

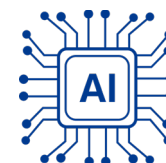


शिक्षा मंत्रालय
MINISTRY OF
EDUCATION



robotex
India

FUNDAMENTALS OF ROBOT & ROBOTICS: SENSORS, ACTUATORS, & CONTROLLERS



Defining Robot

A **robot** is a programmable machine designed to carry out tasks automatically or semi-autonomously, often mimicking human or animal actions. At its core, a robot combines three essential elements:



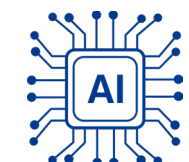
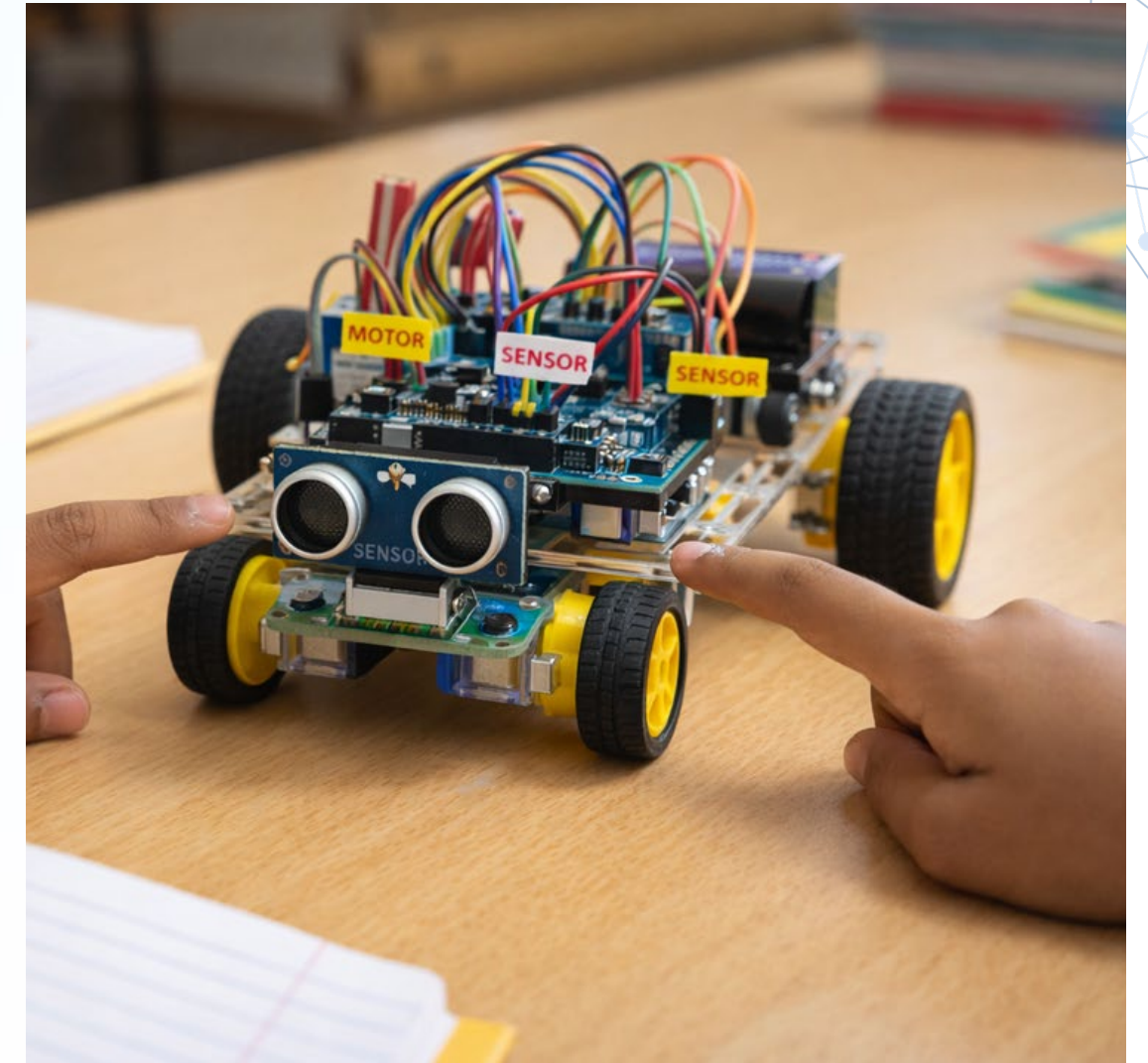
1. Senses: collects information using sensors



