Week – 5 & 6

- **Robotics And AI**
- **Emergence**
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ROBOTICS AND AI

Definition….

It is that branch of AI that is concerned with design, construction and operations of robots.

WHAT IS A ROBOT?

Definition….

"A robot is a reprogrammable, multi-functional, manipulator designed to move material, parts, tools, or other specialized devices through various programmed motions for the performance of a variety of tasks."

WHY USE ROBOTS?

Use of Robots

There are two main justifications for use of robots. These are:

- **Productivity Improvement:** Business and industry are very concerned abut the productivity of its workers. The more work that can be turned out in the least amount of time the greater will be the profit of the company.

  Humans get tired or bored or sick. We take vacations and tea breaks. Humans get mad, talk to their co-workers, and otherwise slow down the work.

  The robot simply does not exhibit any of these problems. The robot works tirelessly, never having to take breaks or time of the job. They are not affected by emotional work situations or de-motivational actions.

- **Replace Humans In Hazardous Environments:** There are many jobs in the industry that are just plain dangerous for human beings. Workers are exposed to hazardous materials including sharp, heavy metal pieces, elevated temperatures, toxic chemicals and high noise level.

MAIN APPLICATION AREAS

Robots can perform a variety of different tasks. Some are given below:

- **Welding:** the most frequent application of robotic arms in manufacturing is welding. Welding is a dangerous activity, and it requires intense concentration and skill. Further, the locations of many welds require humans to physically maneuver into difficult positions.

- **Materials Handling:** Materials, components, and assemblies can be transferred from one place to another using a robot arm. Some robot arms can look through an assembly of parts and pick out a specific one, pick it up, and move it to another place.

- **Assembly:** In many manufacturing applications, robots actually perform the assembly of some machine or device. Individual components are picked up by the arm and put together in a proper sequence to form a device.

- **Spraying:** Another widely used application is spraying. At the end of the robot arm, a special nozzle connected to a hose and a source of liquid is used to spray components during the manufacturing process. The most common form of spraying is painting. The robot arm can be programmed to move precisely to provide even coat of paint to even the most unusually shaped objects in a very short period of time. The amount of paint can be controlled precisely.

TYPES OF ROBOTS

Two major categories are there:

- **GENERAL PURPOSE ROBOTS**
  - **Androids:** Androids are synthetic human beings with mechanical limbs and electronic brains, also known as humanoid.
  - **Cyborgs:** it is a human being, which has been supplemented by some type of electromechanical device. A cyborg uses robot-like parts to correct a physical deficiency or to enhance mental or physical capabilities.

- **INDUSTRIAL ROBOTS**
  - **Fixed Arm Robots:** these are the most common robots in the industrial environment. These robots are mounted on a base in a single location near where it will perform its work. It is generally secured to a cement floor with heavy bolts or is mounted on a table or other work surface so that it cannot move. In some special applications, the robot arm can be moveable. E.g.: it may be mounted on rails so that it can slide along a production line.
  - **Mobile Robots:** a mobile robot is capable of moving around. Such robots are generally manipulator arms mounted on a small vehicle-like structure with wheels or

bulldozer-like tracks. Other methods of propulsion may also be used in special circumstances. E.g. robots with legs or propulsion motor for under water robots.

LAWS OF ROBOTICS

If we are ever to able to produce such androids, we should make sure they are positive influences in our society. **Issac Asimov**, wrote that all androids should follow the three laws of robotics. These laws are:

- A robot may not injure a human being or, through inaction, allow a human to be harmed.
- A robot must obey orders given by human except when that conflicts with the first law.
- A robot must protect its own existence unless that conflicts with the first or second law.

COMPONENTS OF A TYPICAL ROBOT

The typical industrial robot consists of four major components: **the manipulator arm, the end effector, the actuator, and the controller.**

1. **MANIPULATOR ARM**
   It resembles or works like the arm of a human. It often has a shoulder joint, an elbow, and a wrist. However, there is variety of ways that manipulator arms can be made. The **five basic types are used in industry**.

