INTRODUCTION TO CONTROL SYSTEM

CONTROL SYSTEM

A control system is a mechanical or electronic system which controls or regulates the output in a desired manner through a control loop. Figure1 shows a basic control system.

The basic components of a control system are

a. Input or the actuating signal, u
b. Output or the controlled variable, y

BASIC TERMINOLOGIES

Actuating Signal

The actuating signal the algebraic sum of the reference input signal and feedback signal. It is also called the "error signal."

Controlled Variable

The controlled variable is the signal that is measured and controlled. Normally, the controlled variable is the output of the system.

Plants

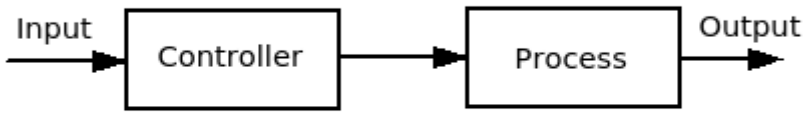
A set of equipment or a hardware or a machine, any physical object which is controlled to perform a specific operation.

Feedback Control

To get more precise control over the output, the controlled variable y is fed back to the input to be compared with the reference input. An error signal or actuating signal is generated in proportion with the difference between the input and the output. The error signal is then sent

through the control system to correct the error in the output. Feedback also affects the performance characteristics of the system like stability, overall gain, bandwidth, disturbances and sensitivity.

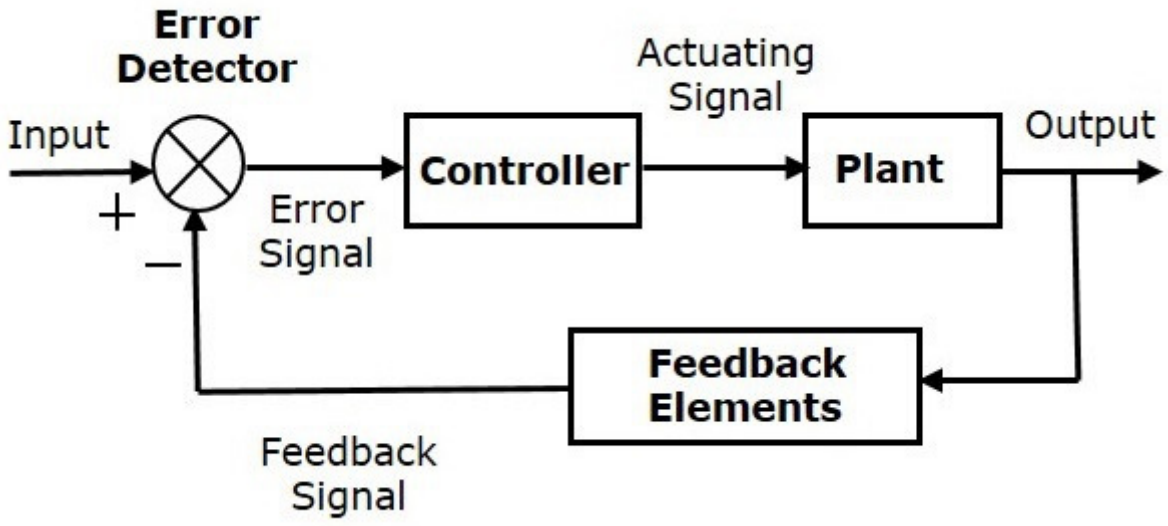
Open Loop Control System



Open Loop Control System

An open loop control system is a simple type of system, usually divided into two parts, the controller and the controlled process as shown in Figure 2. An input signal is applied to the controller, which in turn generates the actuating signal to control the process. Finally, the output is the controlled variable which acts as per the prescribed manner.

Closed Loop Control System



To obtain a far more accurate control over the output, a feedback loop is used in a system. As the output is feedback to the input through one or more loop, it is called a closed loop control system. In this system, the controlled variable y is fed back to the input to be compared with the reference input. An error signal or actuating signal is generated in proportion with the difference between the input and the output. The error signal is then sent through the control system to correct the error in the output. Figure 3 shows a closed loop control system with its basic building blocks

System Sensitivities

The physical elements in a control system, like the basic circuit components or the electrical or mechanical device, all changes their performance and properties over time or temperature. A good control system should be very insensitive to these parameter variations as the changes in basic elements can affect the overall performance of the system.

On the other hand, it must be very sensitive to the changes in input signal. Let us assume, G is the basic parameter of the system which may vary and M is the overall gain of the system. Then the sensitivity is defined as:

$$S_G^M = \frac{\partial T/M}{\partial G/G} = \frac{Percentage\ change\ in\ M}{Percentage\ change\ in\ G}$$

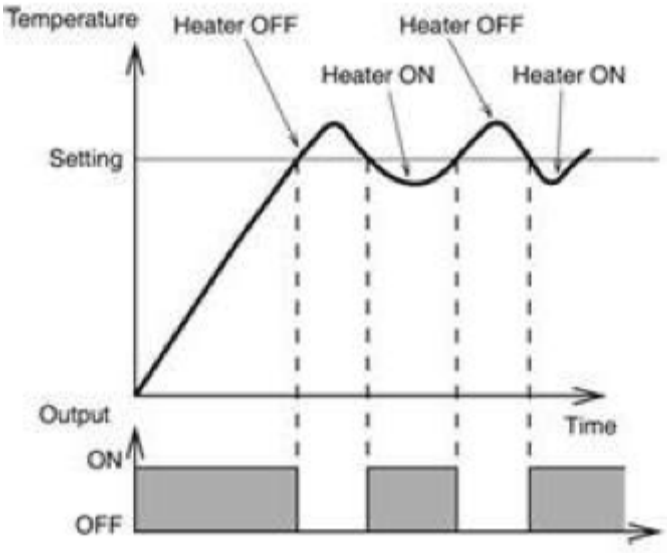
Error Amplifier

An error amplifier, as the name implies, amplify the difference signal between a reference signal and the input. In a control system, the controlled variable y is fed back to the input to be compared with the reference input. If there is a difference between the two signals, this is called an error voltage. The error amplifier amplify the error voltage and sent it to the control system to finally obtain the desired output.

On-Off Controller

On-Off control is the simplest form of feedback control. It controls the process variable from fully closed to fully open depending on the predesigned set point.

The most common example of such a control is the temperature controller. The object of a temperature controller is to maintain the room temperature a specified value or set point, regardless of the changing environment around it. If the temperature is below the set point, it activates a signal to ON the heater. As the temperature rises above the set point, it then activates another signal to OFF the heater. The process continues in a cyclic way as shown in Figure 4.



Reference Books

Automatic Control System by Benjamin C. Kuo

Modern Control Engineering by Katsuhiko Ogata

Control Systems Engineering by I.J. Nagrath and M. Gopal