

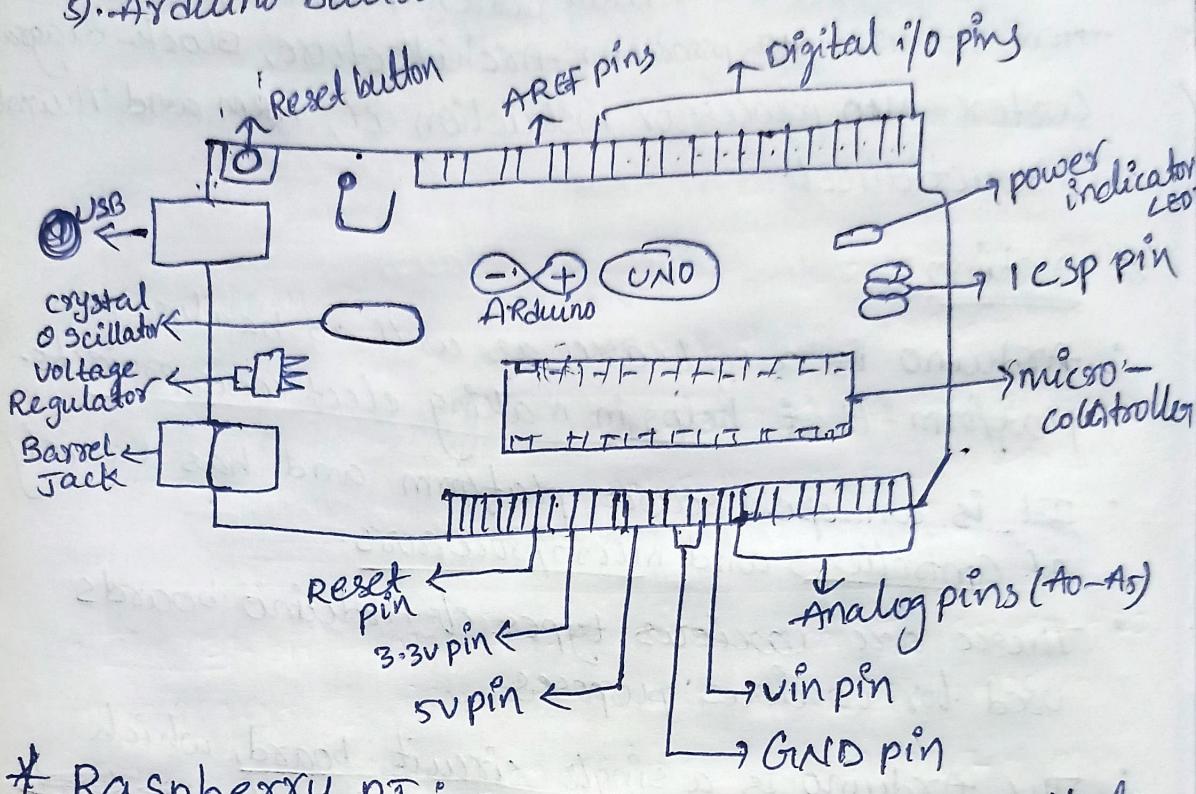
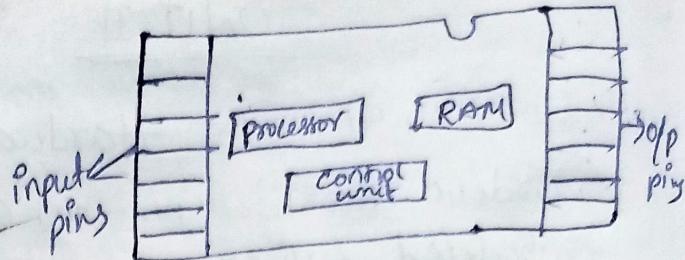
UNIT-II

- ELEMENTS OF IOT :- Hardware components - computing
- Arduino, Raspberry pi, - ARM cortex-A class processor,
 - Embedded devices - ARM Cortex-M class processor,
 - ARM cortex-M0 processor - architecture, block-diagram, Cortex-M0 processor instruction set, ARM and Thumb instruction set.

