# 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

## 19ECT212 – CONTROL SYSTEMS

II YEAR/ IV SEMESTER

### UNIT I – CONTROL SYSTEM MODELING

### TOPIC 1–BASIC ELEMENTS OF CONTROL SYSTEM

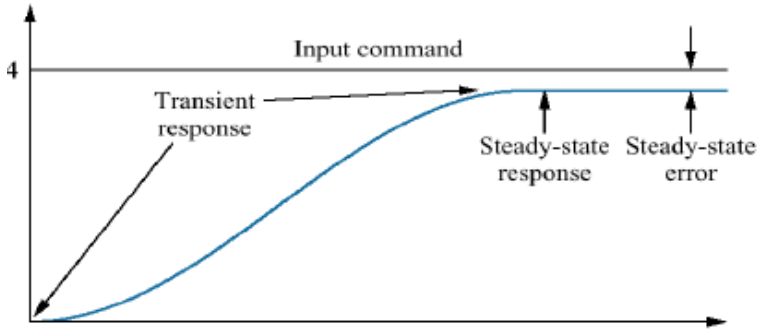
# INTRODUCTION TO CONTROL SYSTEMS

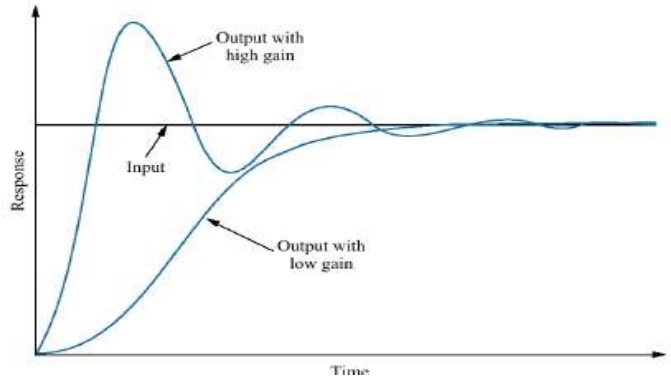
## Course Objectives

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.



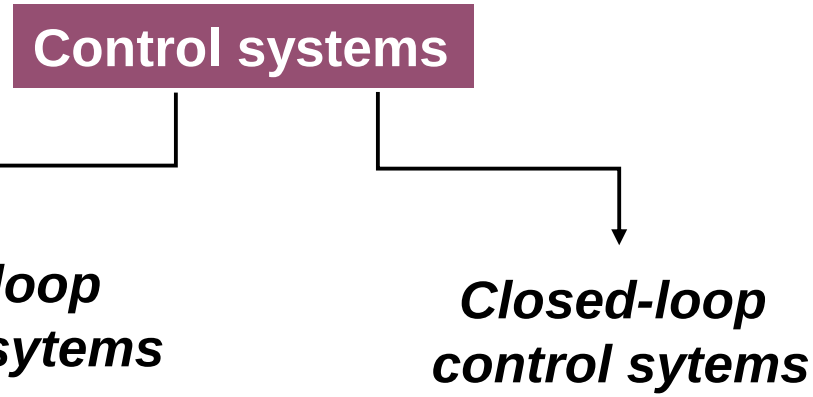
# Basic Components of a Control System

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

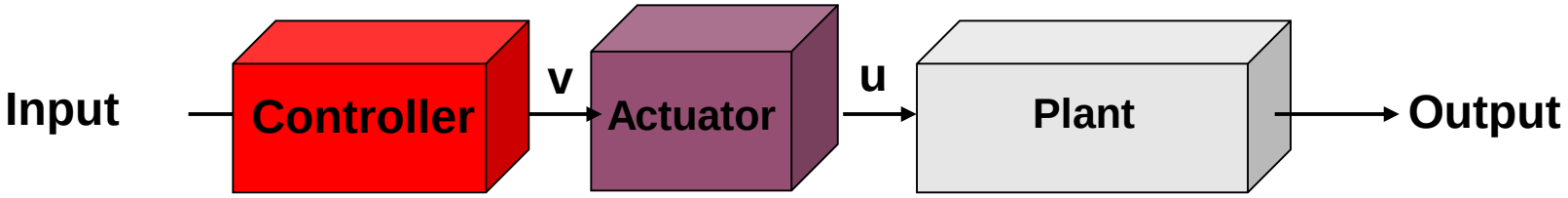
**Robot : Sensors (Optical image, displacement, speed, force, torque, pressure voltage, current). Actuators (AC motors, DC motors, step motors, hydraulic actuators)**

