

Introduction to Embedded Systems



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Outlines

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What is a Microprocessor?

- A **Microprocessor**, popularly known as “**computer processor on a chip**”.
- a general purpose central processing unit (**CPU**) **fabricated** on a single integrated circuit (**IC**) and is a complete digital computer.
- It is a **small** but **very powerful** electronic brain that operates at a blistering speed and is often used to:
 - **carry out instructions** of a computer program.
 - **perform** arithmetic and logical **operations**.
 - **storing** the data, system control, input / output operations

ARM

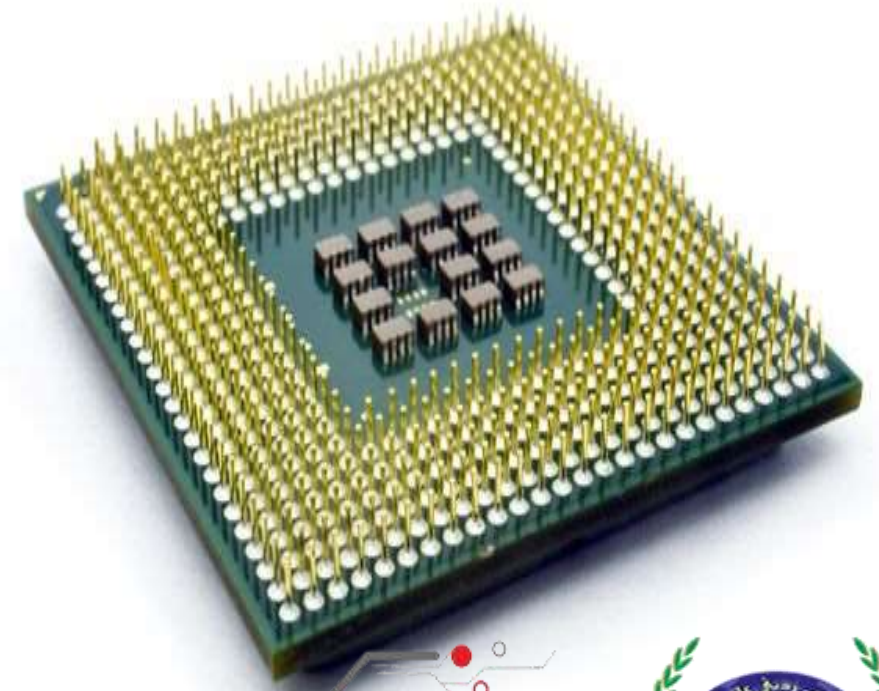
intel

TEXAS
INSTRUMENTS

AMD

