishwashers
Speech recognizers
Stereo systems
Teleconferencing systems
Televisions
Temperature controllers
Theft tracking systems
TV set-top boxes
VCR's, DVD players
Video game consoles
Video phones
Washers and dryers

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Some common characteristics of embedded systems

- Single-functioned
  - Executes a single program, repeatedly
- Tightly-constrained
  - Low cost, low power, small, fast, etc.
- Reactive and real-time
  - Continually reacts to changes in the system's environment
  - Must compute certain results in real-time without delay

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Embedded Systems - Processors

Different types of embedded processors

- General Purpose – Pentium, Athelon, (Intel, AMD)
- Micro-controllers – e.g., PIC (Microchip), MSP430 (TI)
- Special Processors – e.g., TMS320 Series DSP (TI)
- Application Specific Instruction-Set Processors (ASIPs)

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General-purpose processors used in Embedded PC's

- Programmable device used in a variety of applications
  - Also known as "microprocessor"
- Features
  - Program memory
  - General datapath with large register file and general ALU
- "Pentium" one example, but there are hundreds of others – high performance embedded systems.

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Microcontroller

- Microcontroller features
  - On-chip peripherals
    - Timers, analog-digital converters, serial communication, etc.
    - Tightly integrated for programmer, typically part of register space
  - On-chip program and data memory
  - Direct programmer access to many of the chip's pins
  - Specialized instructions for bit-manipulation and other low-level operations
- For embedded control applications
  - Reading sensors, setting actuators
  - Mostly dealing with events (bits): data is present, but not in huge amounts
  - e.g., VCR, disk drive, digital camera (assuming SPP for image compression), washing machine, microwave oven

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Digital Signal Processors (DSP)

- For signal processing applications
  - Large amounts of digitized data
  - Data transformations must be applied fast
  - e.g., cell-phone voice filter ordecoder, digital TV, music synthesizer
- DSP features
  - Several instruction execution units
  - Efficient vector operations – e.g., add two arrays
    - Vector ALUs, loop buffers, etc.

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Application-specific processors

- Programmable processor optimized for a particular class of applications having common characteristics
  - smaller and simpler than their general-purpose counterparts, are able to run at higher clock frequencies, and are more energy efficient.

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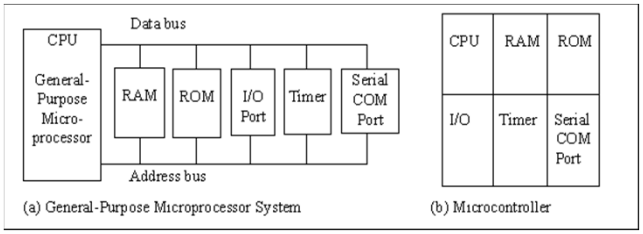
Microprocessor System vs. Microcontroller System



But, microcontrollers can also have external peripherals.

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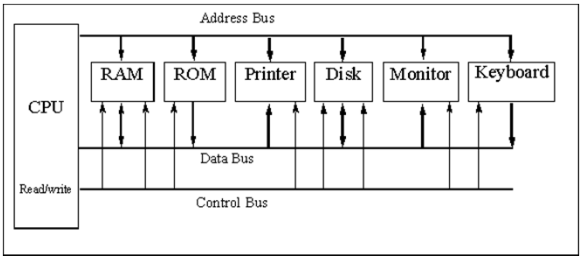
Micro-Computer



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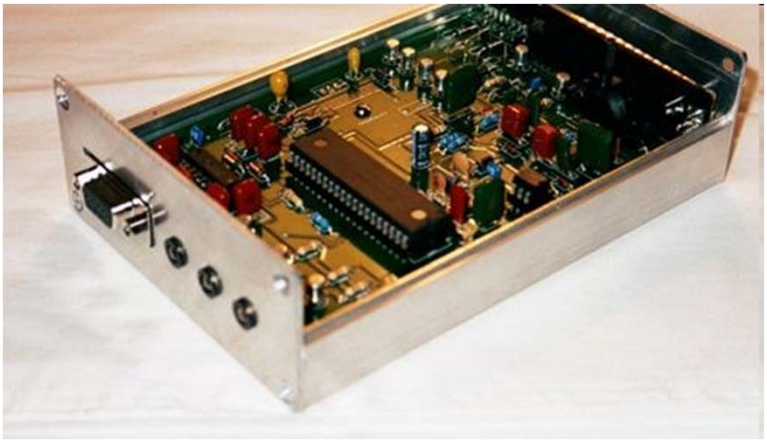
Embedded System – Example
DIY Megasquirt car ECU



