Sudesh Rajbhar · 3067 · ①

Page No.
Date. / /

Embedded Systems

*) Explain applications of Embedded System.

A)= Following are various applications in embedded system:

1. Consumer Electronics: CamCorders, Cameras.
2. Home Appliances : Washing Machine, Refrigerator.
3. Automotive Industry: Anti-lock breaking system (ABS), engine control.
4. Home Automation & Security system: Air conditioners, sprinklers, fire alarms.
5. Telecom: Cellular phones, telephone switches.
6. Computer Peripherals: Printers, Scanners.
7. Computer Networking systems: Network routers and switches.
8. Healthcare: EEG, ECG Machines.
9. Banking & Retail: Automatic Teller Machine, point of sales.
10. Card Readers: Barcode, smart card readers.

*) Give classification of Embedded System.

A)= Classification of embedded system:

(1) On Generation:

(A) First Generation:

- The embedded systems were built around 8 bit microprocessor like 8085 and 4 bit microcontroller.
- Simple in hardware circuit and software developed in assembly code.

(B) Second Generation:

- 16-bit microprocessor and 8 or 16-bit microcontrollers are used to assemble embedded systems.
- The instruction set is much more complex and powerful than 1st generation microprocessor / microcontroller.

(C) Third Generation:

- For advanced processor technology embedded system started making use of 32-bit microprocessor.
- The new concept in this generation is Digital Signal Processor (DSP) and Application Specific Integrated Circuits (ASICs).
- Processor are used in this generation are Intel Pentium and Motorola 68K.

(D) Fourth Generation.

- 64 bit microprocessor and 32 bit microcontroller.
- The new concept is System on chips (SOC), Multi-Core Processors, reconfigurable processors having high performance and tight integration into the embedded device market.
- It is highly performance real time Embedded Systems.

(2) Complexity and Performance:

(A) Small-Scale

- Application need is simple.
- Not Time Critical.
- Built around low performance & low cost, 8 or 16 bit microprocessor.

(B) Medium-Scale.

- Hardware and software requirements are slightly difficult.
- Built around medium performance and low cost.
- They usually contain ES for functioning.

(C) Large-Scale.

- Hardware & Software are difficult.
- 32 or 64 bit RISC microprocessor / controller.

(3) On Deterministic Behaviour.

- Real Time Systems.
- Hard & Soft.

(4) On Trigerring.

*) Explain characteristics of Embedded systems.

A) = Embedded systems possess some specific characteristics below:

(1) Application & Domain Specific.
- Certain functions developed for a specific task i.e. washing.
- Certain E.S. are of a domain e.g. Hearing aid → Signal process

(2) Reactive & Real Time
- Timing Behaviour should be deterministic.
- Designed to react to events that occur in nearby environ.
- Use sensors for inputs & actuators for functionality.
- No Deadline for tasks.

(3) Operation in Harsh Environment.
- Designed to operate in deserts or Antarctica.
- Capable of sustaining the environmental conditions.

(4) Distributed.
- May be part of larger system.
- Independent of each other but work for a larger system.

(5) Small Size and weight.
- Application demand small sized and low weight products
- Small is beautiful.

(6) Power Concerns.
- Designed by considering power management.
- If more heat is dissipated then additional units like sinks & cooling fans are added to circuit.

3067_Sudesh (5)

Page No.:
Date: / /

*) Distinguish: RISC vs CISC.

RISC	CISC
(1) Lesser Number of Instructions.	(1) Greater number of instructions.
(2) Instruction pipelining and increased execution speed.	(2) Generally no instruction pipelining feature.
(3) Orthogonal instruction.	(3) Non-Orthogonal set.
(4) Large number of registers available.	(4) Limited number of general purpose registers.
(5) Single, fixed length.	(5) Variable length instruction.
(6) Harvard Architecture	(6) Von-Neumann Architecture.

* Distinguish: Microprocessor and Microcontroller.

