INTRODUCTION TO EMBEDDED SYSTEM

Definition of embedded system :

An embedded are electronic and electro-Mechanical system.. :

→ Design to perform a specific function and is a combination of both hardware & software (s/w).

→ EMBEDDED systems are becoming a invaluable part of any project or equipment in all fields including household Applications. telecommunication, medical equipment, Industrial control, Consumer products, etc.

Difference b/w Embedded system and general computing systems.

General computing Systems	Embedded system
1) A system which is a combination of generic H/w and general purpose OS for executing variety of Applications.	1) A system is a combination of special purpose H/w and embedded OS for executing a specific set of Applications.

2) Contains a GP OS

3) Applications are ALTERABLE (or) programable by the user

4) Performance is the key deciding factor in the selection of the system. Always faster is better.

5) Response requirement are not time critical.

2) May or May not contain an OS for functioning.

3) Their firmware is preprogram on it is not ALTERABLE by the end users.

4) Application specific Requirements like performance power requirement memory usage etc. are the key deciding factors.

5) For certain category of years like mission critical system. The response time requirement is highly critical.

History of EMBEDDED systems.

→ ES exists in existance even before the IT evaluation and embedded algorithm was developed in low level languages.

→ Advances in semiconductors, nano technologies and IT revaluation. gave way to the development of miniature ES.

→ The first recognized ES is the Apollo guidance computer (AGC) developed by MIT Instrumentation Laboratory for lunar exploration. Then they run the essential guidance system. The command module and Lunar execution module (LEM).

→ CM :- It is design to encircle the Moon

→ LEM :- It is design to go down to the Moon surface and land their safely.

→ AGC is consist of 18 engines.

→ The LM featured in total 18 engines

→ The first Mass produced ES was guidance computer for the Minute Man one missle. in 1961.

→ It was Automatics DT guidance computer built using discrete transistor logic and a Hard disk for a main memory.

→ The first IC and their earlier usage of ES apart from computers. were used by NASA in 1958.

→ AGC used by the USA Military in the Minute Man tool: inter Continental Ballester Missile.

Classification of embedded system

Classification is based on 4 types

1. Based on generation
2. Based on complexity & performance
3. Based on deterministic behaviours.
4. Based on triggering

1. Classification based on generation :-

i) 1.G :- The early years where built around 8-bit Microprocessor like 8085 & Z-80 & 4-bit Microcontroller. simple in H/w circuit with fewer but developed in Assembly code.

Ex:- digital telephone key pads, stepper motor control unit.

ii) 2.G :- There are years built around 8-(or) 16 bit Microcontroller & 16-bit Microprocessor like 8086 following the 1st generation Es.

→ The instructions sets for the 2G processors (or) controllers where much more complex and powerful than the 1G.

Ex:- Data acquisition systems, Scada systems.

iii) 3G:- ~~supervisor year~~ Es developers started Making use of power 32-bit processors and 16-bit Microcontroller for their design.

→ A Neco concept of application and domain specific processors (ASP) controllers like digital signal processes (DSP) And Application specific integrated CKT, (ASIC) come into picture.

→ The instruction set of processors became more complex and pacesetter the concept of instruction pipelining.

Ex:- Robotics, Media, Industrial processor control, Networking.

iv) 4G :- System on chip (SOC), Reconfigurable processors (ASP) Multi core processors. are being high performance. Miniaturization into embedded device market.

These generations making use of high performance real-time embedded os for their functioning

Ex:- Smartphone devices, Mobile Internet devices etc.

v) 5G :-

2) Classification based on complexity & performance

i) Small scale ES :-

It uses low cost 8-bit microprocessor (or) 16-bit Microcontroller it may or may not contain OS for functioning

ii) Medium scale ES :-

ES which are slightly complex in H/w & S/w (F/w) requirements fall under these category. It uses low cost 16-bit microprocessor (or) 32 bit Micro controllers. It contains an OS either general purpose or real-time OS for functioning.

iii) Large scale ES :-

In these ES involve high complex H/w and S/w requirements fall under these category. It uses 32-bit RISC processors (or) 64-bit Controllers (or) PLD's.

→ Decoding of encoding of medium cryptographic function implementation.

3) Classification based on deterministic behaviours

→ It is Applicable for real time systems
→ The Application are task execution behaviours for an ~~process~~ ES can either deterministic (or) undeterministic
→ Based on execution behaviour real time process are classified into hard & soft real time.

4) Based on triggering :-

→ ES which are reactive in nature.

Ex:- process controll systems in industrial controll applications can be classified based on triggers.

→ It can be either event (or) time trigger

Major Application areas of ES

1) Consumer electronics :- ~~cameras~~ camp cellers, camera's, etc.
2) House hold Appliances :- DVD players, TV, washing machines, refrigde:, microwave oven. etc.

3) Home Automation & Security systems :-
Air conditioners, sprinklers, intrud detection alarms, CCTV CKT, cameras, fire alarm etc.

4) Automotive industry :-
Anti lock breaking system, Engine controll egnition systems, Automatic navigation systems.

