Faculty of Engineering
Department of Electrical & Computer Engineering

Control Systems (ECE 331)

Introduction to Feedback Control Systems

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Outline

- Introduction
- Brief History of Automatic Control
- Open Loop & Closed Loop Control System
- Examples of Control Systems
- Mechatronics Systems
- Future Evolution of Control Theory

Introduction

- What is Engineering ???

The creative application of scientific principles to design or develop structures, machines, apparatus, or manufacturing processes, or works utilizing them singly or in combination; or to construct or operate the same with full cognizance of their design; or to forecast their behavior under specific operating conditions; all as respects an intended function, economics of operation or safety to life and property.

Introduction

- What is Control Engineering ???

Control Engineering is based on foundations of feedback theory and linear system analysis, also it integrates the concepts of network theory and communication theory.

Control Engineering is not limited to any engineering discipline, but connected to all fields of engineering.

History of Control Systems

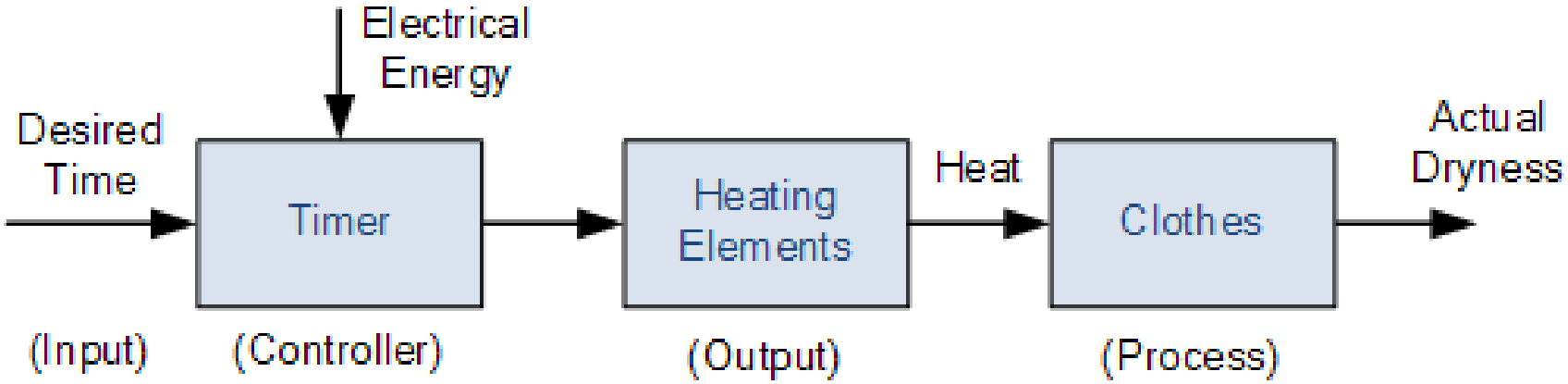
1769	James Watt's steam engine and governor developed. The Watt steam engine is often used to mark the beginning of the Industrial Revolution in Great Britain. During the Industrial Revolution, great strides were made in the development of mechanization, a technology preceding automation.
1800	Eli Whitney's concept of interchangeable parts manufacturing demonstrated in the production of muskets. Whitney's development is often considered to be the beginning of mass production.
1868	J. C. Maxwell formulates a mathematical model for a governor control of a steam engine.
1913	Henry Ford's mechanized assembly machine introduced for automobile production.
1927	H. S. Black conceives of the negative feedback amplifier and H. W. Bode analyzes feedback amplifiers.
1932	H. Nyquist develops a method for analyzing the stability of systems.
1941	Creation of first antiaircraft gun with active control.
1952	Numerical control (NC) developed at Massachusetts Institute of Technology for control of machine-tool axes.
1954	George Devol develops "programmed article transfer," considered to be the first industrial robot design.
1957	Sputnik launches the space age leading, in time, to miniaturization of computers and advances in automatic control theory.