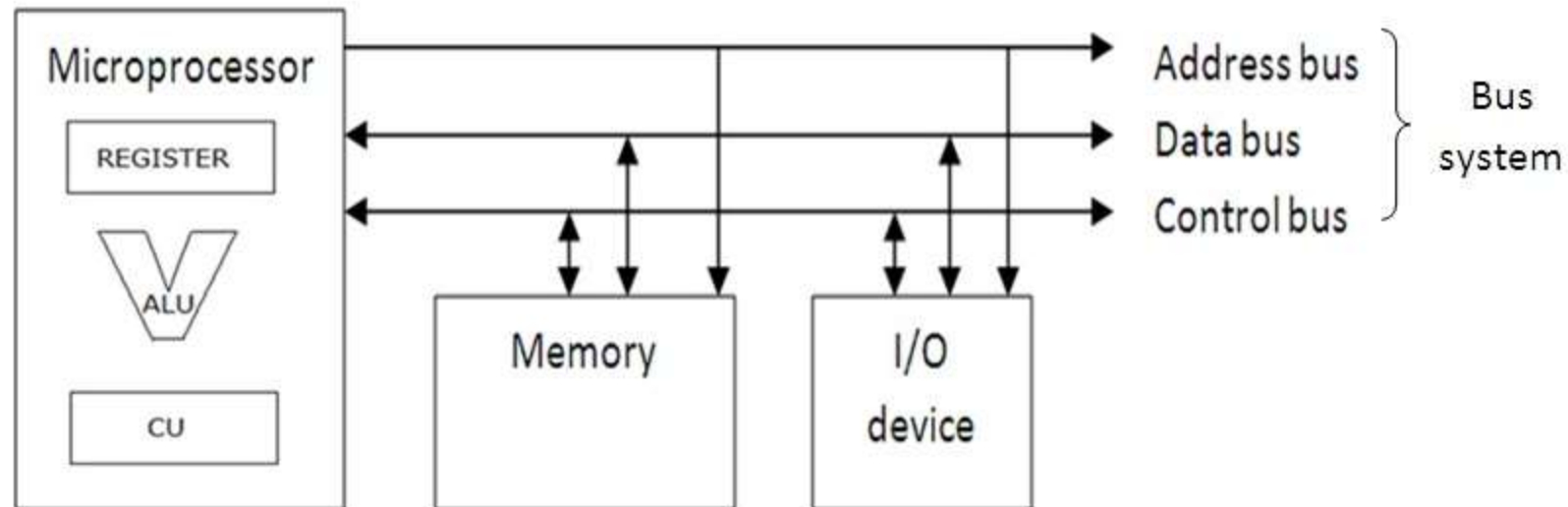


motorola
a Lenovo company



What is a Microprocessor?

- The **main task** of a Microprocessor:
 - **Accepts data** as input from input devices.
 - **Process this data** according to the instructions.
 - **provide the result as output** through output devices.

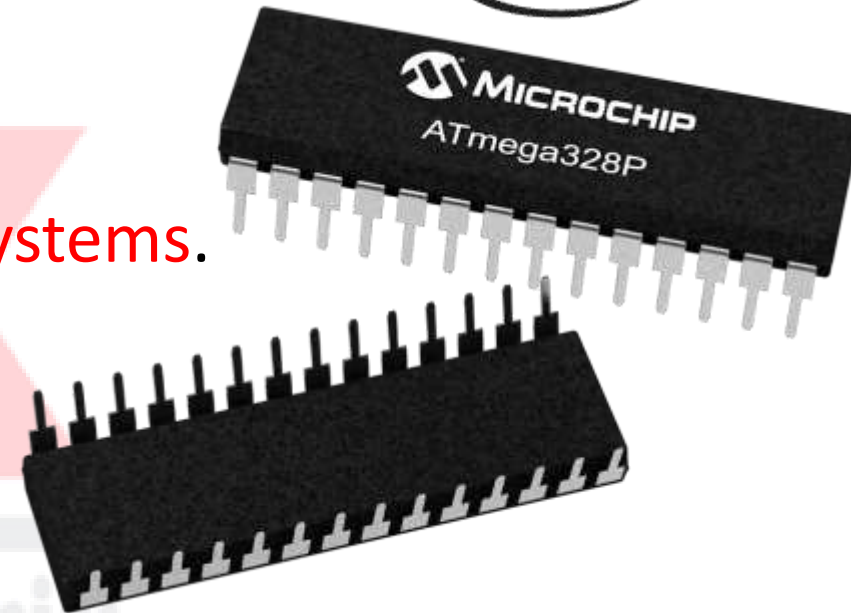


What is a Microprocessor?

- There are **three basic characteristics** used to differentiate Microprocessors:
 - **Instruction Set:**
 - **CISC** – Complex Instruction Set Computer, example intel x86.
 - **RISC** – Reduced Instruction Set Computer, example ARM devices.
 - **Bandwidth:** maximum number of bits processed in a single instruction.
 - **Clock Speed:** number of instructions executed per second (MHz or GHz).