2. Processes: Process data and make a decision



3. Act: Moves or performs a task using motors or actuators

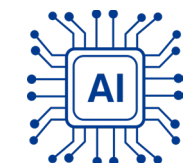


Components of Robots

Sensors: Allow robots to perceive their environment (e.g., cameras, touch sensors, infrared) (**Input**)

Controller: Software or hardware that processes input from sensors and directs actuators to perform tasks. (**Processing**)

Actuators : Motors or mechanisms that enable movement or interaction with objects. (**Output**)



The Electrical "LEGO" Bricks

Before building a robot, one need to recognize and understand these essential electronic components.



LED - The Bulb

Lights up when electricity flows through it. A first sign that the circuit is alive!



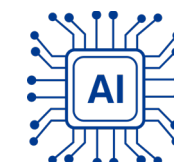
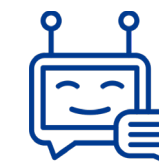
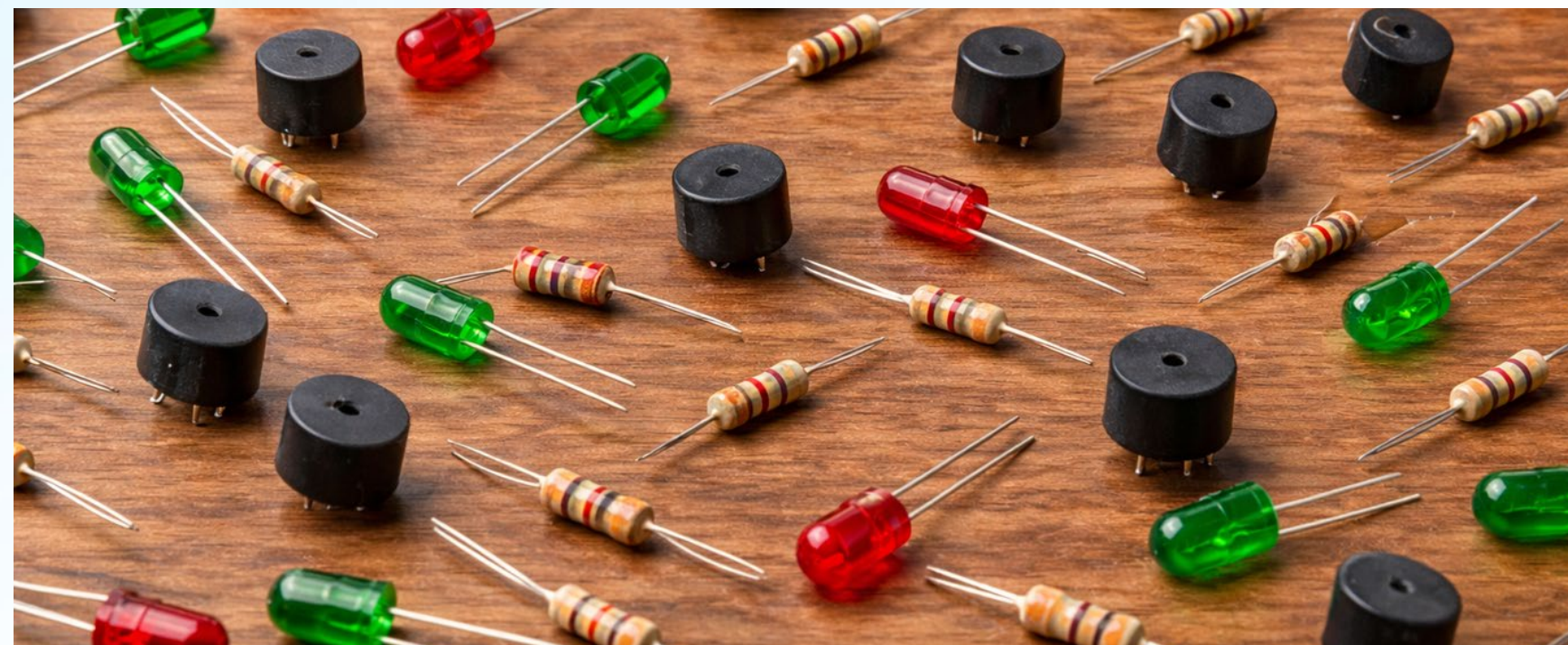
Buzzer - The Voice

Produces a sound for alerts or alarms.
Makes feedback immediate and satisfying for learners.



