EE351: Control Systems

By Dr. Ridha Jemal

Electrical Engineering Department

College of Engineering

King Saud University

Email: rdjemal@ksu.edu.sa

http://faculty.ksu.edu.sa/djemal/default.aspx

Textbook: Modern Control Engineering by Ogata

Course Grading

Midterm#1	(20%)
Midterm#2	(20%)
Tutorial	(10%)
Attendance & Project	(10%)
Final Exam	(40%)

EE351: Control Systems

Course Outlines

Chapter 1: Introduction to Control Systems

Chapter 2: Review of mathematical material

Chapter 3: System Representation

Chapter 4: State variable analysis and state space representation

Chapter 5: Stability of linear control systems

Chapter 6: Time domain analysis of control systems

Chapter 7: Root locus techniques

Chapter 8: Frequency domain analysis (Nyquist plots)

Chapter 9: Frequency domain analysis (Bode Plots)

Chapter 10: Modeling of electric and mechanical systems

Chapter 11: Review and introduction to controller design

Chapter 1 : Introduction to Control Systems

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1431-1432

1.1. Introduction to Control System

1.2. Open Loop and Closed Loop control systems

1.3. Examples of control systems

1.4. Examples

Introduction to control Systems

What is "a system"?

• A system is an arrangement, set or collection of things connected or related in such manner as to form or act as en entire unit.

What is "Control"?

• Make some object (called system, or plant) behave as we desire.
• To Control is also to regulate, direct or command

•Imagine "control" around you!

- ○ Room temperature control
- ○ Car/bicycle driving
- ○ Voice volume control
- ○etc.

Introduction to control Systems

A Control System is a collection of physical components connected or related in such manner as to command, direct, or regulate itself or another system.

- **Definition:** The ***input*** is the stimulus, excitation, or command applied **to** a control system in order to produce a specified response **from** the control system.

- **Definition:** The ***output*** is the actual response obtained from a control system.

Introduction to control System

What is "Automatic Control"?

Not manual!

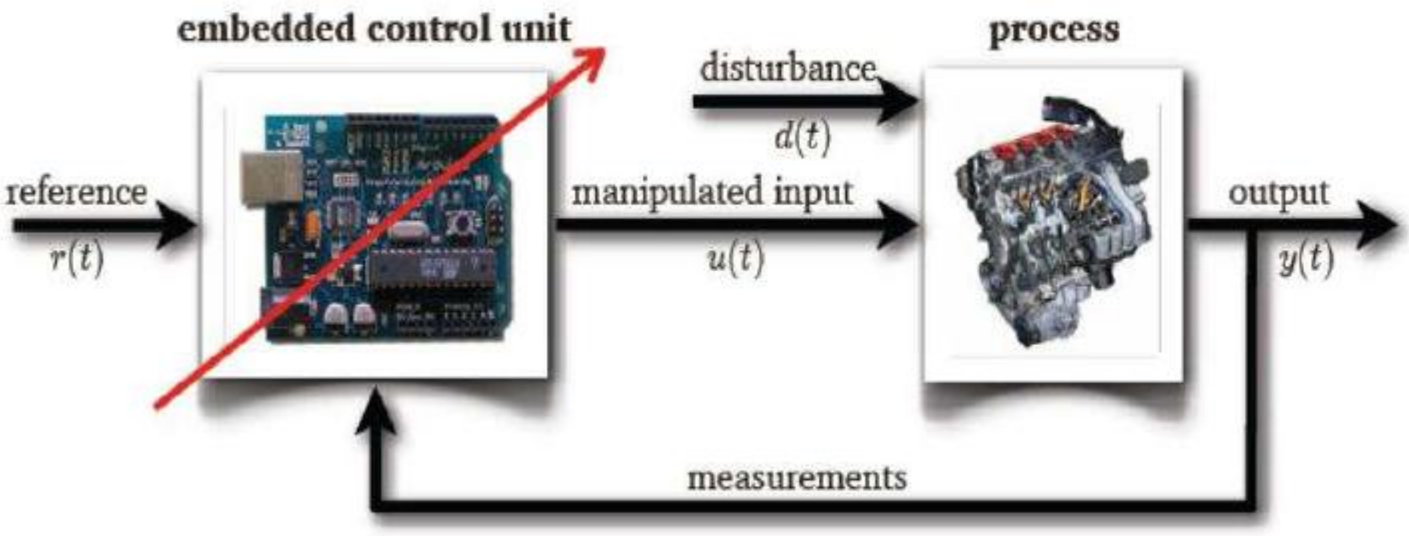
Why do we need automatic control?