   - **RECTANGULAR OR CARTESIAN COORDINATE ARM:** the idea is to move the end effectors of the arm to a given location in space to perform some function. The X, Y and Z-axes of a rectangular coordinate system define this point in space. The robot arm may move from right to left, up and down, and forward and backward.

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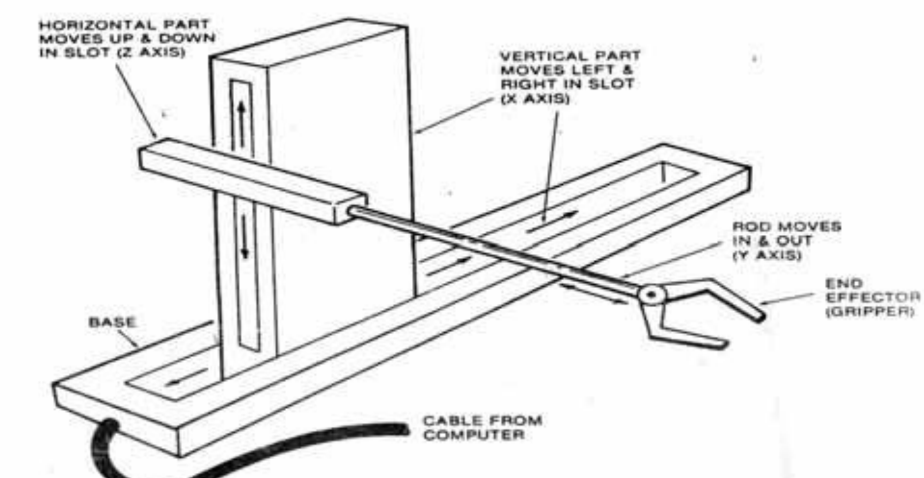

Figure 8-3. *Rectangular or Cartesian coordinate arm.*

- **CYLINDRICAL COORDINATE ARM:** manipulator arm that uses cylindrical coordinates. Instead of simply moving back and forth from left to right, the entire arm assembly can rotate 360 degrees. The remainder of the arm can also move up and down and forward and backwards. Instead of having an X-axis, this robot uses rotation. The position of the arm is determined by an angle from some reference point along with the Y and Z coordinates.

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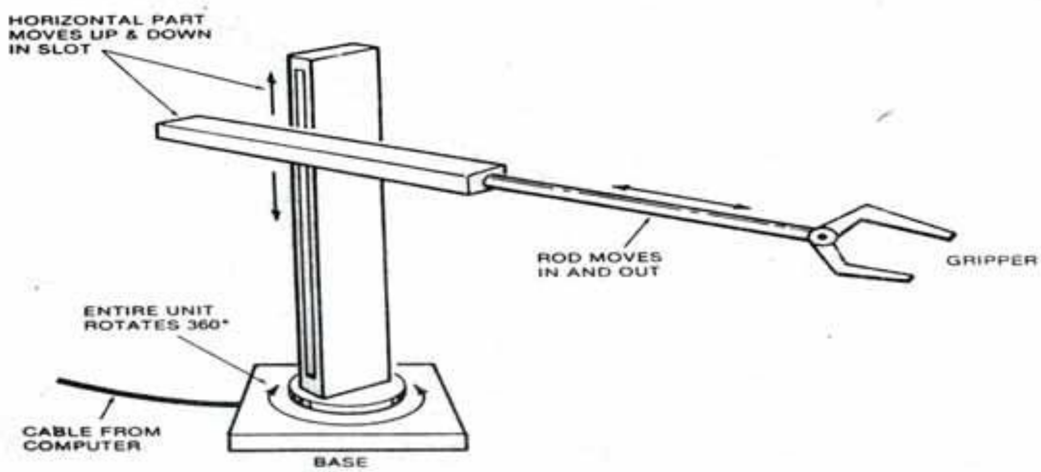

Figure 8–4. *Cylindrical coordinate arm.*

- **POLAR COORDINATE ARM:** the vertical or Y component is replaced by another joint referred to as a shoulder joint. Vertical motion is achieved by rotation in this joint. Again, the entire arm can turn 360dgree and the arm itself can move in and out (the Z-axis). This arrangement traces out a workspace that is a portion of a sphere.