Microprocessor	Microcontroller
(1) A silicon chip representing a central processing unit for arithmetic as well as logic operations.	(1) It is highly integrated chip contains CPU, RAM, special and general purpose arrays, FLASH for storage.
(2) Limited power saving.	(2) Lot of power saving.
(3) No built-in I/O port.	(3) Contain I/O port.
(4) Most of time general purpose	(4) Application oriented or domain specific.
(5) High end market, performace is required.	(5) Performance not so -critical Market.

*) Distinguish: Harvard Architecture & Von-Neumann.

Harvard Architecture	Von-Neumann Architecture.
(1) Seperate buses for instruction and data fetching.	(1) Single shared common bus for instruction and data fetching.
(2) Easier to pipeline, for achieving high performance.	(2) Low performance as compared to Harvard Architecture.
(3) Comparatively high cost.	(3) It is cheaper.
(4) Data Memory and prog. memory are stored physically in different locations, no chances exist for accidental corruption of program memory.	(4) Accidental corruption of program memory may occur if data memory and prog. memory are stored physically in same chip.

*> Explain Endianness & its types.

A)= -Endianness specifies the order in which data is stored in the memory by processor operations in a multi-byte system.
-Based on Endianness processors can be of 2 types:-

Types of Endianness Processors:
1. Little Endian Processors.
2. Big Endian Processors.

1. Little Endian - Means lower order data byte is stored in memory at lowest address and higher order data byte at highest address.

2. Big Endian - Means higher order data type is stored in memory at lowest and lower order data byte is stored.

Little Endian:

Byte address +0	Byte 0	0* 20000 (Base Address)
Byte address + 1	Byte 1	0* 20001 (Base Address+1)
Byte address+2	Byte 2	0* 20002 (Base Address +2)
Byte address + 3	Byte 3	0* 20003 (Base Address+3)

Big Indian

Byte address + 0	Byte 3	0* 20000 (Base Add.)
Byte address + 1	Byte 2	0* 20001 (Base Add. +1)
Byte address + 2	Byte 1	0 * 20002 (Base Add. +2)
Byte address +3	Byte 0	0* 20003 (Base Add. +3)

3067_Sudesh (8)

*) What is ASIC.

A)= (1) ASIC is a microchip design to perform a specific and unique application.

(2) Application Specific Integrated Circuit.

(3) Most of the ASICs are proprietary (which having some trade name) products, it is referred as ASSP (Application Specific Standard Products).

(4) As a single Chip ASIC consumes a very small area in total system in total systems. Thereby helps in design of smaller system with high capabilities.

(5) The developers of such chips may not be interested in revealing internal detail of it.

3067_Sudesh (9)

Page No.:
Date: / /

*) Explain PLD, CPLD & FPGA.

A)= (1) Programmable logic Devices (PLD's)

- A PLD is an electronic component and it is used to construct digital circuits which are reconfigurable.

- A logic gate has a fixed function but a PLD does not have a defined function at time of manufacture.

- PLDs offers customers a wide range of logic capacity, features, speed, voltage characteristics.

- PLDs can be reconfigured to perform any number of various functions at any time.

- A variety of tools are available for designers of PLDs which are inexpensive and help to develop, simulate & test

(A) CPLD (Complex Programmable logic device).

- CPLDs offer much smaller amount of logic upto 10000 gates.
- It is ideal for critical control CPLDs, having very predictable timing characteristics.
- Low amounts of power.

(B) FPGAs (Field Programmable Gate Arrays).

- It offers highest amount of performance as well as highest logic density.
- FPGAs are used in variety of applications ranging from data processing and storing to instrumentation, telecommunications, digital signal processing.

3067_Sudesh (10)

*) Distinguish : FPGA vs CPLD.

CPLD	FPGA
(1) Provides Minimum logic resources.	(1) Provides a massive amount of logic resources and storage elements to create complex system.
(2) Cost effective	(2) More expensiven than CPLD.
(3) Made of large blocks.	(3) Made of tiny blocks.
(4) Uses EEPROM (Non-volatile)	(4) Uses RAM (Volatile)
(5) Easier to predict the delays.	(5) Not easy to predict the delays.
(6) Consumes low power.	(6) Consumes more power.
(7) More secure.	(7) Less secure.
(8) Small to Medium Scale Applications.	(8) Complex Apps.

