*Heaven's light is our guide*

# Rajshahi University of Engineering & Technology

**MTE 1101**

# Mechatronic Systems

Prepared By:

Prangon Das

Lecturer, Department of Mechatronics Engineering,

Rajshahi University of Engineering & Technology.

# Outlines

- Advantages and Disadvantages of Mechatronics
- Control System
- General Control System
- Control System Classification
- Open Loop Vs Closed Loop CS
- Control System Examples
- Control System Design Process

References: Slide, Internet, Recommended Books (Rajput/Bolton: Chapter 1)

# Advantages and Disadvantages of Mechatronics

## Advantages:

1. The products produced are cost effective and of very good quality.
2. The performance characteristics of mechatronics products are such which are otherwise very difficult to achieve without the synergistic combination.
3. High degree of flexibility.
4. A mechatronics product can be better than just sum of its parts.
5. Greater extent of machine utilization.
6. Due to the integration of sensors and control systems in a complex system, capital expenses are reduced
7. Owing to the incorporation of intelligent, self correcting sensory and feedback systems, the mechatronic approach results in :

- greater productivity ;
- higher quantity and producing reliability.

## Disadvantages :

1. High initial cost of the system.
2. Imperative to have knowledge of different engineering fields for design and implementation.
3. Specific problems for various systems will have to be addressed separately and properly.
4. It is expensive to incorporate mechatronics approach to an existing/old system.

# Control System

A control system is an arrangement of physical components corrected or related in such a manner as to command, direct or regulate itself or another system.

**Elements of a control system:**

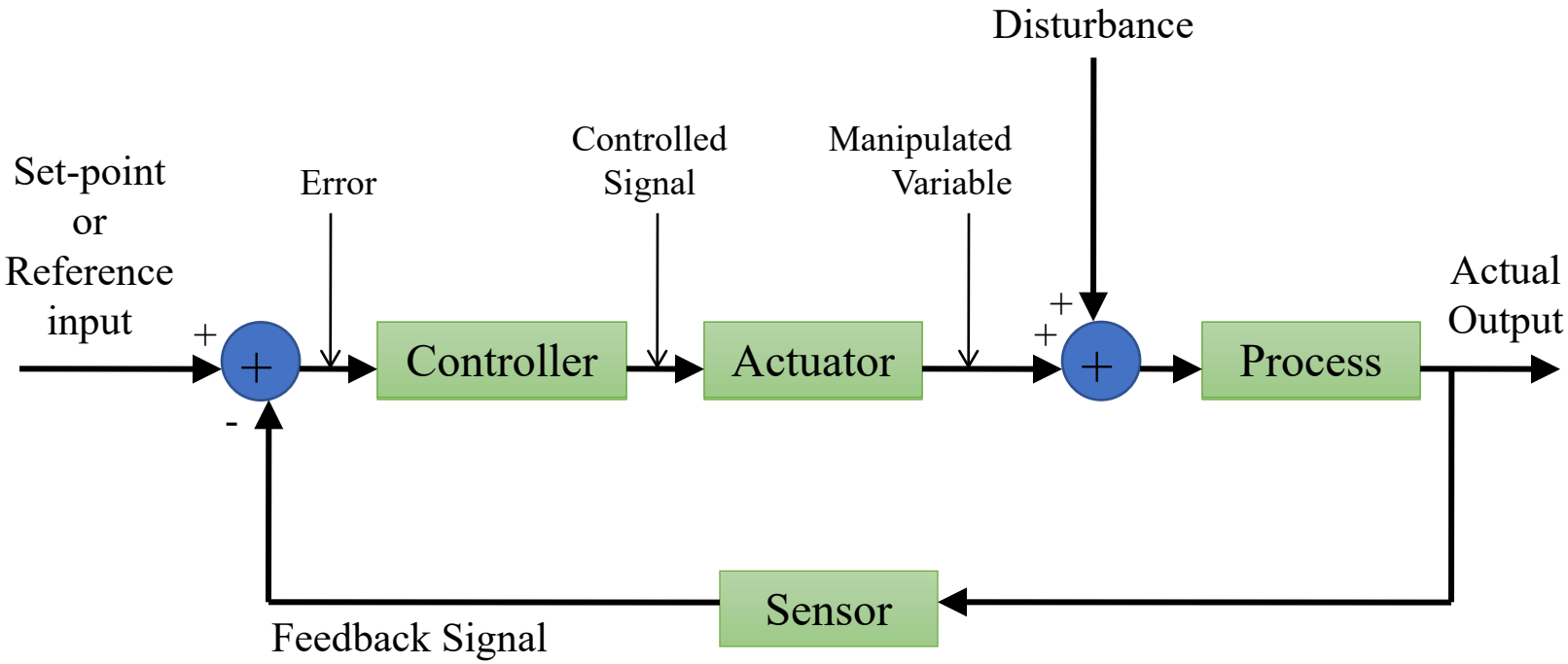
The elements of a control system are enumerated and defined below :