**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)**

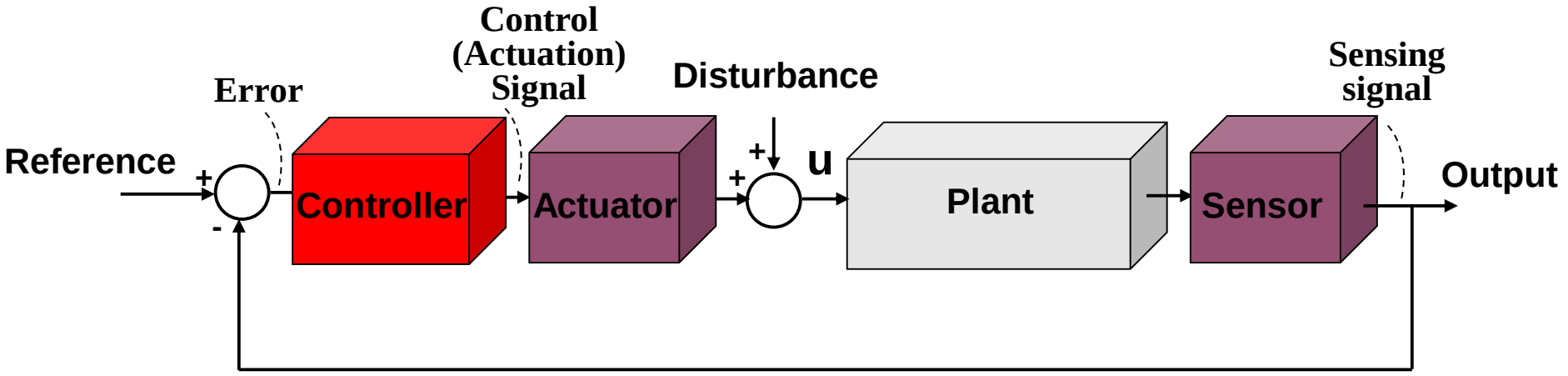


# Open Loop Control Systems




**Sensitive to changing in parameters and disturbance.**

# Closed Loop Control Systems: (Feedback Systems)

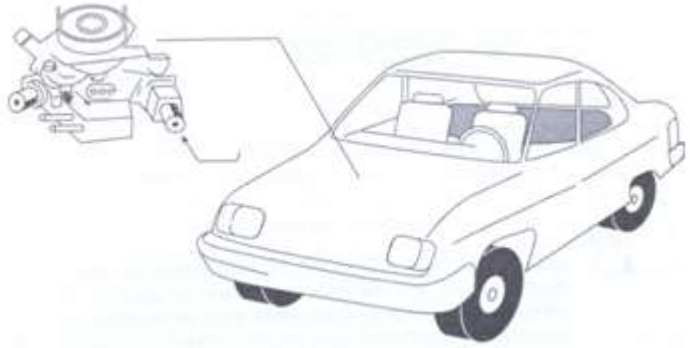



Error signal= Reference – Sensing signal

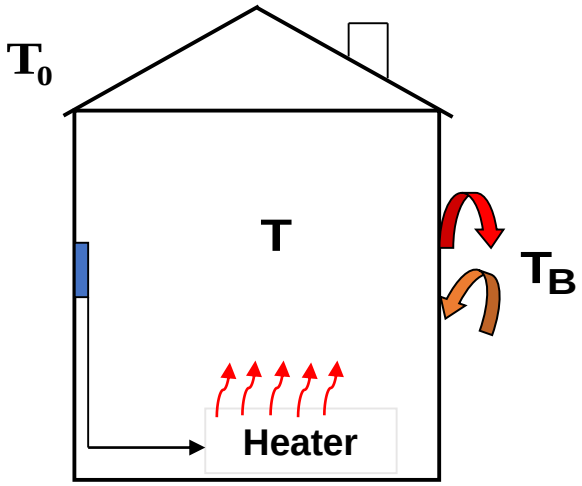
# Examples of Control System Applications