*) Advantages of PLD.

A)= 1. It offers much more customers for flexibility during design cycle.
2. It does not require long lead times for production parts.
3. It can be programmed.
4. It allows customers to order just the number of parts as they want.
5. It does not require customers to pay for large NRE costs and purchase expensive mask sets.

*) What is COTS. Advantages & Dis-advantages.

A) = (A) Commerical off-the-Shelf components (COTS):

1. A Commercial Off-the-Shelf product is one which is used 'as-is'.
2. The COTS components are develop around a general purpose.
3. They are readily available in market, and are chip.
4. The manufacturer of COTS component may withdraw product.
5. E.g. Remote Controlled Toy Car.

(B) Advantages:

1. Ready to use.
2. Easy to Integrate.
3. Reduces Development Time.

(C) Dis-advantages:

1. No operational or manufacturing standard.
2. vendor or manufacturer may discontinue production of a COTS product.

*) Sensors and Actuators.

A) = (1) The changes in system environment are detected by sensors connected to input port of embedded system.
(2) Actuators are connected to output port of system.
(3) In ECG machine sensors are used - Different electrode sets connected to body of patient.
(4) The variations are captured and presented to doctor through a visual display.

- Sensors -
(1) A sensor is used for taking Input.
(2) It is a transducer that converts energy from one form to another for any measurement or control purpose.
(3) E.g. Temp. sensor, ECG Machine.

- Actuators.
(1) Actuator is used for output.
(2) Signal to physical Actions. E.g. LED
(3) LED is a p-n junction Diode and contains a CATHODE and ANODE.
(4) For functioning, anode is connected to +ve end of power supply and cathode connected to -ve end of power supply.
(5) The maximum current flowing through LED is limited by connecting a Resistor series.

*) What is Communication Interface & it's types.

A) = Communication Interface is divided into foll:

(A) On-Board Communication Interface:

- These are used for internal communication of embedded system i.e. communication between different components present on system. Following are the various interfaces for onboard communication:

(a) Inter-Integrated Circuit (I2C) buses:

- The Inter Integrated Circuit Bus is a synchronous bi-directional half duplex two wire serial Interface Bus.
- Developed by Philips semiconductor 1980.
- Two buses - SCL → serial clock, SDA → serial Data.
- I2C is a shared bus system.
- Master Device transmits data.

(b) Serial Peripheral Interface (SPI) Bus:

- It is a synchronous bi-directional full duplex four-wire serial Interface bus.
- SPI is a single master multi-slave system.
- Four signal lines for communication:
  1. Master Out Slave in (MOSI)
  2. Master out slave Out (MISO)
  3. Serial Clock (SCLK)
  4. Slave Select (SS)

(B) External Communication Interface:

- The External communication Interface are used to different communication channels i.e. Communication of different components present on system with external devices.

- RS-232 & RS-485
- USB (Universal Serial Bus)
- IEEE 1394
- Infrared
- Bluetooth
- WiFi
- ZigBee

*) What is Embedded Firmware:

A):- (1) Embedded Firmware is the flash memory chip that stores specialized software running in a chip in an embedded device to control it's function.
(2) Firmware in embedded systems fills same purpose as a ROM but can be updated more easily for better adaptability to conditions.
(3) There are various methods available for developing embedded firmware:

*) Explain Operational & Non-Operational Quality Attributes.
A):- (A) Operational Quality Attribute.
(a) Response:
- Response is a quickness of system.
- How fast changes are tracked.
(b) Throughput:
- It deals with efficiency of system.
- It can be defined as rate of production or process of a defined process over a period of time.
(c) Reliability.
- Reliability is a measure of how much percentage you rely apon proper functioning of system.
- In defining system reliability use Mean Time between failures & Mean Time to Repair.
- Mean Time to repair can be defined as avg. time in repairs.
(d) Maintainability:
- Maintainability is support and maintain enance to the end user in case of tech. issues.