| Element | Definition |
|---|---|
| 1. *Controlled variable* | The quantitly or condition of the controlled system which can be directly measured and controlled is called *controlled varibale.* |
| 2. *Indirectly controlled variable* | The quantity or condition related to controlled variable, but cannot be directly measured is called *indirectly controlled variable.* |
| 3. *Command* | The input which can be independently varied is called *command.* |
| 4. *Reference input* | A standard signal used for comparison in the close-loop system. |
| 5. *Actuating signal* | The difference between the feedback signal and reference signal is called *actuating signal.* |
| 6. *Disturbance* | Any signal other than the reference which affects the system performance is called *disturbance.* |
| 7. *System error* | The difference between the actual value and ideal value is called *system error.* |

Examples of control system **applications**:

1. Steering control of automobile.
2. Print wheel control system.
3. Industrial sewing machine.
4. Sun-tracking control of solar collectors.
5. Speed control system.
6. Temperature control of an electric furnace.

# General Control System

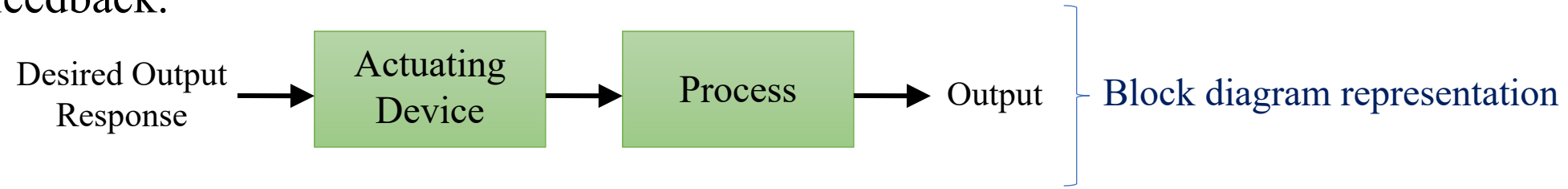


# Control System Classification

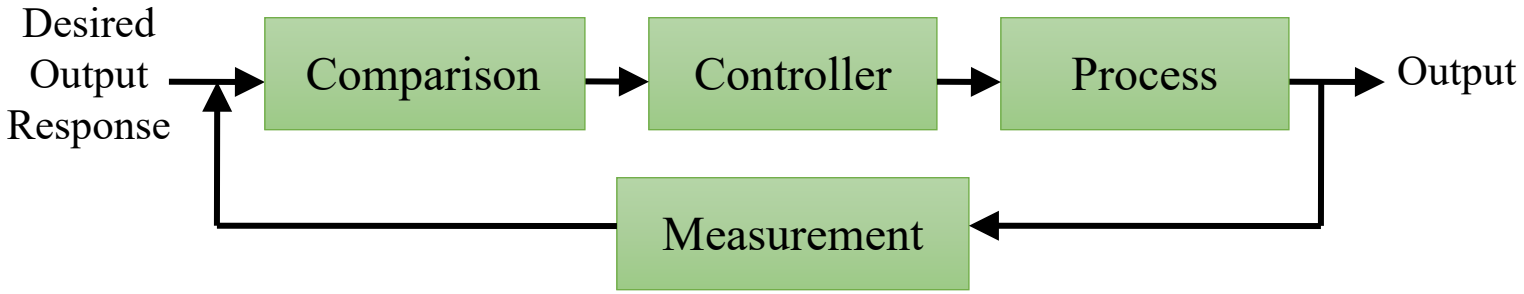
Control systems can be classified into two categories:

i. Open-loop control system
ii. Closed-loop/ feedback control system

- An open-loop control system utilizes an actuating device to control the process directly without using feedback.




- A closed-loop/ feedback control system uses a measurement of the output and feedback of the output signal to compare it with the desired output or reference.



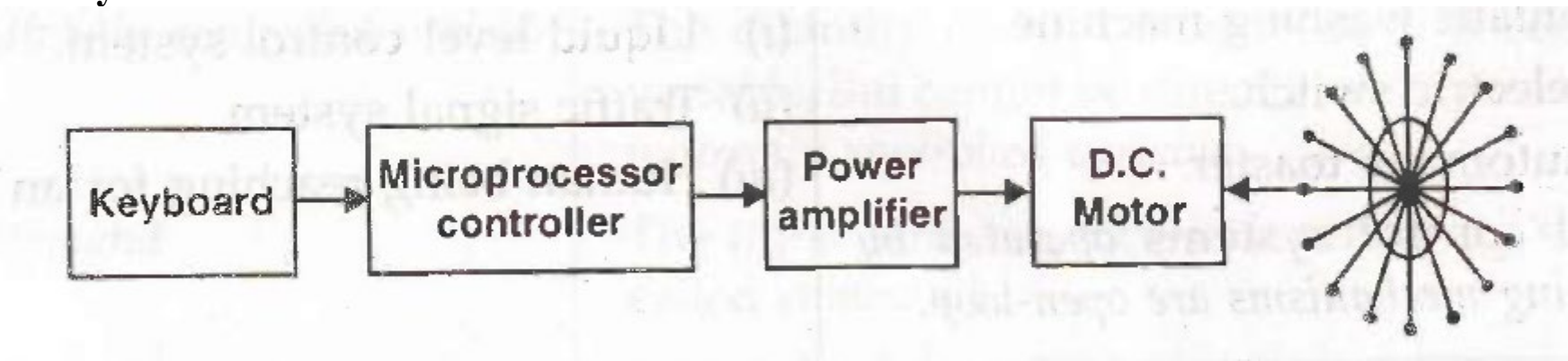
# Open Loop Vs Closed Loop CS

**Task:** Advantages & Disadvantages, characteristics of Open loop & Closed Loop CS

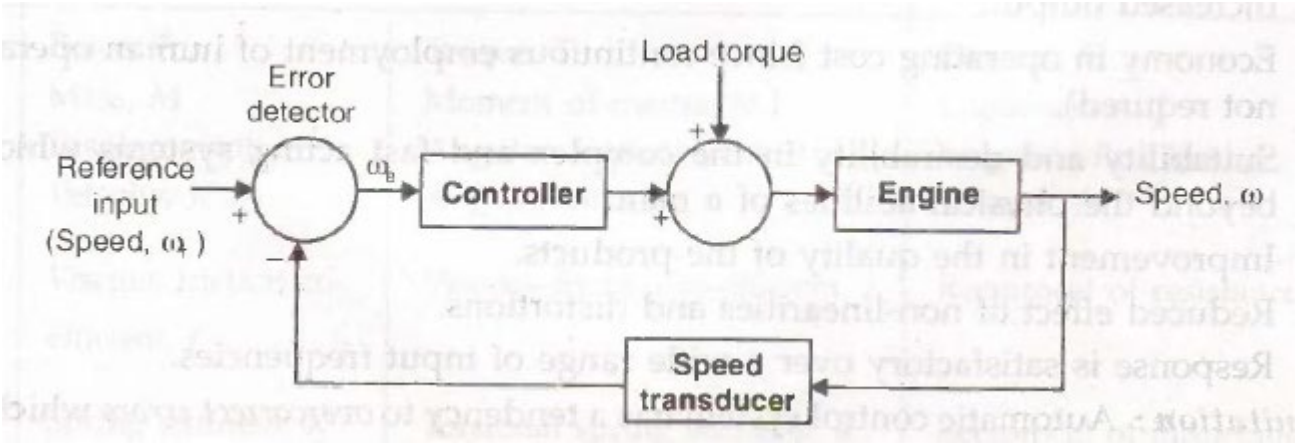
| Open loop | Closed loop |
|---|---|
| 1. Simple in construction and ease of maintenance | 1. Complex and difficulty in maintenance |
| 2. Used when input is known previously, and no disturbances are present | 2. Used only when unpredictable disturbances and/or unpredictable variations in system components are present |
| 3. Since there is no feedback, system needs accurate controller, which implies costly equipment. | 3. feedback makes the system response relatively insensitive to external disturbances and internal variations in system parameters. Thus the system is inexpensive. |
| 4. No stability problem | 4. Stability is a major problem |
| 5. Less components are necessary | 5. Needs more components |
| 6. Convenient when output is hard to measure or measuring the output precisely is economically not feasible. | 6. Convenient when output is easy to measure. |
| 7. Recalibration is necessary for good quality output. | 7. No calibration is necessary . Feedback signal helps to maintain stable output. |

