Control Systems

Introduction

- A control system is a control system for a process or plant, wherein control elements are distributed throughout the system. This is in contrast to non-distributed systems, which use a single controller at a central location. In a DCS, a hierarchy of controllers is connected by communications networks for command and monitoring.
- A type of automated control system that is distributed throughout a machine to provide instructions to different parts of the machine. Instead of having a centrally located device controlling all machines, each section of a machine has its own computer that controls the operation. For instance, there may be one machine with a section that controls dry elements of cake frosting and another section controlling the liquid elements, but each section is individually managed by a DCS. A DCS is commonly used in manufacturing equipment and utilizes input and output protocols to control the machine.
- Collection of hardware and instrumentation necessary for implementing control systems.
- Provide the infrastructure (platform) for implementing advanced control algorithms.

What is Control Systems?

Let us study about a new type of engineering study which is called as **Control Systems Engineering**.Its very interesting subject and has a lot of calculation part.Control system theory evolved as an engineering discipline and due to universality of the principles involved,it is extended to various fields like economy,sociology,biology,medicine etc.Control theory has played a vital role in the advance of engineering and science.The automatic control has become an integral part of modern manufacturing and industrial processes.For example ,numerical control of machine tools in manufacturing industries,controlling pressure,temperature,humidity,viscosity and flow in process industry.

When a number of elements or components are connected in a sequence to perform a specific function,the group thus formed is called a system.In a system when the output quantity is controlled by varying the input quantity,the system is called **control system**.The output quantity is called controlled variable or response and input quantity is called command signal or excitation.

Feature of Control System

The main feature of control system is, there should be a clear mathematical relation between input and output of the system. When the relation between input and output of the system can be represented by a linear proportionality, the system is called linear control system.

Again when the relation between input and output cannot be represented by single linear proportionality, rather the input and output are related by some non-linear relation, the system is referred as non-linear control system.

Basic Components

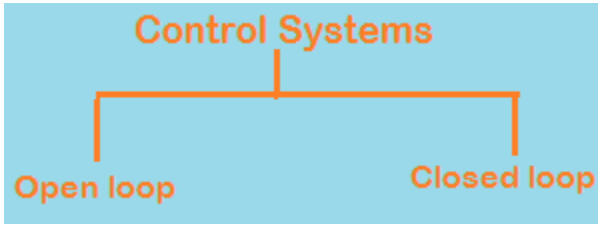
The Basic Components of a control system are as below:

- Plant
- Feedback
- Controller
- Error detector

The combined unit or error detector, controller, plant, and feedback makes a complete automatic control system.

1. **Plant:** The portion of a system which is to be controlled or regulated is called as plant or process. It is a unit where actual processing is performed and if we observe in the above figure, the input of the plant is the controlled signal generated by a controller. A plant performs necessary actions on a controlled system and produces the desired output.
2. **Feedback:** It is a controlled action in which the output is sampled and a proportional signal is given to the input for automatic correction of any changes in the desired output. The output is given as feedback to the input for correction i.e. information about output is given to input for correcting the changes in output due to disturbances. The feedback signal is fed to the error detector. Negative feedback is preferred as it results in better stability and accuracy. The other disturbance signals are rejected.
3. **Error detector:** The function of error detector is to compare the reference input with the feedback signal. It produces an error signal which is a difference of two inputs which are reference signal and a feedback signal. The error signal is fed to the controller for necessary controlled action. This error signal is used to correct the output if there is a deviation from the desired value.
4. **Controller:** the element of a system within itself or external to the system which controls the plant is called as a controller. The error signal will be a weak signal and so it has to be amplified and then modified for better control action. In most of the systems, the controller itself amplifies the error signal and integrates or differentiates to generate a control signal. An amplifier is used to amplify the error signals and the controller modifies the error signal.

Types of Control Systems



Control systems is of two types.They are

1)Open Loop System
2)Closed Loop Sytem

1)Open loop control system:

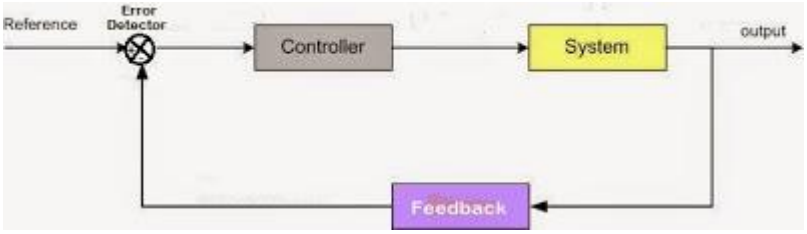
Any physical system which does not automatically correct the variation in its output,is called an open loop system or control system in which the output quantity has no effect upon the input quantity are called **open-loop control system**.This means that the output is not fedback to the input for correction.

In open loop control system the output can be varied byvarying the input.But due to external disturbances the system output may change.When the output changes due to disturbances,it is not followed by changes in input to correct the output.In open loop systems the changes in output are corrected by changing the input manually.

2)Closed loop control system:

Control systems in which the output has an effect upon the input quantity in order to maintain the desired output value are called **closed loop systems**.

The **open loop system** can be modified as closed loop system by providing a feedback.The provision of feedback automatically corrects the changes in output due to disturbances.Hence the closed loop system is also called automatic control system.The general block diagram of an automatic **control system** is shown in figure below.It consists of an error detector,a controller,plant (open loop system) and feedback path elements.



The reference signal (or input signal) corresponds to desired output.The feedback path elements samples the output and converts it to a same type as that of reference signal.The feedback signal is proportional to output signal and it is fed to the error detector.The error signal generated by the error detector is the difference between reference signal and feedback signal.The controller modifies and amplifies the error signal to produce better control action.The modified error signal is fed to the plant to correct its output.

Advantages of Open loop control system:

1.The **open loop systems** are simple and economical.
2.The open loop systems are easier to construct.
3.Generally the **open loop sytems** are stable.

Disadvantages of open loop systems:

1.The **open loop systems** are inaccurate and unreliable.
2..The changes in the output due to external disturbances are not corrected automatically.

Advantages of closed loop systems:

1.The **closed loop systems** are accurate.
2.The closed loop systems are accurate even in the presence of non-linearities.
3.The sensitivity of the systems may be made small to make the system more stable.
4.The closed loop systems are less affected by noise.

Disadvantages of closed loop systems:

1.The **closed loop systems** are complex and costly.
2.The feedback in closed loop system may lead to oscillatory response.
3.The feedback reduces the overall gain of the system.
4.Stability is a major problem in closed loop system and more care is needed to design a stable **closed loop system**.

Comparison of Closed Loop And Open Loop Control System

Sr. No.	Open loop control system	Closed loop control system
1	The feedback element is absent.	The feedback element is always present.
2	An error detector is not present.	An error detector is always present.
3	It is stable one.	It may become unstable.
4	Easy to construct.	Complicated construction.
5	It is an economical.	It is costly.
6	Having small bandwidth.	Having large bandwidth.
7	It is inaccurate.	It is accurate.
8	Less maintenance.	More maintenance.
9	It is unreliable.	It is reliable.
10	Examples: Hand drier, tea maker	Examples: Servo voltage stabilizer, perspiration

Examples of Control Systems

- Distinct examples of control systems are as follows:
- Liquid level control system
- Room temperature control system
- Traffic control system
- Home heating systems

References

- www.google.com
- www.wikipedia.com
- www.studymafia.org