

First Lecture

Introduction to Embedded Systems & Microcontroller



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Introduction



- ✧ Embedded means something that is attached to another thing.
- ✧ An embedded system is a microcontroller based system which is designed to perform a specific task. For example, a fire alarm is an embedded system; it will sense only smoke.

Real-time systems



Real-time systems are defined as those systems in which the correctness of the system depends not only on the logical result of computation, but also on the time at which the results are produced.

Types of Real-Time Embedded System

- ❧ Hard Real-Time System: (Must response in Millisecond or Shorter) such as car air-bag control system
- ❧ Soft Real-Time System: (The allowed latency delay can be seconds rather than millisecond) such as microwave, and washing machine

Some applications of the Embedded System.

❧ *Smart Homes*

❧ *Offices*

❧ *Transportation*

❧ *Healthcare*

❧ *Industrial world*

❧ *Aerospace and Defense*

Various Application of Embedded System



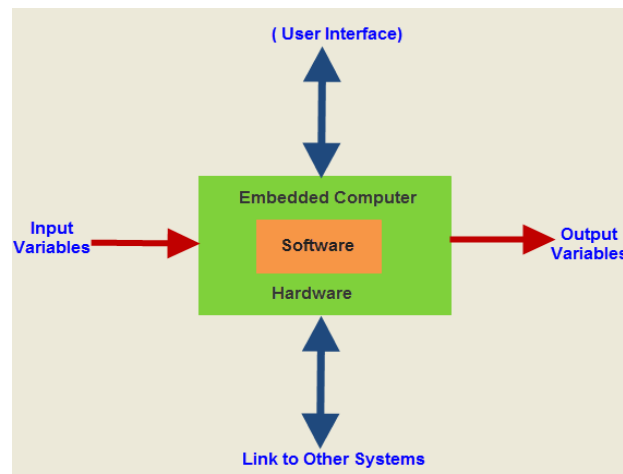
Advantages of Embedded System

- ❧ Small size and faster to load
- ❧ More specific to one task
- ❧ Easy to manage
- ❧ Low cost
- ❧ Spend less resources

Embedded System Basics



✧ The embedded system basics are the combination of embedded system hardware and embedded system software.



Embedded System Hardware

✧ The core of any embedded target is the electronic hardware – which resides on a Printed Circuit Board (PCB). The embedded development board is divided into five modules. They are Processor, Memory, Input devices, Output devices and Bus controllers.

Microcontroller (CPU)



✧ A Microcontroller is preferred to build small applications with precise calculation. Technically, a micro controller is an intelligent device that computes the tasks assigned by the user in an efficient manner.

Embedded System Software



✧ The software of an embedded system is written to execute a particular function. It is normally written in a high-level setup and then compiled down to offer code that can be stuck within a non-volatile memory in the hardware.

Microcontroller



✧ A microcontroller can be considered as self-contained system with a processor, memory and input/output peripherals can be used as an embedded system.

Microcontroller Vs. Microprocessor

- ❧ Modern embedded systems are often based on microcontrollers.
- ❧ A microcontroller is a Small Computer on a Single Chip (SCSC) containing a processor, memory, and programmable input/output peripherals, etc...

Microcontroller Vs. Microprocessor (I)

No.	Microcontroller	Microprocessor
1.	CPU, RAM, ROM, I/O, and Timer are all on a single chip	CPU is a standalone, RAM, ROM, I/O, and Timer are separate
2.	Fix amount of on-chip RAM, ROM, and I/O ports.	Designer can decide the amount of RAM, ROM, and I/O ports.
3.	Since memory and IO are internal, most of operation are internal instruction, hence speed is fast	Since memory and IO are external, each instruction will need external operation, hence it is relatively slower

Microcontroller Vs. Microprocessor (II)

No.	Microcontroller	Microprocessor
4.	Usually runs a single program, performing dedicated task(s)	Can run numerous programs depending users needs
5.	Cost of the entire system is low	Cost of the entire system is high
6.	is the heart of embedded systems	is the heart of computer systems
7.	Low power consumption	High power consumption
8.	Single purpose (controlling)	General purpose

Atmel Microcontrollers



According Atmel official website, there more than 500 modules of Atmel microcontroller available. Atmega328, which is used in Arduino Uno board, is one of Atmel Microcontroller family.