Resistor - The Speed Breaker

Controls and limits the flow of electricity, protecting components like the LED from burning out.



Connecting the Pieces

These three elements form the physical foundation of every circuit that is built.



Breadboard

A reusable "Connect-the-Dots" board. Plug in components to test circuits - **no soldering needed**. Perfect for classrooms!



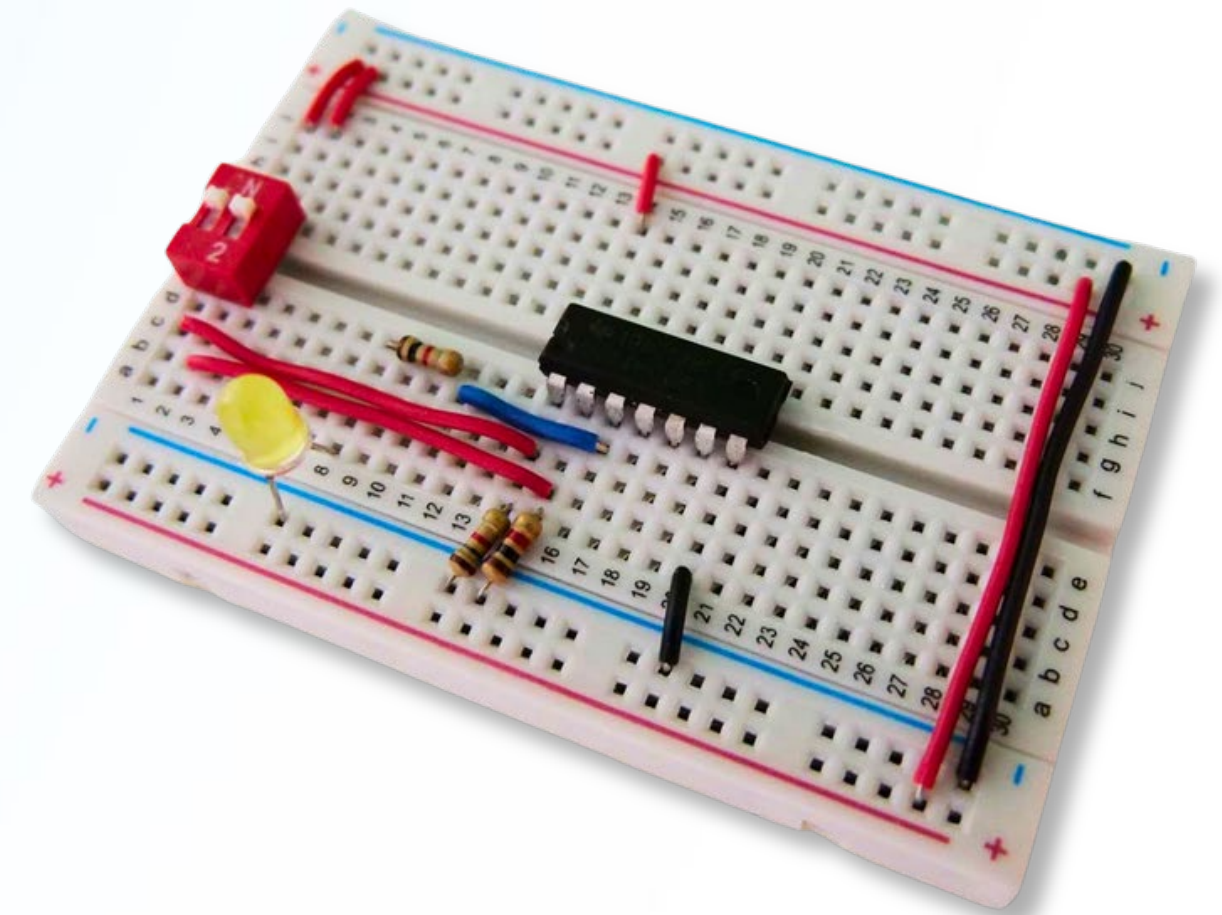
Connecting Wires

The "**highways**" for electricity. Color-coded wires help students trace the flow and debug problems easily.



