



CENG4480

Lecture 01: Introduction

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香港中文大學

The Chinese University of Hong Kong

Overview



Important Notes

Grading System

Introduction to Embedded Systems (ES)

Course Overview

Overview



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Important Notes



- ▶ Be **PUNCTUAL** to class
- ▶ Keep **QUIET** during class, unless
 - ▶ you are raising questions to teachers or tutors
 - ▶ during in-class activities



Zero Tolerance

- ▶ Plagiarism, cheating, misconduct in test/exam will be reported to the Faculty Disciplinary Committee for handling.

Penalty

- ▶ **Zero** marks for the concerned assignments/test/exam/whole course, reviewable demerits, non-reviewable demerits, suspension of study, dismissal from University.

University Guidelines to Academic Honesty

- ▶ <http://www.cuhk.edu.hk/policy/academichonesty/>

Student/Faculty Expectations



- ▶ Let's join hands to create a **positive**, **respectful**, and **engaged** academic environment inside and outside classroom.
- ▶ Full version of Student/Faculty Expectations on Teaching and Learning
- ▶ <http://www.erg.cuhk.edu.hk/upload/StaffStudentExpectations.pdf>

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- ▶ Homeworks (20 marks)
- ▶ 9 Labs (25 marks)
- ▶ Midterm Exam (15 marks)
- ▶ Final Exam (40 marks)

A student must gain at least 50 marks in order to pass the course.

Grading System – Tips



- ▶ Individual lab (academic honesty!)
- ▶ About Absence in mid-term
- ▶ ~~Class attendance: in-class quiz~~
Ex: http://www.cse.cuhk.edu.hk/~byu/doc/quiz_example.pdf
- ▶ Lecture review
- ▶ Bonus question
- ▶ Please read your marks from Blackboard (<https://blackboard.cuhk.edu.hk>)

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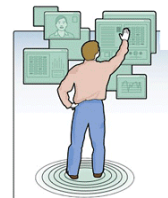
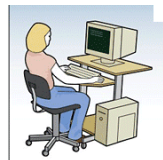
Course Overview

Computing System



- ▶ Computing systems are everywhere
- ▶ Most of us know **general-purpose computers**
 - ▶ Laptop
 - ▶ PC
 - ▶ Server
 - ▶ Mainframe
 - ▶ Supercomputer
- ▶ But there is another type of computing system; And it is far more **common**

An Era of Embedded Computing Systems



Computing system type	Mainframe	Mini computer	Personal computer	Embedded computer
Era	1950s on	1970s on	1980s on	2000s on
Form factor	Multi-cabinet	Multi-board	Single board	Single chip
Owner type	Corporates	Departments	Persons	Things
Users/system	1000s ~ 100s	100s ~ 10s	10s ~ 1s	1s ~ 1/10s
Cost	\$1 Ms +	\$100 Ks +	\$10Ks – \$1Ks +	\$100s – \$1s +
Total units	10Ks +	100Ks +	Billions +	Trillions +

Embedded System Overview



Definition

- ▶ A short name for **embedded computing system**
 - ▶ Different from general-purpose computing system, such as desktop computers, it is usually embedded in a larger physical system
 - ▶ Carry **one or a fixed set** of specific tasks by design or usage
-
- ▶ Nearly any computing system other than laptop, desktop, server, mainframe, and supercomputer
 - ▶ About 50 per household and per automobile
 - ▶ Billions of units produced yearly, versus millions of desktops

Computers are in here...



and here...



and even here...



Embedded System Examples



- Consumer electronics
 - Digital camera and camcorder
 - Cell phone
 - CD player
 - Wireless router
 - TV
 - Blu-ray player
 - Microwave oven
 - USB key
 - Remote control
 - Digital watch and clock
- ...



Embedded System Examples



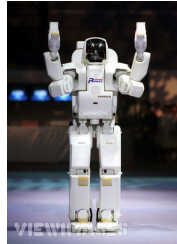
- Also in your desktops and laptops
 - Graphics card
 - Sound card
 - Network card
 - Hard disk
 - DVD drive
 - Keyboard, mouse
 - Touch pad
 - LCD monitor
 - Even inside laptop battery
 - ...



Embedded System Examples



- In robots
 - Vision system
 - Arm and leg control
 - ...
- In medical instruments
 - Blood pressure monitor
 - Diabetes monitor
 - ...
- In telecommunications
 - Internet switch and router
 - Mobile phone base station
 - ...



Embedded System Examples



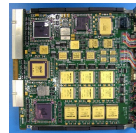
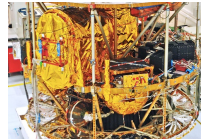
- In aircraft
 - Auto pilot system
 - Communication system
 - ...
- In watercraft
 - Navigation system
 - Radar system
 - ...
- In automobile
 - Engine control system
 - Anti-lock braking system (ABS)
 - Navigation system
 - Collision protection system
 - ...



Embedded System Examples



- In space shuttle
 - Positioning system
 - Communication system
 - Navigation systems
 - ...
- In satellite
 - Communication system
 - Power control system
 - ...
- In Mars rover
 - Automatic driving system
 - Automatic lab system
 - ...



Characteristics of Embedded Systems



Limited functions

- ▶ Doing a specific set of tasks repeatedly
- ▶ High-end embedded systems are often multi-function systems
- ▶ Cell phone, slate ...

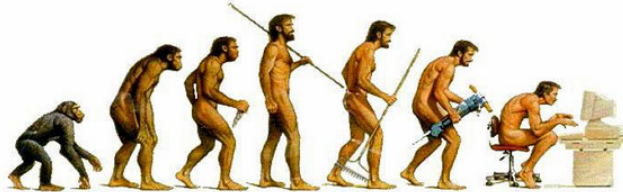
Tightly constrained

- ▶ Low cost, energy efficient, small, fast, etc.
- ▶ Usually must meet the performance requirement (such as speed)

Reactive and even real-time

- ▶ Continually reacts to changes in the system's environment
- ▶ Some systems must compute certain results in real-time without delay
- ▶ ABS, auto-pilot system ...