* Arduino :-

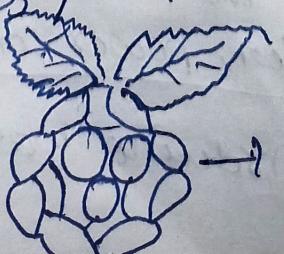
- Arduino is a software as well as hardware platform that helps in making electronic projects.
- It is an open source platform and has variety of controllers and microprocessors.
- There are various types of Arduino boards used for various purposes.
- The Arduino is a single circuit board, which consists of different interfaces or parts. ~~and~~
- The board consists of the set of digital and analog pins that are used to connect various devices & components, which we want to use for the functioning of the electronic devices.
- The most of Arduino consists of 14 digital I/O pins.
- The Analog pins in Arduino are mostly useful for fine-grained control.
- The pins in the Arduino board are ~~are~~ arranged in a specific manner.
- The other devices on the Arduino board are USB port, microcontroller, power connector etc...
- Some of the popular Arduino boards are below:

- 1) Arduino UNO
- 2) Arduino Nano
- 3) Arduino mega
- 4) Arduino Due
- 5) Arduino Bluetooth



* Raspberry pi:

- The Raspberry pi is a very small computer that is almost the size of your credit card. It costs b/w RS.750 and RS.4000.
- The "Raspberry" name is a homage to computer companies in early times that were being named after a fruit like Apple, Apricot computers, Tangerine computer systems.
- The idea to make a small computer to run only the python programming language is where the "pi" derives from.



→ Raspberry PI

- The first Raspberry Pi unit which was available commercially was launched on Feb 19, 2012.
- This version featured 256MB of RAM, could run on Linux-based desktop operating systems.
- This was named the model A.
- It is much more popular than targeted, because of its low cost, modularity and open architecture, it is now commonly used in many fields, such as for weather forecasting.
- Raspberry Pi became the best-selling British computer. As on December 2019, over more than 30 million boards have been sold.
- The large percentage of Pis are produced in a factory in Pencoed, Wales, while others are manufactured in China and Japan.

Reduced instruction set computer

- ARM-Cortex-A class processor:
 - The ARM Cortex-A is a group of 32-bit and 64-bit RISC ARM processor cores licensed by ARM Holdings.
 - The cores are intended for application use.
 - The group consists of 32-bit only cores:
 - ARM Cortex-A5, ARM Cortex-A7, ARM Cortex-A8, ARM Cortex-A9, ARM Cortex-A12, ARM Cortex-A15, ARM Cortex-A17 MP core, and ARM Cortex-A32.
 - The 32/64 bit mixed operation cores:
 - ARM Cortex-A35, ARM Cortex-A53, ARM Cortex-S5, ARM Cortex-A57, ARM Cortex-A72, ARM Cortex-A73, ARM Cortex-A75, ARM Cortex-A76, ARM Cortex-A77, ARM Cortex-A78, ARM Cortex-A710, and ARM Cortex-A510.
- Refresh,

- The 64-bit only cores -

ARM Cortex-A34, ARM Cortex-A65, ARM Cortex-A510 and ARM Cortex-A715.