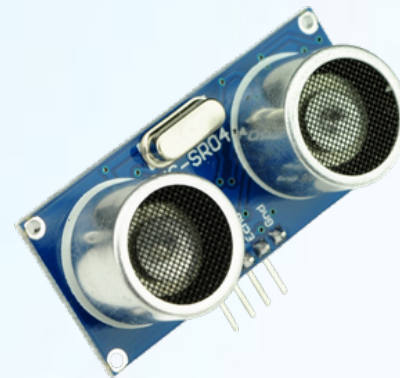
Power Supply (Battery)

The "**fuel**" that energizes the entire circuit. No power = no robot. Simple, memorable, true.



What Is a Sensor?

A sensor detects changes in the environment and sends a signal to the controller. It is the robot's "**eye (Vision/Light)**", "**ear (Sound/Audio)**", or "**skin (Touch/Proximity)**". Sensors can detect light, heat, distance, sound, touch, and even smoke.



IR Sensors - “The Invisible Eye”

Sends invisible light; detects when an object reflects it back.

Real life: TV remote!

Ultrasonic Sensor - “The Bat Ear”

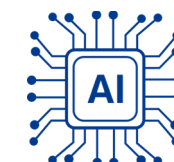
Emits a sound wave and measures echo time to calculate distance.

Real life: Car parking sensors that detect nearby objects.

LDR - “The Light Hunter”

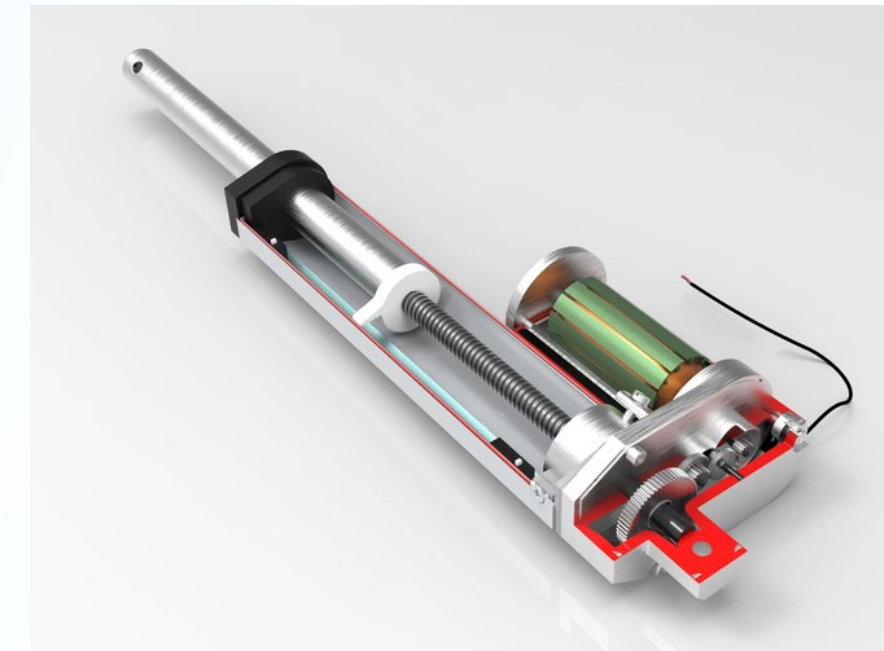
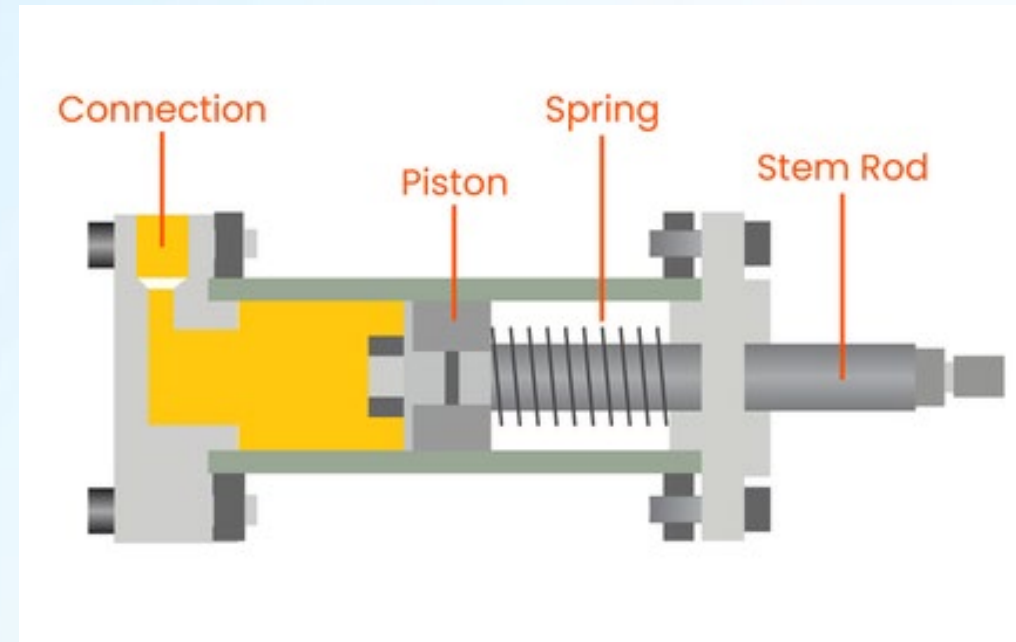
Light Dependent Resistor - its resistance changes with brightness.

