SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
An Autonomous Institution

Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A++' Grade
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

23ECT212 – LINEAR CONTROL SYSTEMS

II YEAR/ IV SEMESTER

UNIT I – CONTROL SYSTEM MODELING

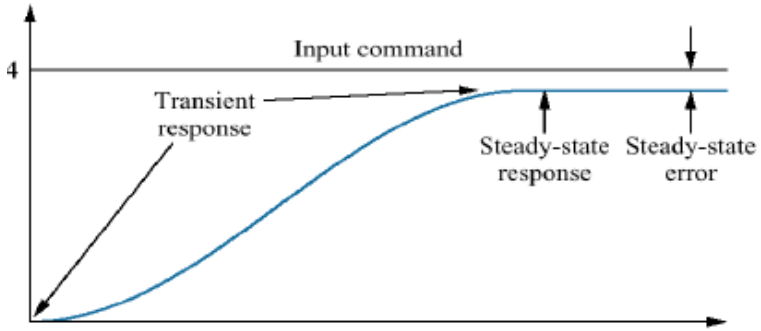
TOPIC 1–ELEMENTS OF CONTROL SYSTEM

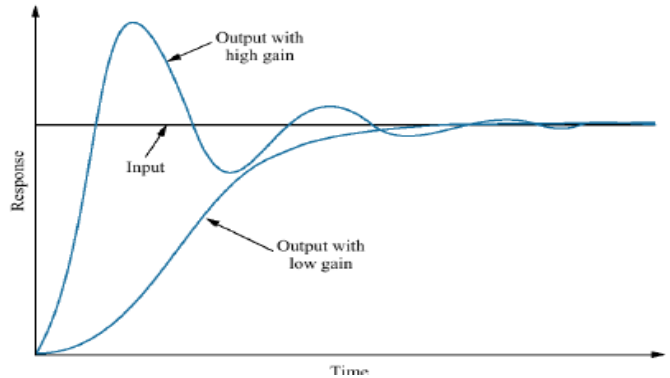
Course Objectives

1. Model common control system components.
2. Select an appropriate control algorithm of PID type or one of its variations.
3. Analyze the performance of a control algorithm using transfer functions, block diagrams, and computer methods, in light of given performance specifications.
4. Using MATLAB and Simulink to analyze and simulate control systems

A control system consists of subsystems and plants for the purpose of obtaining a desired output with desired performance, given a specified input.

A major application of the methods of system dynamics is the design of control systems.





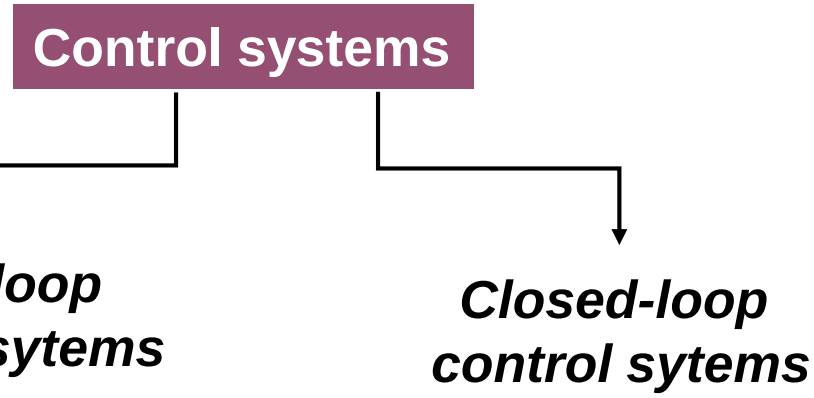
Basic Components of a Control System

1. **Objectives of control (Inputs)**
2. **Control system components (Controller, plant, actuator, sensor,…)**
3. **Results (Outputs)**

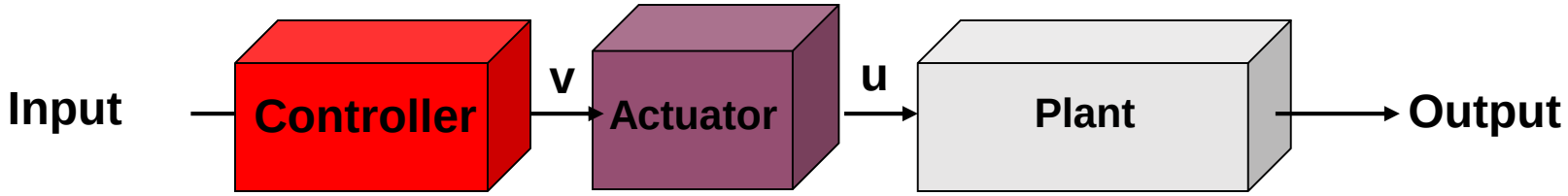
Robot : Sensors (Optical image, displacement, speed, force, torque, pressure voltage, current). Actuators (AC motors, DC motors, step motors, hydraulic actuators)