- Convenient (room temperature control, laundry machine)
- Dangerous (hot/cold places, space, bomb removal)
- Impossible for human (nanometer scale precision
- Positioning, work inside the small space that human cannot enter,
- Huge antennas control, elevator)

- It exists in nature. (human body temperature control)
- High efficiency (engine control)
- Many examples of automatic control around us

Examples of control systems

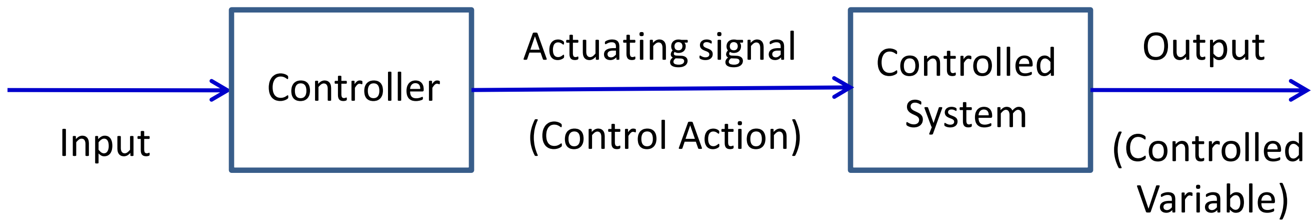
Automatic Control



- Operator has been replaced by an **electronic** circuit
- Control is now **automatic** it is accomplished without human intervention

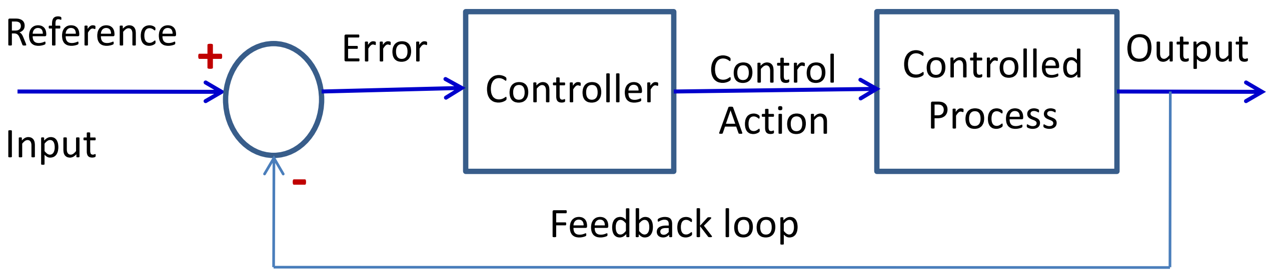
Open Loop and closed loop control systems

- **Definition:** An **open loop** control system is one in which the control action independent of the output.