Real life: A street light that automatically turns on when it becomes dark after sunset



What Is an Actuator?

An actuator is the device that **creates movement** - it converts electrical energy into physical action. If the sensor is the robot's ear, the actuator is its hand. It lets the robot respond to what it senses.



DC Motor

Fast, continuous rotation - perfect for **robot wheels**. Think: remote-control car wheels spinning at speed.



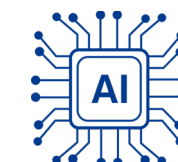
Gear Motor

Slower but **much stronger** than a DC motor. Ideal for lifting or gripping heavy objects.

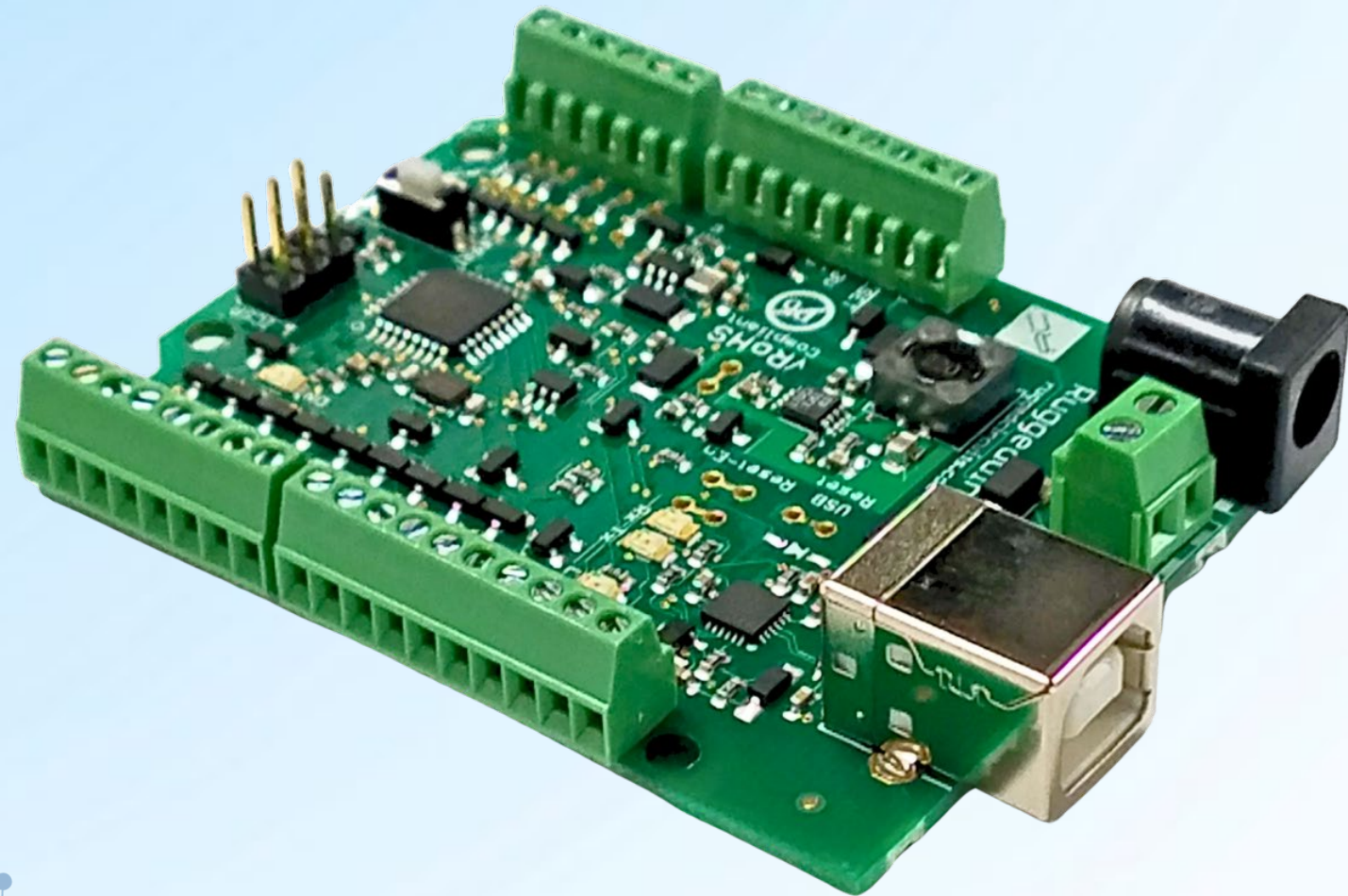


Servo Motor

Moves to a **precise angle** (e.g., exactly 90°). Great for a robot's elbow or claw/gripper.



The Microcontroller: Tiny Chip, Big Power



A **microcontroller** is a tiny programmable chip that acts as the robot's brain. Without it, the robot cannot make any decisions - it's just a collection of parts.

1. Read sensor data

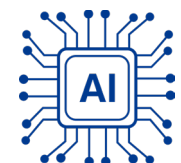
Listens continuously to all connected sensors

1. Follow the code

Executes the instructions the programmer wrote

1. Command the actuators

Sends the right signals to motors and outputs



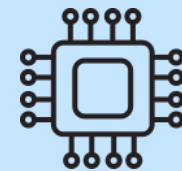
How Sensors, Actuators, & Controllers Work Together

Robots are not just machines; they are systems that interact with their surroundings. They work in a simple loop - Sense, Process, and Act - which helps them detect information, think about it, and respond accordingly.



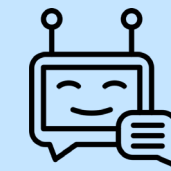
Sensor

Detects: Gathers data from the environment, acting as the robot's "eyes" and "ears." For example, it might detect an obstacle in its path.



Controller

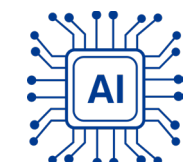