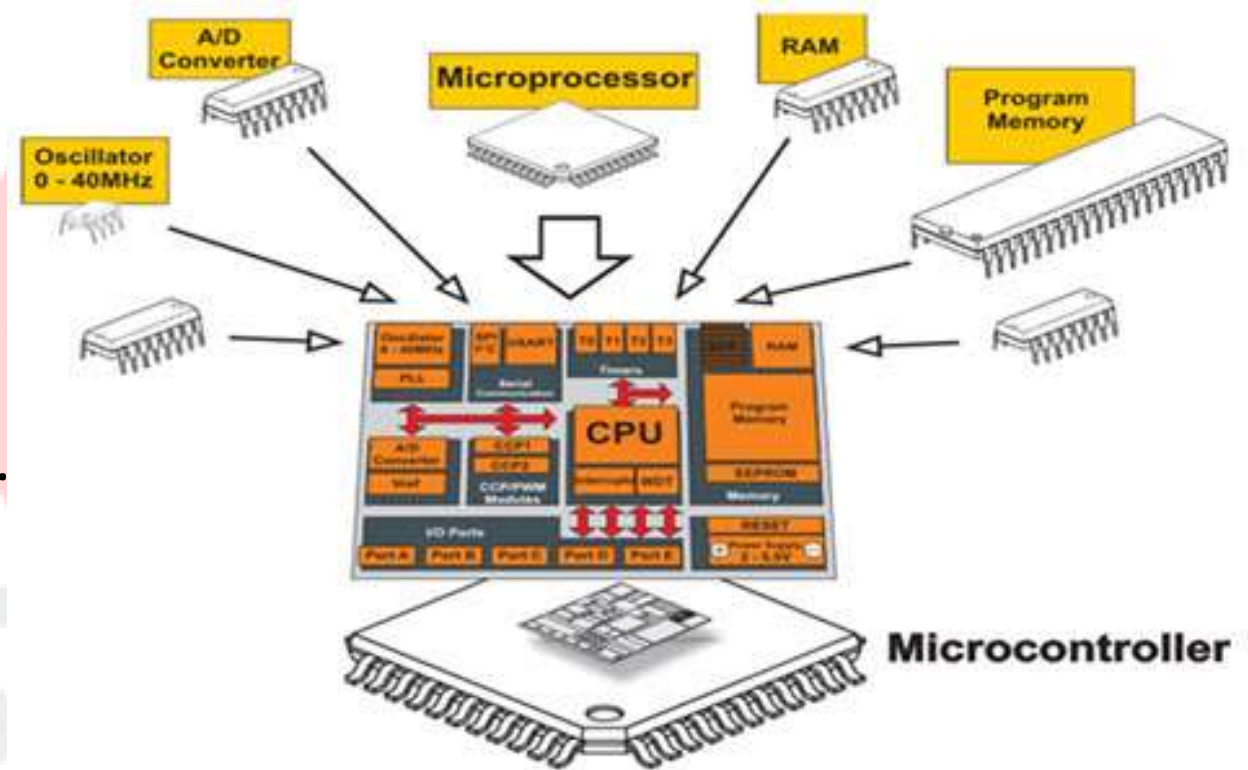
What is a Microcontroller?

- Microcontrollers are “Small computer On a Chip”.
- It consists of:
 - CPU.
 - Memory.
 - Input/output ports and timers.
- They are basically used in embedded systems.
- They are classified according to:
 - Bus width.
 - Memory structure.
 - Instruction set.



What is a Microcontroller?

- **Bus Width:** is the size of the data bus. Example: 8bits, 16bits and 32bits.
- **Memory structures:**
 - Embedded Memory
 - External Memory
- **Instruction Set:**
 - CISC: majority of microcontrollers.
 - RISC



Microprocessors Vs. Microcontrollers

Microprocessor	Microcontroller
Microprocessor assimilates the function of a central processing unit (CPU) on to a single integrated circuit (IC).	Microcontroller can be considered as a small computer which has a processor and some other components in order to make it a computer.
Microprocessors are mainly used in designing general purpose systems from small to large and complex systems like super computers.	Microcontrollers are used in automatically controlled devices.
Microprocessors are basic components of personal computers.	Microcontrollers are generally used in embedded systems
Computational capacity of microprocessor is very high. Hence can perform complex tasks.	Less computational capacity when compared to microprocessors. Usually used for simpler tasks.
Generally microprocessors are not used in real time systems as they are severely dependent on several other components.	Microcontrollers are used to handle real time tasks as they are single programmed, self sufficient and task oriented devices.

