

Introduction to Microcontrollers and Sensors

Lesson Objectives:

- Understand what sensors and microcontrollers are.
- Identify everyday devices that use sensors and microcontrollers.
- Learn the core components of a microcontroller.
- Explore popular microcontroller platforms like micro:bit and Arduino.
- Understand how to connect and use basic electronic peripherals.

1. The Basics: Sensors and Microcontrollers

Environmental conditions—such as light levels, temperature, or soil moisture—are constantly changing. To detect these changes automatically, we use **sensors**.

Once a sensor gathers data, it needs a "brain" to understand that data and take action. This brain is called a **microcontroller**.

The Three-Step Process

A microcontroller functions similarly to a basic computer by following a simple three-step cycle:

1. **Input:** Collects data from sensors (e.g., detecting if it is dark outside).
2. **Process:** Reads the data and executes programmed instructions.
3. **Output:** Releases the necessary command (e.g., turning on a street light).

Everyday Examples

- **Solar Lamps:** Use light sensors and microcontrollers to automatically turn on when it gets dark to minimize electricity waste.

MICROCONTROLLERS IN EVERYDAY LIFE



- **Washing Machines:** The user inputs instructions via buttons; the microcontroller processes these inputs to control the wash cycle.
- **Microwave Ovens:** The microcontroller maintains the heat for the specific duration and temperature set by the user.

2. Components of a Microcontroller

A microcontroller is a specialized chip designed to perform operations based on specific instructions. It consists of four main components:

Component	Function
Central Processing Unit (CPU)	The core brain that processes data into information to provide an output.
Memory	<p>Non-volatile: Stores the permanent program; data remains even without power.</p> <p>Volatile (RAM): Temporarily stores data and results while running; erases when power is lost.</p>
System Clock	An electronic device that synchronizes the operations of all components.
Peripheral Devices	Small pins used to collect input data (analog/digital) and release output data (digital).

Key Terminology:

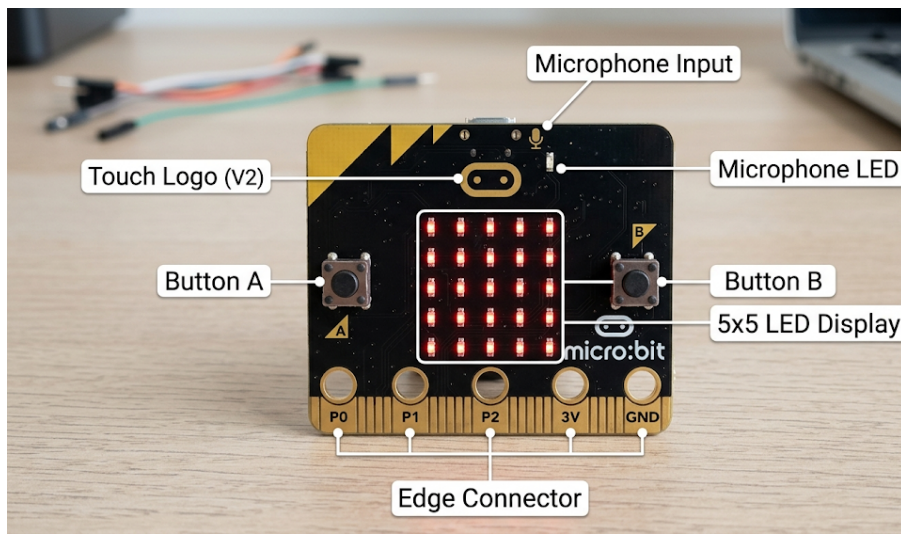
- **Single-Board Computer (SBC):** Has memory, input/output, and a microcontroller all on a single circuit board (e.g., Raspberry Pi).
- **Single-Chip Computer (SCC):** Has the CPU, memory, and input/output built directly into a single integrated circuit (IC) chip (e.g., Arduino chip).

3. Exploring the Micro:bit

Developed by the BBC, the micro:bit is a beginner-friendly microcontroller module that features built-in sensors, LEDs, and memory.

Key Hardware Features:

- **Front:** Two programmable buttons (A and B), a 5x5 grid of individually programmable LED bulbs, and digital/analog input/output pins.
- **Rear:** Bluetooth smart antenna, CPU, Micro USB port, 3V battery connector, accelerometer, compass, and pin edge connectors.



