Lecture-21

Control Units

Control of Motor

A DC motor is connected at each joint of a robot, where torque is proportional of the armature current.

$$\tau_m \propto I_A$$

$$\tau = K_m . I_A$$

Control of Motor

A DC motor is connected at each joint of a robot, where torque is proportional of the armature current.

$$\tau_m \propto I_A$$ Armature current

$$\tau = K_m . I_A$$

Constant of proportionality or motor constant

- Joint torque τ can be represented as follows:

$$\tau = D(\theta)\ddot{\theta} + h\left(\theta, \dot{\theta}\right) + C(\theta)$$

where

$D(\theta)$: inertia terms

$h\left(\theta, \dot{\theta}\right)$: Coriolis and centrifugal terms

$C(\theta)$: gravity terms

- Joint torque τ can be represented as follows:

$$\tau = D(\theta)\ddot{\theta} + h\left(\theta, \dot{\theta}\right) + C(\theta) + F\left(\theta, \dot{\theta}\right)$$

where

$D(\theta)$: inertia terms

$h\left(\theta, \dot{\theta}\right)$: Coriolis and centrifugal terms

$C(\theta)$: gravity terms

Let us consider partitioned control scheme

$$\tau = \alpha \tau' + \beta$$

where $\alpha = D(\theta)$

$$\beta = h\left(\theta, \dot{\theta}\right) + C(\theta) + F\left(\theta, \dot{\theta}\right)$$

Now, τ' can be written as follows:

Derivative gain

$$\tau' = \ddot{\theta}_d + K_p E + K_D \dot{E}$$ (for Proportional Derivative (PD) control law)

Desired acceleration

Proportionality gain

$$E = \theta_d + \theta$$

$$\dot{E} = \dot{\theta}_d + \dot{\theta}$$

Now, τ' can be written as follows:

$$\tau' = \ddot{\theta}_d + K_p E + K_D \dot{E}$$ (For Proportional Derivative (PD) control law)

$$\tau' = \ddot{\theta}_d + K_p E + K_I \int E dt + K_D \dot{E}$$ For PID control law

Integral gain

Integral

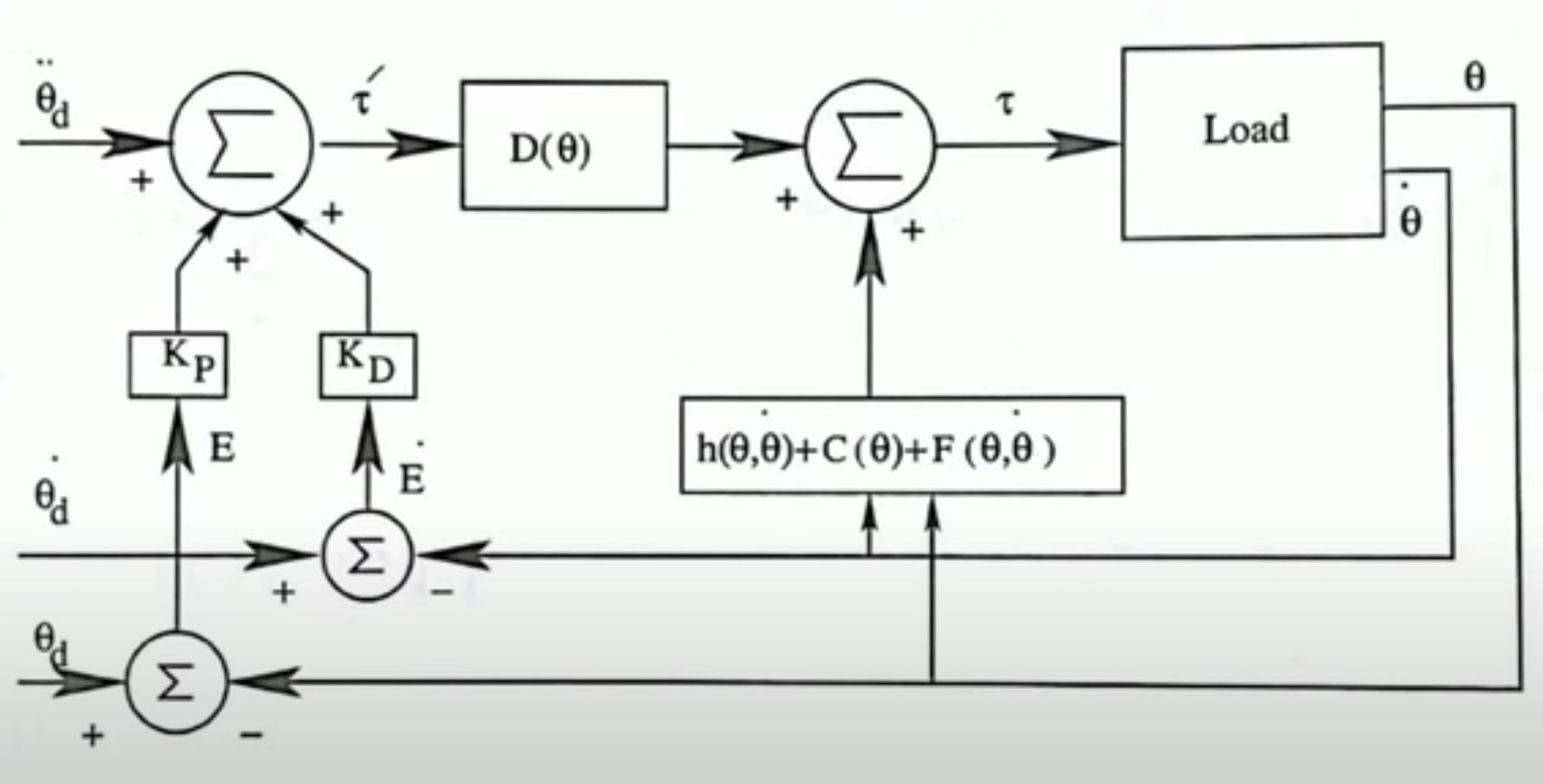
where $E = \text{error} = \theta_d - \theta$