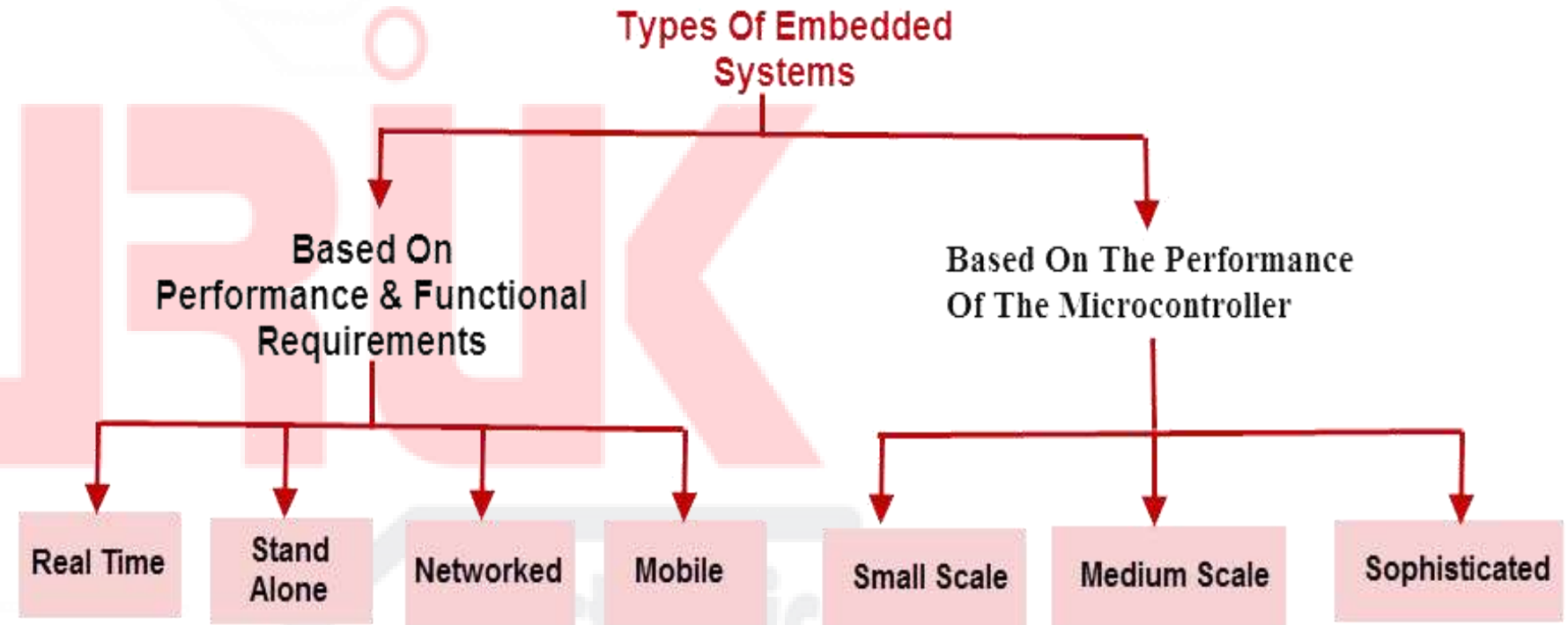
What is Embedded System?

- An **Embedded System** is a **computer** system **with a dedicated function** within larger mechanical or electrical system, often real-time computing constrains.
- It is **Embedded as part** of a complete device often including hardware and mechanical parts.
- Embedded system **control** many devices in common use today.

Embedded Systems Characteristics and types

- Embedded system important characteristics:

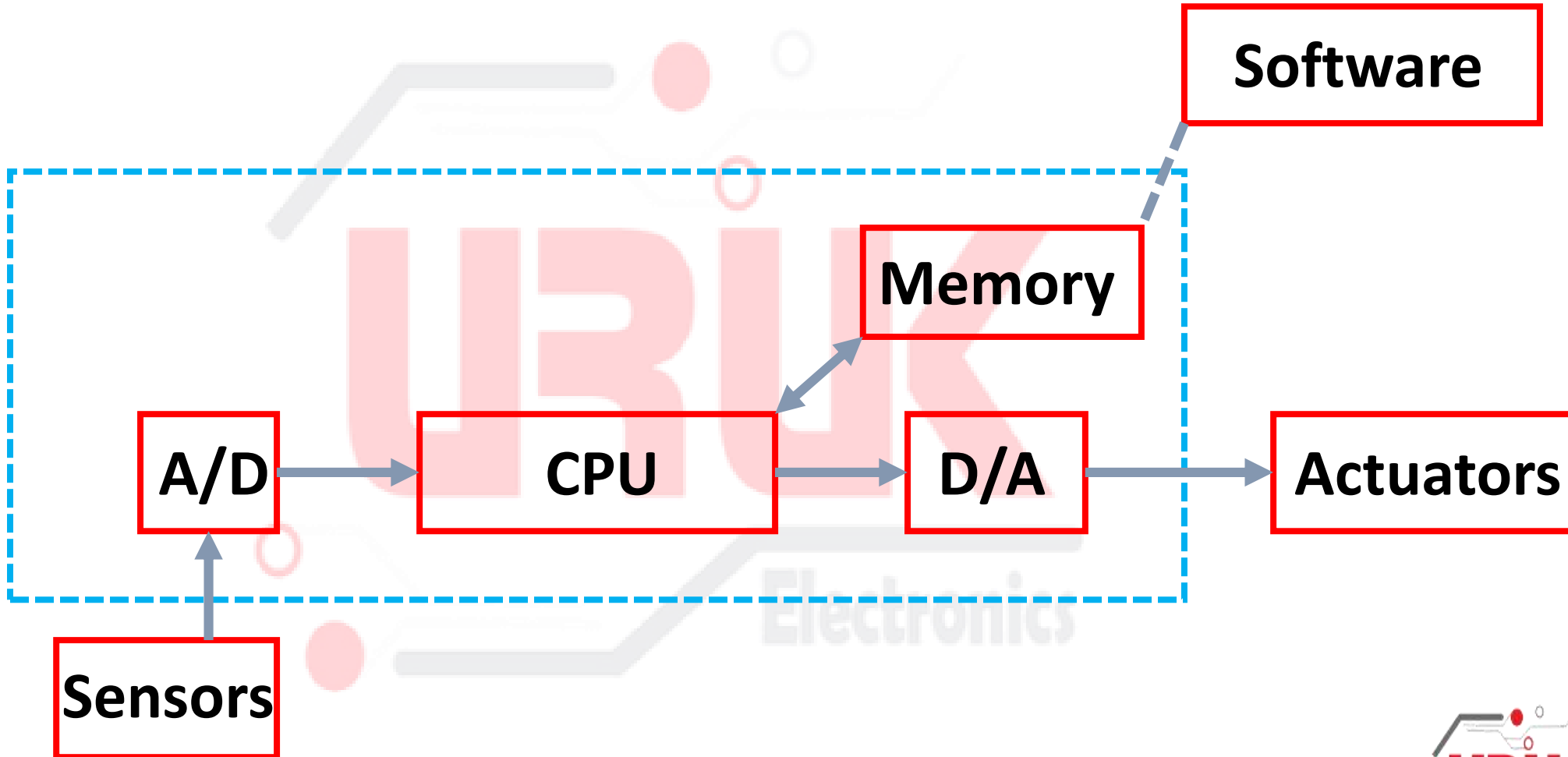
- Speed
- Cost
- Storage
- Size
- Power
- Reliability
- Accuracy
- Adaptability