The ATmega328



- ❧ **The ATmega328P:** is a low power CMOS 8-bit microcontroller based on the AVR improved Reduced Instruction Set Computing (RISC) architecture.
- ❧ ATmega328P is high-performance Atmel picoPower 8-bit microcontroller which can be used as a main feature of any system

General Specifications of ATmega328 Microcontroller

Device Name	ATmega328P
Flash memory	32 Kbytes
SRAM	2 Kbytes
EEPROM	1 Kbytes
Pin Count	28 Pins
General purpose I/O lines	23 I/O pins
Max. Operating Frequency	16 MHz
CPU	8-bit AVR
General purpose working registers	32
Number of ADC Inputs	6-channel 10-bit A/D converter
Timers	3
Interface Type	I2C, SPI, USART
Temp. Range (deg C)	-40 to 85 °C
Operating Voltage (Vcc)	1.8-5.5 volts.

Arduino



✧ Arduino is a small microcontroller board with a USB plug to connect to computer and a number of connection sockets that can be wired up to external electronics, such as motors, relays, light sensors, laser diodes, etc.

Arduino Software



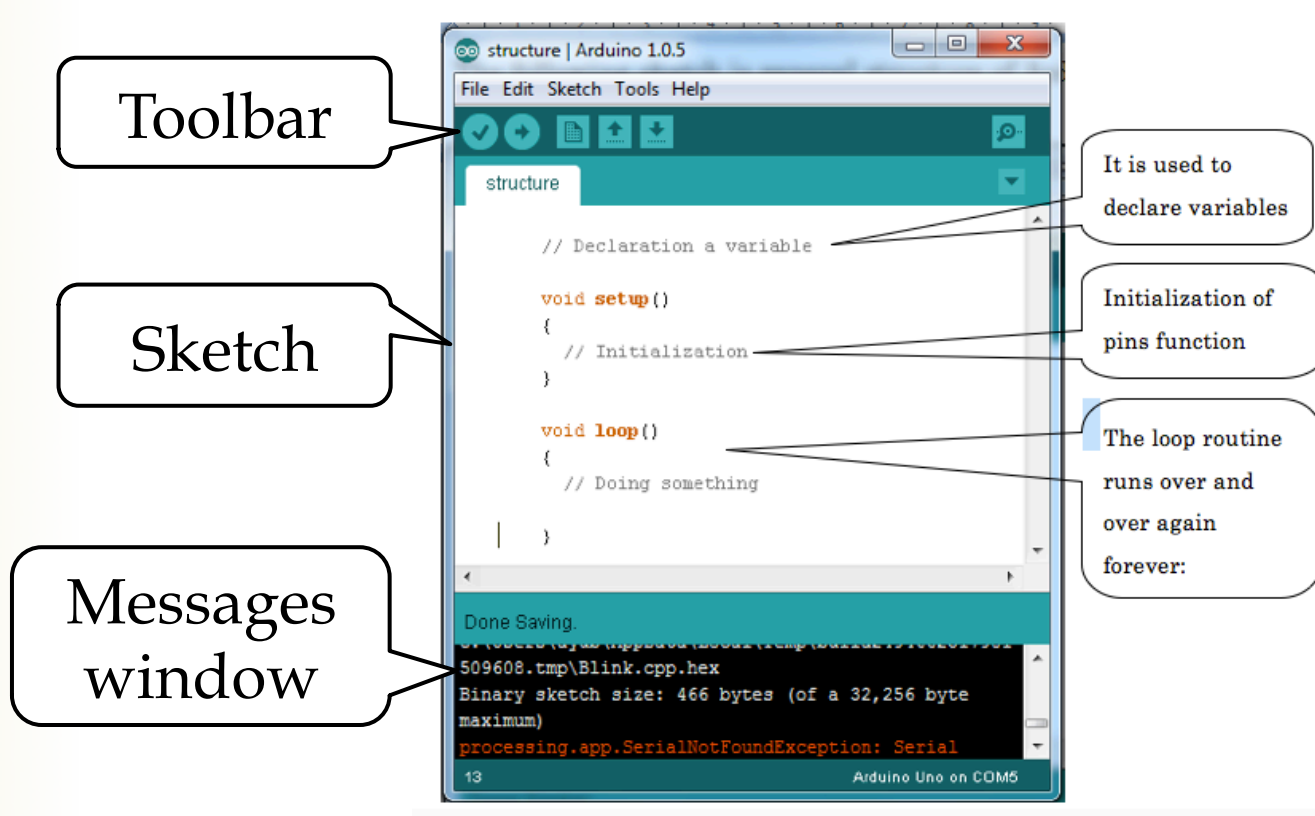
✧ Arduino is an open-source environment which makes it easy to write code and upload it to the Arduino development board. It operates on Windows, Mac OS X, and Linux.