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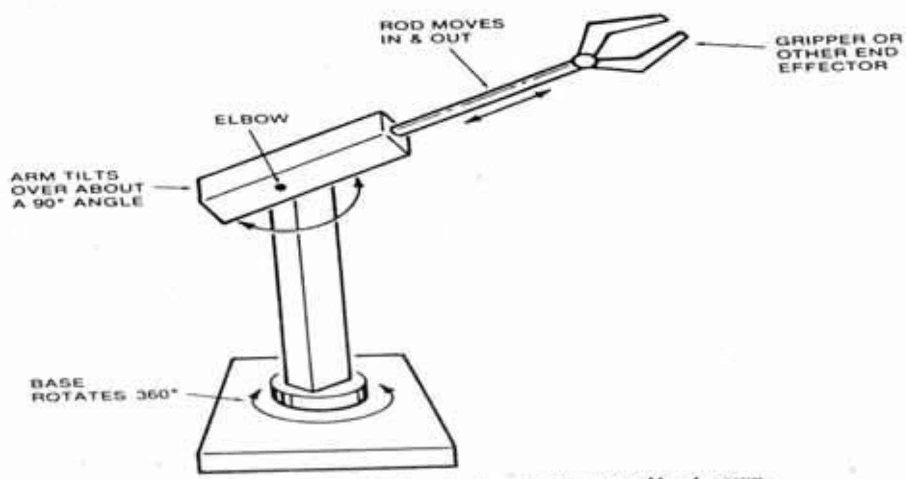

Figure 8–5. *Spherical or polar coordinate arm.*

- **ARTICULATED OR JOINTED SPHERICAL COORDINATE:** it can rotate 360 degrees. However, in addition to having a shoulder joint, it also has elbow and wrist joints. This gives the arm greater flexibility of movement and, as a result, it can trace out a larger portion of a sphere.