Washing machine

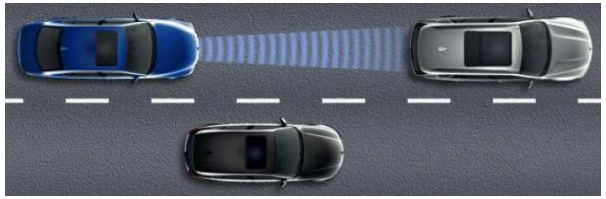
Step motors



Idle-speed control




Home heating system



Cruise control

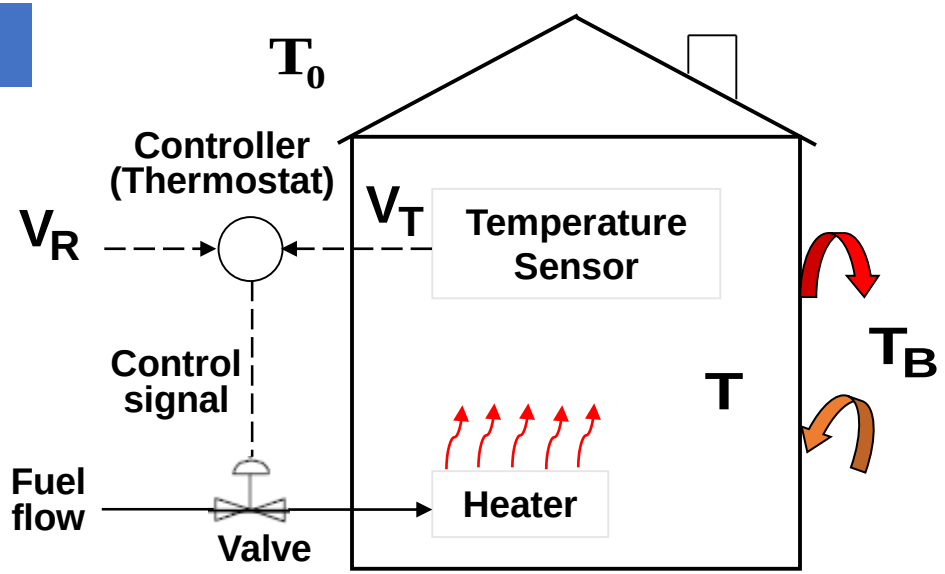
Robots

# Home Heating Control System

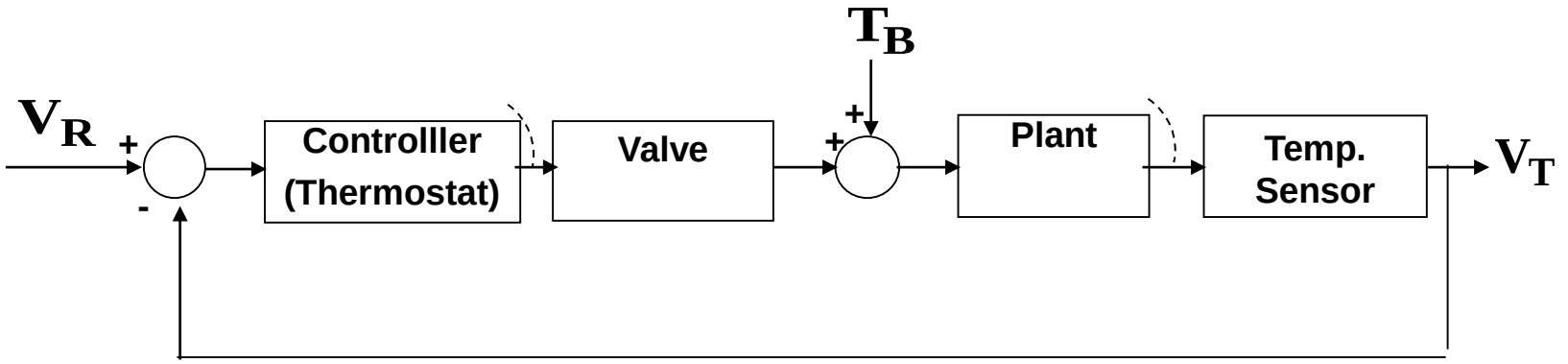
$V_R$ : Reference temp.