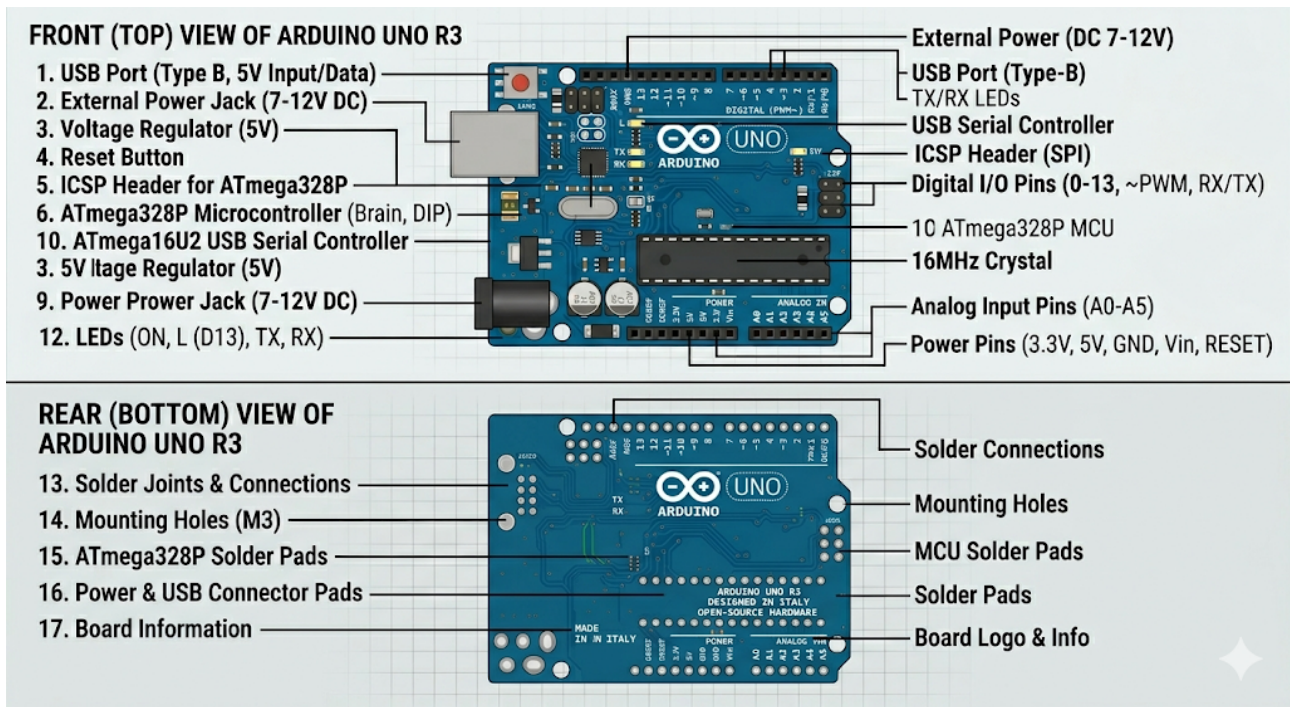
Coding the Micro:bit: The micro:bit is programmed online (often via www.makecode.microbit.com) using a simple drag-and-drop Block Editor. You connect blocks representing different commands (like displaying numbers, reading sensor data, or repeating actions). It can also be programmed in JavaScript, Python, or C++. When connected to a computer via USB, it acts like a standard storage drive, allowing you to easily transfer your code.

4. Exploring the Arduino

Arduino is a widely used microcontroller platform developed by Atmel. While there are many types of Arduino boards (Mega, Nano, Micro), the **Arduino Uno** is the most common for beginners.

Anatomy of an Arduino Uno:

Part	Description
Mini USB Port	Connects the board to a computer to upload code and provide 5V power.
DC Power Jack	Used to supply external power when not connected to a computer.
Power Regulator	Safely controls the voltage entering the Arduino board.
ATMEGA328p Chip	The actual microcontroller IC on the board that stores and runs code.
Digital Pins	Used to receive digital inputs and send digital outputs.
Analog Pins	Used to receive continuous analog inputs (like varying sensor readings).
Power Pins	Used to supply electricity (like 5V or 3.3V) to external components on a circuit.



5. Essential Peripherals and Sensors

To build functional projects, microcontrollers must be connected to external components.

Basic Components

- **Breadboard:** A reusable plug-and-play board for building circuits without needing to solder. All (+) holes are linked together, and all (-) holes are linked together.
- **Light Emitting Diode (LED):** A small bulb that emits light when electricity passes through it. Electricity can only flow through an LED in one direction.

Common Sensors

1. Passive Infrared (PIR) Sensor Detects infrared energy (like body heat from humans or animals) in its field of view. It features two adjustable dials (trimpots) to control sensitivity/distance (up to 7m) and the time delay of the output.

- **Pins:** GND (Negative), VCC (Positive 5V), OUT (Outputs 3.3V when motion is detected).

2. Ultrasonic Sensor Used to measure the distance to an object. It works much like a bat's echolocation: it sends out a high-frequency sound wave and measures how long it takes for the echo to bounce back.

- **Pins:** GND (Negative), VCC (Positive 5V), TRIGGER (Input to send the sound wave), ECHO (Output to receive the bounced wave).