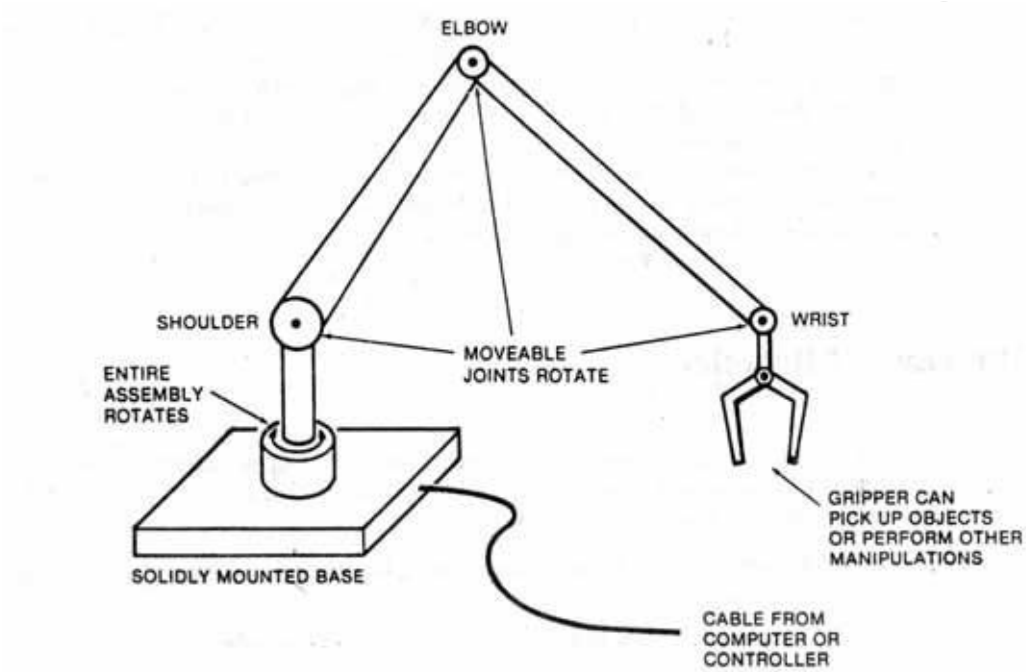

Figure 8–1. *A typical industrial robotic arm.*

- **SELECTIVE COMPLIANCE ASSEMBLY ROBOT ARM:** its basic workspace is a cylinder. However, that cylinder is derived in an unusual manner. It can rotate 360 degrees. However, it has an elbow joint that moves horizontally rather than vertically. A vertical element at the end of the arm can move up and down providing the Y-axis. Arms of this type are sometimes used in high speed assembly work, such as putting together electronic equipment.

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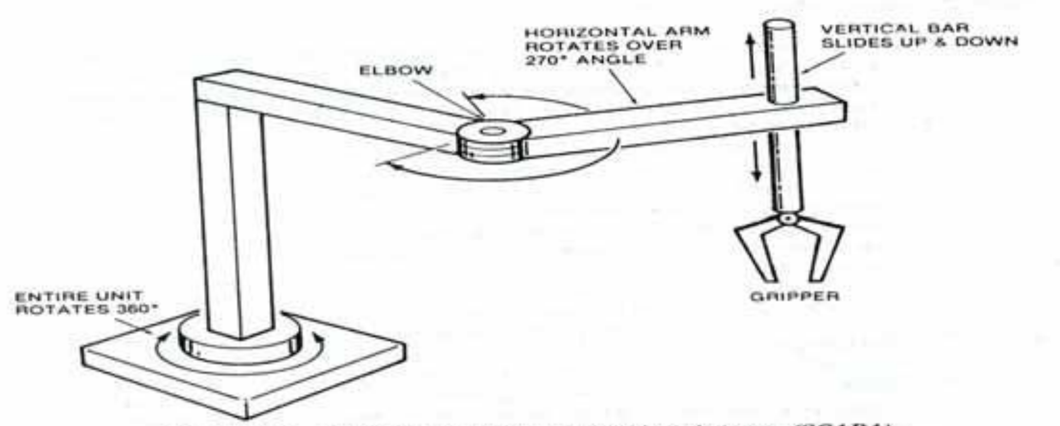
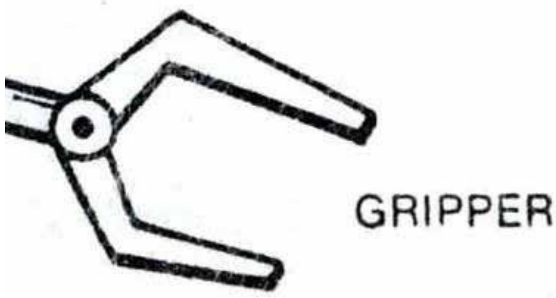


Figure 8–6. *Selective compliance assembly robot arm (SCARA).*

2. END EFFECTORS

The end effector attaches to the end of the arm. It is the device that performs the designated operation. An almost unlimited number of variations are possible. Most end effectors are specially designed for the job to be done.

One of the most popular types of end effectors is *gripper*. In its simplest form, the gripper is a pincher-type assembly that simulates a thumb and one finger. This allows the robot to be able to pick up objects within a certain size limitation. More sophisticated assemblies use three or more “fingers” to provide added flexibility.