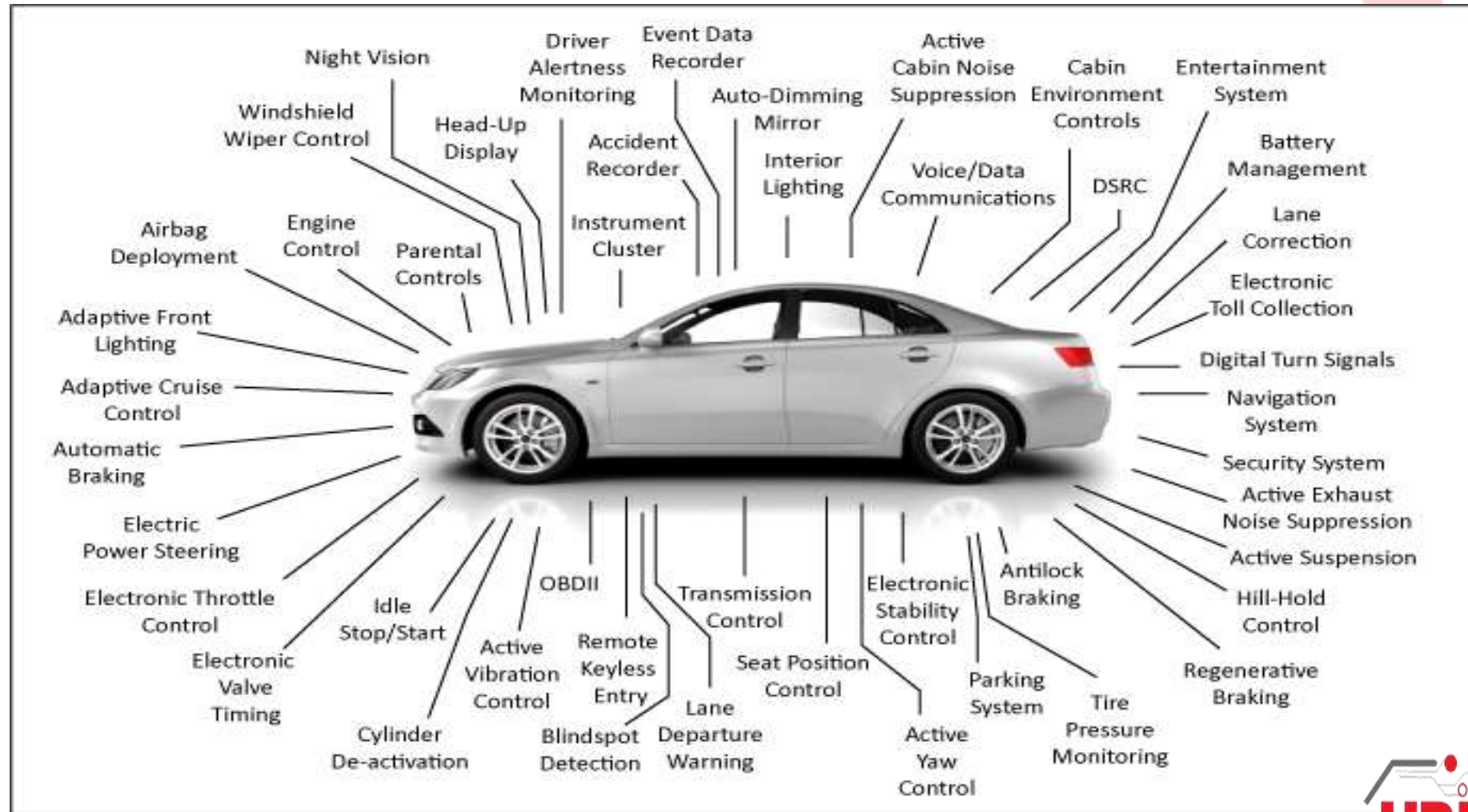
Types of Embedded Systems

- Embedded systems are **classified based on their performance and functional requirements** into:
 - **Stand Alone Embedded Systems**: it works by itself like mp3 players, digital cameras, video games consoles, etc.
 - **Real-Time Embedded Systems**: a system that gives its required input/output in a particular time. And it is classified into hard and soft real time systems.
 - **Networked Embedded systems**: embedded systems that are related to a network to access the resources.
 - **Mobile Embedded Systems**: used in portable embedded devices like cell phones, mobiles, etc.