History of Control Systems

1960	First Unimate robot introduced, based on Devol's designs. Unimate installed in 1961 for tending die-casting machines.
1970	State-variable models and optimal control developed.
1980	Robust control system design widely studied.
1983	Introduction of the personal computer (and control design software soon thereafter) brought the tools of design to the engineer's desktop.
1990	Export-oriented manufacturing companies emphasize automation.
1994	Feedback control widely used in automobiles. Reliable, robust systems demanded in manufacturing.
1995	The Global Positioning System (GPS) was operational providing positioning, navigation, and timing services worldwide.
1997	First ever autonomous rover vehicle, known as Sojourner, explores the Martian surface.
1998–2003	Advances in micro- and nanotechnology. First intelligent micromachines are developed and functioning nanomachines are created.
2007	The Orbital Express mission performed the first autonomous space rendezvous and docking.

Open Loop Control Systems

Open Loop Control Systems:



Open loop control system known as Non Feedback Control System. It is type of continuous control system in which output has no influence or effect on the control action of input signal.

Open Loop Control Systems

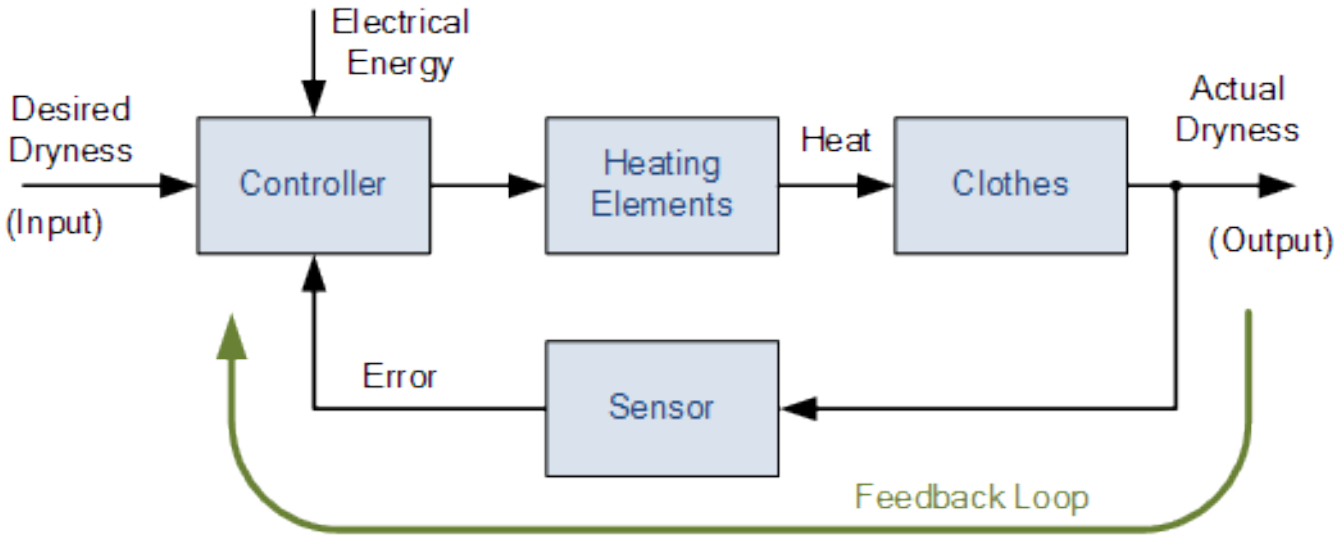
Characteristics of Open Loop Control System:

- No comparison between actual & desired values.
- An open loop system has no self-regulation or control action over the output value.
- Each input setting determines a fixed operating position for the controller.
- Changes or Disturbances in external conditions does not result in a direct output change.

Examples: Electric cloth dryer, Ordinary washing machine, DC Motor control, etc…

Closed Loop Control Systems

Closed Loop Control Systems:



A closed loop control system, also known as Feedback Control System is a control system having open loop control system with feedback.