The end effector is usually mounted at the wrist of the arm and provides several additional movements referred to a wrist articulation, as shown:

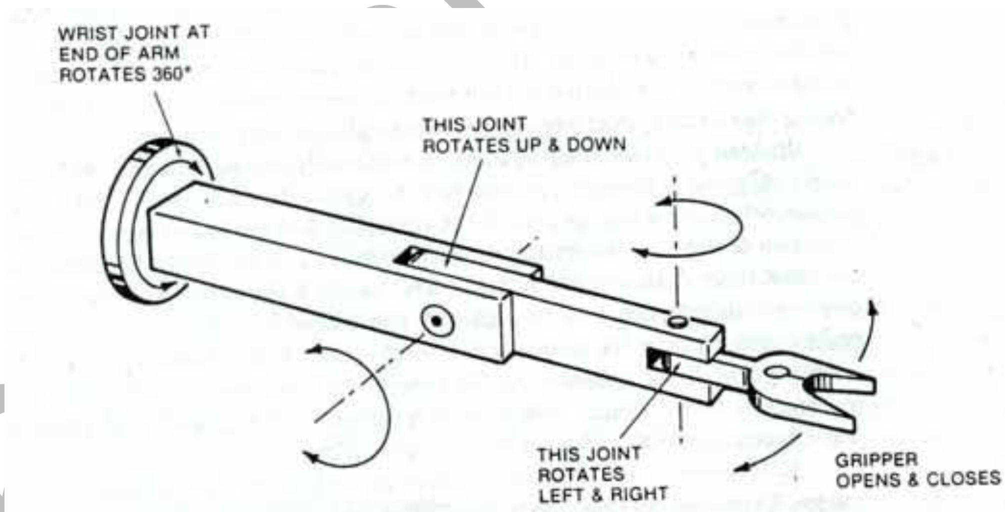


Figure 8-7. ***Wrist articulation for flexible end effector movement.***

The wrist can rotate swivel up and down and back and forth. Once the arm has been positioned, these three additional wrist movements can provide additional flexibility in positioning the end effector for its work.

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3. ACTUATOR

The actuator is also referred as the ***power source***. This is the basic source of energy for moving the arm, controlling the joints, and operating the end effector. Three basic types of power sources are used: **electric, hydraulic, and pneumatic.**

ELECTRONIC ACTUATORS are AC and DC motors that provide rotation or joint movement. These are used in combination with mechanical assemblies such as gears or pulleys to make the basic movements. There is usually one motor per joint.

HYDRAULIC SYSTEM consisting of a pump that puts a liquid such as oil under pressure. By uses of valves and other mechanisms, this pressurized liquid can control all of the arm motion. Hydraulic systems are extremely powerful. They are capable of lifting far greater weights than electrical systems and are, therefore, used in applications requiring maximum strength and durability.

A few robotic arms use a **PNEUMATIC SYSTEM** for power. Compressed air is forced through lines to cause movements. Pneumatic systems are weak and are used for only very light duty work.

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4. CONTROLLER

The fourth major component in a robotic system is the controller. This is the instrumentation that sends signals to the power source to move the robot arm to a specific position and to actuate the end effector.

Controllers are electronic circuits. They can be a special purpose programmable controller, which gives the robot arm a sequence of movement instructions and actions. The most flexible kind of controller, of course, is a general-purpose digital computer, which allows the arm to reprogram for a wide variety of applications.

CHARACTERISTICS OF ROBOTS

ROBOT SENSORS

The robots can be given sensors to perceive their environment.

- **ROBOT VISION:** information about the work environment can be obtained by vision than by any other means. Machine vision systems are widely available and readily adaptable to robot systems.

  Giving the robot system vision is as easy as mounting a video camera so that it focuses on the workspace. Placement of the camera is critical to give the robot the best possible view, and the position of the camera may change as needed. In some cases, two or more cameras might be necessary to provide the kind of feedback required.

- **TOUCH:** this sense enables the robot to know when it has come into contact with the work piece. It gives robot the sense of knowing how much pressure is being applied to workspace by the arm or end effector. A gripper will apply a fixed amount of pressure as it picks an item up.