Home Heating System : Sensors (Temperature, pressure, fluid flow). Actuators (Motors, pumps, heat sources)

Automobile : Sensors (Displacement, speed,force,pressure,temperature, fluid flow, fluid level voltage, current). Actuators (DC motors, step motors, pumps, heat sources)

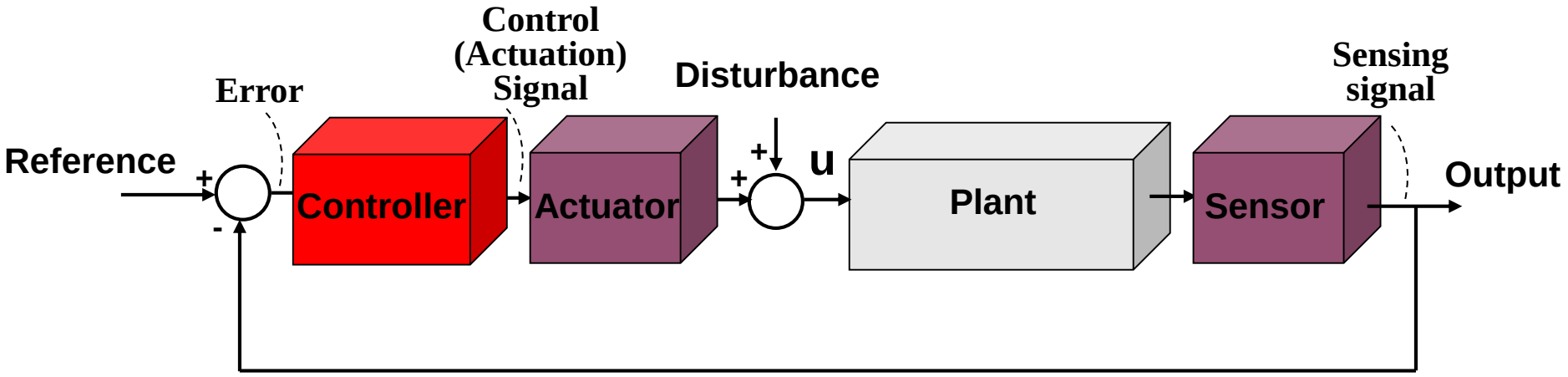


Open Loop Control Systems



Sensitive to changing in parameters and disturbance.

Closed Loop Control Systems: (Feedback Systems)