Closed Loop Control Systems

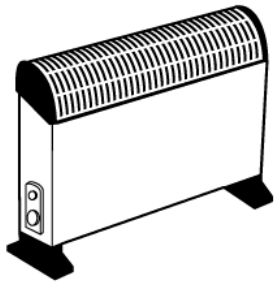
Characteristics of Closed Loop Control System:

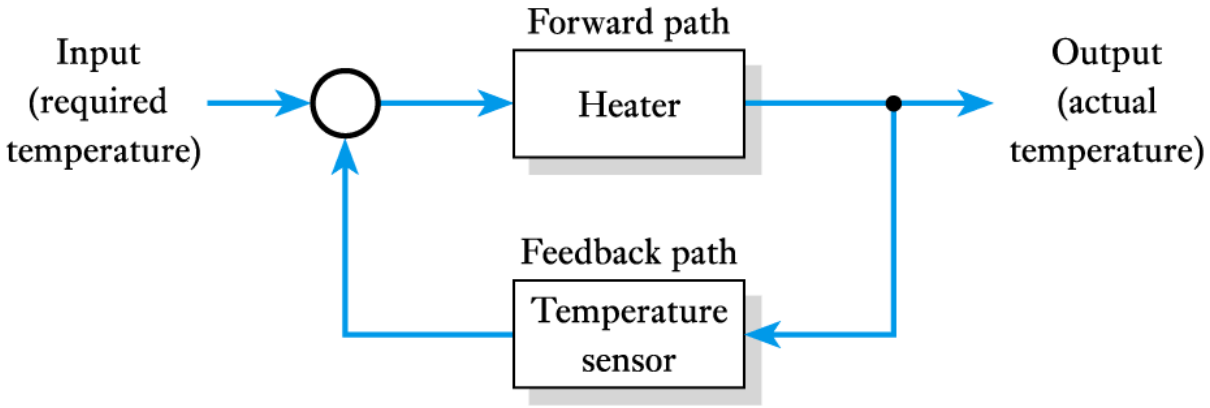
- To reduce errors by automatically adjusting the system input.
- To improve stability of unstable system.
- To increase or reduce the system sensitivity.
- To enhance robustness against external disturbances to the process.
- To produce a reliable and repeatable performance.