  Strain Gauges are used on robot grippers to provide pressure feedback. They are a type of transducer whose electrical resistance varies with the pressure or stress applied to it. When connected into an electrical circuit, the strain gauge produces an analog signal proportional to the pressure. The signal is converted into binary from an A-to-D converter and used by computer to determine the amount of pressure being applied by the grippers. The controller program will adjust the actuation devices, either increasing or decreasing pressure as required by the application.

Another kind of sensors used in robot systems is the **Proximity Detector**. It provides the feedback on the position of an item relative to the arm. Robot must know when the work piece is coming within range, but it doesn't have to touch the work piece to know how close it is. As soon as the work piece is within a specified distance. The robot knows to get ready and position itself in an appropriate way.

- **HEARING:** A robot with the speech recognition system would be more useful. With the help of speech recognition system you can speak commands instead of controlling the robot from levers and computer.

  The voice input to the microphone produces an analog speech signal. This is converted in to binary through ADC (analog-to-digital Converter). This binary version is stored in the system and compared with previously stored binary representations of words and phrases. When match occurs recognition is achieved. Once recognition is achieved the robot executes the command.

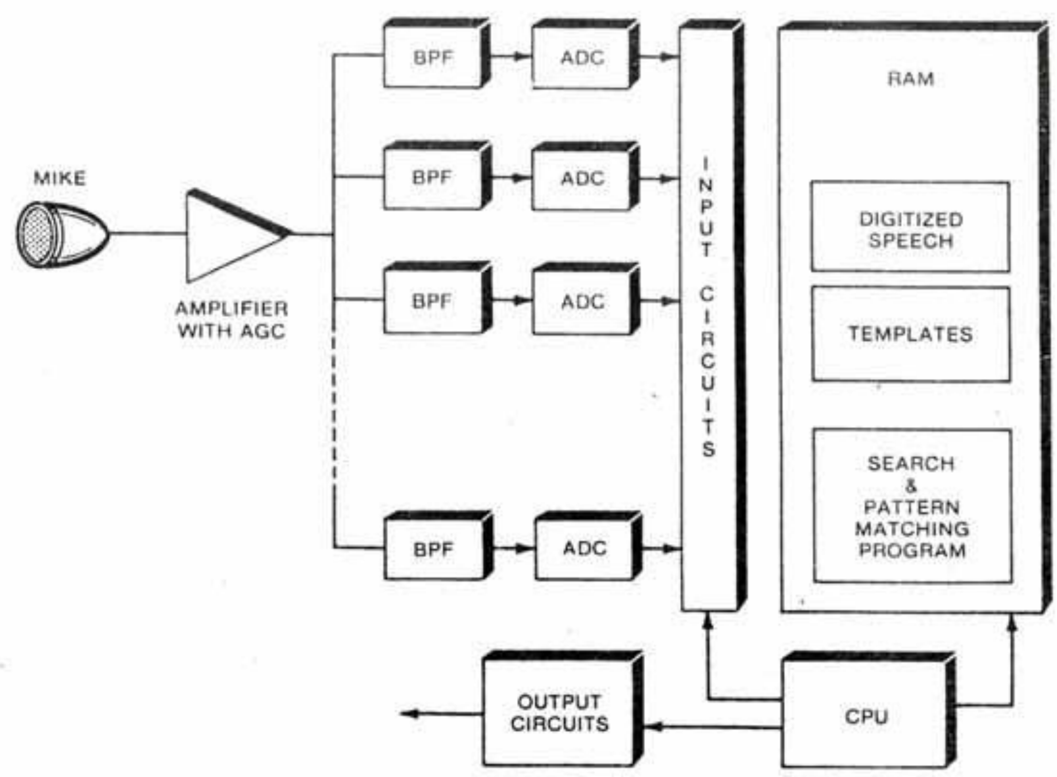

Figure 6-7. *A speaker dependent word recognition speech recognizer.*

ROBOT PROGRAMMING TOOLS

There are many robot programming language

- **WAVE** by **Stanford University**
- **HELP** by **General Electric corporation**
- **JARS** by **Jet Propulsion Laboratory**
- **AML** by **IBM**

GENERAL BLOCK DIAGRAM

The work environment represents the object to manipulate. The arm is driven by the computer from an output interface. The sensors monitor various conditions in the work environment. The electrical signals they generate are conditioned by amplifiers, A-to-D converters, or other circuits to make them compatible with the with the computer interface.

