

Robotics

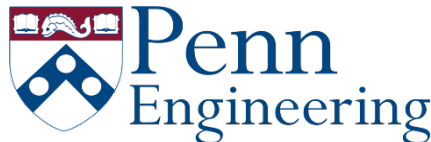
Estimation and Learning
with Dan Lee

Week 4. Localization

4.1 Odometry Modeling

4.2 Sensor Registration

4.3 Particle Filter



Week 4.

Localization

4.1 Odometry Modeling

Localization

- Encoder and local sources of information can be very precise $\sim 200,000$ pulse/m ^[1]
- Laser range finding: 3-5 cm obstacle detection ^[2,3]
- RGB(-D) Vision: 1-10cm
- Gyroscope (turning)
 - Accelerometer integration provides poor accuracy
- Higher precision, but *local* information

¹ <http://www.clearpathrobotics.com/husky-unmanned-ground-vehicle-robot/>

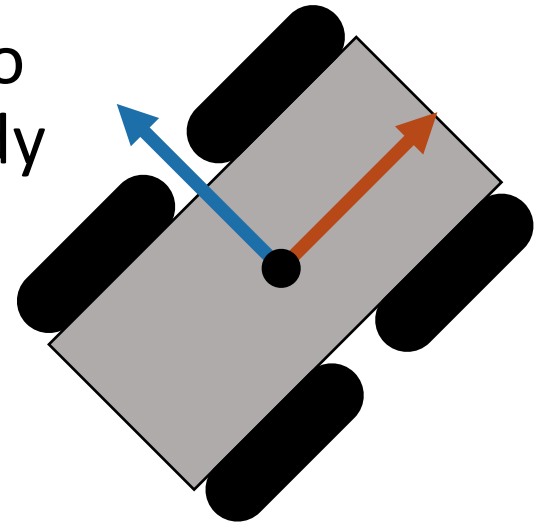
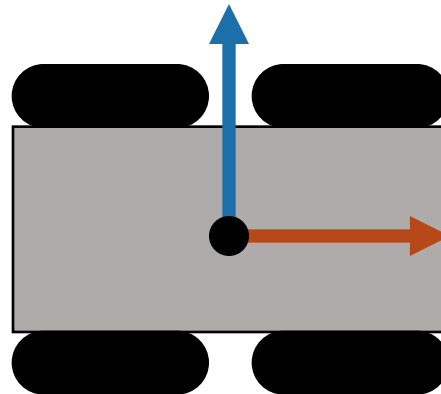
² http://www.hokuyo-aut.jp/02sensor/07scanner/utm_30lx_ew.html

³ <http://velodynelidar.com/vlp-16-lite.html>

⁴ Robust Real-Time Visual Odometry for Dense RGB-D Mapping

Simple Approach

- Integrate odometry information
- Form a model of the vehicle
 - Skid steer, in this case
- Map ticks of the wheel encoders to translation and rotation of the body



Tracking Angular Movement

- Encoder ticks (e) are observed at the inner and outer radii

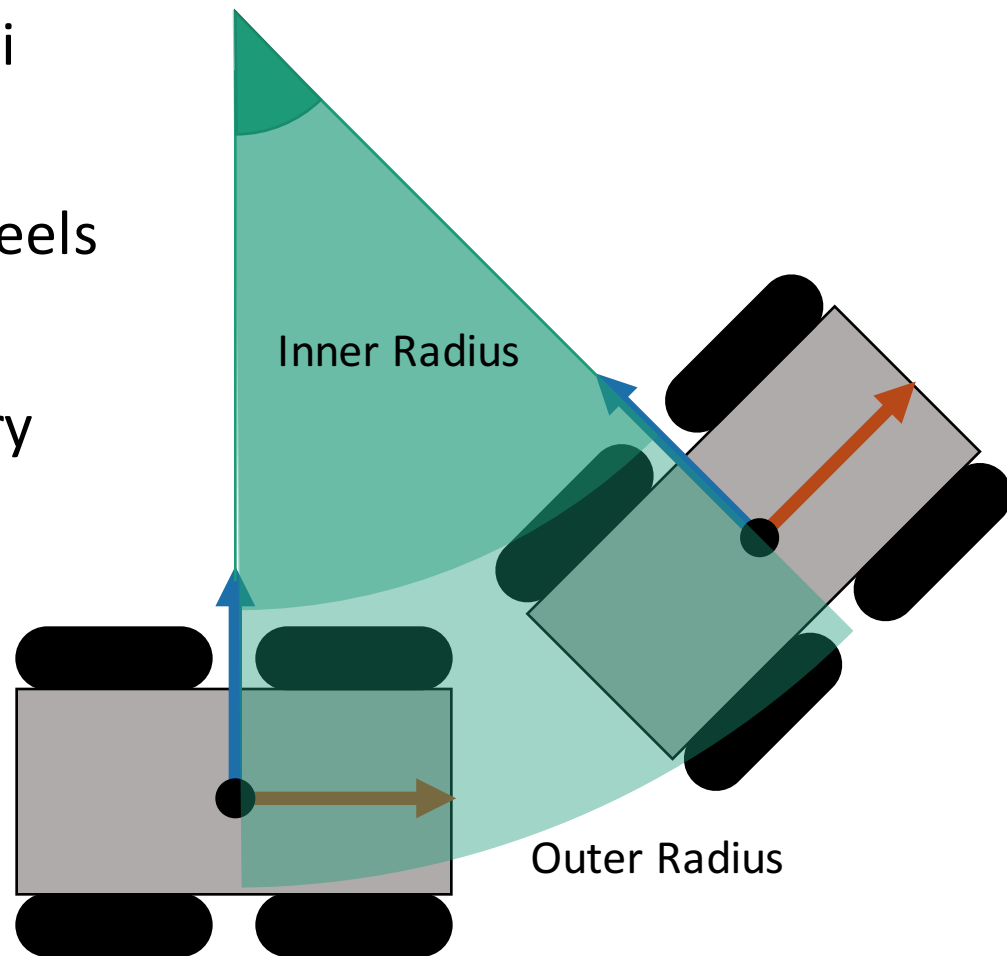
$$e_i = \theta r_i \quad e_o = \theta r_o$$