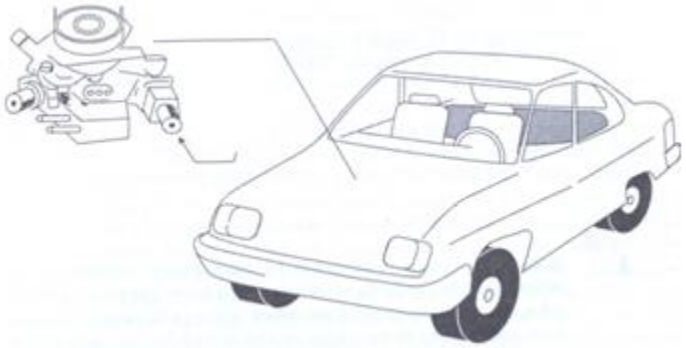


Error signal= Reference – Sensing signal

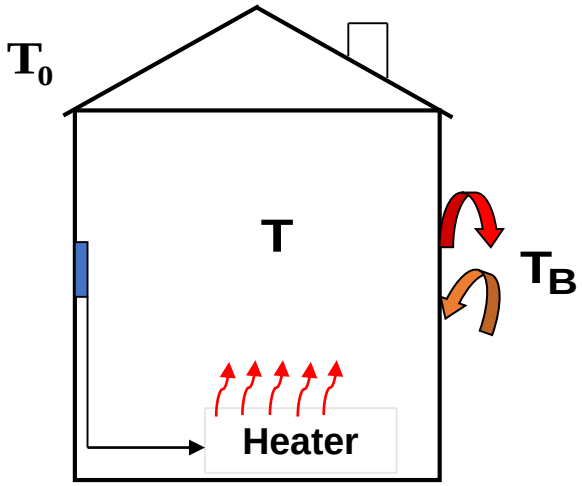
Examples of Control System Applications

Washing machine

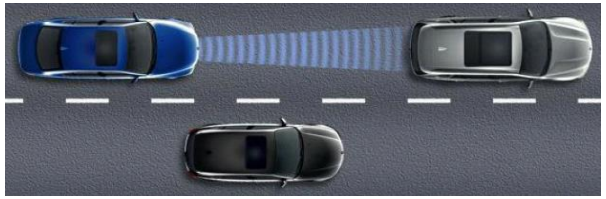
Step motors



Idle-speed control



Home heating system



Cruise control

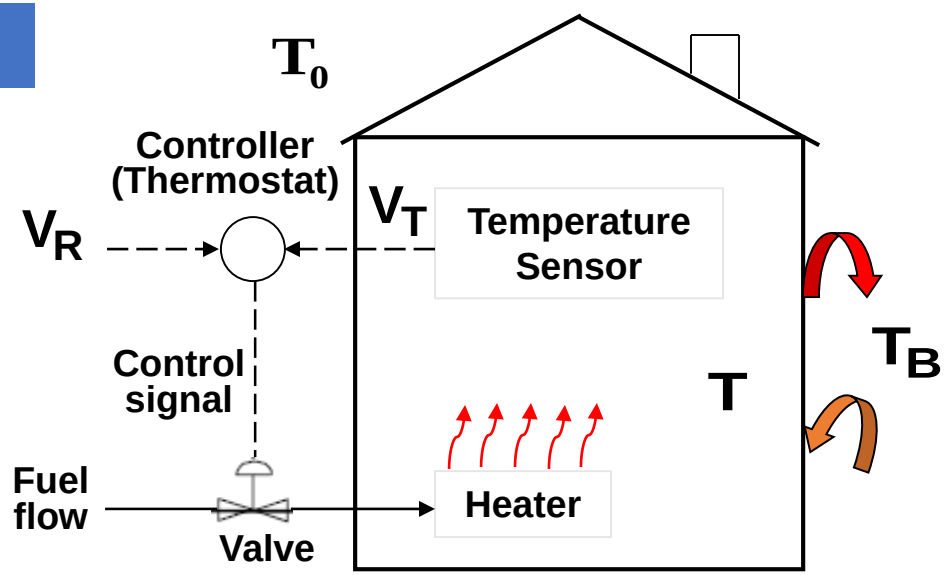
Robots

Home Heating Control System

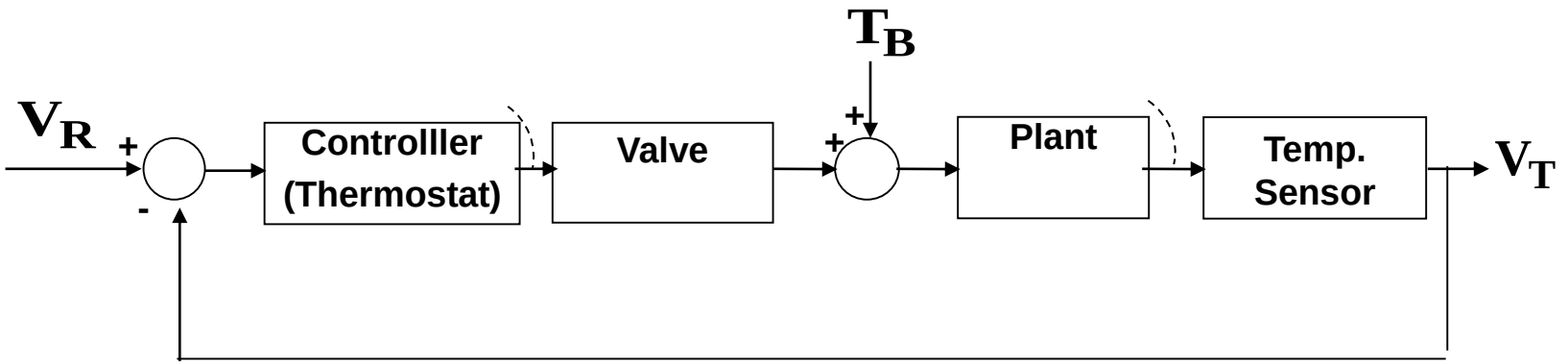
V_R : Reference temp.