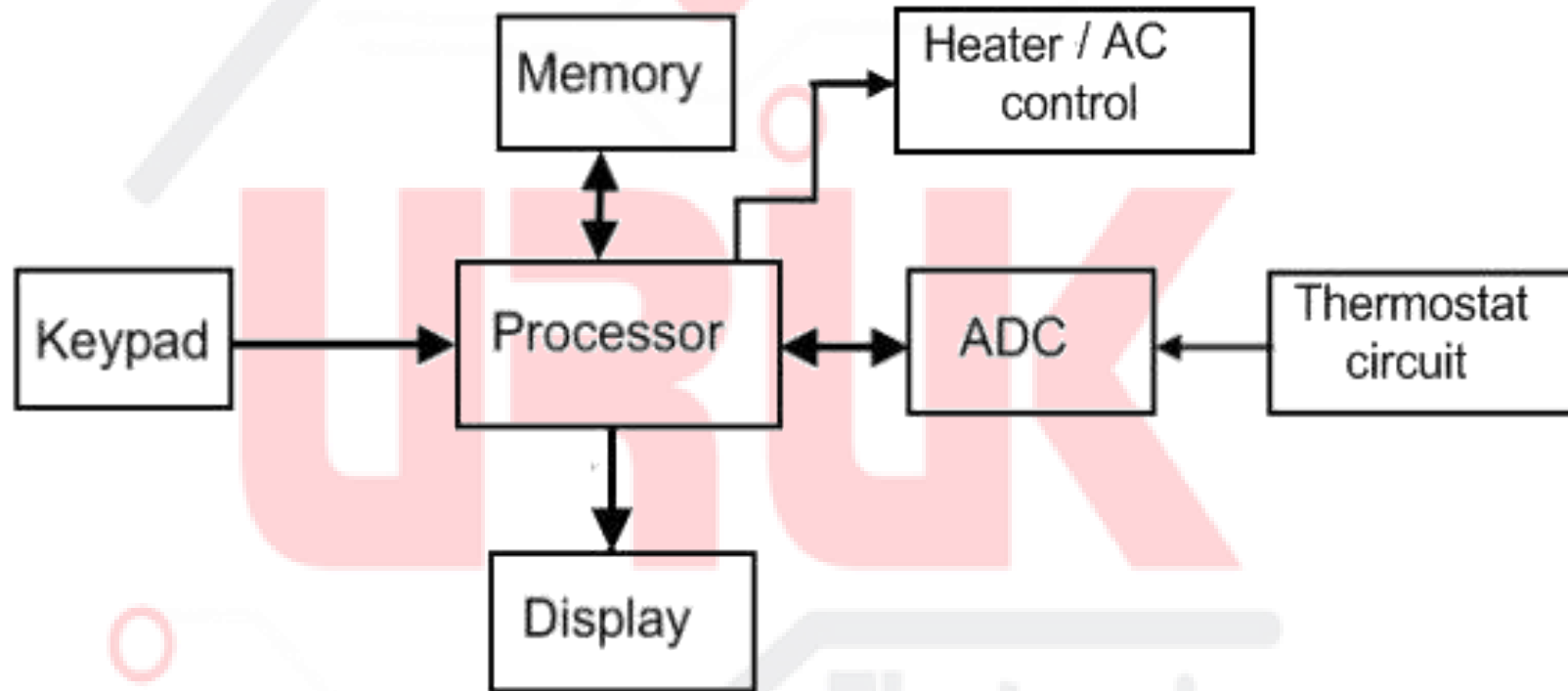
Embedded System Structure



Embedded System Examples



Embedded System Examples



A digital thermostat as an example of embedded system

How to Select a Microcontroller



Arduino Platform

- The **Arduino** is a **microcontroller development platform** paired with an intuitive programming language that you develop using the Arduino integrated development environment (IDE).
- By **equipping the Arduino** with **sensors, actuators, lights, speakers**, add-on modules (called **shields**), and other integrated circuits, you can turn the Arduino into a programmable “brain” for just about any embedded system.

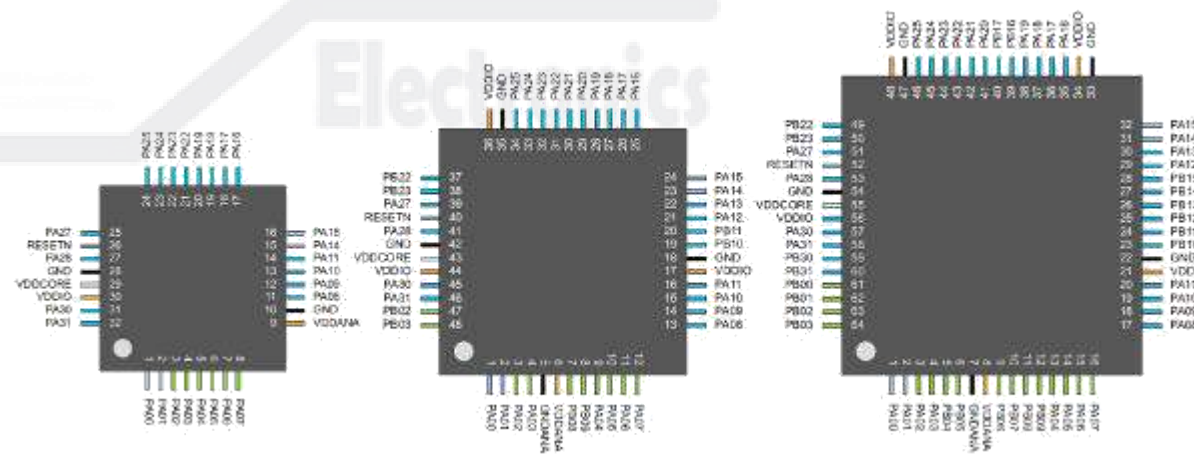


Arduino Functionality

- All Arduino boards have a few key capabilities and functions:
 - Atmel microcontroller.
 - USB programming/communication interface(s).
 - Voltage regulator and power connections.
 - Breakout I/O pins.
 - Debug, Power, and RX/TX LEDs.
 - Reset button.
 - In-circuit serial programmer (ICSP) connector(s).

Atmel Microcontroller

- At the **heart of every Arduino** is an **Atmel microcontroller** unit (MCU).
- Most Arduino boards, including the Arduino Uno, use an AVR ATmega microcontroller.
- The **Arduino Uno** uses an **ATMega328p**.
- The **Due** is an **exception**; it uses an **ARM Cortex** microcontroller.



