ROBOT COMPONENTS:

A robot, as a system, consists of the following elements, which are integrated together to form a whole.

MANIPULATOR OR ROVER.

This is the main body of the robot, which consists of the links, joints, and other structural elements of the robot. Without other elements, the manipulator alone is not a robot.

END EFFECTOR:

This is the part that is connected to the last joint (hand) of a manipulator and that generally handles objects, makes connection to other machines, or performs required tasks. In most cases, all they supply is a simple gripper. Generally, the hand of a robot has provisions for attaching specialty end effectors that are specifically designed for a purpose. Welding torches, paint spray guns, glue-laying devices, and parts handlers are but a few examples.

ACTUATORS:

Actuators are the “muscles” of the manipulators. The controller sends signals to the actuators, which in turn move the robot’s joints and links. Common types are servomotors, stepper motors, pneumatic actuators, and hydraulic actuators. Other novel actuators are used in specific situations. Actuators are under the control of the controller.

SENSORS:

Sensors are used to collect information about the internal state of the robot or to communicate with the outside environment. The robot controller needs to know where each link of the robot is in order to know what the robot’s configuration is. It is similar for a human.

CONTROLLER:

The controller is rather similar to your cerebellum; although it does not have the power of the brain, it still controls your motions. The controller receives its data from the processor (the brain of the system), controls the motions of the actuators, and coordinates the motions with the sensory feedback information. For example, suppose that in order for the robot to pick up a part from a bin, it is necessary that its first joint be at 35 degrees. If the joint is not already at this magnitude, the controller sends a signal to the actuator (a current to an electric motor, air to a pneumatic cylinder, or a signal to a hydraulic servo valve), causing it to move. It then measures the change in the joint angle through the feedback sensor attached to the joint (a potentiometer, an encoder, and so on). When the joint reaches the desired value, the signal is stopped.

PROCESSOR:

The processor is the brain of the robot. It calculates the motions of the robot's joints based on the programs it runs, determines how much and how fast each joint must move to achieve the desired location and speeds, and oversees the coordinated actions of the controller and the sensors. The processor is generally a computer, which works like all other computers but is dedicated to this purpose. It requires an operating system, programs, and peripheral equipment like a monitor, and it has the same limitations and capabilities. In some systems, the controller and the processor are integrated together into one unit. In others, they are separate units. And in some, although the controller is provided by the manufacturer, the processor is not; the manufacturer expects the user to provide their own processor.

SOFTWARE:

Three groups of software programs are used in a robot:

(i) The operating system operates the processor.

(ii) Robotic software calculates the necessary motions of each joint based on the kinematic equations of the robot. This information is sent to the controller. This software may be at many different levels, from machine language to sophisticated languages used by modern robots.

(iii) A collection of application-oriented routines and programs are developed in order to use the robot or its peripherals for specific tasks, such as assembly, machine loading, material handling, and so on. This includes additional vision routines when the robot is equipped with a vision system.

ROBOT DEGREES OF FREEDOM:

Degrees of Freedom (DOF) refers to the number of independent movements a robot or mechanical system can perform. In three-dimensional space, a rigid body has six degrees of freedom, including three translational and three rotational motions. Each robotic joint contributes at least one DOF. Higher DOF enables robots to perform complex medical tasks like surgery, rehabilitation, and prosthetic manipulation with greater precision. However, higher DOF increases system complexity and cost.

To locate a rigid body (a three-dimensional object rather than a point) in space, we first need to specify the location of a selected point on it, and therefore we require three pieces of information. Next, we also need to specify the orientation of the object to fully specify it in space. This means that six pieces of information are needed to fully specify the location and orientation of a rigid body. By the same token, there need to be 6 degrees of freedom (DOF) available to fully place the object in space and also orientate it as desired.

Each DOF represents one independent motion such as:

- Translation (linear movement):

Translation is the straight-line movement of a robot or its part from one position to another without any rotation.

- Rotation (angular movement):

Rotation is the circular or turning movement of a robot or its part about an axis.