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EMBEDDED SYSTEMS DESIGN.

A processor on a single chip is called a microprocessor. A processor is an electronic device that can process the information ~~does not~~ that has been input. It has ALU and necessary Registers. A device that has memory is called a microcontroller. It also serves as a port for I/O devices.

Embedded systems is a processor embedded on a device. They are used in ATM machines, consumer electronics, vehicles, appliances etc.

Embedded systems - Includes a programmable computer but it isn't a general purpose one.

Whirlwind was the first embedded system. Later on in 1970s, Intel 4004 was the first microprocessor and it was used in a Calculator. HP-35 was the first handheld Computer. Typical embedded word sizes are 8 bit, 16 bit, 32-bit.

Eg:- BMW 850i Anti Lock Brake System and Stability Control. It brakes at regular intervals to make sure that skidding of vehicles doesn't happen.

Characteristics of E.S:-

→ Sophisticated functionality. → Lower manufacturing cost.
→ Real-time operation → Low power.
→ Designed to tight deadlines by small teams.

a) They are expected to run sophisticated algos and provide advanced UIs.
(eg) GPS in mobiles.

b) A real time operation is one that has a deadline.

i) Hard RT :- missing deadlines.

ii) Soft RT :- Degraded Performance.

They involve multi-rate ops ie. each component runs at different speed.

eg:- multimedia apps.

c) Costs of embedded systems is very low. Power Consumption is a major issue w.r.t. embedded systems. (whether Battery or Source powered).

d) Design teams are sparsely populated. Avg. Delivery time is 6 months.

Proven alternatives for μprocessors are FGPA etc.

Adv. of μprocessors:-

- heavily pipelined
- Large Design teams
- VLSI tech
- Smaller Design
- Many different algorithms based on the program executed.
- Decouples H/W and S/W designs.

Challenges in ESD :-

- H/W requirement.
- deadlines and cost constraints.
- Minimize power Consumption
- Reusability of H/W components by upgrading S/W.
- Lack of development environments.

Performance in terms of E.S.:-

- Meeting the real time deadlines. The parameters for analysing performance are CPU, platforms (I/O and bus) programs, tasks given and multiprocessor.

Design Goals :-

- Performance
- Power Consumption
- cost.
- Size and weight
- functionality.

Levels of Abstraction :-

requirements
↓
Specification
↓
Architecture
↓
Component design
↓
system Integration.

Top-down :-

Start from most abstract and work towards most detailed.

Bottom-up :-

Most detailed to most abstract.

Stepwise Refinement :-

Analyse and Refine the work done at each level.

Requirements

→ Ask the Customer

Mock-up

A prototype is built and given to the customer.

Specification

→ A technical representation that has to be clear and unambiguous.

→ A UML has to be used for the given situation.

Architecture :-

→ Defines the implementation of the function and should satisfy the requirements specified.

→ The overall architecture representation has to be drafted and then H/W and S/W must be represented separately.

Component Design

→ Put the architecture into work.

System Integration.

→ Testing and unearthing Bugs.

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ARM process

→ ARM stands for Advanced RISC Machines. It follows the Von-Neumann Architecture. In VN architecture, Data and operations are stored in common memory.

→ Eg:- BACK JMP address | ADD $r_0, r_1, r_2 \Rightarrow r_0 = r_1 + r_2$.

Label Nmemonic operand | ; stands for comment.

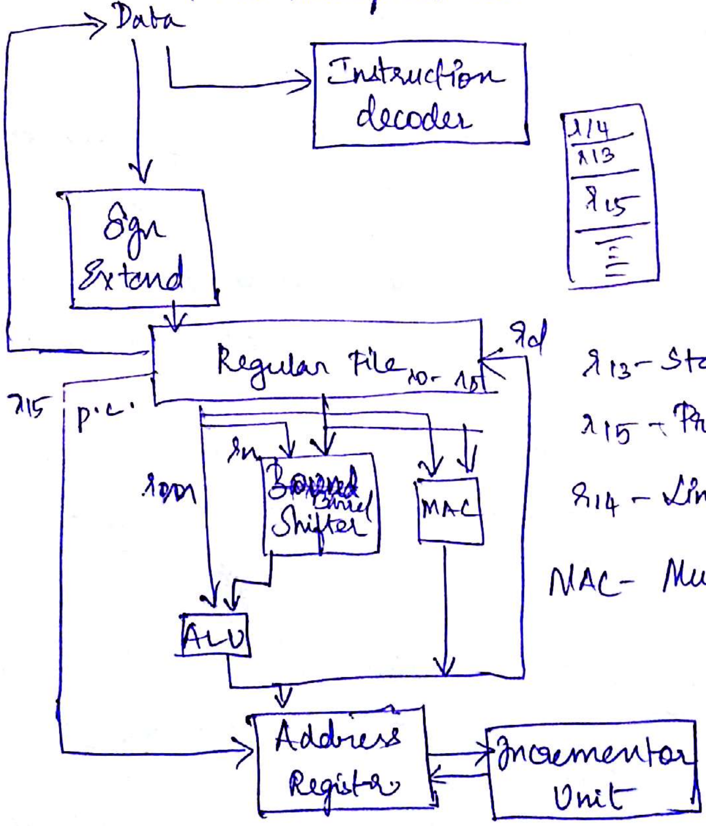
Pseudo Operations (Or) Assembler Directives:-

→ They purely direct the assembler to carry out the necessary languages.

→ Data is of 32 bits and converted into 4 bytes. So the ARM processor canbe programmed to be little endian or Big endian.

Little Endian - LSB takes the first address.

Big Endian - MSB takes first address.



r_{13} - Stack point Register.

r_{15} - Program Counter.

r_{14} - Link Register.

MAC - Multiply and Accumulate.

Current Program Status Register (CPSR):-

→ Stores the ~~result of the~~ status of the result of a particular operation.

→ Zero → 0
Carry and Overflow and Neglect } Status bits available for various possible results.

Carry bit is used for unsigned data and Overflow is checked when operated on signed data. The Status Register change its value for every instruction executed.

Data Instructions:-

Arithmetic :- ADD, ADC (add with carry), SUB, SBC (Subtract with Carry), RSB (Reverse Subtract), RSC (Reverse Subtract with Carry), MUL, MLA (multiply and accumulate

Logical Instructions:-

AND, ORR, EOR (Exclusive OR), BIC (Bit Clear). ANDNOT.

Comparison:-

CMP (Subtract and Compare)
→ They change flags.

CMN (Negated Compare).
→ CMN $r_1, r_2 = r_1 + r_2$.

TST (Bitwise Test)
→ $r_1 \wedge r_2$

TEQ (Bitwise negated Test)
→ r_1 exor r_2.

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