V_T : Measured temp.

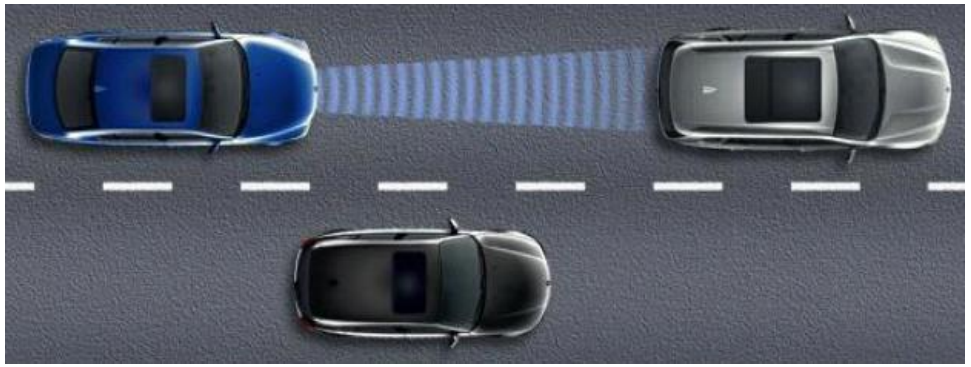
T_B : Disturbance
(heat transfer: door, window, wall, etc.)



Error	Status	Control action
$V_R - V_T > 0$	Cold	Open valve
$V_R - V_T < 0$	Hot	Close valve



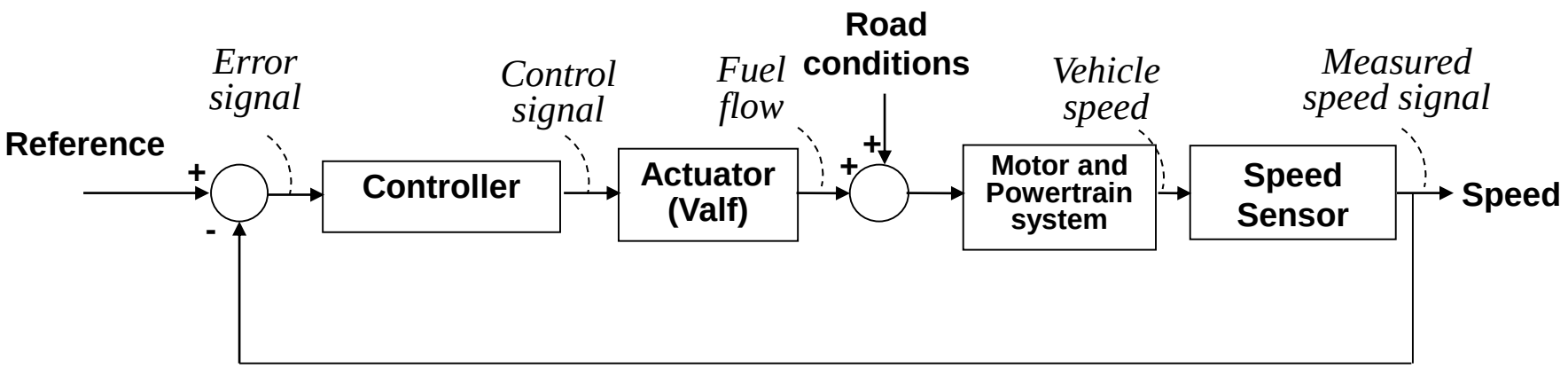
Cruise Control System



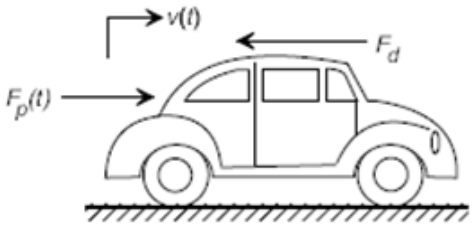
Usage in 1990's

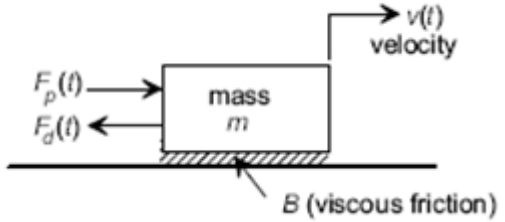
Driver comfort

Save fuel



a) Mathematical model (Cruise Control System) :



