CSE 331
Microprocessor Interfacing and Embedded System

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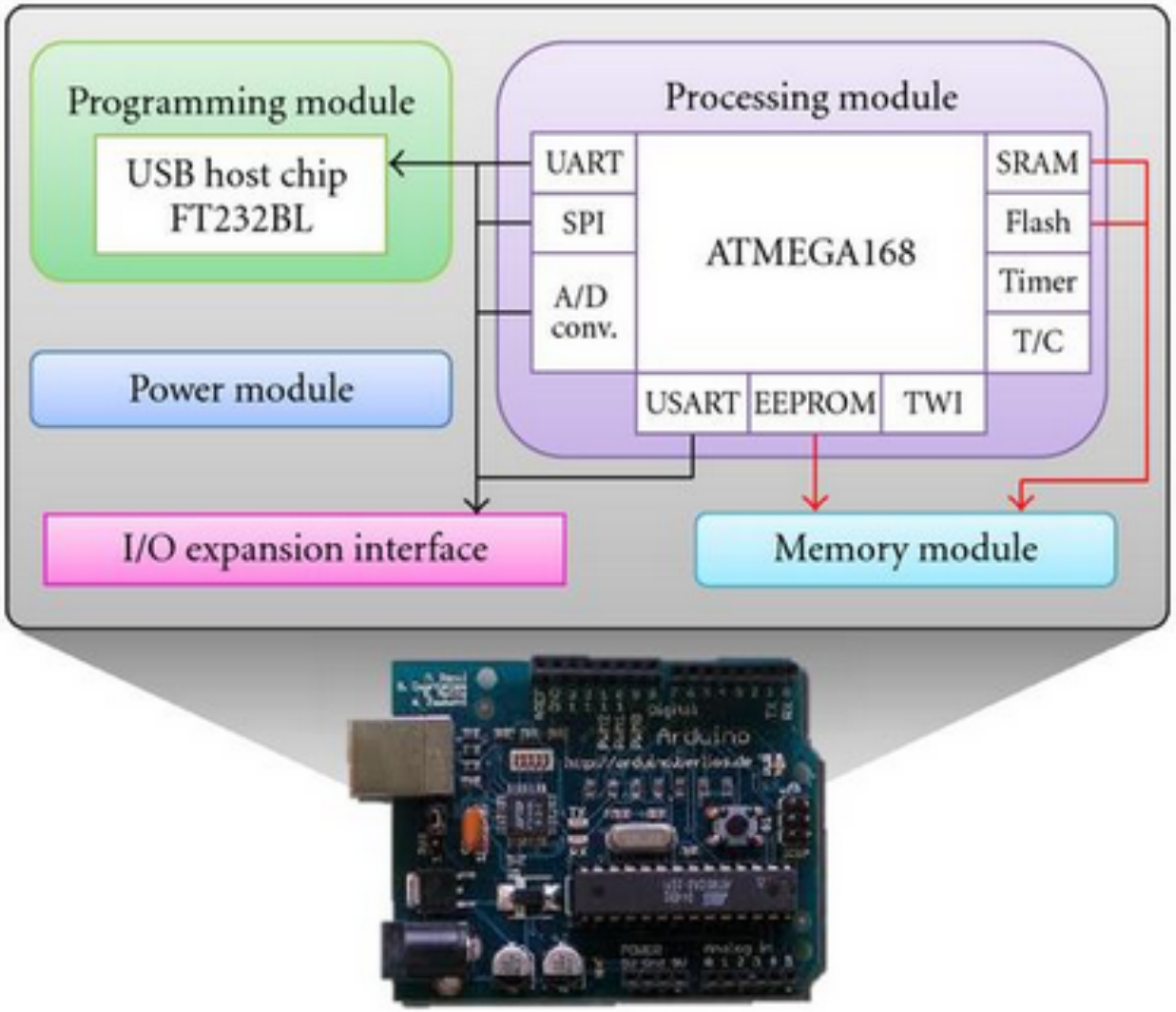
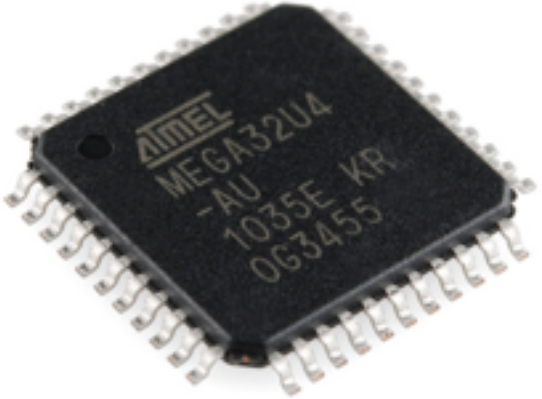
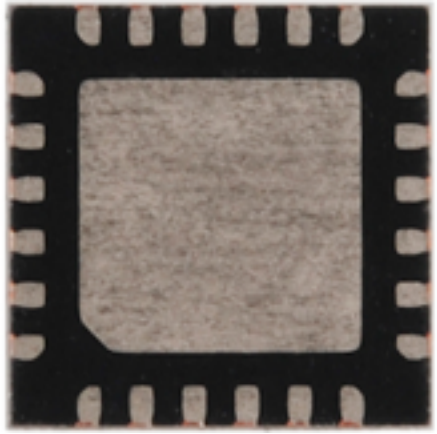
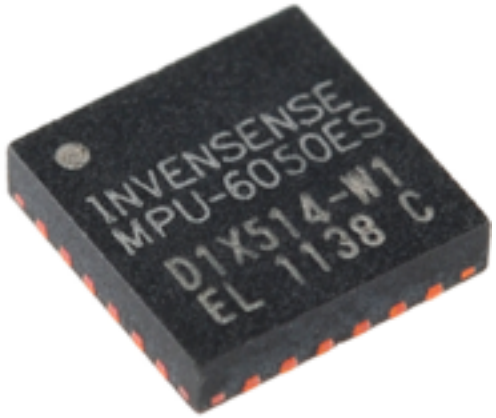
Microcontroller architecture