Examples: Automatic electric cloth dryer, Automatic washing machine, etc…

Examples of Control Systems

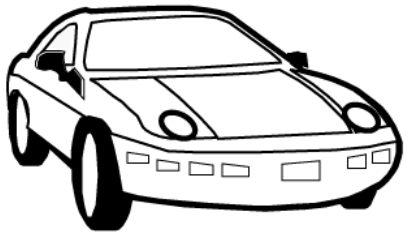
temperature control using a room heater

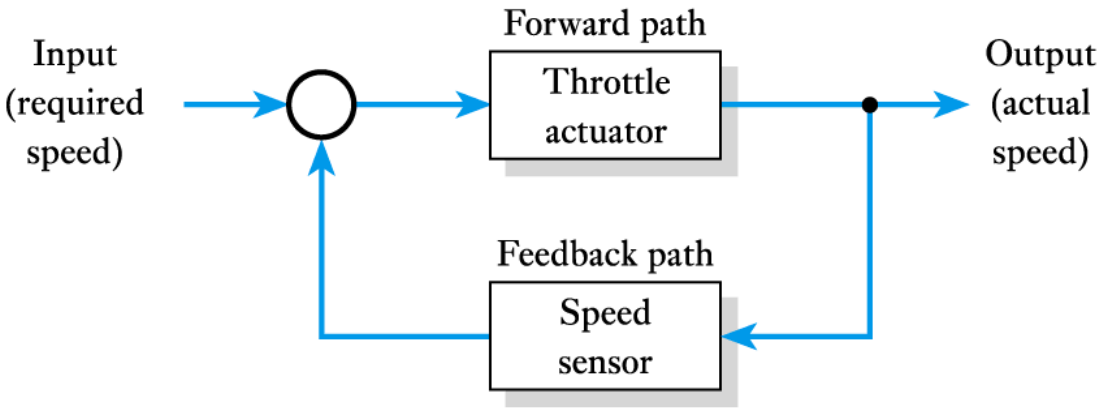




Examples of Control Systems

Cruise control in a car

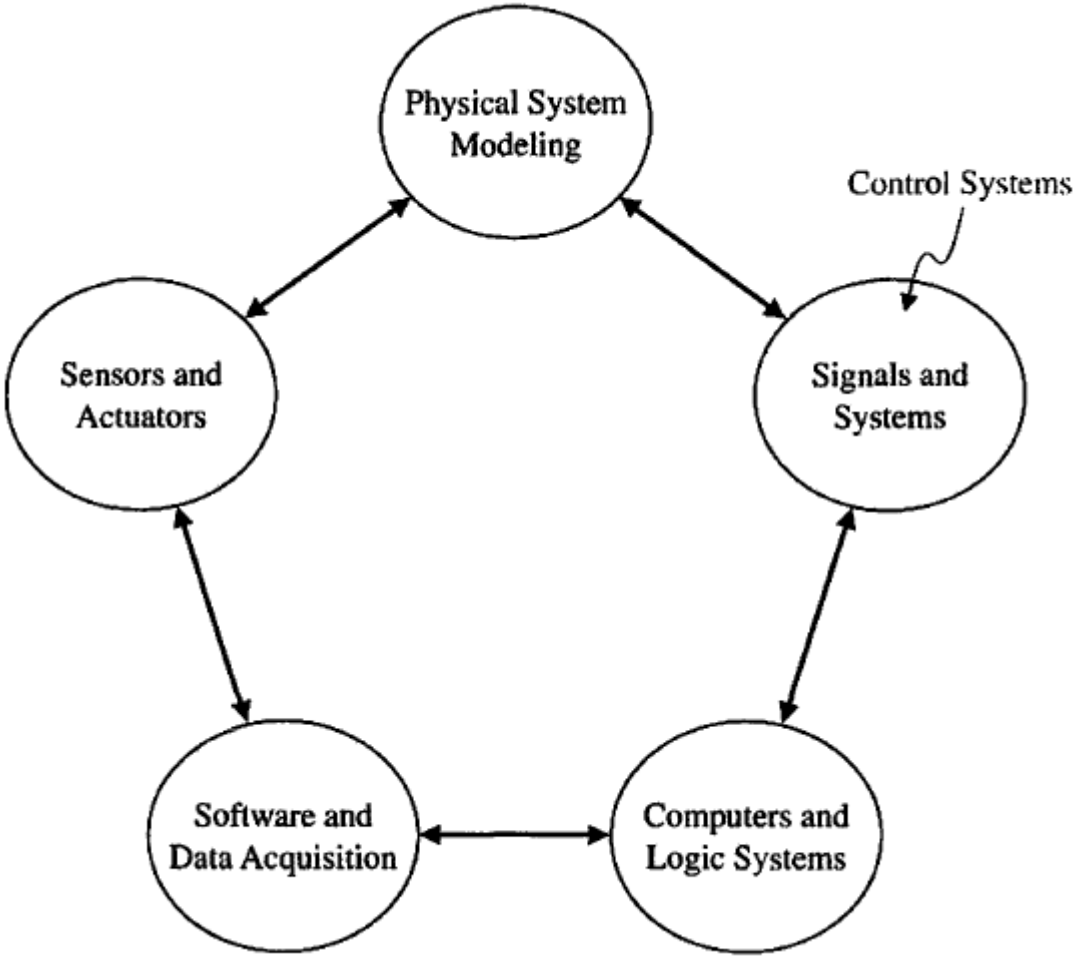




Mechatronics Systems

A natural stage in the evolutionary process of modern engineering design give new branch, known as Mechatronics.

- The term Mechatronics used first time in Japan in 1970s.