# Control System Examples (Cont.)

**Print wheel control system:**

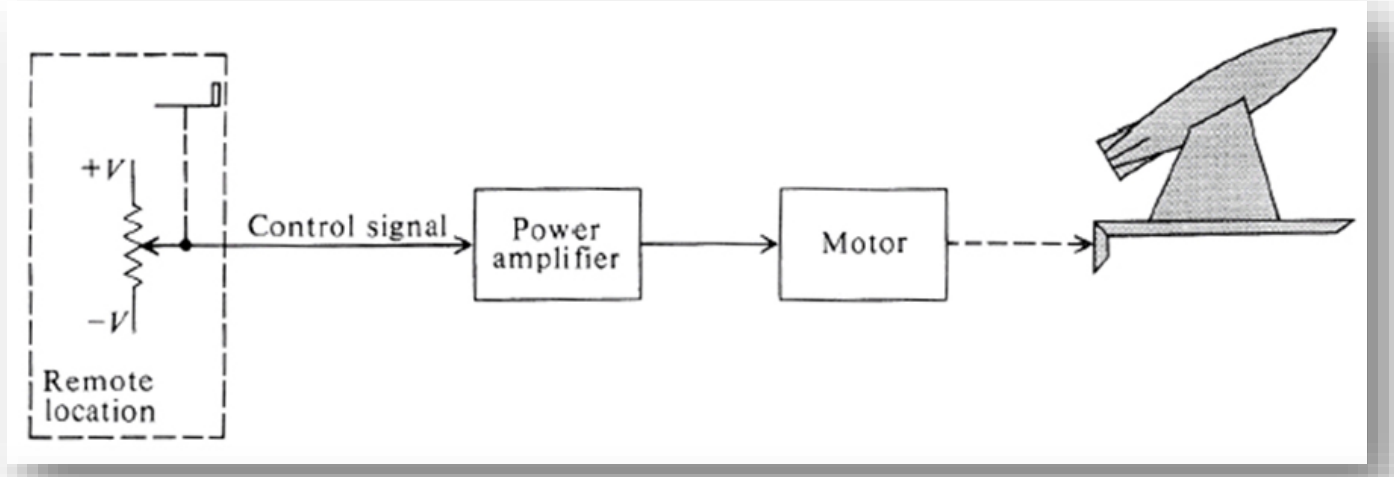



**Idle-speed control system**

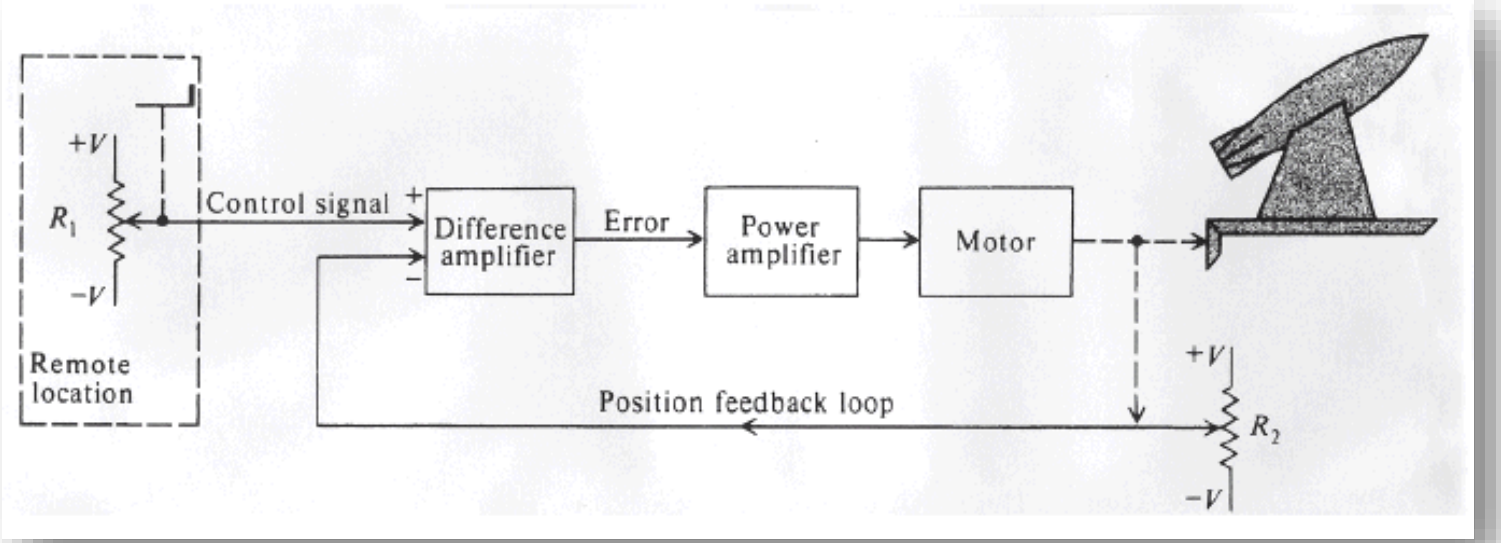


# Control System Examples (Cont.)

**Missile Launcher System**




Open-Loop Control System