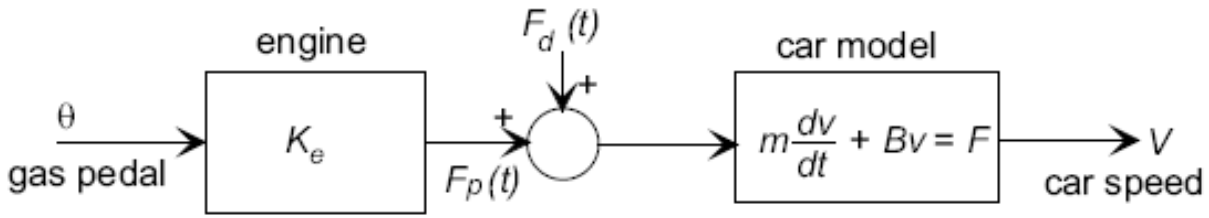


F_p: Pushing force (from engine)

F_d: Distrubance (wind, gravity, enviromental factors, etc.)

$$F_p(t) = K_e\theta(t) \qquad F_B = Bv$$

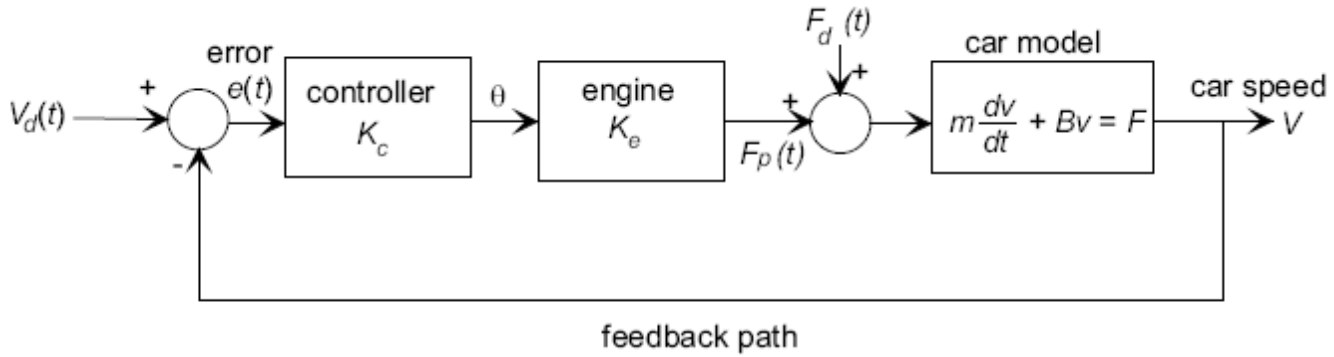
$$m\frac{dv}{dt} + Bv = F_p(t) + F_d(t) \qquad \boxed{m\frac{dv}{dt} + Bv = K_e\theta(t) + F_d(t)}$$



