Lesson

VIA UNIVERSITY COLLEGE

Introduction
to
Hardware Oriented Programming

(HWP I1)

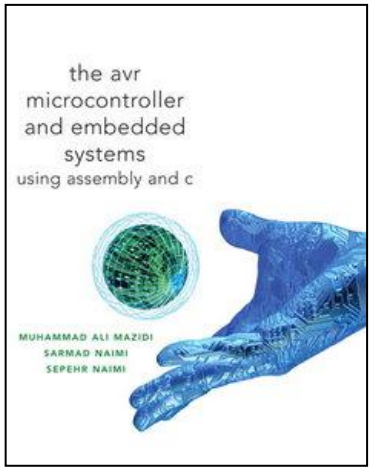
Aim of subject

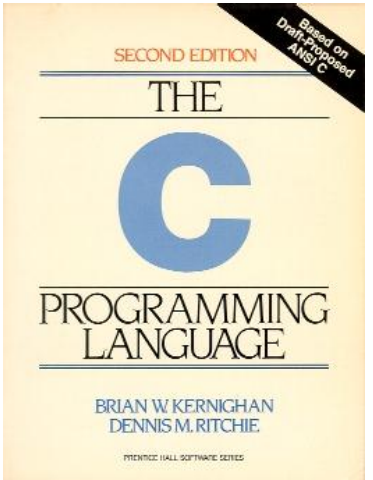
- To enable a student to understand the architecture of an embedded system
- To enable a student to design and program a low-level driver for some hardware in C/Assembler
- To enable a student to understand the difference between high- and low-level programming
- To enable the student to make a good documentation for an embedded system

HWP I1 Site in Study Net

- Can you login and see the room?

- Books
  - [Mazidi, 2011] The avr micro…
  - [Kernighan, 1988] The C programming… (can be found as pdf in Study net)



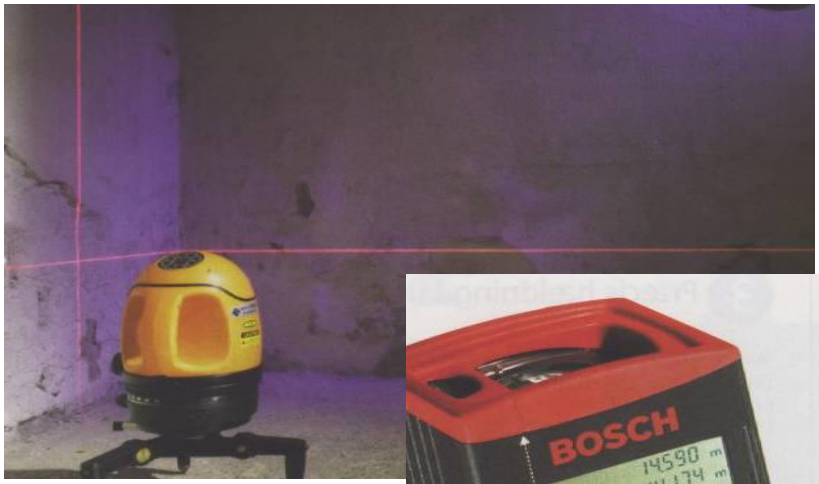


What do you know about hardware oriented programming?

- Discussion what do you know about?
  - Memory
  - Embedded systems
  - CPU's
  - Assembler
  - C/C++
  - make
  - Debuggers
  - peripherals
  - etc.

  (Use 10 minutes)

What is an embedded system?

