ROBOT DYNAMICS

~~[illegible]~~ Tutorial.

WE HAVE CONSIDERED KINEMATICS
- STATIC ? POSITIONS
- VELOCITIES

WHAT FORCES ARE REQUIRED TO CAUSE MOTION?

NOW WE CONSIDER THE EQUATIONS OF MOTION FOR THE MANIPULATOR

TYPICALLY WE MODEL THESE BY A SET OF DIFFERENTIAL EQUATIONS

WE CONSIDER $\theta, \dot{\theta}, \ddot{\theta}, d, \dot{d}, \ddot{d}$

WE USE LAGRANGIAN DYNAMICS TO DERIVE THE ROBOT SYSTEM DIFFERENTIAL EQUATIONS

LAGRANGIAN FUNCTION

DIFFERENCE BETWEEN THE TOTAL KINETIC ENERGY AND THE TOTAL POTENTIAL ENERGY STORED IN THE SYSTEM

$$L = \underbrace{K(\underset{\sim}{q}, \dot{\underset{\sim}{q}})}_{\text{(KINETIC)}} - \underbrace{P(\underset{\sim}{q})}_{\text{(POTENTIAL)}}$$

$\underset{\sim}{q}$ - Vector of System States

LAGRANGIAN EQUATIONS (DIFFERENTIAL EQUATIONS OF MOTION OF THE SYSTEM

$$\frac{d}{dt}\left(\frac{\partial L}{\partial \dot{\underset{\sim}{q}}_i}\right) - \frac{\partial L}{\partial \underset{\sim}{q}_i} = \underset{\sim}{\tau}_i$$

$$\frac{d}{dt}\left(\frac{\partial L}{\partial \dot{\underset{\sim}{q}}_i}\right) - \frac{\partial L}{\partial \underset{\sim}{q}_i} = 0$$

PRACTICALLY:

- Find equations for x, y, z etc.
- Calculate $\dot{x}$, $\dot{y}$, $\dot{z}$
- Calculate K & P

$$K = \frac{1}{2} m v^2 \qquad P = mgh$$

- Calculate Lagrangian Function (L)

$$L = K - P$$

- Calculate

$$\frac{\partial L}{\partial \theta_1} \quad \frac{\partial L}{\partial \theta_2} \quad \frac{\partial L}{\partial \theta_3} \quad \text{etc.}$$

$$\frac{\partial L}{\partial \dot{\theta}_1} \quad \frac{\partial L}{\partial \dot{\theta}_2} \quad \frac{\partial L}{\partial \dot{\theta}_3} \quad \text{etc}$$

$$\frac{d}{dt}\left(\frac{\partial L}{\partial \dot{\theta}_1}\right) \quad \frac{d}{dt}\left(\frac{\partial L}{\partial \dot{\theta}_2}\right) \quad \frac{d}{dt}\left(\frac{\partial L}{\partial \dot{\theta}_3}\right) \quad \text{etc.}$$

- Calculate

$$\tau_1 = \frac{d}{dt}\left(\frac{\partial L}{\partial \dot{\theta}_1}\right) - \frac{\partial L}{\partial \theta_1}$$

$$\tau_2 = \frac{d}{dt}\left(\frac{\partial L}{\partial \dot{\theta}_2}\right) - \frac{\partial L}{\partial \theta_2}$$

$$\tau_3 = \frac{d}{dt}\left(\frac{\partial L}{\partial \dot{\theta}_3}\right) - \frac{\partial L}{\partial \theta_3}$$

etc.