

HOW DOES THAT WORK?

ROBOTS

While there are many different types of robots, which perform tasks as varied as space exploration, shelf-stacking and surgery, they still have core features in common. A robot can sense its environment, plan an action and then carry out the action.

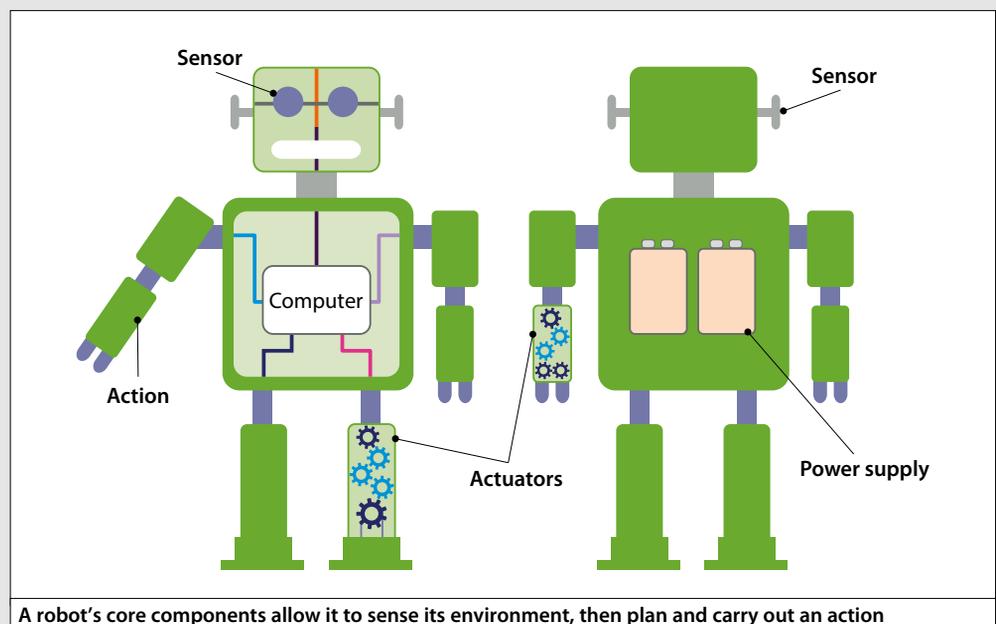
Robots are generally made up of the same components: a movable physical structure, a motor, a sensor system, a power supply, and a computer to control the processes, which can be an external device or internal control system. Robots vary between being autonomous, semi-autonomous or manually controlled, and may have a humanoid form or be designed for a specific task.

The actuator is the part of a machine that moves and controls parts of the system. The actuators connect to an electrical circuit, which powers the electrical motors and electromagnets directly or activates a hydraulic system through electrical valves.

In robots, the actuators are powered by a battery, solar power or mains power supply, and are usually one of the following:

- Hydraulic – hydraulic actuators have a cylinder or fluid motor that uses hydraulic power to create motion. As they are powered by liquid, which cannot be compressed, hydraulic actuators exert a large force.
- Pneumatic – pneumatic actuators use pressurised air to create movement, converting energy formed by a vacuum. This system enables considerable forces to be produced from relatively small changes in pressure.
- Electrical – motors power electric actuators to convert electrical energy into movement. These are more precise, quieter and easier to reprogramme than hydraulic or pneumatic actuators.

The actuators are attached to an electrical circuit, which powers the electrical motors that activate them. For



A robot's core components allow it to sense its environment, then plan and carry out an action

example, a hydraulic system is activated by manipulating electrical valves that drive the compressed fluid's path through the machine. Then, to move a hydraulic arm for example, the robot's controller would open the valve leading from the fluid pump to a piston cylinder attached to that arm. The fluid would extend the piston, swivelling the arm. To move their segments in different directions, robots use pistons that can push both ways. The robot's computer controls everything that is wired to the circuit.

Engineers programme the computer to switch on the relevant motors or valves to carry out pre-planned tasks. Algorithms for specific tasks are programmed into the robot, which send the correct signals to the actuators.

Different robots use a variety of sensors, such as a photodetector and microphone help to identify light and sound, facial recognition systems to identify faces and ultrasonic transducers to detect how close an object is. While some robots can see and hear, most have the ability to sense movement. A simple design to allow a robot to sense its own movement incorporates slotted wheels on the robot's joints. Beams from an LED light shine through the slots, and a sensor on the other side reads the pattern of flashing light as the wheel turns, sending data to the computer to analyse how far the joint has moved based on the light pattern.

Robots are already carrying out tasks in many industries, including healthcare, manufacturing, research and military, and look set to have further applications in many more.