$V_T$ : Measured temp.

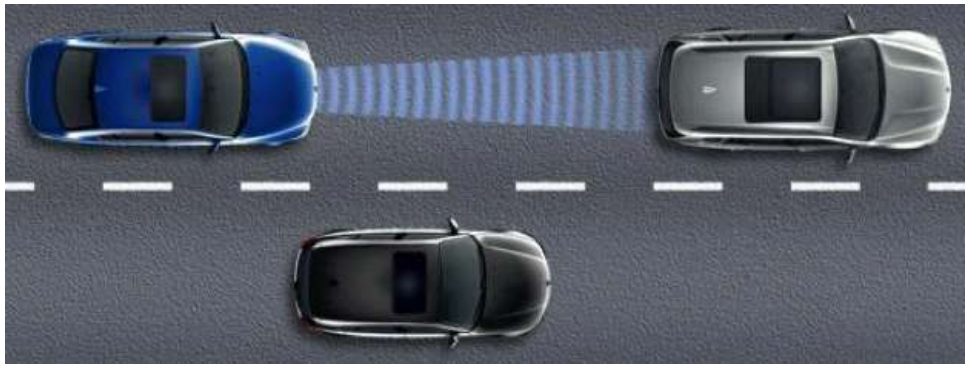
$T_B$ : Disturbance
(heat transfer: door, window, wall, etc.)