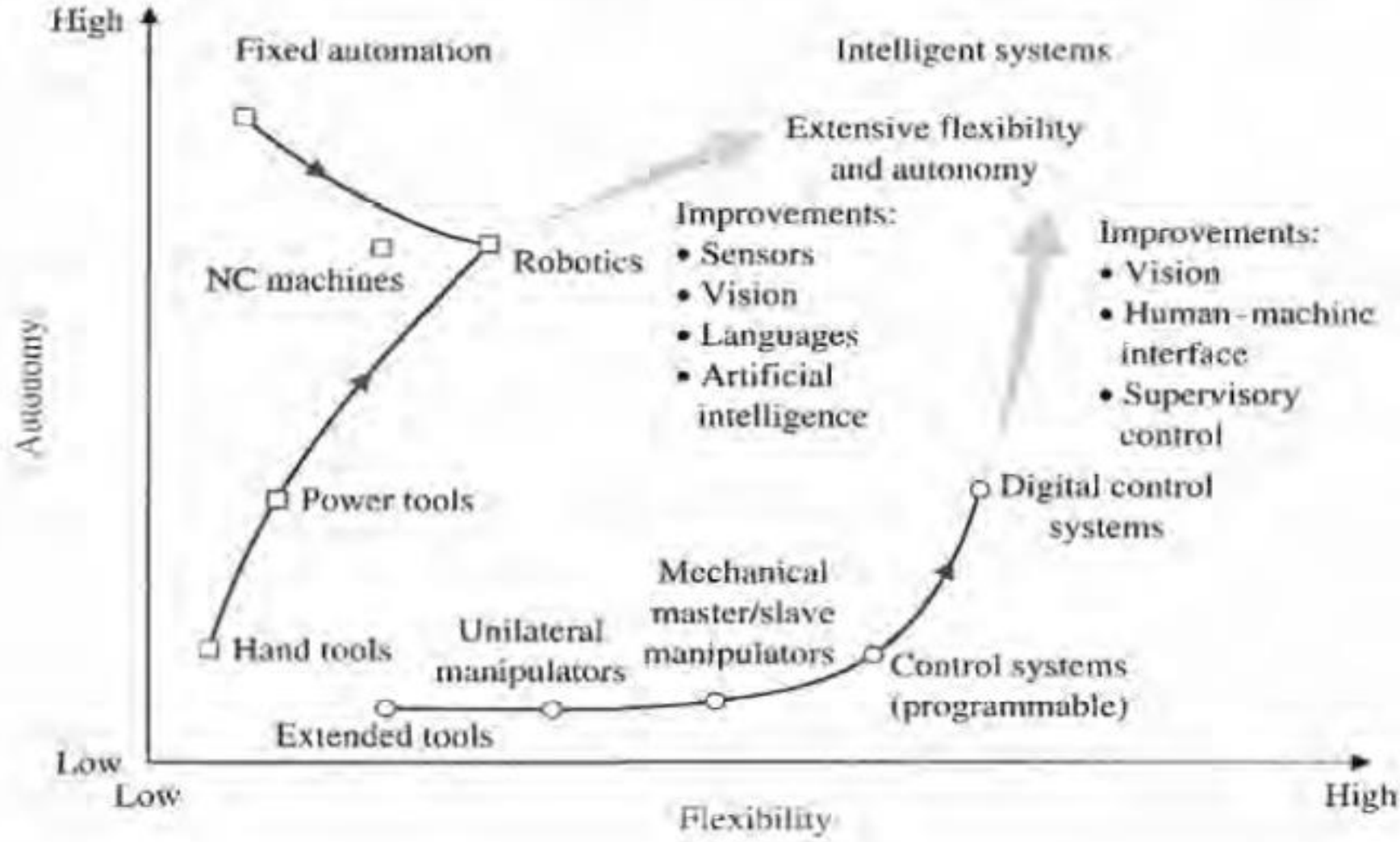


Mechatronics Systems

Mechatronics is the synergistic integration of mechanical, electrical and computer system, and has evolved over the past 40 years.

Examples of mechatronics includes Hybrid Electric Vehicles (HEVs), Wind Power Generation, Autonomous vehicles, Smart home appliances, Robot assisted surgery, etc...

Future Evolution of Control Theory



Thank You !