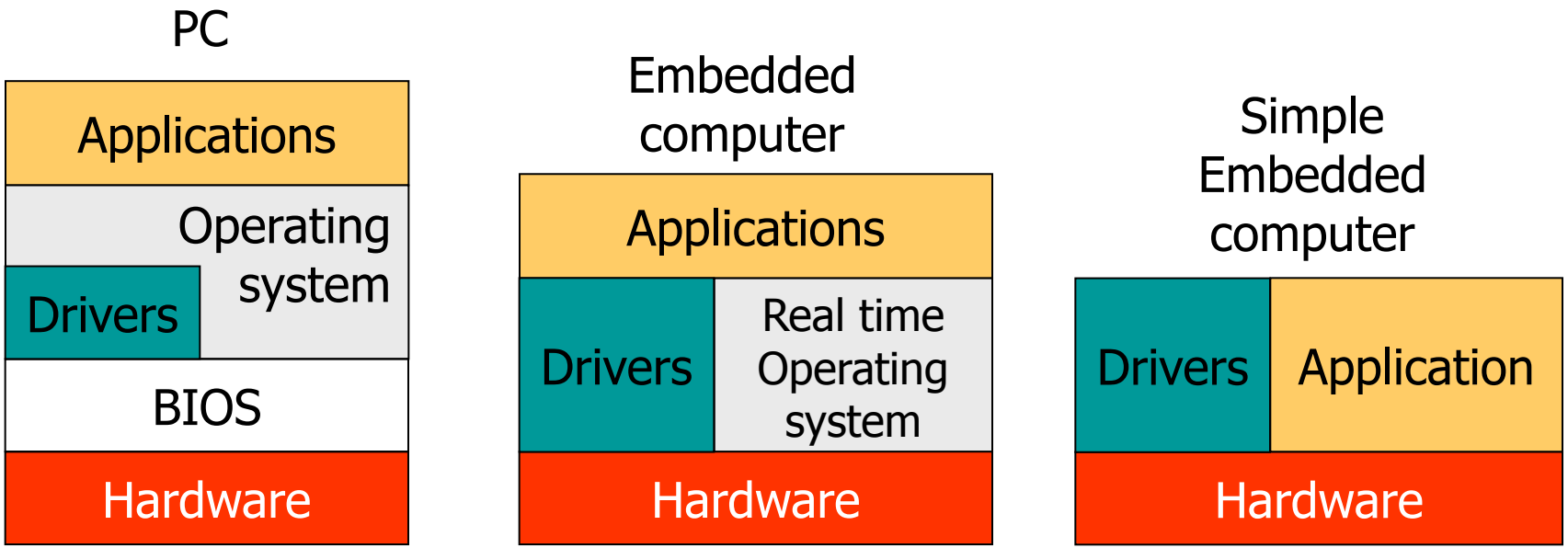


What is an embedded system

- Controls physical things
- Specialized computing
- Not user programmable
- Performs one specific task
- Replacement for digital electronic
- Functionality can be changed by software changes with the same hardware

- Pervasive Computing
  - Computers everywhere

Computer overview



Programming language overview

Processor independent

Portable

General

C++/C
Java Visual Basic
ADA...

C

Processor dependent

Efficient

ASM

Machine code

Hardware

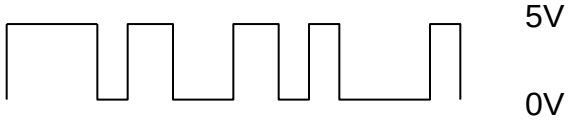
```
class DoSomething {
   private int voltage;
```

```
malloc(0x1000);
```

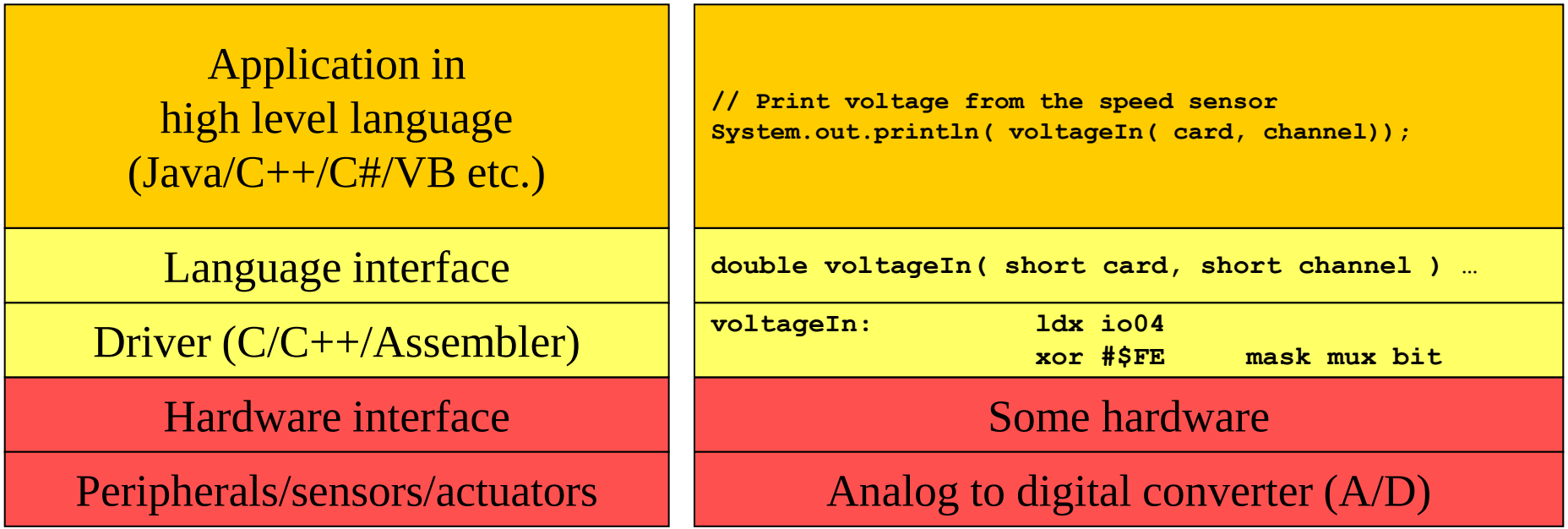
```
LDA       #00
STA       ,X        ;clear the counter
```

```
00 47 Fe 81 A3 11 01 AB
```

