Lecture 6:
Introduction to Feedback Control

COSMOS - Making Robots and
Making Robots *Intelligent*

The Robobrain Dynamic Model

<u>States:</u> (x,y,θ) - position and orientation

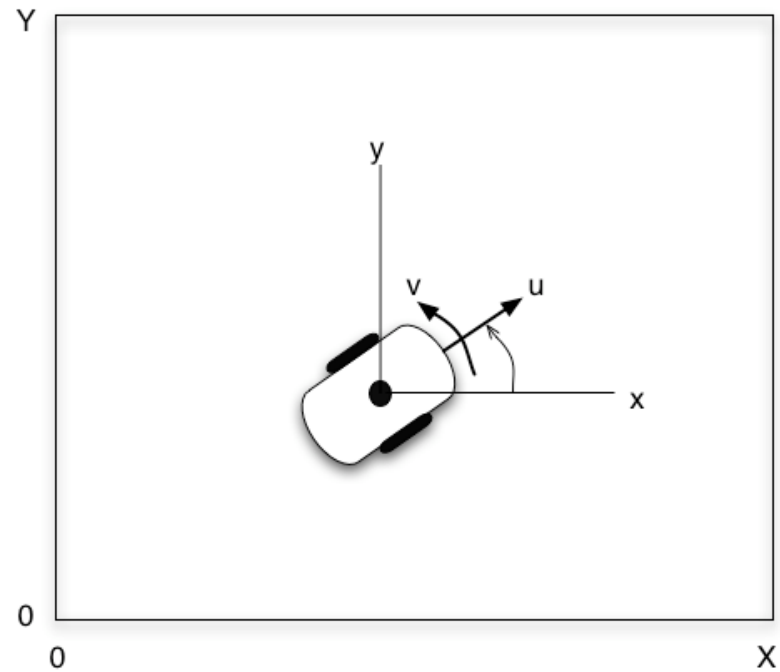
<u>Inputs (Controls):</u> (u,v) - forward and turning velocity

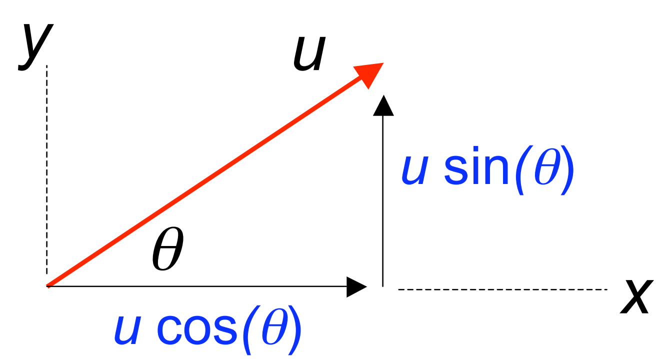
<u>Dynamics:</u>

$$x_{k+1} = x_k + \Delta u_k \cos(\theta_k)$$

$$y_{k+1} = y_k + \Delta u_k \sin(\theta_k)$$

$$\theta_{k+1} = \theta_k + \Delta v_k$$





Engineering Equilibrium = Choice of Feedback

Model of "*Bob*" with Cruise Control:

$$m v_{k+1} = m v_k + \Delta[-b v_k + u_{eng} + u_{hill}]$$

$$u_{eng} = K(v_{des} - v_k), \quad K > 0$$

Steady-state (when $v_k = v_{ss}, \;\; k = 0, 1, 2, \ldots$):

$$\Longrightarrow v_{ss} = \frac{K}{b+K} v_{des} + \frac{1}{b+K} u_{hill}$$

==> shaping the system dynamics

Robobrain control (*u,v*) determines wheel speed:

$$u = \frac{r}{2}(\omega_R + \omega_L) \qquad v = \frac{2\pi r}{l}(\omega_R - \omega_L)$$

$$\Longleftrightarrow$$

$$\omega_R = \frac{l}{\pi r}\left[\frac{4\pi}{l} u + v\right] \qquad \omega_L = \frac{l}{\pi r}\left[\frac{4\pi}{l} u - v\right]$$

Objective

• Shaping the dynamics for a general model (iterated map).

• Stabilizing an *engineered* fixed-point/equilibrium.

• Practice with Examples and Robobrain Model.