Elements of an open-loop Control

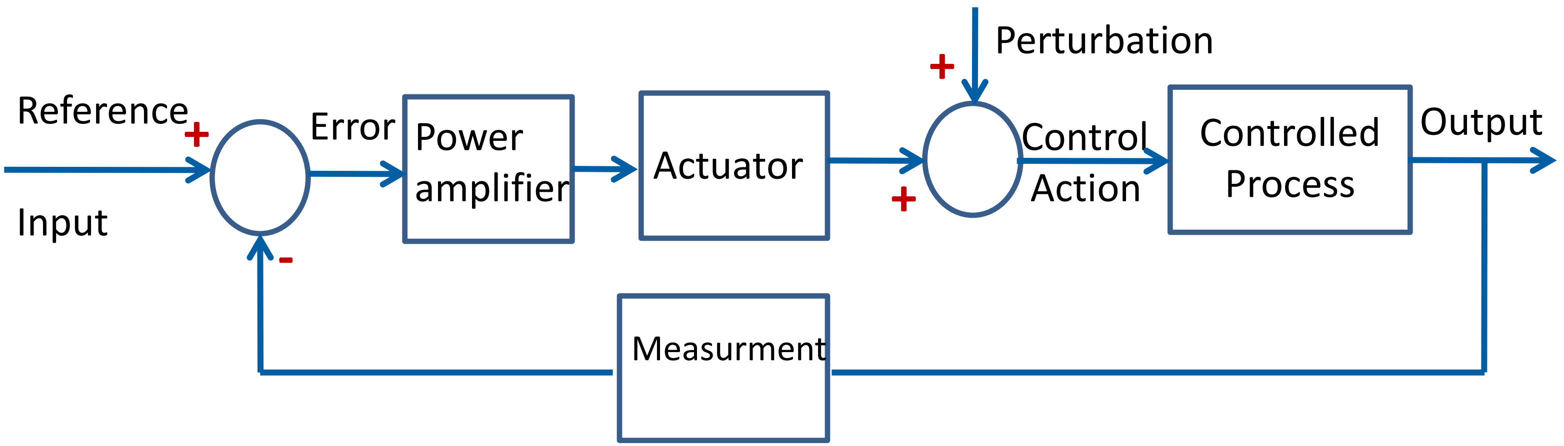
- **Definition:** A **closed lo**op control system is one in which the control action is somehow dependent on the output. Closed-loop control system are commonly called ***FEED BACK*** Control System



Elements of a closed-loop Control

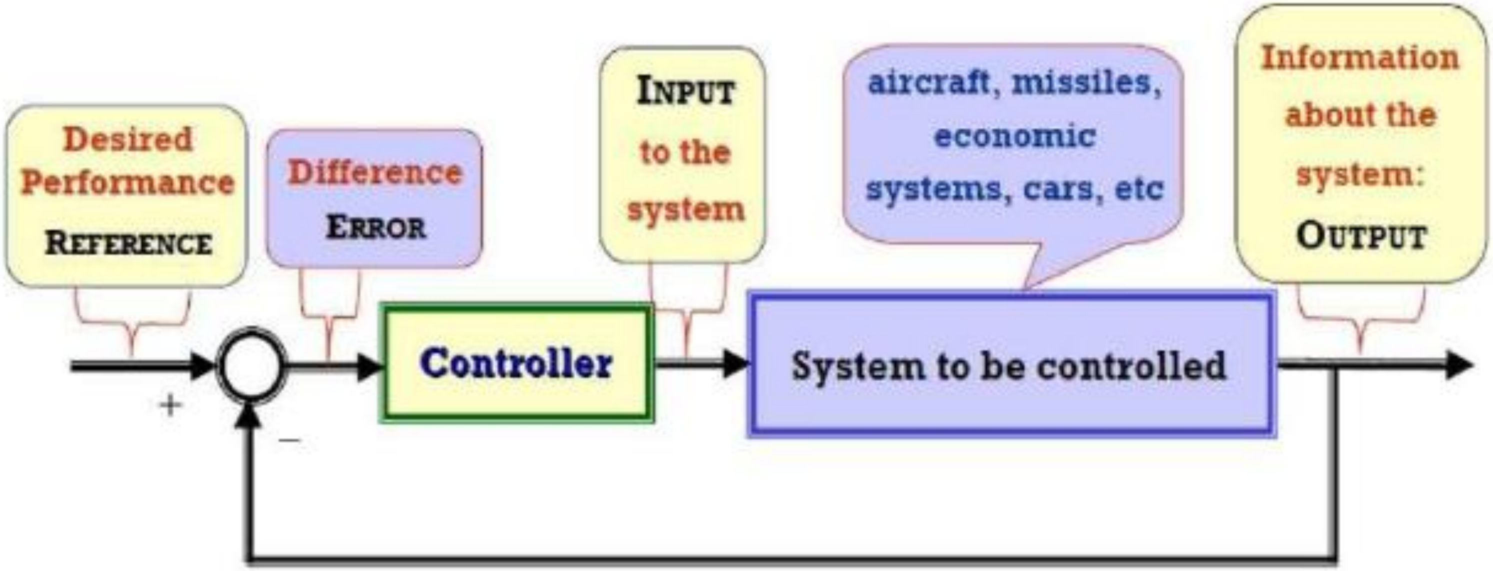
The fundamental difference between the open- and closed-loop systems is the feedback action.