010101



Hardware Abstraction Layer (HAL)



What do speed/time mean?

Business and commercial systems	Hundreds of milliseconds/seconds
Distributed industrial systems	Tens of milliseconds
Distributed computing	Milliseconds
Operating systems	Hundreds of microseconds
Drivers	Tens of microseconds
Interrupt routines	Nano/Microseconds

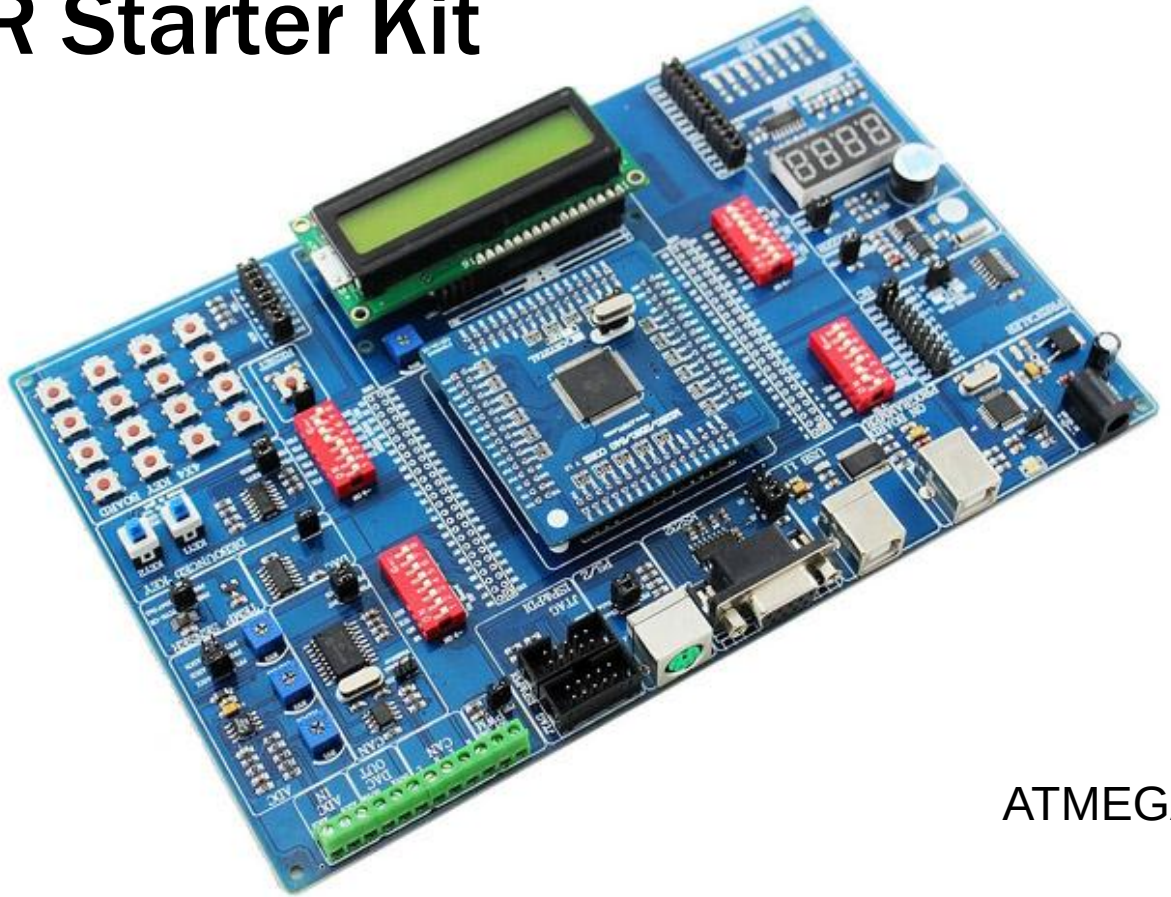
Software in embedded systems

- Contains all functionality
  - Hardware initialisation
  - Operating system
  - Hardware drivers
  - Application software
  - Automatically starts up
- Can include
  - User interface
  - LAN connection
  - Real-time OS
  - Etc.

You will make drivers for

- Simple LEDs
- RGB Led
- RC-Servo
- H-Bridge (motor speed and direction)
- Digital Temperature sensor
- Etc.

AVR Starter Kit



ATMEGA1280 MCU

http://www.edcbase.com/product/showproduct.php?lang=en&id=42

AVR Starter Kit

- On-board AVRISP MKII USB interface
- On-board external ISP, JTAG Programming interface
- Atmega1280 chip, rich on-chip resource
- USB1.1 communication interface
- RS232 serial communication interface
- 74HC4060 Variable Frequence
- 4X4 Keyboard
- 4in1 7-segment LED display drived by HC595
- 8 separate LED
- 1 active buzzer, also can be accessed by passive buzzer
- Calendar clock DS1337
- 1 I^2C bus EEPROM AT24C01