Arduino Boards

UNO

- an ATmega328p as the main MCU.
- Operating voltage 5V.
- Input voltage (Recommended) 7-12V.
- 14 I/O Digital pins, 6 provide PWM.
- 6 Analogue pins.
- 2KB SRAM, 32KB Flash Memory, and 1KB EEPROM.
- Clock speed 16MHz.
- It is available in both DIP and SMD versions.



Arduino Boards

101

- Intel Curie as the main MCU.
- Operating voltage 3.3V.
- Input voltage (Recommended) 7-12V.
- 14 I/O Digital pins, 4 provide PWM.
- 6 Analogue pins.
- 24KB SRAM, 196KB Flash Memory.
- Clock speed 32MHz.

Arduino Boards

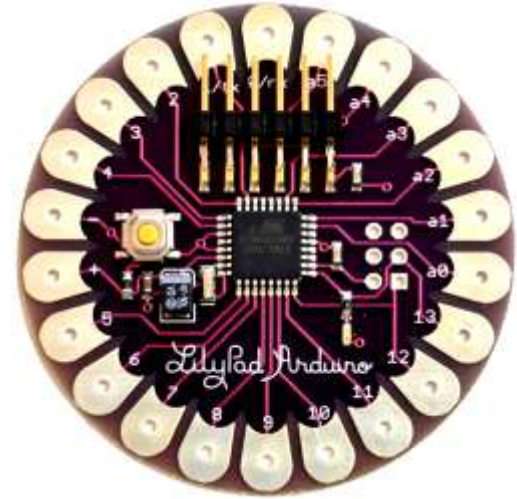
101

- Intel Curie as the main MCU.
- Operating voltage 3.3V.
- Input voltage (Recommended) 7-12V.
- 14 I/O Digital pins, 4 provide PWM.
- 6 Analogue pins.
- 24KB SRAM, 196KB Flash Memory.
- Clock speed 32MHz.

Arduino Boards

LilyPad

- ATmega168V or ATmega328P as the main MCU.
- Operating voltage 2.7V, 5V.
- 14 I/O Digital pins, 4 provide PWM.
- 6 Analogue pins.
- 1KB SRAM, 16KB Flash Memory and 0.512 EEPROM.
- Clock speed 8MHz.



Arduino Boards

Mega2560

- ATmega2560 as the main MCU.
- Operating voltage 5V.
- Input voltage (Recommended) 7-12V.
- 54 I/O Digital pins, 15 provide PWM.
- 16 Analogue pins.
- 8KB SRAM, 256KB Flash Memory and 4KB EEPROM.
- Clock speed 16MHz.



Arduino Boards

Micro

- ATmega32U4 as the main MCU.
- Operating voltage 5V.
- Input voltage (Recommended) 7-12V.
- 20 I/O Digital pins, 7 provide PWM.
- 12 Analogue pins.
- 2.5KB SRAM, 32KB Flash Memory AND 1KB EEPROM.
- Clock speed 16MHz.

Arduino Boards

Pro Mini

- ATmega328P as the main MCU.
- Operating voltage 3.3V/5V.
- Input voltage (Recommended) 3.35/5V-12V.
- 14 I/O Digital pins, 6 provide PWM.
- 6 Analogue pins.
- 2KB SRAM, 32KB Flash Memory and 1KB EEPROM.
- Clock speed 8/16MHz.

Sensors

Sensors

The image displays a variety of electronic sensors, each with a small 'URUK' logo. The sensors are organized into the following categories:

- Accelerometers & Gyroscopes:** Includes several blue printed circuit boards (PCBs) with various components and connectors.
- Distance:** Features a green PCB with a white sensor, a black cable with a connector, a blue PCB with a black sensor, a blue PCB with a white sensor, a yellow and black cable with a sensor, and a blue PCB with two cylindrical sensors.
- Light:** Shows a black PCB with several components, a white PCB with a sensor, and a small red component.
- Medical:** Includes a white cable with multiple colored connectors, a black PCB with a sensor, a red cable with a sensor, and a red PCB with a sensor.
- Motion:** Displays a red PCB with a sensor, a white PCB with a sensor, a green PCB with a sensor, and a black PCB with a sensor.
- Voltage & Current:** Shows a blue PCB with a sensor and a blue PCB with a sensor.
- Weather:** Includes a blue PCB with a sensor, a white PCB with a sensor, a black cable with a sensor, a blue PCB with a sensor, and a black PCB with a sensor.

A large, semi-transparent watermark for 'URUK Electronics' is positioned on the right side of the image.

Actuators



Thank you ...

Q&A