Operation begins with sensors that monitor the environment and generate electrical signals and binary data compatible with the computer. The binary information or data base is stored in computer's memory (RAM). This data represents feedback signals that tell the computer what's going on.

Within the computer is the inference engine that can think or reason by implementing pattern matching strategies. It will use the database information during processing. The knowledge base contains rules, semantic networks, frames, scripts or other representations of knowledge.

The outputs of the inferencing mechanism modify the control program, and the control program sends signals to the robot arm via the output interface. The sensors may then perceive changes that modify the database.

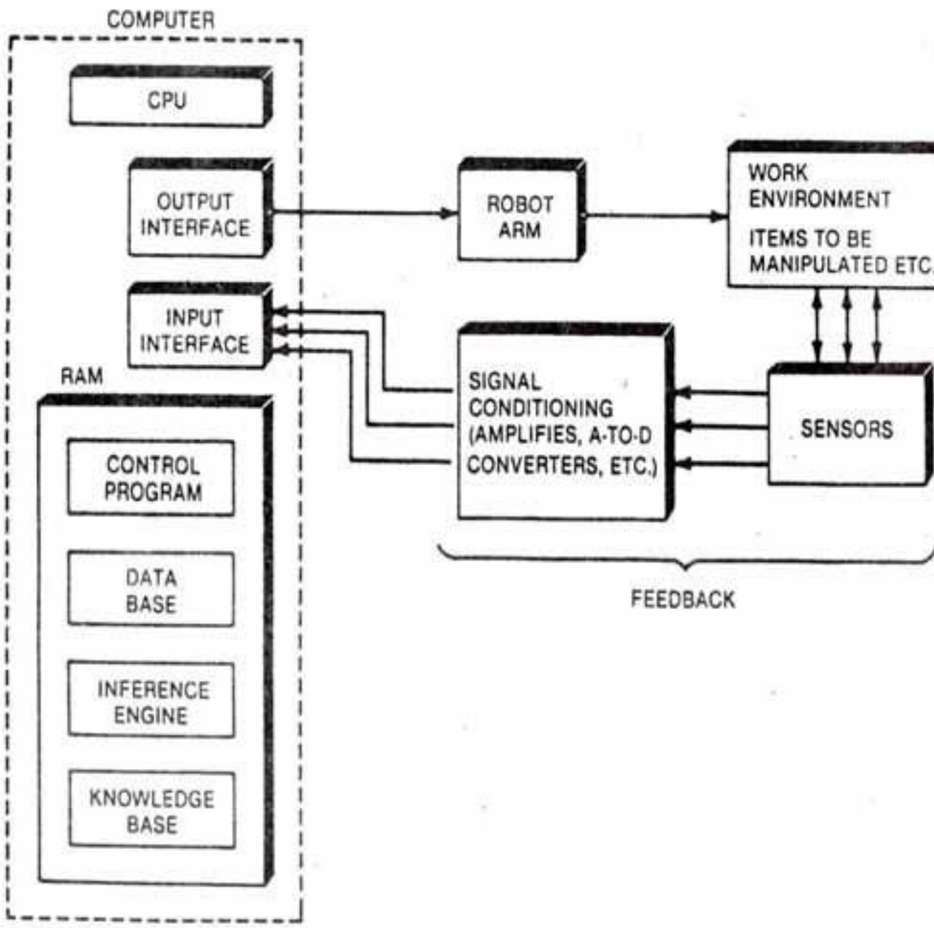

Figure 8-8. *General block diagram of an intelligent robot.*