ARM cortex-A

General information

Designed by

ARM Holdings

-Architecture & classification

instruction set

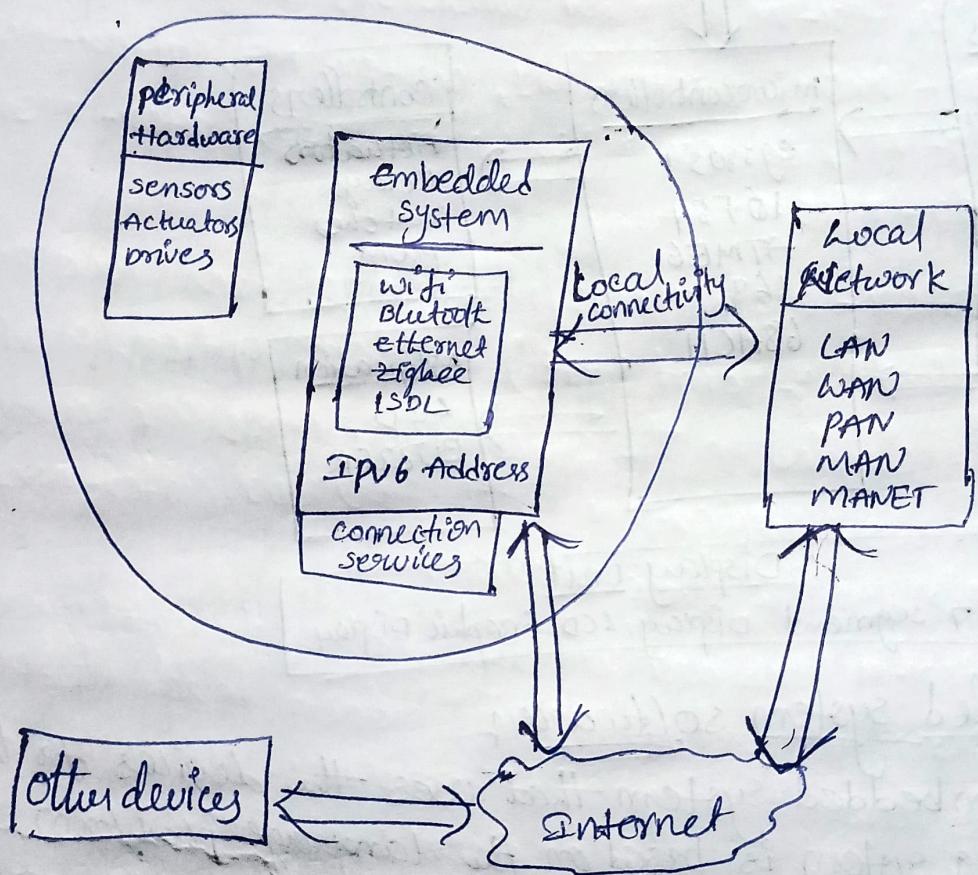
ARM, Thumb-2 (32-bit cores);
ARMv7-A and ARMv8-A.

A64, A32, T32 (64-bit cores);
ARMv8-A, ARMv8.1-A, ARMv8.2-A,
ARMv8.3-A, ARMv9-A.

- The 32-bit ARM cortex-A cores, except the cortex-A32, implement the ARMv7-A profile of the ARMv7 Architecture.
- The main distinguishing feature of the ARMv7-A profile, compared to the other two profiles, the ARMv7-R profile implemented by the ARM cortex-R cores and the ARMv7-M profile implemented by most of the ARM cortex-M cores, is that only the ARMv7-A profile includes a memory-management unit (MMU).
- The many modern operating systems require a MMU to run.
- The 64-bit ARM cortex-A cores as well as the 32-bit ARM cortex-A32 implement the ARMv8-A profile of the ARMv8 Architecture.

* Embedded devices

- The embedded devices are the objects that build the unique computing system. These systems may or may not connect to the internet.
- An embedded device system generally runs as a single application.
- However, these devices can connect through the internet connection, and able communicate through other network devices