Arduino Software

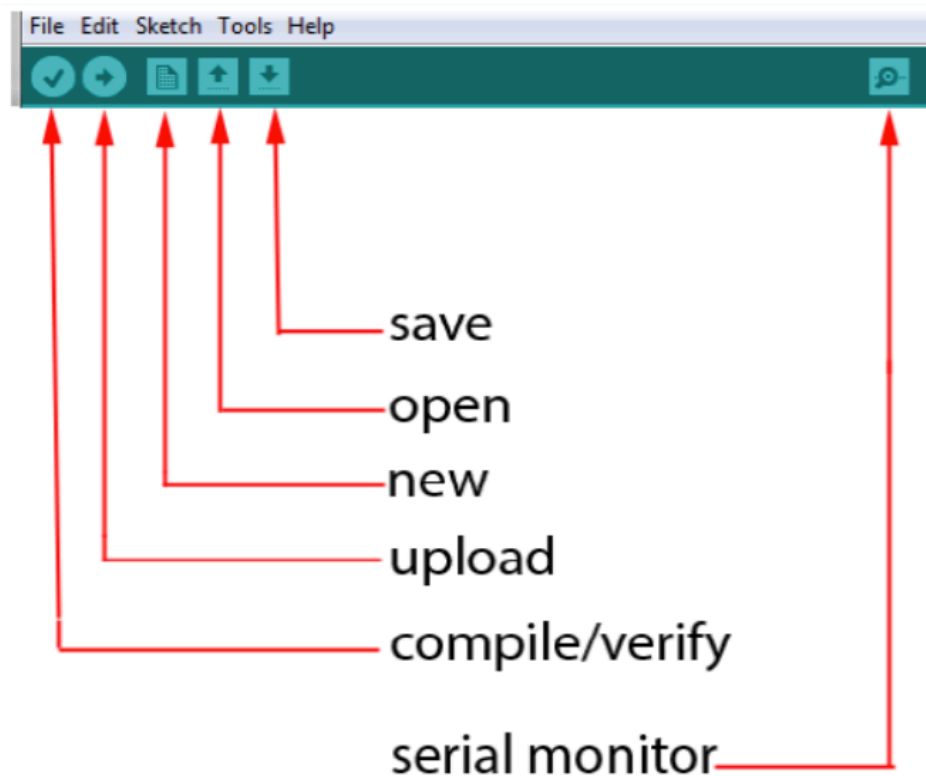


- ❧ The Arduino language is a modified of the C++ programming language, but it uses built-in libraries to simplify complex coding jobs to make it easier for users to pick up
- ❧ Arduino Software written is called **sketches**. These sketches are written in the text editor, which are saved with the file extension .ino.

Arduino Integrated Development Environment (IED)



The Arduino IDE



Arduino IDE



- ✧ **Verify:** Checks your code for errors.
- ✧ **Upload:** Compiles your code and uploads it to the Arduino board.
- ✧ **New:** Creates a new sketch.

Arduino IDE



- ❧ **Open:** Presents a menu of all the sketches in your sketchbook.
- ❧ Clicking one will open it within the current window.
- ❧ **Save:** Saves your sketch.
- ❧ **Serial Monitor:** used to receive serial data from the board and send the serial data to the board.

Selecting Board Type and Port

- ❧ You'll need to select the entry in the **Tools > Board** menu that corresponds to your Arduino or Genuino board.
- ❧ Select the serial device of the board from the **Tools > Serial Port** menu. This is likely to be COM3 or higher (COM1 and COM2 are usually reserved for hardware serial ports).

Thank You



End