Tools of the Information Age



- ▶ **Information** is the center of the Information Age
- ▶ Information is any knowledge, and one possible method to represent information is by **data** which are quantities with or without natural physical meanings.
- ▶ Embedded system is used to collect, convert, store, protect, process, transmit, retrieve, and share information
- ▶ Human spend more time to design and let embedded system to do tedious and dangerous jobs

Companies Developing ES



Develop ES **applications**

- ▶ Microsoft, Google, telecom companies, banks ...

Develop ES

- ▶ IBM, Apple, Samsung, NEC, Philips, Oracle, Dell, HP, Sony, Nokia, Cisco, Huawei, Lenovo ...

Develop **IC** for ES

- ▶ Intel, AMD, TI, ST, Qualcomm, Broadcom, Xilinx ...

Develop **design automation tools** for ES

- ▶ Cadence, Synopsys, Mentor Graphics ...

Many companies work in multiple areas instead of one



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Overview – Part A



How to build up a Robot?



Overview – Part A

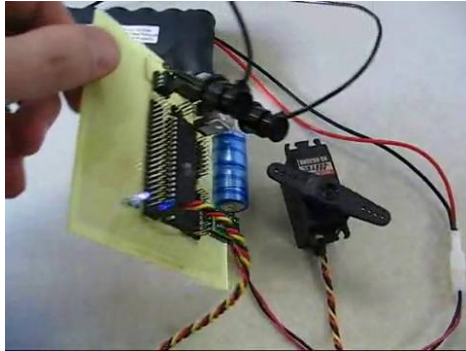


A1 Sensors

- ▶ Use of different sensors and their characteristics

A2 Op Amps and Analog Interfacing

- ▶ How to connect sensors to systems



Sensor demo (<http://www.youtube.com/watch?v=9NEiBDBXFEQ>)

Overview – Part A



A3 Analog-to-digital conversions ADDA

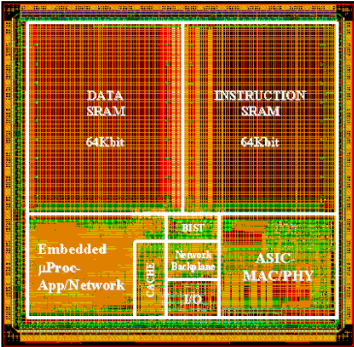
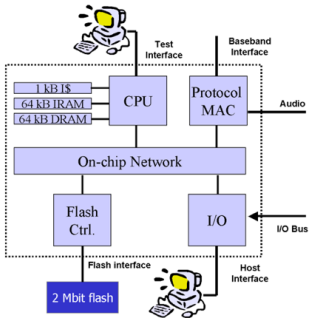
- ▶ Internal operations of different ADDA devices

A4 PID controller

- ▶ feedback control of motors



Overview – Part B



How to design an embedded system?

Overview – Part B

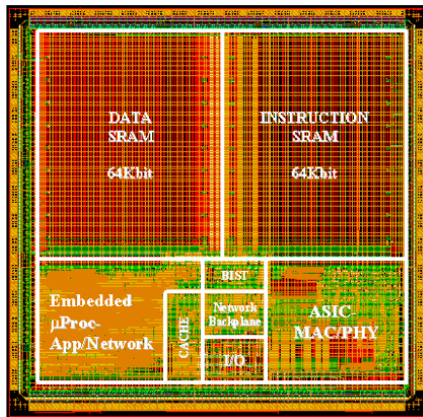


B1 HW/SW Co-design

B2 Memory

B3 Clock

B4 Design Style (Optional)



Overview – Project Demos



- ▶ **Demo 1: Self-Balancing Robot**
<https://youtu.be/dQWATsLa30g>
- ▶ **Demo 2: Robot Car w. Color Sensor**
<https://youtu.be/PKCPdWjZCqY>
- ▶ **Demo 3: Robot Hand**
<https://youtu.be/ai94rHHuaXc>
- ▶ **Demo 4: Robot**
<https://youtu.be/1D0e7SS85Xc>



- ▶ <https://www.arduino.cc/>
- ▶ <https://youtu.be/nL34zDTPkcs>

The screenshot shows the Arduino website homepage with a teal header. The header contains the Arduino logo, navigation links (HOME, BUY, SOFTWARE, PRODUCTS, EDUCATION, RESOURCES, COMMUNITY, HELP), and utility icons (search, cart, sign in). The main content area is divided into several sections:

- WHAT IS ARDUINO?**: A section featuring an image of an Arduino Uno board and three buttons: "BUY AN ARDUINO" (with a shopping cart icon), "LEARN ARDUINO" (with a bell icon), and "DONATE" (with a heart icon).
- BLOG**: A section with a "BLOG" label, an image of a function generator, and the text "BUILD YOUR OWN ARDUINO-POWERED PORTABLE FUNCTION GENERATOR".
- FREE SHIPPING IN AUGUST!**: A promotional banner with an orange background, clouds, and a box with an Arduino logo being lifted by a parachute. Text: "For all orders over €100 on the EU Store and \$120 on the U.S. Store."
- MKR GSM 1400**: A section with a "BLOG" label, an image of the MKR GSM 1400 board, and text: "THE FUNCTIONALITY OF THE ZERO PLUS GLOBAL GSM CONNECTIVITY! SHOP NOW".
- ARDUINO CREATE**: A section with the Arduino logo and text: "Write code, make IoT projects, and access cool tutorials!".