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



# Cruise Control System

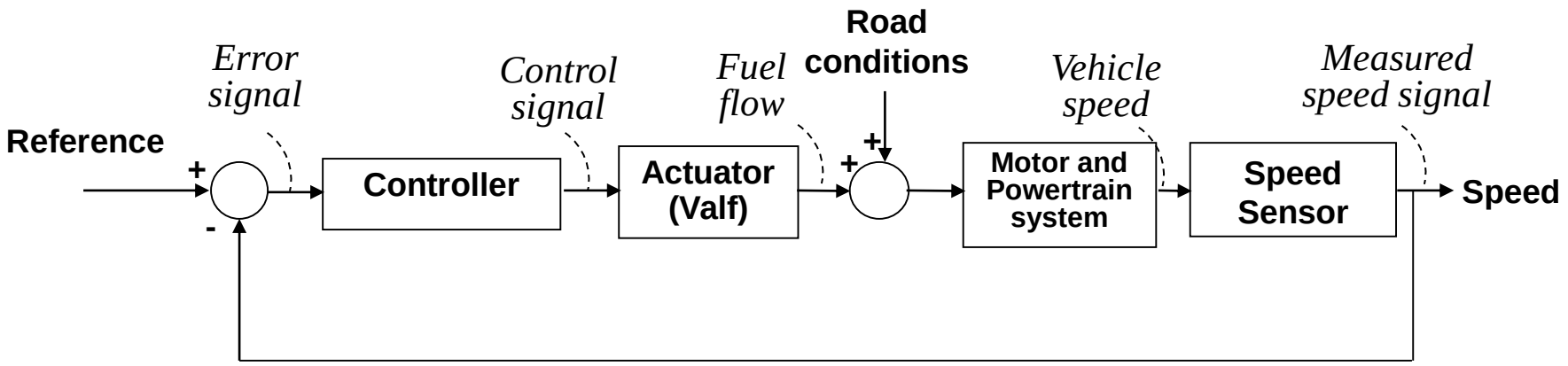


**Usage in 1990's**

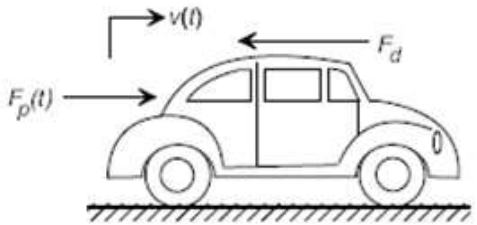
**Driver comfort**

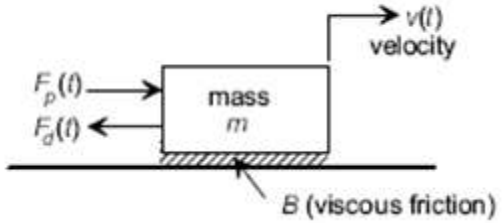
**Save fuel**





# a) Mathematical model (Cruise Control System) :



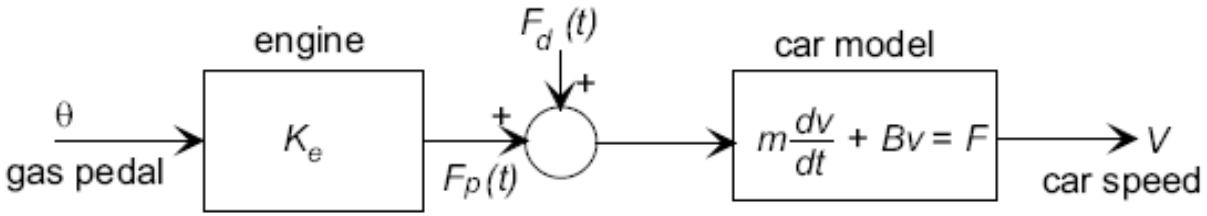

**$F_p$: Pushing force (from engine)**

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

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

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

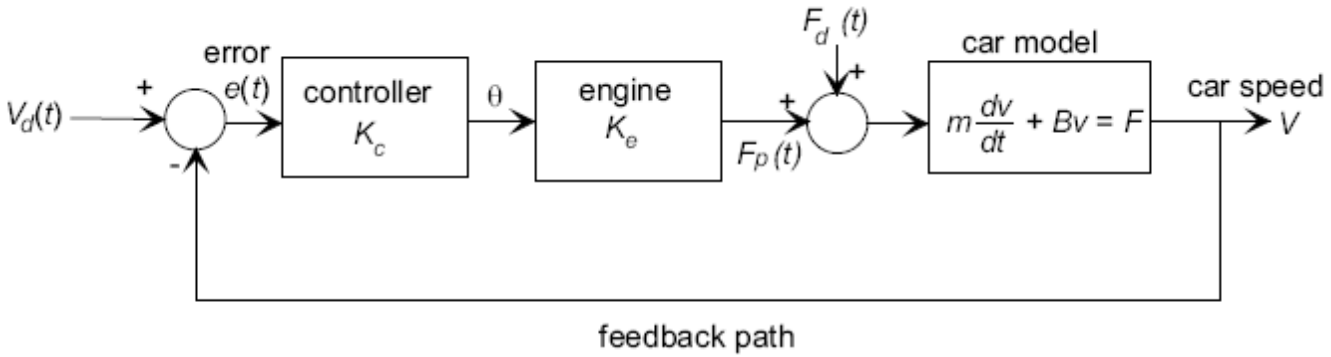
$$\boxed{m\frac{dv}{dt} + Bv = K_e\theta(t) + F_d(t)}$$