Category of microcontroller (packaging)







Features of a microcontroller

CPU – Microcontrollers brain is named as CPU. CPU is the device which is employed to fetch data, decode it and at the end complete the assigned task successfully. With the help of CPU all the components of microcontroller is connected into a single system. Instruction fetched by the programmable memory is decoded by the CPU.

Features of a microcontroller

Memory – In a microcontroller memory chip works same as microprocessor. Memory chip stores all programs & data. Microcontrollers are built with certain amount of ROM or RAM (EPROM, EEPROM, etc) or flash memory for the storage of program source codes.

Memory Types

- EEPROM - Electrically Erasable Programmable Read Only Memory

  Many microcontrollers have limited amounts of EEPROM on the chip. EEPROM seems more suited (becuase of its economics) for small amounts of memory that hold a limited number of parameters that may have to be changed from time to time. This type of memory is relatively slow, and the number of erase/write cycles allowed in its lifetime is limited.

Memory Types

- FLASH

  Flash provides a better solution than regular EEPROM when there is a requirement for large amounts of non-volatile program memory. It is both faster and permits more erase/write cycles than EEPROM.

Memory Types

- OTP - One Time Programmable

An OTP is a PROM (Programmable Read-Only-Memory) device. Once your program is written into the device with a standard EPROM programmer, it can not be erased or modified.

Features of a microcontroller

Input/output ports – I/O ports are basically employed to interface or drive different appliances such as- printers, LCD's, LED's, etc

Example : USART, UART etc

Serial Ports – These ports give serial interfaces amid microcontroller & various other peripherals such as parallel port.

Example : SPI,SCI etc

Features of a microcontroller

Timers – A microcontroller may be in-built with one or more timer or counters. The timers & counters control all counting & timing operations within a microcontroller. Timers are employed to count external pulses. The main operations performed by timers' are-

✓pulse generations,

✓clock functions,

✓frequency measuring,

✓modulations,

✓making oscillations, etc.

Features of a microcontroller

ADC (Analog to digital converter) – ADC is employed to convert analog signals to digital ones. The input signals need to be analog for ADC. The digital signal production can be employed for different digital applications (such as- measurement gadgets).

DAC (digital to analog converter) – this converter executes opposite functions that ADC perform. This device is generally employed to supervise analog appliances.

Category of microcontroller (bits)

- 8 bit Microcontrollers

executes logic & arithmetic operations

- 16 bit Digital Signal Controllers (DSC) and General Purpose Microcontrollers

executes with greater accuracy and performance in contrast to 8-bit.

- 32 bit Microcontrollers

is employed mainly in automatically controlled appliances such as office machines, implantable medical appliances, etc. It requires 32-bit instructions to carry out any logical or arithmetic function

Category of microcontroller (memory)

- External Memory Microcontroller – When an embedded structure is built with a microcontroller which does not comprise of all the functioning blocks existing on a chip it is named as external memory microcontroller. For illustration- *8031 microcontroller does not have program memory on the chip.*
- Embedded Memory Microcontroller – When an embedded structure is built with a microcontroller which comprise of all the functioning blocks existing on a chip it is named as embedded memory microcontroller. For illustration- *8051 microcontroller has all program & data memory, counters & timers, interrupts, I/O ports and therefore its embedded*

Category of microcontroller (instruction set)

- CISC: CISC is a Complex Instruction Set Computer. It allows the programmer to use one instruction in place of many simpler instructions.

- RISC: The RISC stands for Reduced Instruction set Computer, this type of instruction sets reduces the design of microprocessor for industry standards. It allows each instruction to operate on any register or use any addressing mode and simultaneous access of program and data.

RISC vs. CISC

```
MULT 2:3, 5:2
```

CISC

vs.

