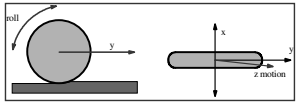
CSE-571
AI-based Mobile Robotics

Wheeled Locomotion

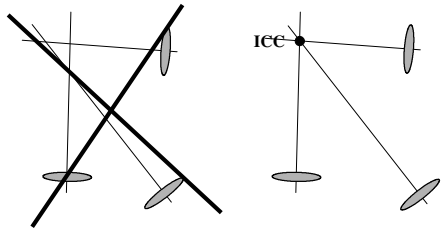
Locomotion of Wheeled Robots

Locomotion (Oxford Dict.):
Power of motion from place to place



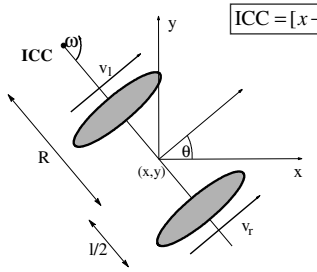
- Differential drive (AmigoBot, Pioneer 2-DX)
- Synchronous drive (B21)
- Car drive (Ackerman steering)
- Holonomic drive (XR4000)
- Tracked vehicles (Urban)

Instantaneous Center of Curvature



- For rolling motion to occur, each wheel has to move along its y-axis

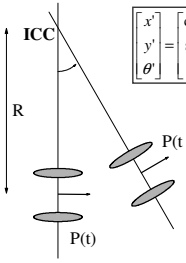
Differential Drive



$$\mathrm{ICC} = [x - R\sin\theta,\ y - R\cos\theta]$$

$$\omega(R + l/2) = v_r$$
$$\omega(R - l/2) = v_l$$
$$R = \frac{l}{2}\frac{(v_l + v_r)}{(v_r - v_l)}$$
$$\omega = \frac{v_r - v_l}{l}$$

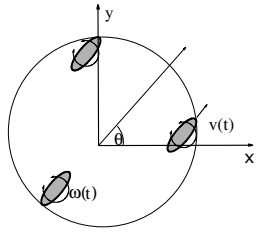
Differential Drive: Forward Kinematics



$$\begin{bmatrix} x' \\ y' \\ \theta' \end{bmatrix} = \begin{bmatrix} \cos(\omega\delta t) & -\sin(\omega\delta t) & 0 \\ \sin(\omega\delta t) & \cos(\omega\delta t) & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x - \mathrm{ICC}_x \\ y - \mathrm{ICC}_y \\ \theta \end{bmatrix} + \begin{bmatrix} \mathrm{ICC}_x \\ \mathrm{ICC}_y \\ \omega\delta t \end{bmatrix}$$

$$x(t) = \int_0^t v(t')\ \cos[\theta(t')]dt'$$
$$y(t) = \int_0^t v(t')\ \sin[\theta(t')]dt'$$
$$\theta(t) = \int_0^t \omega(t')\ dt'$$

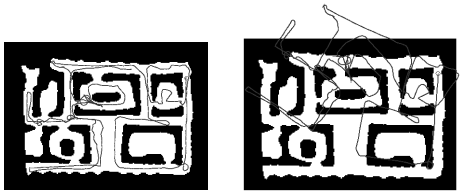
Synchonous Drive



$$x(t) = \int_0^t v(t')\ \cos[\theta(t')]dt'$$
$$y(t) = \int_0^t v(t')\ \sin[\theta(t')]dt'$$
$$\theta(t) = \int_0^t \omega(t')\ dt'$$

Holonomic Drive: Priamos, XR4000

[Priamos, Karlsruhe]

Tracked Vehicle: Urban Robot

Dead Reckoning