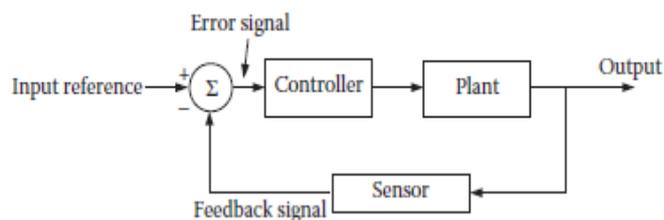


BASIC COMPONENTS AND TERMINOLOGY

A control system is used to change (control) the behaviour of a device, machine, or process (called a plant). The plant may be an air conditioning system, a chemical process, an iron, a robot, and so on. In each case, the plant creates an effect—an output such as the changing temperature of the room or the iron, the flow rate in the chemical process, or the motion of the robot arm. To perform its function, the control system uses sensors such as a thermostat, a flow-meter, or a potentiometer and encoder to measure the output of the plant. The controller receives the output signal (as its own input signal) and, based on its design, controls the plant and its output – the desired temperature in a room or on an iron, the rate of flow, or the final destination of the robot linkage and its speed. Note that there is a difference between the nature of different controllers. In the air conditioning system or the iron, the controller regulates the output. In the robot, it tracks the motions and controls their specification. This is called a servo-controller system.



An open-loop controller lacks a feedback signal and is not aware of the output. For example, as we discussed in Chapter 1, a robot's processor calculates the destination's joint variables and sends the information to the controller. If the robot controller were open-loop, it might send a signal to a joint motor proportional to how far it needs to go, but not be aware of whether or not the joint moves at the desired rate. With a closed-loop controller that includes feedback, the controller will receive a signal from the joint indicating its response to the control signal. If the motion is not as desired, the controller increases or decreases the control signal to force the arm to behave as desired. Figure 8.1 also shows a summing operation between the feedback signal and the input reference signal. As you see, the feedback signal is subtracted from the reference input signal, resulting in an error signal. The error signal is the driving signal for the controller. For a stable system, the feedback signal must be subtracted from the input reference signal. Otherwise, if they are added, the resulting signal becomes larger as the output increases, further increasing the output until the system "blows up." To better understand the relationship between the different elements of a control system, let's first consider the behaviour of a plant or the system's dynamics.