A Typical Control System



- Reference/Input : r(t)
- Error: e(t) or ε(t)
- Control Action: u(t)
- Perturbation or disturbance: p(t) or d(t)
- Output: y(t)

What is a Control System



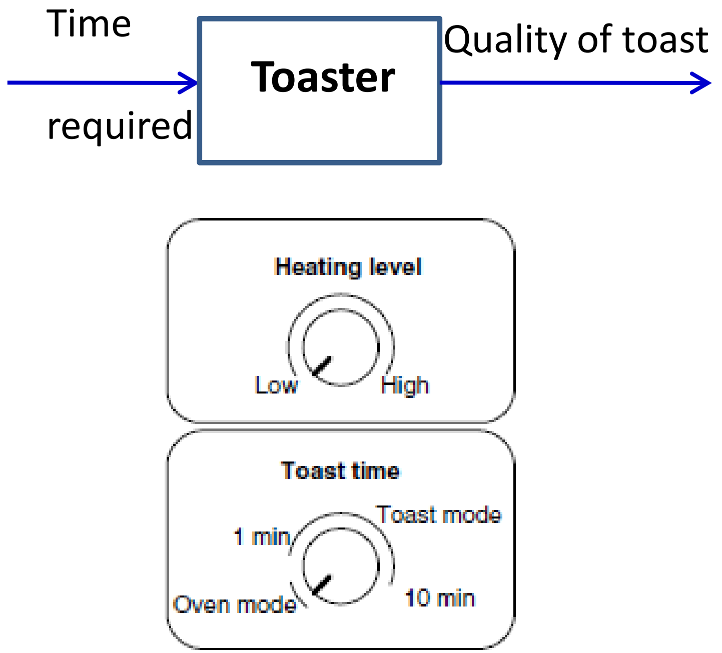
Objective: To make the system **Output** and the desired **REFERENCE** as close as possible, i.e., to make the **ERROR** as small as possible.

Key Issues: 1) How to describe the system to be controller ? (Modeling and Analysis)

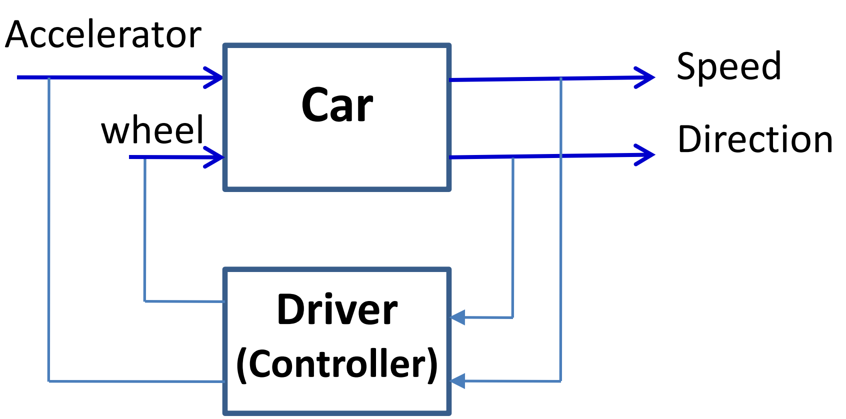
2) How to design the controller? (Control)