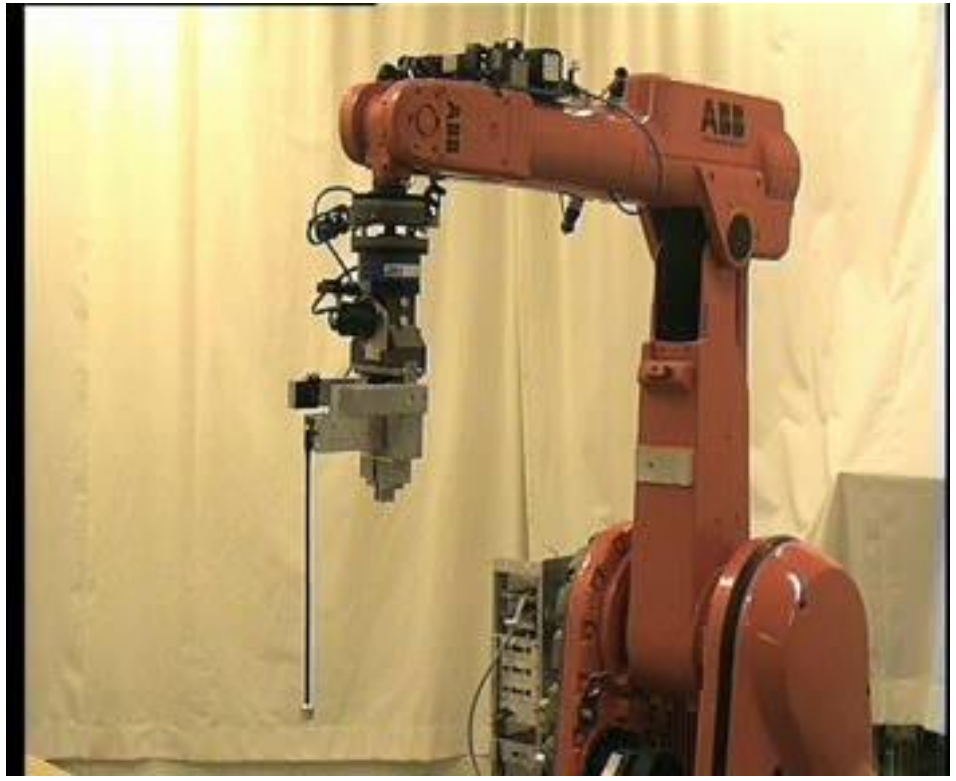
b) Closed loop control:

$$e(t) = v_d(t) - v(t) \qquad \theta(t) = K_c e(t) = K_c(v_d(t) - v(t)),$$

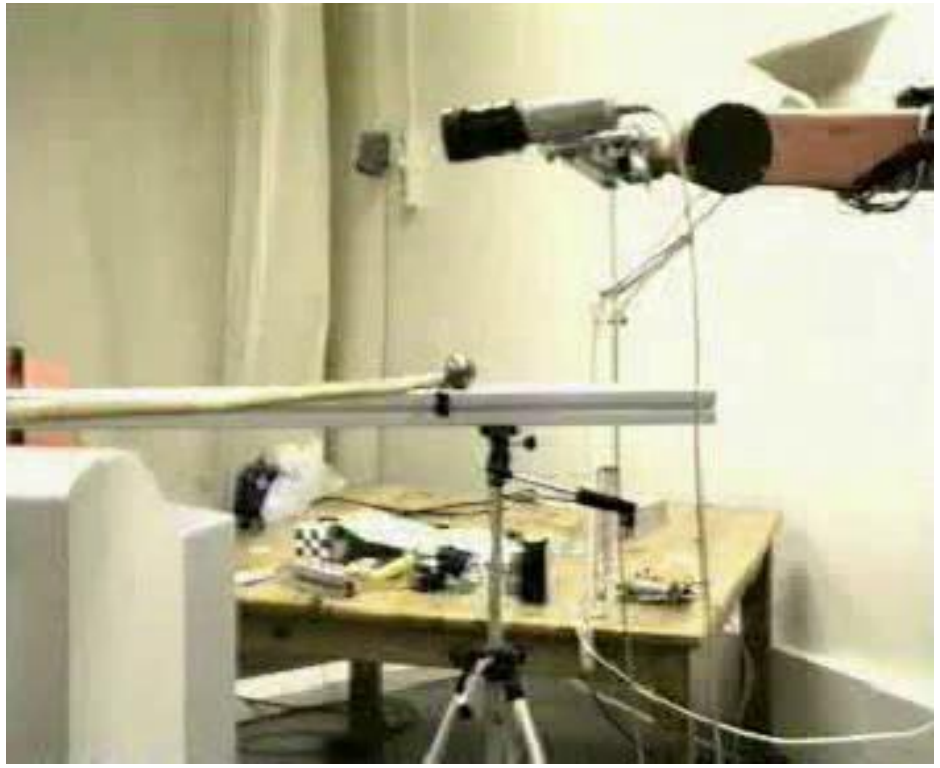
$$F_p(t) = K_e K_p e(t) = K_e K_c(v_d(t) - v(t))$$



Control Aplications with Industrial Robots



Inverted pendulum control



Ball grabber

How does the controller use the information from the sensor to make decisions?

The controller compares the actual temperature reported by the sensor with the desired set point (target temperature). If the temperature deviates from the set point, the controller computes the error and determines the necessary control actions to correct it, such as adjusting the heating element's output.

SUMMARY