5) Telecom :-
cellular Telephones, Telephone switches, Hand set multimedia Applications, etc.

6) Computer peripherals :-
printers, scanner, Fax machine etc.

7) Computer N/w systems :-
N/w routers, switches, firecalls etc.

8) Health care :-
Different kinds of scanners, electrocardiogram machines, Double eg machines etc.

9) Measurement & instrumentation :-
Digital Multimeters, digital ERO's, Logic Analyzers PLC systems etc.

10) Banking & Retail :-

Automatic teller Machine (ATM), currency counters, point of sells Machine.

11) Card readers :-

Bar code, smart card readers, House hold devices etc.

purpose of ES

→ ES are used in various domains and design to serve the purpose of any one are a combination of following task :

1. Data collection (or) storage (or) representation
2. Data communication
3. Data processing
4. Monitoring
5. Control
6. Application specific user interface.

1) Data collection and storage (or) Representation

→ It is usual done for storage analysis and manupulation & transmission.

→ The term data refers all kinds of information like text, voice message, video, image, electrical signals. and any other measurable quantities

→

2) Data communication :-

Embedded data communication systems are deployed in applications ranging from complex satellite communication system to simple home N/w systems. The transmission is achieve either by wire line medium (or) wireless medium

3) Data processing :-

The data collected by Es may be used for various kind of data processing.

→ Es with signal processing like speech coding sensitheads, Audio, video codes. (modem).

transmission Applications etc.

→ Digital ~~theory~~ coding head is a typical example of Data processing.

4) Monitoring:-

These are specific design for monitoring purpose example ECG.

Examples of ES with monitoring functions are digital CROs, digital multimeters, logic analyzers. status of some variable like current, voltage etc.

5) Control :-

It control over some variables according to the changing input variables. It contains both sensors and achievators. sensors are connected in the i/p ports whose as achievators are connected to the o/p port.

6) Application specific user interface:

-> These are like buttons, switches, keypads, bells. lights, display units etc. mobilephone is a best example of these.

Characteristics of ES

These characteristics are unique for each ES some of them are.

1. Application are domain specific
2. Real time and reactive.

3. operates in harsh environment
4. distributed
5. small size & width
6. passes constrains.

1. Application are domain specific :-
- Each ES is having certain functions to perform and they are develop such a manner to do intended functions only. They cannot be used for any other purpose.

Ex:- We cannot replace the embedded control unit of Microwave oven with Air conditioners.

2. Reactive and Real time :-
- ES are inconsistent interaction with the real world through sensors and user define i/p devices which are connected to the i/p ports of the system.
- Any changes happening in the real-world are capture by the sensors are i/p devices

Ex:- Flight control systems, Anti lock break systems.

3. operates in hash environment:-

- It is not necessary that all ES should be deploy in control environments. It may be a dust one, a high temperature zone. an area subjected to vibrations & shock. Systems placed in such areas should be capable of to be stand all operating conditions

4. Distributed:-

- ES may be a part of large systems many numbers of such distributed ES form a single large embedded control unit.

Ex:- Automatic vedding, Automatic teller machine. which contains card reader, embedded unit. which is used to perform. vedding functions and transactions to achieve goal.

5. Small Size & weight :-

product as it is important factor choosing a product.

Ex:- When you plan buy new brand mobile phone.

as it is :- size, space, width, weight.

6. Power Consump :-

power management is another important factors. That needs to contain to designing Es. To minimize heat dispate by the system. The more power consumption the less is the battery life.

Quality Attributes of Es :-

Quality Attributes are divide into two operational & non operational.

Operational :-

- It represents the quality Attributes related to Es. When process in the operational mode (or) online mode.

- The important QA are

1. Response
2. Throughput
3. Realiblity.
4. Maintainability
5. security.
6. Safty.

1) Response :- It is the measure of thickness of a system it gives the idea about how past your system is tracking the changes in i/p variables.

Ex:- Flight control application.

2. Throughput :- It deals with the efficiency of the system in general it can be define as the rate of production are operations of a define process over stated period of time. It is measure in terms of benchmark.

Ex:- Card reader.

3) Realiability :-

It is a measure of how much percentage how can relay upon proper functions of the system (or) what is the percentage sustainability of a system to failures. Mean time b/w failure. MTF, Mean time to repair. MTR, are the terms used in define system realiability.

4. Maintainability :-

It deals with support and maintenance to the end user are client in case of technical issue and product failures are on the bases of routine system check up.

→ Realiability & Maintainability are two complementary discipline as realiability increases. The need for maintainability of the system is reduce.

→ Availability = $\frac{MTF}{MTF + MTR}$

5. Security :- Confidentiality, integrity & Availability

Confidentiality are the three major measures of Information security Confidentiality deals with protection of data and application from unauthorize disclosures.

Integrity - unauthorized Modification.

Availability - unauthorized users.

Ex:- personal digital Assitant.

6. Safety :- Safety & security are two confusion terms sometimes you may feel both are same but the represent two unique aspects in O.A. Safety deals with possible damages that can happen to the operators It occurs due to the emission of radio active or Azardis materials from the embedded products.