Processes: Interprets the sensor data and makes decisions, functioning as the robot's "brain." It could decide, "I need to move away from this obstacle."



Actuator

Executes: Performs the physical action based on the controller's decision, serving as the robot's "muscles." This might involve turning its wheels to avoid the obstacle.

This continuous feedback loop allows robots to operate autonomously and adapt to changing conditions in real-time, making complex tasks possible.



Putting It All Together: Complete Robot Systems

The magic happens when sensors, controllers, and actuators work as a coordinated system. Here are classroom ready examples that demonstrate all three components working together -

Obstacle Avoiding Robot

Sensors: Ultrasonic distance sensor detects obstacles ahead

Controller: Processes distance data and decides when to turn

Actuators: DC motors change direction to avoid collision

Student learning: If-then logic, decision making, autonomous behavior

Line Following Robot

Sensors: IR sensors detect line position underneath robot

Controller: Compares left and right sensor readings continuously

Actuators: Motors adjust speed to keep robot centered on line

Student learning: Feedback loops, calibration, error correction

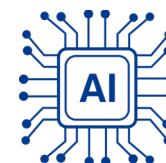
Light Seeking Robot

Sensors: Two light sensors on left and right sides

Controller: Compares which sensor detects more light

Actuators: Motors turn robot toward brightest light source

Student learning: Comparison logic, environmental response, biomimicry



The Golden Rule: Input > Process > Output

Every single robot project - no matter how simple or complex - follows this **three-step logic loop**. Knowing this concept clearly, the working of all robots becomes easy to understand.