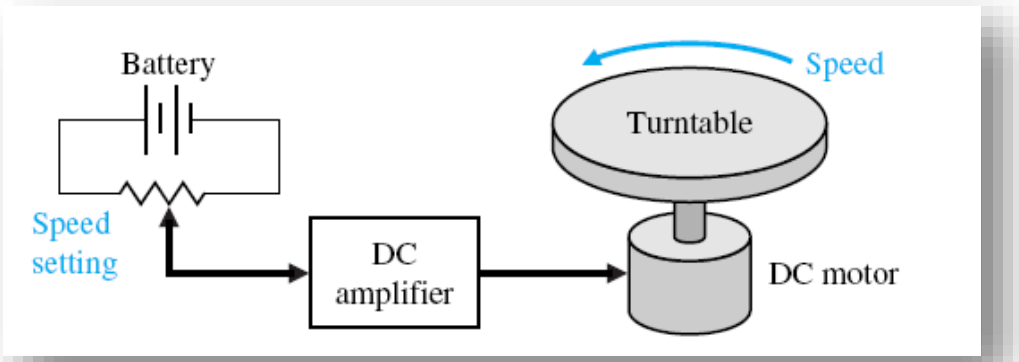



Closed-Loop Feedback Control System

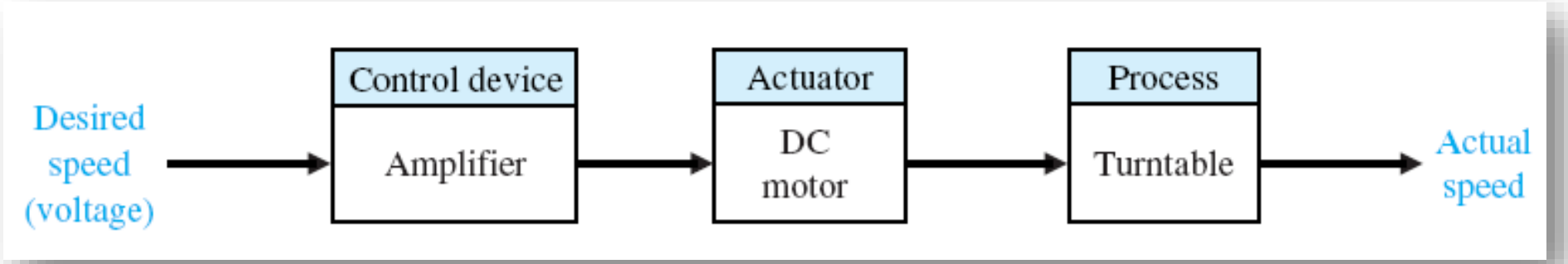
# Control System Examples

Turntable Speed Control

- Application: CD player, computer disk drive
- Requirement: Constant speed of rotation
- Physical system:



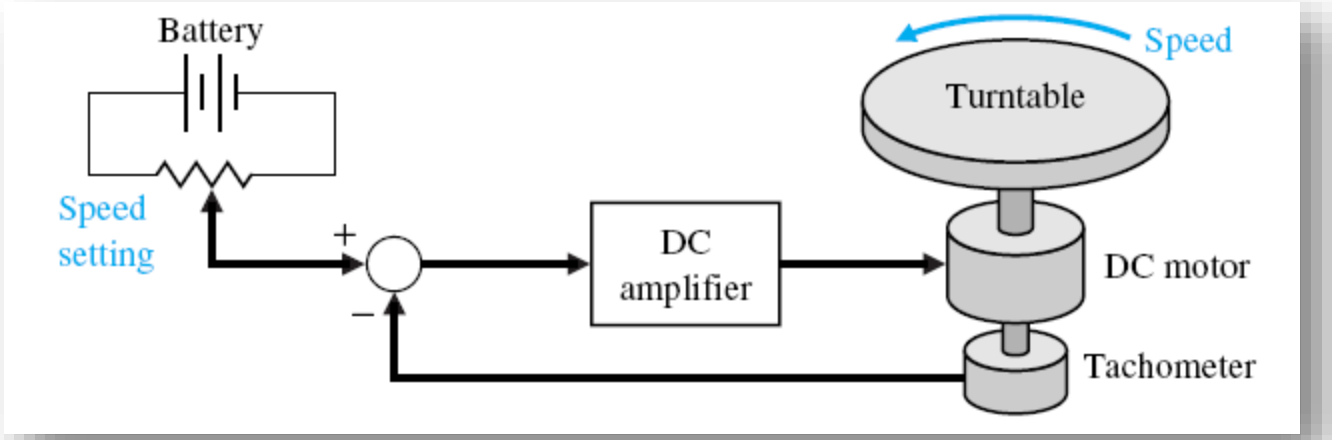

- Block diagram representation: Open loop control system



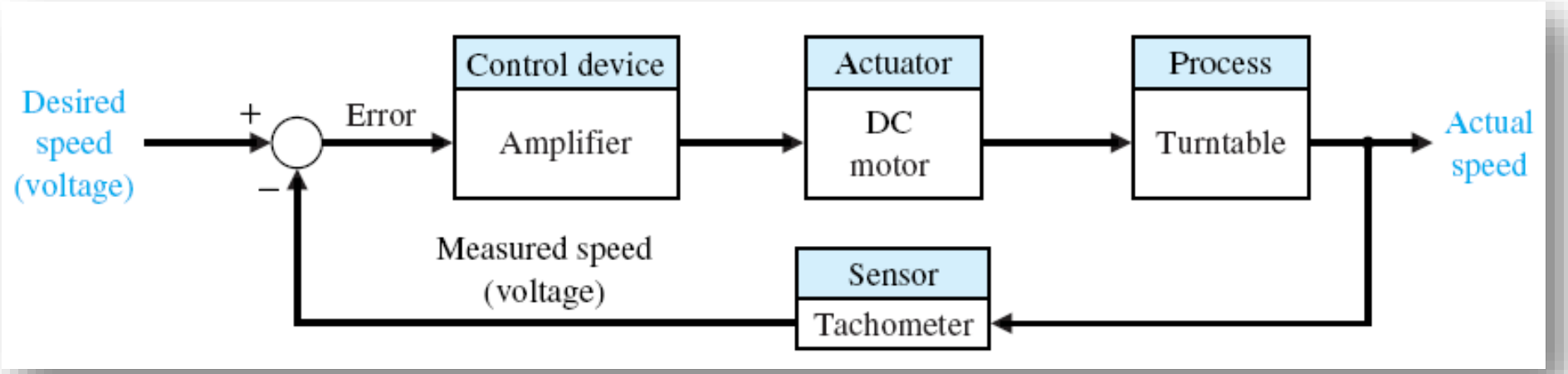
# Control System Examples (Cont.)

Turntable Speed Control

- Physical system:

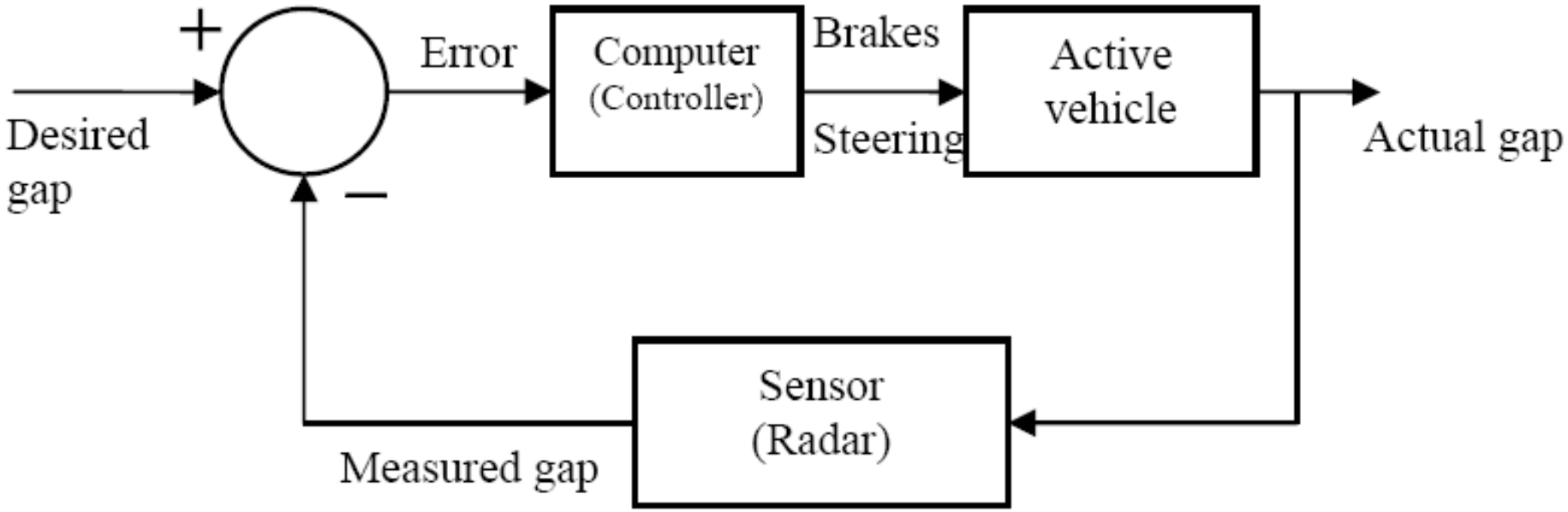



- Block diagram representation: Closed-Loop Feedback Control System



# Control System Examples (Cont.)

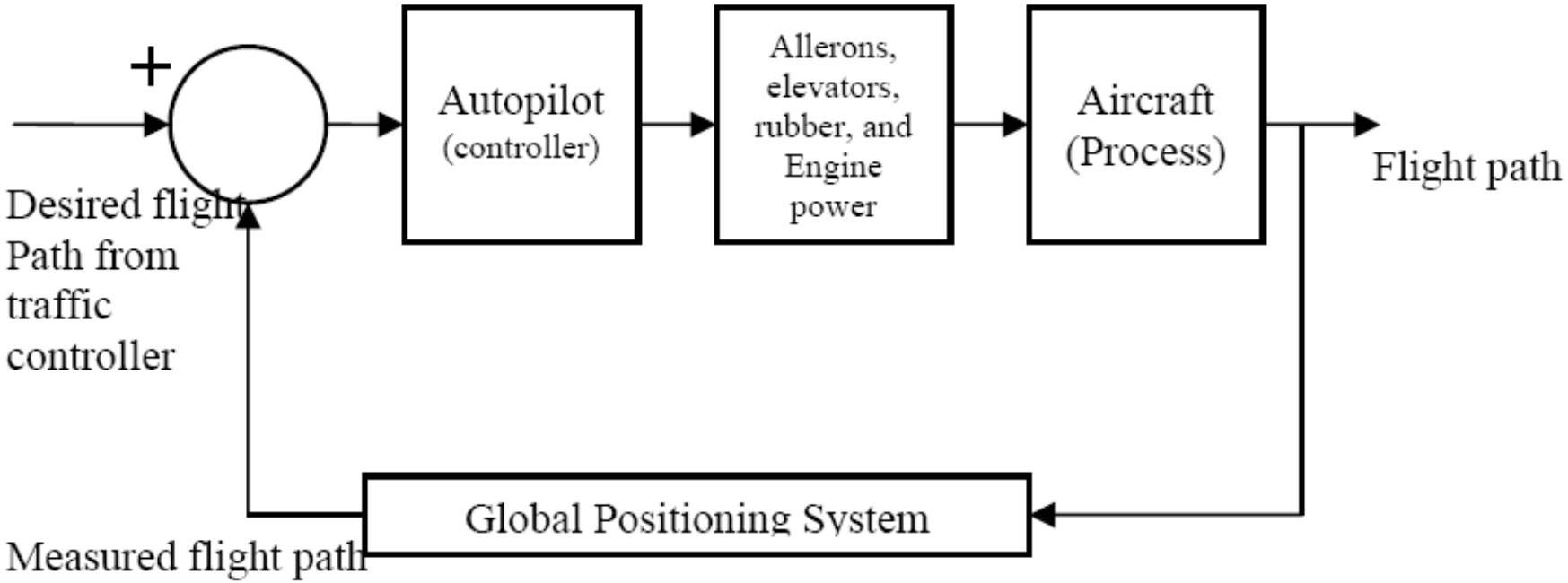
## Vehicle Control System




Closed-Loop Feedback Control System

# Control System Examples (Cont.)

## Autopilot Control System




Closed-Loop Feedback Control System

Home Task: **Temperature Control System, Humidity Control System, Maglev Control System**

# Control System Design Process

1. Establish control goals
2. Identify the variables to control
3. Write the specifications for the variables
4. Establish the system configuration and identify the actuator
5. Obtain a model of the process, the actuator and the sensor
6. Describe a controller and select key parameters to be adjusted
7. Optimize the parameters and analyze the performance

If the performance does not meet specifications, then iterate the configuration and actuator

If the performance meet the specifications, then finalize design

**To Be Continued…..**

# THANK YOU