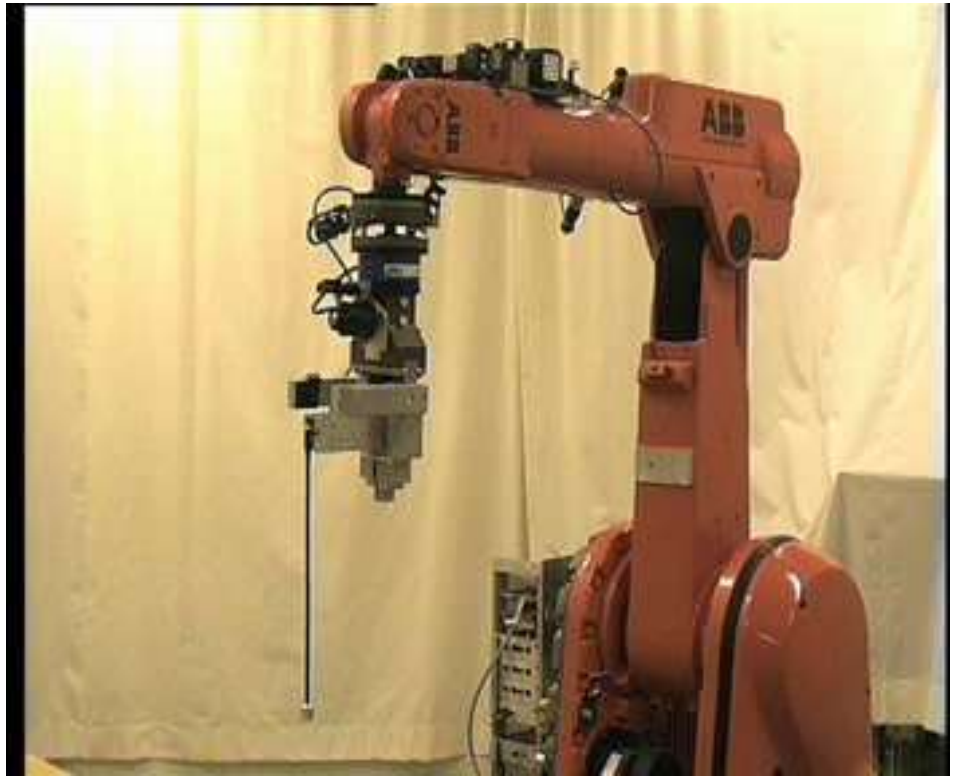

# b) Closed loop control:

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

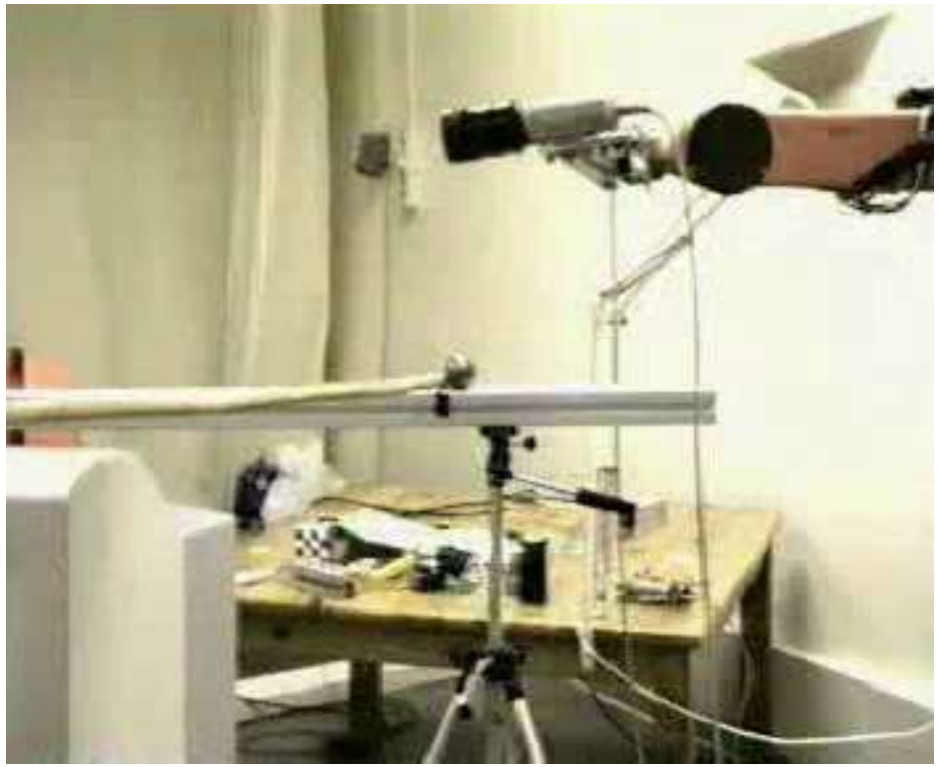
$$F_p(t) = K_e K_p e(t) = K_e K_c(v_d(t) - v(t))$$



# Control Aplications with Industrial Robots




**Inverted pendulum control**



**Ball grabber**

# SUMMARY