Automatic Control

Chapter One

Introduction to control systems

By

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Introduction to control systems

History:-

•James Watt's centrifugal governor for the speed control of a steam engine in the eighteenth century

•Minorsky (1922): showed how stability could be determined from the differential equations describing the system

•Nyquist (1932):- developed a relatively simple procedure for determining the stability of closed-loop systems

•In the early 1940s Ziegler and Nichols suggested rules for tuning PID controllers, called Ziegler–Nichols tuning rules

•From the end of the 1940s to the 1950s, the root-locus method due to Evans was fully developed

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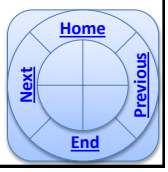
Definitions :-

•**Control system:-** is a system composed of controllers designed in first place based on a model of the controlled system and applied to this model in real.

•**Controlled system:-** is the system needed to be controlled. This system has to be modeled first and then a control system is added.

•**System stability:-** is the divergence in controlled system response from the required output when the control system is actually applied to it. The combination of controlled and control systems must be stable.

•**Error:-** the deviation from the desired output and its used to measure the stability of the system.



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Definitions :-

Controlled Variable and Control Signal or Manipulated Variable. The controlled variable is the quantity or condition that is measured and controlled. The *control signal* or *manipulated variable is the quantity or condition that is varied by the controller so* as to affect the value of the controlled variable

Plants. A plant may be a piece of equipment, perhaps just a set of machine parts functioning together, the purpose of which is to perform a particular operation

Disturbances. A disturbance is a signal that tends to adversely affect the value of the output of a system

Feedback Control. Feedback control refers to an operation that, in the presence of disturbances, tends to reduce the difference between the output of a system and some reference input and does so on the basis of this difference

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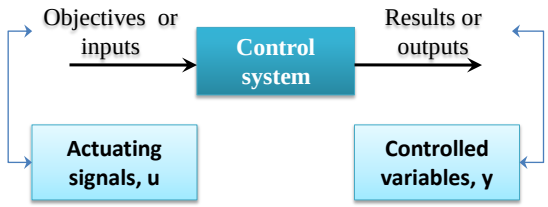

The objective of control system is to control the outputs in some manner described by the inputs

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Examples on control systems

Handle valve	This valve control fluid flow according to the input comes from the operator hand
Sun tracer	This system rotate another system according to the sun position in the sky
Steering system in vehicles	This system control the direction of the vehicle according to the input comes from the operator hand
Air bag releasing system	When an accident happen, electrical signal will be received by this system and the system will open the bags

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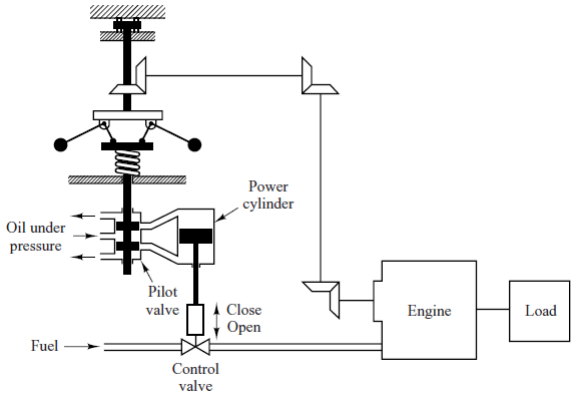
Examples on control systems

Figure 1–1
Speed control system.



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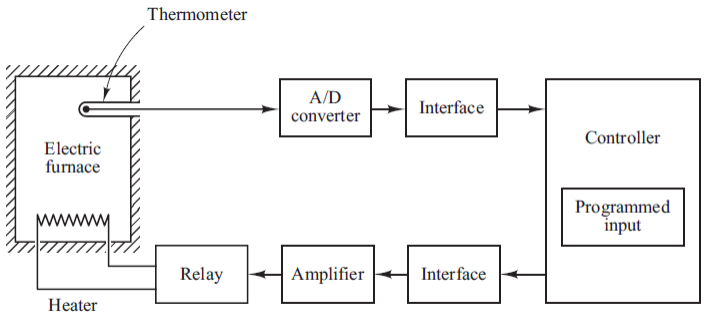
Examples on control systems

Figure 1–2
Temperature control system.



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Control system is a configuration of interrelated components used to provide a desired system response

Control system is based on feedback theory and linear system analysis

Feed the signal back to the system to compare it with a reference value

Assume that there is cause – effect relationship between system components and so, the component or process in a control system can be represented by **block**

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Types of control systems

Open-loop system

- This type is usually contains two parts: the controller and the controlled process.
- Is used to control none critical systems which dose not need high accuracy such as the washing machines.
- In most cases, if you want to change the outputs, you need to change the inputs manually.

Closed-loop system

- This type has a feedback part which return the output signals to the control system to compare it with a reference value.
- This system is more accurate than the open loop system and it is used in more sophisticated systems.
- It differs from each other by the time needed to finish the process

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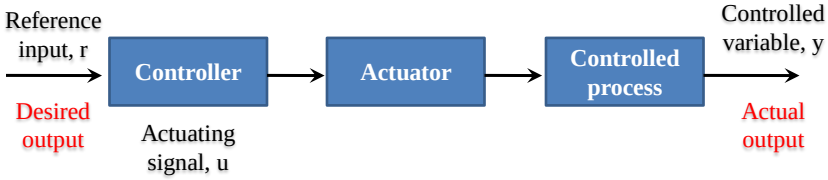
Types of control systems

Open-loop system



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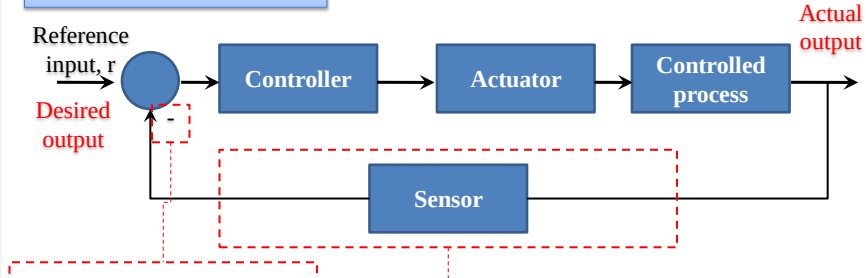
Types of control systems

Closed-loop system



Negative feedback system

Feedback system measure the actual output and compare it with the desired output

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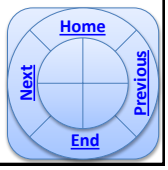
Feedback system

Use the feedback system to compare between the desired output and the actual output. The difference between these outputs is called the error

Sequence of the process of a control system

- The error sensed by the sensor is fed back to the controller
- The controller adjust the error and send the adjusted signal to the actuator
- The actuator modulate the process in order to reduce the error

Feedback system can be single or multi - loop system



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DESIGN AND COMPENSATION OF CONTROL SYSTEMS

Compensation is the modification of the system dynamics to satisfy the given specifications.

Compensation methods:-

1. the root-locus approach
2. frequency-response approach
3. the state-space approach

PID controller is one of the most common compensators

In the actual design of a control system, whether to use an electronic, pneumatic, or hydraulic compensator is a matter that must be decided partially based on the nature of the controlled plant