RISC

```
LOAD A, 2:3
LOAD B, 5:2
PROD A, B
STORE 2:3, A
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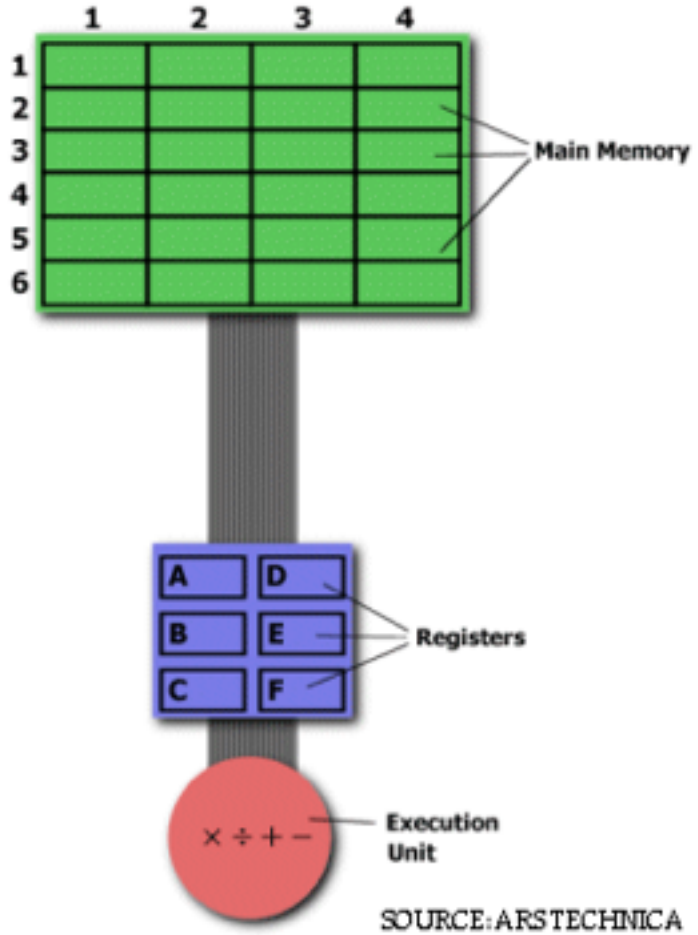


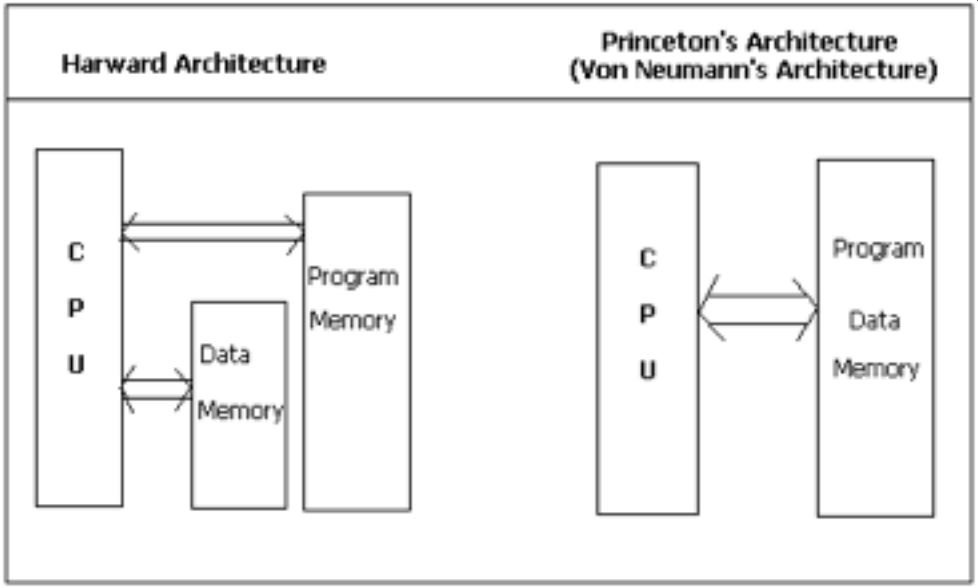
Category of MCU

Harvard architecture has a distinct memory address space for

i. Program mem & Data mem

à hence separate control signal[s], for data transfers from these two memories.

Princeton architecture → has a common memory space for both.



Microcontroller Manufacturers

- Analog Devices
- Atmel
- Dallas Semiconductor
- Freescale Semiconductor
- Hitachi Semiconductor
- Intel
- Microchip
- National Semiconductor
- Renesas
- STMicro
- Texas Instruments
- Zilog

Selection of MCU

- **Checklist**
  - 8/16/32 bit ALU
  - Max. power dissipation
  - Clock speed needed
  - Instructions set → RISC/CISC

Selection of MCU…

- **Checklist -**
  - Memory architecture
  - Memory size
  - Cache, memory management unit, DSP calculations
  - Internal PROM/…
  - I/O ports
  - Cost

What is your take?

- Identify a microcontroller from its family
- Understand their application
- Understand the category, types
- An idea about how to select a microcontroller