



INTEGRATED TECHNICAL EDUCATION CLUSTER
AT ALAMEERIA

E-626-A

Real-Time Embedded Systems (RTES)

Lecture #1

Introduction to Embedded Systems

Instructor:

Dr. Ahmad El-Banna



Agenda



Course Objectives



Course Information



Introduction to Embedded System

Course Objectives

- ***Determine and analyze the concepts and principles of real-time systems and definition of embedded systems.***
- ***Build/construct an embedded system around a PIC microcontroller with evaluating embedded system performance, correctness, and speed.***
- ***Perform continuation of system performance evaluation.***
- ***Conduct evaluation performance analysis.***

Course Information

Instructor:	Dr. Ahmad El-Banna, http://bu.edu.eg/staff/ahmad.elbanna Office: Room #305 Email: ahmad.elbanna@feng.bu.edu.eg ahmad.elbanna@ejust.edu.eg
Lectures:	Sunday, 12:30 -14:15 Lecture notes are found at: http://bu.edu.eg/staff/ahmad.elbanna-courses/12134
Office Hours:	Sunday (14:15~15:30)
T.A.:	Eng.
Texts/Notes:	<ul style="list-style-type: none">• John Catsoulis, Designing Embedded Hardware, 2005.• Qing Li and Carolyn Yao, Real-Time Concepts for Embedded Systems, 2003.• Michael Barr, Programming Embedded Systems in C and C++, 1999.
Assignments	<ul style="list-style-type: none">• Assignment #1 (P1:P4), 7th week.• Assignment #2 (P5:P8), 14th week.

Lectures List

- **Weeks 1:3**
 - *Determine and analyze the concepts and principles of real-time systems and definition of embedded systems.*
- **Weeks 4:7**
 - *Build/construct an embedded system around a PIC microcontroller with evaluating embedded system performance, correctness, and speed.*
- **Weeks 8:10**
 - *Perform continuation of system performance evaluation.*
- **Weeks 11:14**
 - *Conduct evaluation performance analysis.*
- **Week 15**
 - *Course close and feedback*

INTRODUCTION TO EMBEDDED SYSTEMS



(6)

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Examples of Embedded Systems



What's an Embedded System?

- An ***embedded system (ES)*** is a combination of computer hardware and software, and perhaps additional mechanical or other parts, designed to perform a ***specific function***.
- A good example is the microwave oven. Almost every household has one, and tens of millions of them are used every day.
- Embedded system is a component within some larger system.
- For example, modern cars and trucks contain many embedded systems.
- If an embedded system is designed well, the existence of the processor and software could be completely unnoticed by a user of the device. Such is the case for a microwave oven, VCR, or alarm clock.

Embedded vs. Standalone Systems

- Embedded Systems is in direct contrast to the personal computer. It too is comprised of computer hardware and software and mechanical components (disk drives, for example).
- However, a personal computer is *not* designed to perform a *specific function*. Rather, it is able to do many different things.
- Many people use the term ***general-purpose computer*** to make this distinction clear.
- At the possible risk of confusing you, it is important to point out that a general-purpose computer is itself made up of numerous embedded systems.
- For example, the computer consists of a keyboard, mouse, video card, modem, hard drive, floppy drive, and sound card—each of which is an embedded system.

Real-Time Systems

- One subclass of embedded systems is real-time systems.
- As commonly defined, *areal-time system* is a computer system that has timing constraints.
- In other words, a real-time system is partly specified in terms of its ability to make certain calculations or decisions in a timely manner.
- These important calculations are said to have deadlines for completion.
- And, for all practical purposes, a missed deadline is just as bad as a wrong answer.

Hard and Soft Real-Time Systems

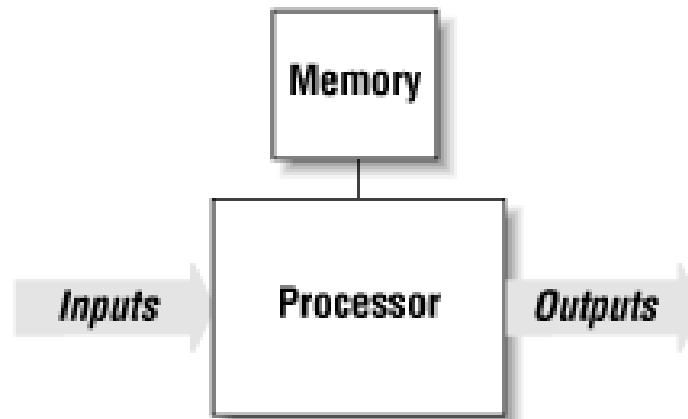
- The issue of what happens if a deadline is missed is a crucial one.
- For example, if the real-time system is part of an airplane's flight control system, it is possible for the lives of the passengers and crew to be endangered by a single missed deadline.
- However, if instead the system is involved in satellite communication, the damage could be limited to a single corrupt data packet.
- The more severe the consequences, the more likely it will be said that the deadline is "**hard**" and, thus, the system a *hard real-time system*.
- Real-time systems at the other end of this continuum are said to have "**soft**" deadlines.

Variations on the theme

- Unlike software designed for general-purpose computers, embedded software cannot usually be run on other embedded systems without significant modification.
- This is mainly because of the incredible variety in the underlying hardware.
- The hardware in each embedded system is tailored specifically to the application, in order to keep system costs low.
- As a result, unnecessary circuitry is eliminated and hardware resources are shared wherever possible.

A Generic Embedded Systems

- By definition all embedded systems contain a processor and software, but what other features do they have in common?
- Certainly, in order to have software, there must be a place to store the executable code and temporary storage for runtime data manipulation. These take the form of ROM and RAM, respectively.
- All embedded systems also contain some type of inputs and outputs. (u wave oven)



Design Requirements of ES

- Production cost
- Processing power
- Memory
- Development cost
- *Number of units*
- *Expected lifetime*
- *Reliability*

Criterion	Low	Medium	High
Processor	4- or 8-bit	16-bit	32- or 64-bit
Memory	< 16 KB	64 KB to 1 MB	> 1 MB
Development cost	< \$100,000	\$100,000 to \$1,000,000	> \$1,000,000
Production cost	< \$10	\$10 to \$1,000	> \$1,000
Number of units	< 100	100-10,000	> 10,000
Expected lifetime	days, weeks, or months	years	decades
Reliability	may occasionally fail	must work reliably	must be fail-proof

The range of possible values for each of the previous design requirements.

- For more details, refer to:
 - Chapter 1, Michael Barr, **Programming Embedded Systems in C and C++**, 1999.
- The lecture is available online at:
 - <http://bu.edu.eg/staff/ahmad.elbanna-courses/12134>
- For inquires, send to:
 - ahmad.elbanna@feng.bu.edu.eg