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GLOSSARY IN *ROBOT REVOLUTION*

Below are a list of terms and overall robotics concepts represented in *Robot Revolution*, supported by Google.org with additional major support from The Boeing Company:

A **robot** is a reprogrammable, multifunctional manipulator designed to perform a variety of tasks. No matter their function, capabilities or design, the robots we encounter all have one thing in common: they sense, plan and act.

- Robots all have **sensors** that detect what's going on.
- **Software** reacts to what the sensor detects and tells the robot what to do.
- **Actuators** and **effectors** take action.
- All robots need some kind of **power source** to keep moving.

Robots and grippers that are **adaptable** can also perform more than one task, often in quickly changing situations.

Robot brains are similar to computers, and most have software written in computer code that controls their actions. These series of logical steps that help the robot decide what to do with the information it has are called **algorithms**.

An **autonomous** robot performs behaviors or tasks without human input. These kinds of robots can detect what's happening around them and respond accordingly. An **automaton** is a self-operating machine.

Whether it's the lightweight structure of a bird's skeleton, the strong legs kangaroos use to hop or even the way human infants learn, engineers have opened "nature's toolbox" to find creative ways to design robots and give them new skills. This is called **biomimicry**.

A **bipedal robot** has two legs, helpful for moving and working in the same environment as humans. However, bipedal robots are complicated to build and program, as it is difficult for these robots to stand and balance.

The robot control mechanism is usually a computer of some type, which is used to store data and execute programs, which operate the robot. The **controller system** contains the programs, data, algorithms, logic analysis, and various other processing activities, which enable it to perform.

To move in multiple directions means to have multiple **degrees of freedom**. A human arm, for example, has seven degrees of freedom. When an arm is pointed straight ahead and moved back and forth, that's one degree of freedom. Notice how many degrees of freedom robots have in this exhibit.

A **delta robot** utilizes a tripod linkage—three arms connected to **universal joints**, or joints in a rigid rod that allows the rod to bend in any direction, at the base. This type of structure gives the robot the ability to move very quickly, rendering them popular for picking and packaging in factories.

Like other robots, **drones** sense, plan and act, but what makes a drone special is its mobility. Often called **unmanned autonomous vehicles** (UAVs), drones can operate independently or be controlled remotely. Many have guidance systems that allow them to adjust their speed, correct their flight path and navigate on their own.

Effectors are the tools robots use to make things happen. A gripper is an effector (sometimes called an “end-effector”) at the end of a robot’s arm. They include grippers but can also be paint guns, welders, vacuums and lasers.

Robots have hands or **grippers**, which they use to hold and manipulate objects. Some grippers are simple pincers, and others are almost as complex as human fingers and hands. Grippers are a type of **effector**, a tool that allows a robot to interact with its environment. **Actuators**, much like a human’s muscles, make them move.

Emergent behaviors can appear when multiple robots or machines operate in an environment, forming more complex behaviors as a collective whole. These surprises occur when programming causes robots to do things that astonish even their programmers.

A **facial action coding system** is a research tool useful for measuring any facial expression a human being can make, especially useful for psychologists and animators.

A mechanism through which information from sensing devices is fed back to the robot's control unit is the robot’s **feedback sensor**.

FIRST, or For Inspiration and Recognition of Science and Technology, is an organization founded by inventor Dean Kamen in 1989 in order to develop ways to inspire students in engineering and technology fields.

Gyroscopes provide balance for many robotic systems, and it is the same the technology used to keep airplanes and spacecraft stable.

A **hexapod** walker is a six-legged walking robot, using a simple insect-like locomotion.

A **humanoid robot** is built with its body shape and physical attributes to resemble that of the human body.

Typical applications of **industrial robots**, which work in manufacturing and factory settings, include welding, painting, ironing, assembly, pick and place, palletizing, product inspection, and testing, all accomplished with high endurance, speed and precision.

Input devices allow a human-to-machine interface. This allows the human to program, control and stimulate the robot. Such devices include programming pendant, computer keyboards, a mouse, joy-sticks, push buttons, operator panel, operator pedestal, etc.

An **insect robot** is a small robot designed to imitate insect behaviors rather than complex human behaviors.

An **intelligent robot** can be programmed to make performance choices through a system of various responsive sensors with little or no help from human intervention.

Interface is a point where two systems or subjects meet and interact.

Joints are the parts of a robot arm which actually bend or move.

Kinematics is the study of motion, as applied to robots. This includes designing parts that give robots motion, power, control and stability. Kinematics also covers programming a robot's planning mechanism, such as choosing a sequence of movements to achieve a broader task.

Some robots are programmed with **machine learning**, a process that allows a robot to learn from experience and make predictions about what their next course of action should be.
A **material processing robot** is designed and programmed so that it can machine, cut, form, or change the shape, function or properties of materials it handles between the time the materials are first grasped and the time they are released in a manufacturing process.

A machine or robotic mechanism usually consists of a series of segments jointed or sliding relative to one another, called a **manipulator**, for the purpose of grasping and/or moving objects (pieces or tools) usually in several degrees of freedom.

Microspines, tiny hooks that resemble little claws, are used on robots to help them climb over obstacles.

A **proximity sensor** is a device used to sense when objects are a short distance away and determine the distance of the object.

A **servo motor** is an electrical power mechanism used to effect motion, or maintain position of the robot (for example, a motor which converts electrical energy to cause the robot to move). The motor responds to a signal received from the control system and often incorporates a feedback device that provides the current position and other data back to the control system.

Social machines or robots can detect emotional cues from humans, as well as mimic emotion. This is not the same as having, feeling or experiencing emotions.

Inspired by swarms of insects, schools of fish and flocks of birds, **swarm robotics** explores how robots working in groups can work together and have advantages over single robots.

A **touch sensor** is a sensing device, sometimes used with the robot's hand or gripper, which senses physical contact with an object, giving the robot an artificial sense of touch. The sensors respond to contact forces that arise between themselves and solid objects.

Alan Turing, in a 1950 paper, proposed a test called "The Imitation Game" that proposes a solution to determining machine intelligence. Otherwise known as the **Turing test**, it analyzes the machine's ability to exhibit intelligent behavior equivalent to, or indistinguishable from, that of a human. Since 1950, the Turing test has become an essential concept in the philosophy of artificial intelligence.

The **uncanny valley** is a hypothesized perceptual zone in which humanoid robot behavior and appearance begin to approach that of actual humans, but are still missing vital elements. As the behavior or appearance more closely resembles that of humans, these mimicked actions or images can cause a dip in some observers' comfort levels.

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