Examples of control systems

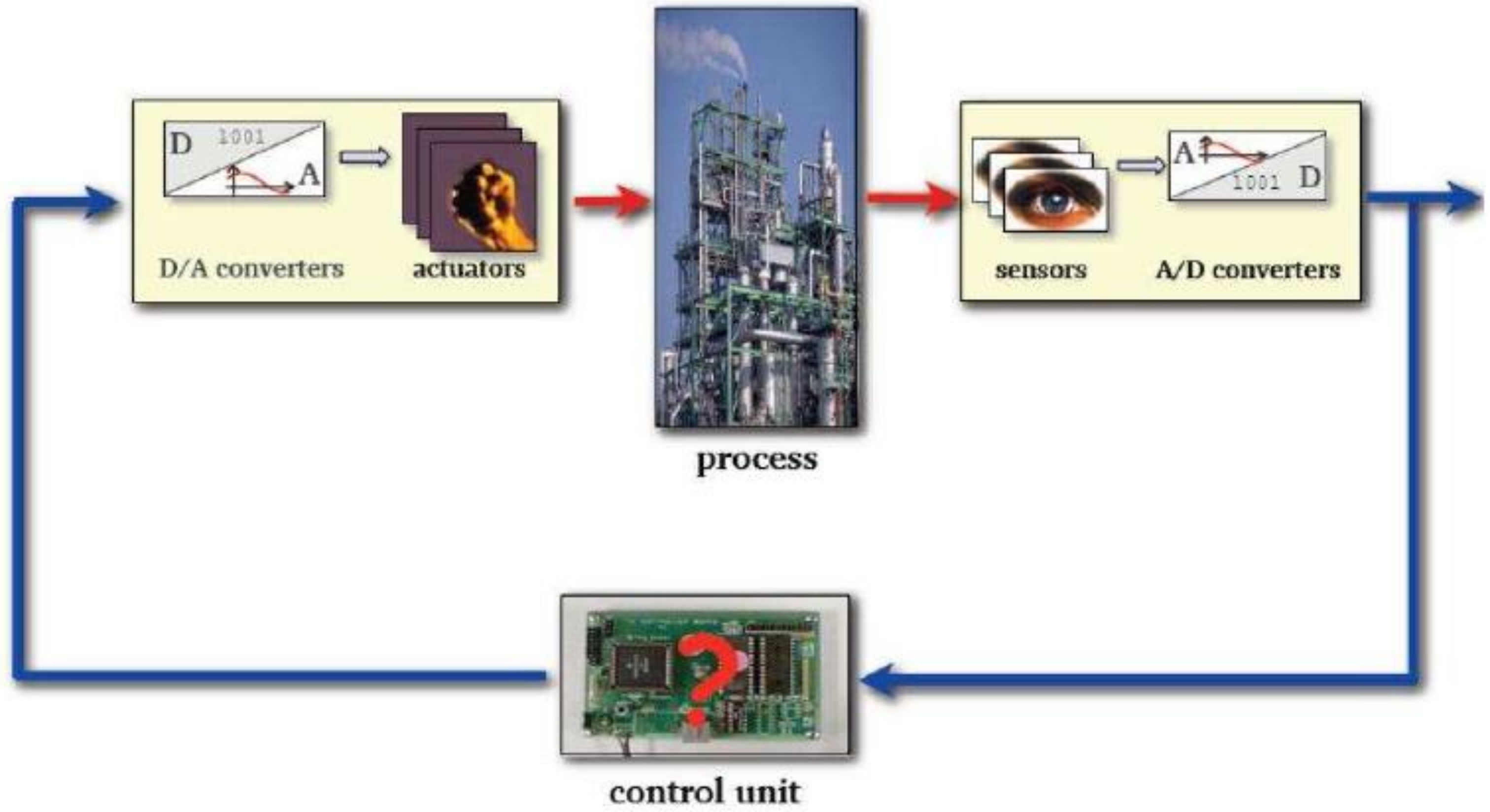
- Toaster (open loop)



- Closed-loop



A Typical Example of control systems



Most used sensors and actuators in control systems

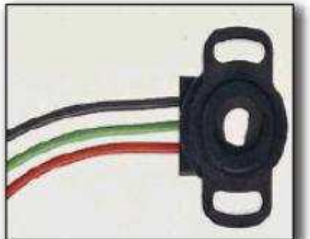
Sensors

- temperature
- pressure
- flow
- level
- velocity, position
- acceleration
- force (strain) / deformation

Actuators

- electrical motors (DC, brushless, step)
- pumps
- valves
- heaters

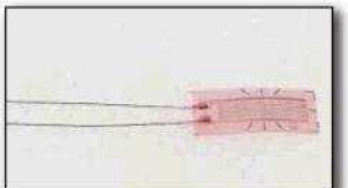
Sensors and actuators in control systems



angular position

thermocouple

pressure sensor



strain gage

brushless motor

liquid flow sensor

pump

valve