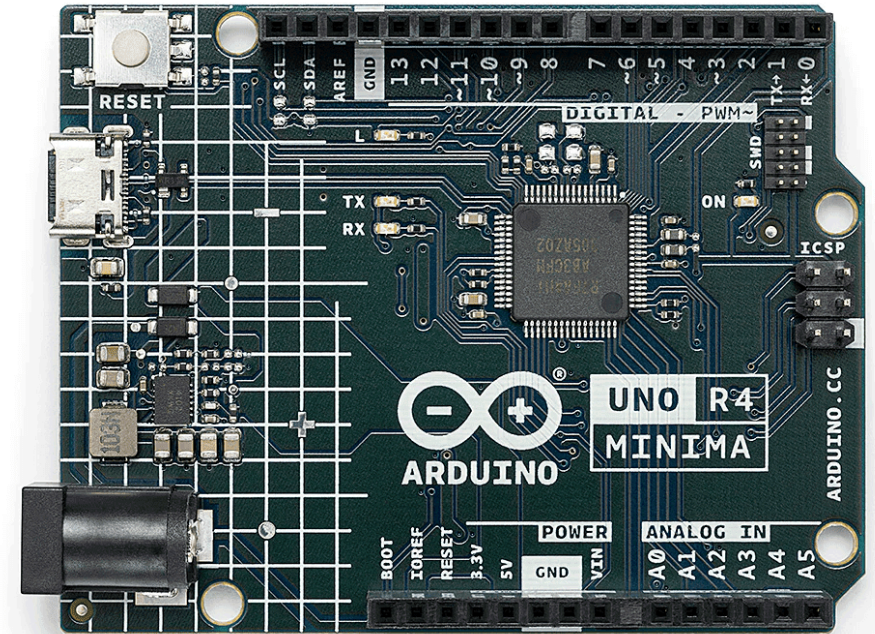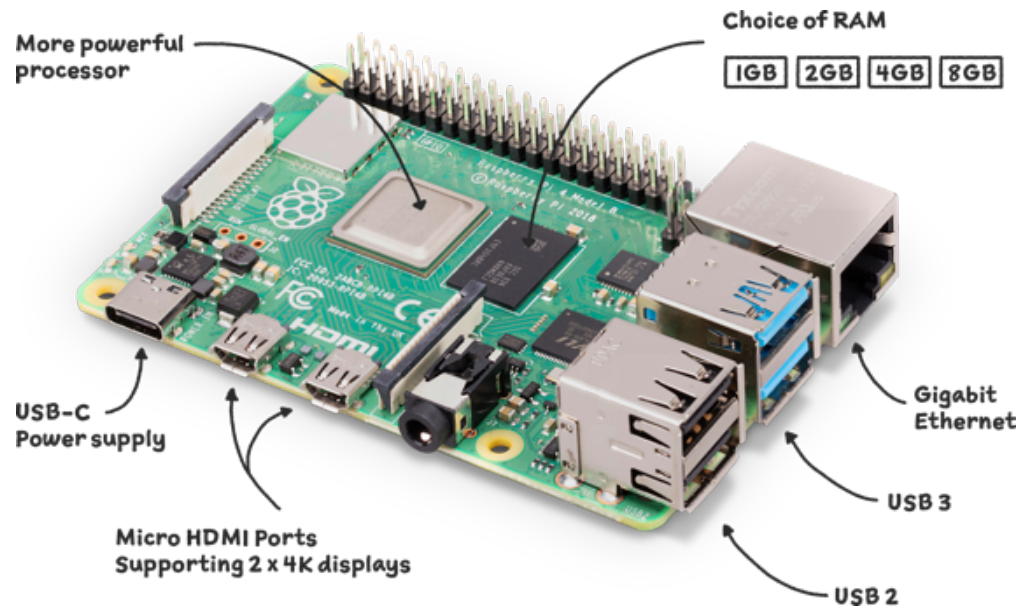# Embedded Systems

Ahmed Shuaib

Embedded System ?

- Computer system that comprises of:

  - Processor

  - Memory

  - I/O

- General-purpose computers systems are designed to handle a wide range of applications.

- Embedded systems are optimized for a specific function.

More powerful processor

Choice of RAM

1GB 2GB 4GB 8GB

USB-C Power supply

Gigabit Ethernet

Micro HDMI Ports Supporting 2 x 4K displays

USB 3

USB 2

RESET

SCL SDA AREF GND 13 12 ~11 ~10 ~9 8 7 ~6 ~5 4 ~3 2 TX▶1 RX◀0

DIGITAL - PWM~

L

SWD

TX

RX

ON

ICSP

ARDUINO UNO R4 MINIMA

ARDUINO.CC

BOOT IOREF RESET 3.3V 5V GND VIN

POWER

ANALOG IN

A0 A1 A2 A3 A4 A5

Role of Assembly Language

- Modren embedded systems are based on micro-controllers consisting of internal.

  - Memory

  - I/O

- Developing embedded systems is often done in languages that are closer to bare metal.

- Assembly offers unparalleled control, efficiency, and optimization capabilities.

- Use of Assembly can significantly enhance the performance and reliability of the system.

Architecture

- ARM Processors -> AArch32 and AArch64

  - Based on RISC design principles

  - Reduced instruction set computer (RISC) focuses on simplifying instructions and increasing speed.

- Atom Processors -> x86 and x86-64

- AMD Ryzen Embedded Processors -> x86 and x86-64

- PI uses Quad core Cortex-A72 64-bit SoC.

- UNO uses Renesas RA4M1 32-bit SoC

- They both basically use a Arm processors like the majority of boards

Real-Time Embedded Systems

- When designing embedded systems the are time constraints to consider.
- Hard Real-Time -> Extremely strict requirements
  - Missing a "deadline" is unacceptable, as it can be catastrophic.
- Soft Real-Time -> Lenient requirements
  - Missing a "deadline" while not desirable, may not be catastrophic.
- Real-Time Operating Systems
  - FreeRTOS
  - Linux Implementations
    - Lynx OS
    - RTLinux
  - Unix Implementations
    - QNX

Embedded Real-Time systems are reactive systems

"The system observes changes in the environment, computes appropriate actions, and conveys the actions to various components so that the system as a whole operates correctly while the designated time constraints is met." [7]

Other Constraints

- Engineering Costs of designing a critical system must me minimal.

- Cost of each unit must be minimal, as units are mass produced.

- The power consumption of the systems must be minimal.

- Performance should not be a bottleneck.

Applications

- Internet of things devices (IoT)

  - Smart thermostats, speakers, lighting, cameras, locks, appliances, fitness trackers, basically everything.

- Automotive

  - Engine control, Safety features like airbags and ABS, Entertainment systems.

- Aerospace and Defense

  - Flight control, Weapon systems, Communication systems.

Cons

- Privacy Concerns

  - IoT devices collect data
    - What data ?
    - How much data ?

- Security Vulnerabilities

  - Vulnerable to hacking and unauthorized access
  - Who sees your data ?

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Thank You :)