- Types of Maintainability:
1. Scheduled or Periodic: Regular Maintenance.
2. Maintenance to Unexpected Failure.

(e) Security:
- Confidentiality, Integrity & Availability.
- Confidentiality deals with protection of data.
- Integrity gives protection from unauthorized access.
- Availability gives reliability.

(f) Safety.
- Deals with consequences of damaage of the Embedded System to operating Person.

(B) Non-Operational.
(1) Testability & Debug-ability.
- It deals with how easily one can test his/her design, app and by with method.
- Firmware Testing is functioning in expected way.

(2) Evolvability.
- Ease with which Embedded product can be modified.

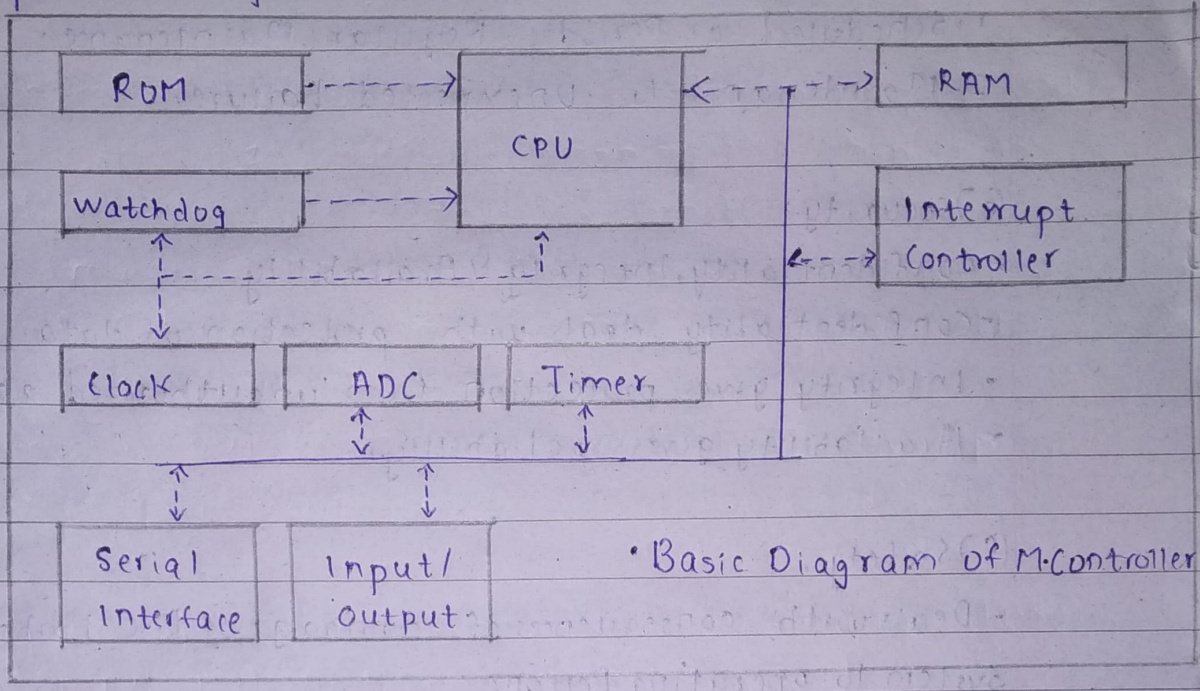
(3) Portability
- System Independence.

(4) Time to Prototype & Market.

(5) Per Unit & Total Cost.

*) Explain working of Microcontroller.

A)=



• Basic Diagram of M.Controller

Working:

- When power supply is on, crystal oscillators triggers clock pulses & generates frequency. After some time, oscillator gets stabilized.

- Now, microcontroller starts working from Program Counter (PC).
- The Program Counter address is stored in ROM. The PC stores the address of next instruction to be executed.
- It performs instructions from start address of program counter.
- This address is sent to instruction decoder which will understand and completes instructions.