- Analog Temperature Sensors TC1047A
- SPI bus digital Temperature Sensor TC72
- Hardware debounce circuitry
- CAN bus circuit
- Digital-analog conversion circuit constituted by the MCP4922
- PS/2 Keyboard connector
- Crystal oscillator and reset circuit
- Optional active crystal oscillator circuit
- AD voltage adjustment potentiometer
- Potentiometer voltage reference and voltage under test adjust
- 4 8-bit DIP switch
- 100Pin MCU pins marking all the external terminal
- 12864 LCD Interface
- 1602 LCD Interface

Project opportunities

- Driver for scanned keyboard and 7-segment display
- Other suggestions

Everything is possible as long as you use the:

Atmel Microcontroller starter kit (AVR RISC computers)

Remember

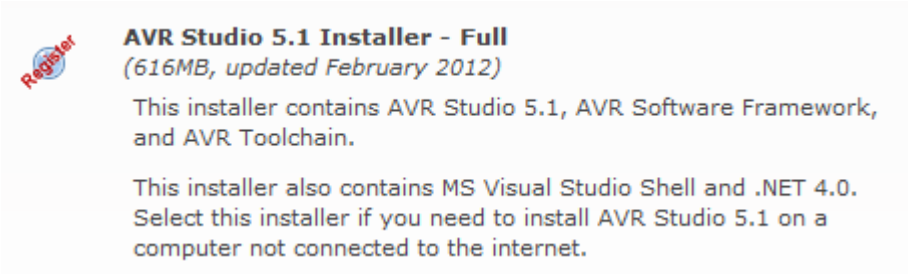
- Make a Log book during the course
- Document what you are doing along the way

Homework

- [Mazdi, 2011] Section 01
  - Numbering and coding systems
- Solve problems 1-10
  - your solution **must** be handed in
    No later than Tueday, February 28

Install Software tools (1)

- AVR Studio 5
- http://www.atmel.com/tools/ATMELAVRSTUDIO.aspx
- Take the full installation is you not have MS-Visual Studio on your computer



- Registration is free ☺

Install Software tools (2)

- Doxygen
  - http://www.stack.nl/~dimitri/doxygen/download.html#latestsrc