where θ_d : Desired value of θ

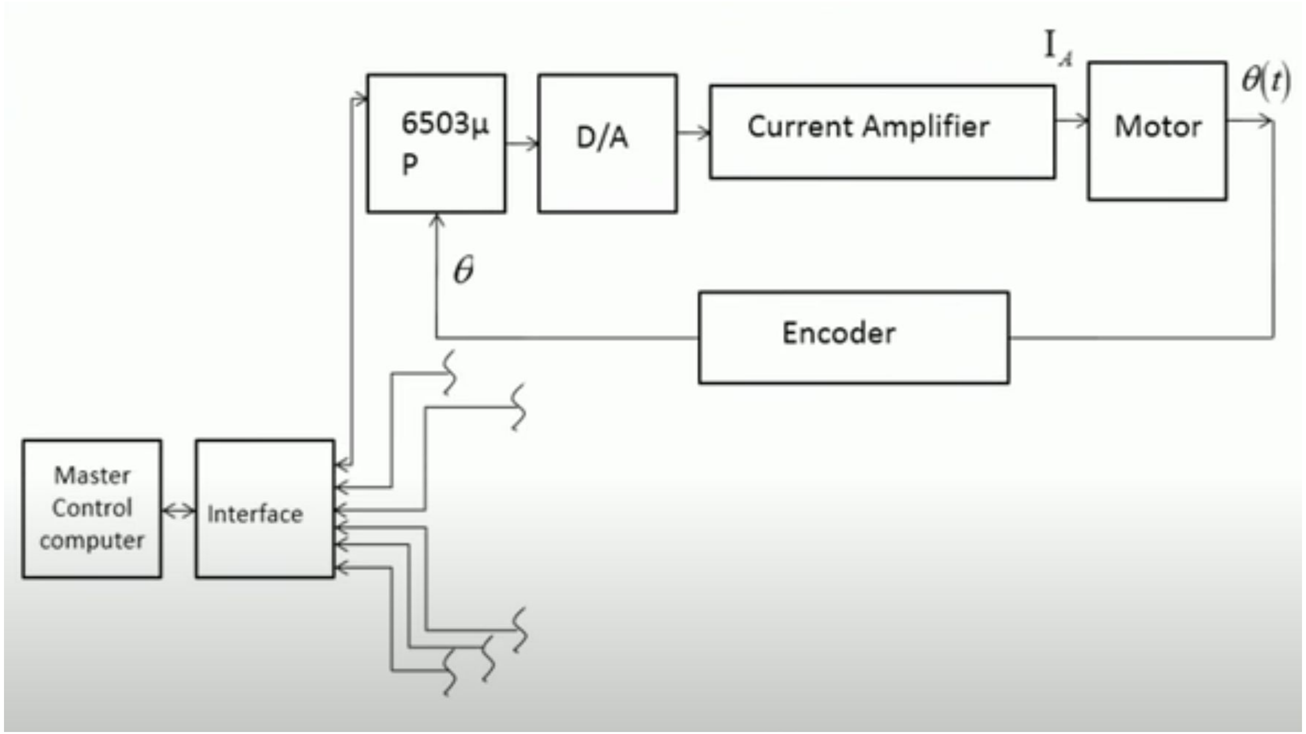
θ : Actually obtained value of θ

ziegler nicholas (K_p, K_I, K_D)

Control Architecture



PUMA



6503µ P
D/A
Current Amplifier
I_A
Motor
$\theta(t)$
θ
Encoder
Master Control computer
Interface