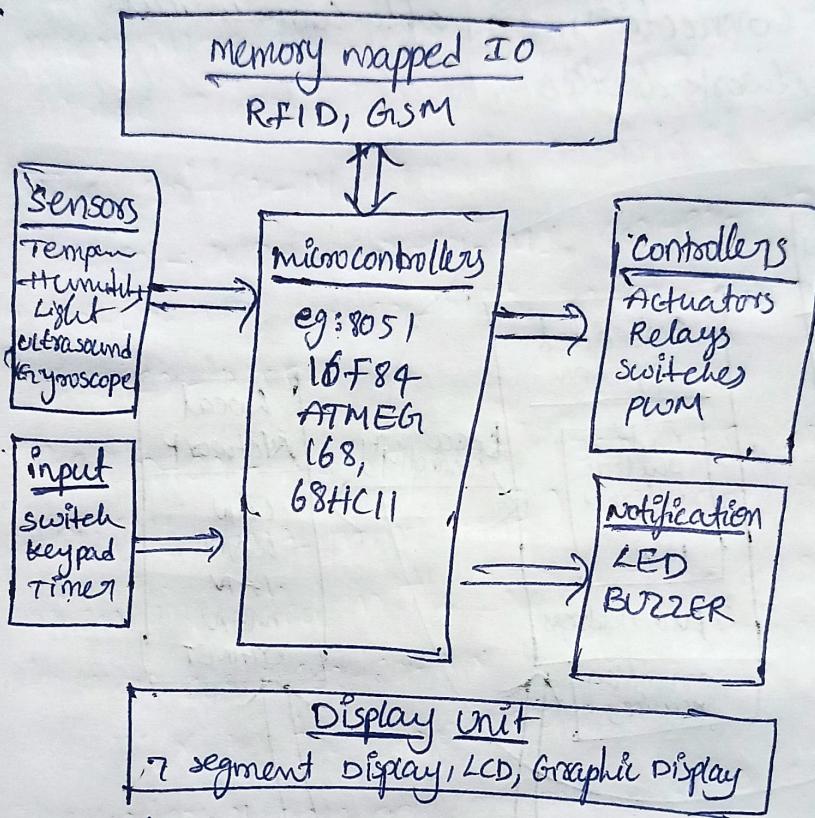
IOT

Embedded systems Hardware

- The embedded system can be of type microcontroller or type microprocessor. Both of these type contain an integrated circuit (IC).
- The essential component of the embedded system

is RISC family microcontroller like Motorola 68HC11, PIC 16F84, Atmel 8051 and many more.

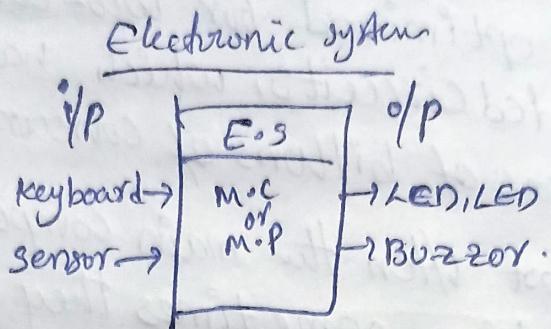
- The most important factor that differentiate these microcontrollers with the microprocessor like 8085 is their internal read and writable memory. The essential embedded device components and system architecture are specified below.



Embedded system software

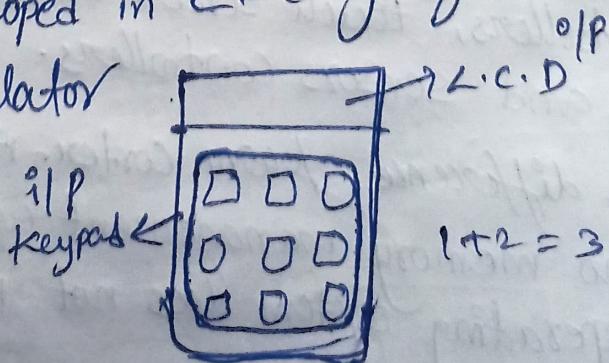
- The embedded system that uses the devices for the operating system is based on the language platform, mainly where the real-time operation would be performed.
- Manufacturers build embedded software in electronics, e.g., cars, telephones, modems, appliances etc.
- The embedded system software can be as simple as lighting controls running using an 8-bit controller. It can also be complicated software for missiles, process control systems, airplanes etc.

E.S or is the combination of h/w & s/w. By using this h/w & s/w we derive an electronic device (system). which is used for specific function is called embedded system.



- The electronic system takes the I/P and process the information and generate the O/P.
- if we see the O/P in text format we use 'LCD', and for indication purpose we use 'LED'.
- ~~if the electronic system~~
- if the E.S process the information then the electronic system wants an intelligence system i.e microprocessor or micro controller
- The micro processor or micro controller takes the input and process the information & gives O/P.
- The developer develops the s/w & inbuild it in MC or MP.
- The s/w is preprogrammed in MC or MP and the s/w developed in C-language.