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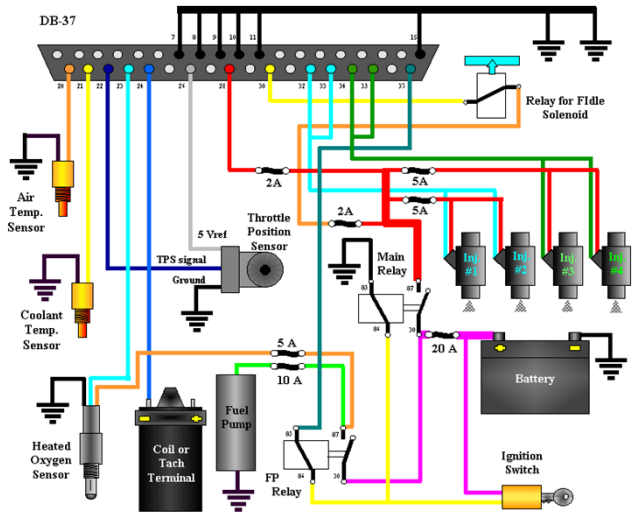
What does Megasquirt do?



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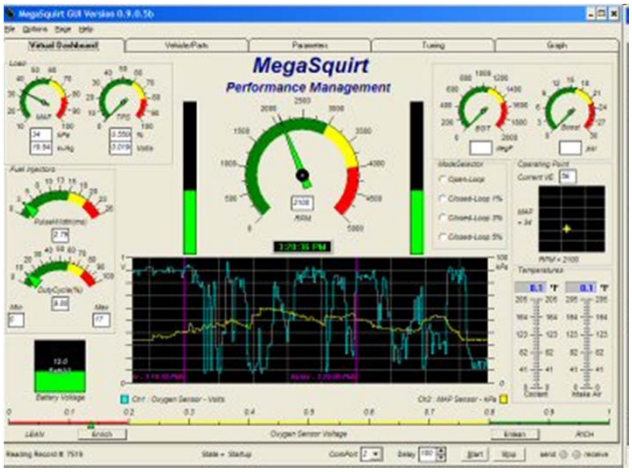
Tuning your car



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Embedded PC

- E.g., Beaglebone Black (similar to Raspberry PI)
  - Processor: AM335x 1GHz ARM® Cortex-A8
  - 512MB DDR3 RAM
  - 2GB 8-bit eMMC (on-board flash storage)
  - 3D graphics accelerator
  - NEON floating-point acce
  - 2x PRU 32-bit microcontr

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Embedded PC

- E.g., Advantech PCM-9562
  - Embedded Intel® Atom™ processor N450 Single Core/D510 Dual Core 1.66 GHz +
  - Supports up to 3 Intel GbE, 6 COM, and 2 Watchdog timer
  - Essentially a full-PC

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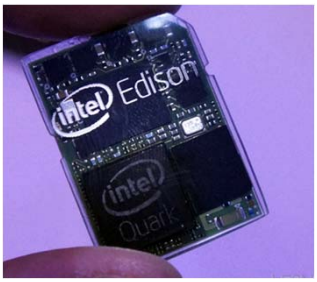
Embedded PC

- E.g., Intel Edison (SD card sized)
  - 22nm Quark dual-core processor (32-bit x86 system-on-chip with extra-low power consumption)
  - Wi-Fi module and Bluetooth 4.0.
  - runs on Linux and has its own app store



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Impact

- There are many more Embedded processors sold than PC processors.

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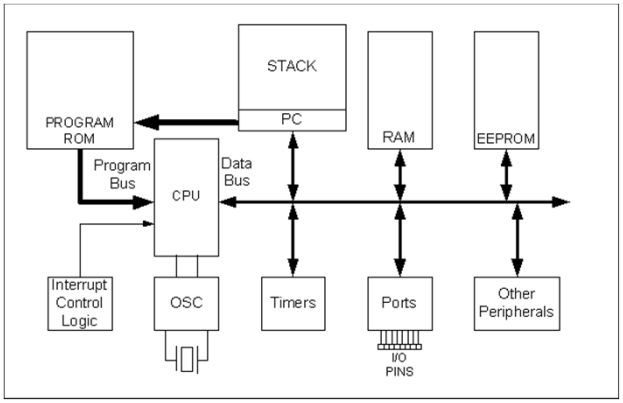
PIC Microcontroller



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