Ex calculator

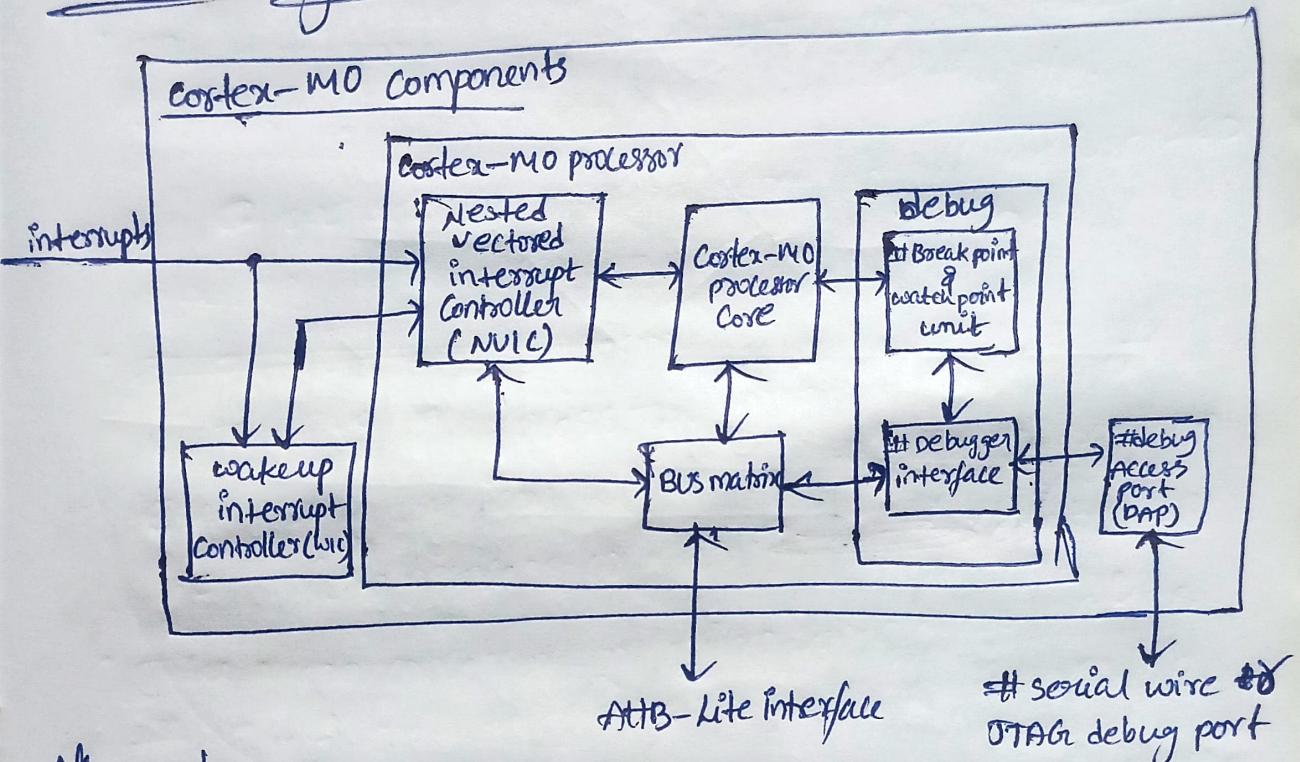


* ARM cortex-m class processor

- The ARM cortex-m is a group of 32-bit RISC ARM processor cores licensed by Arm Holdings.
- These cores are optimized for low-cost and energy efficient integrated circuits, which have been embedded in tens of billions of consumer devices.
- Though they most often the main component of microcontroller chips, sometimes they are embedded inside other types of chips too.
- The cortex-m family consists of cortex-m0, cortex-m0+, cortex-m1, cortex-m3, cortex-m4, cortex-m7, cortex-m23, cortex-m33, cortex-m35p, cortex-m55.
- The cortex-m4/m7/m33/m35p/m55 cores have an FPU (floating-point unit) silicon option, and when included in the silicon these cores are sometimes known as "cortex-mx with fpu" or cortex-mxf", where 'x' is the core variant.
- The cortex-m cores are commonly used as dedicated microcontrollers chips, but also are "hidden" inside of SOC chips as power management controllers, I/O controllers, system controllers, touch screen controllers, smart battery controllers, and sensors controllers.
- The main difference from cortex-a core is that there is no memory management unit (MMU). A full-fledged operating system does not normally run on this class of processor.

- * ARM cortex-M0 processor
- The ARM cortex-M0 processor is "one of the smallest ARM processor available".
 - The cortex-M0 has an exceptionally small silicon area, low power and minimal code footprint, enabling developers to achieve 32-bit performance at an 8-bit price point, by passing the step to 16-bit devices.

Block-diagram



* cortex-M0 processor instruction set - Growtham.

ARM instruction set

- The ARM instruction sets. The ARM v7 architecture is a 32-bit processor Architecture.
- It is also a load/store architecture, meaning that data-processing instructions operate only on values in general purpose registers.
- only load and store instructions access memory. General purpose registers are also 32 bit.