- Known width between wheels

$$w = r_o - r_i$$

- Calculate angular odometry

$$\theta = \frac{e_o - e_i}{w}$$

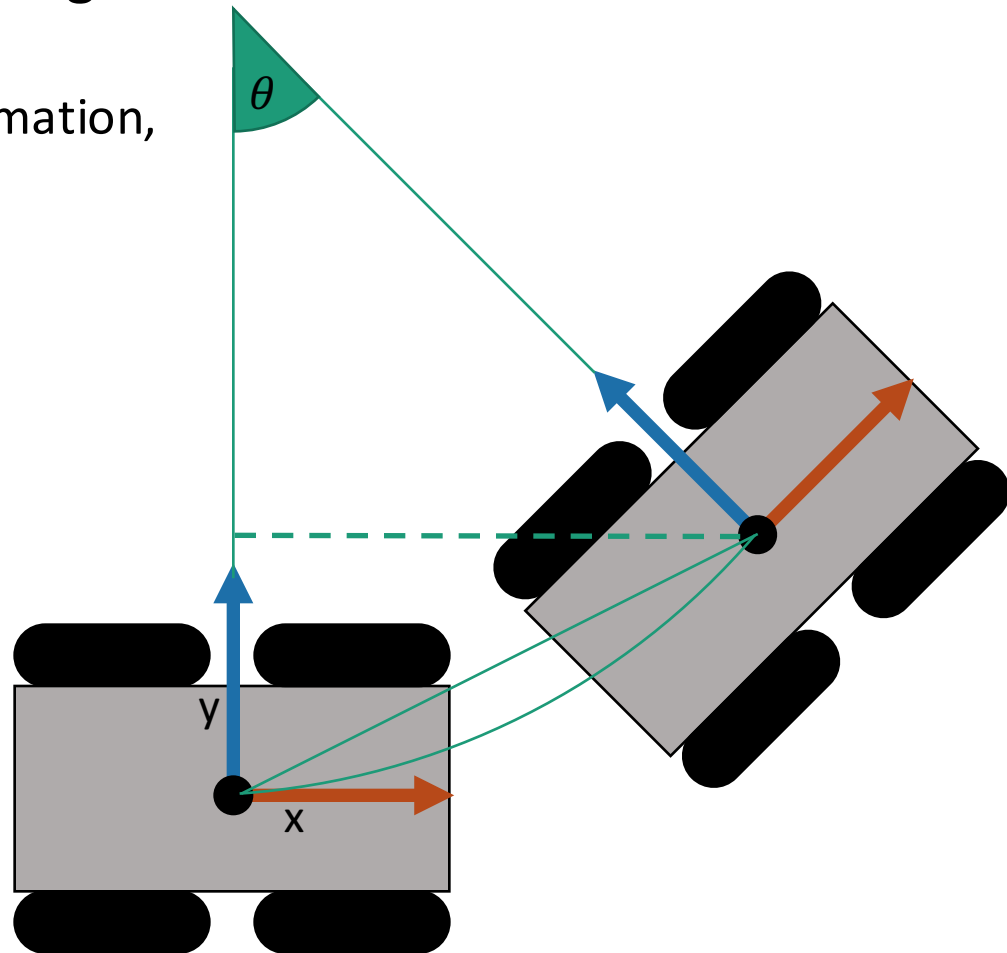


Tracking Translational Motion

- Translation requires knowledge of the angular movement
 - Use circular sector approximation, valid for small movements
- *Quiz: Spinning in Place*

$$y = \frac{e_o + e_i}{2} \cos \theta$$

$$x = \frac{e_o + e_i}{2} \sin \theta$$



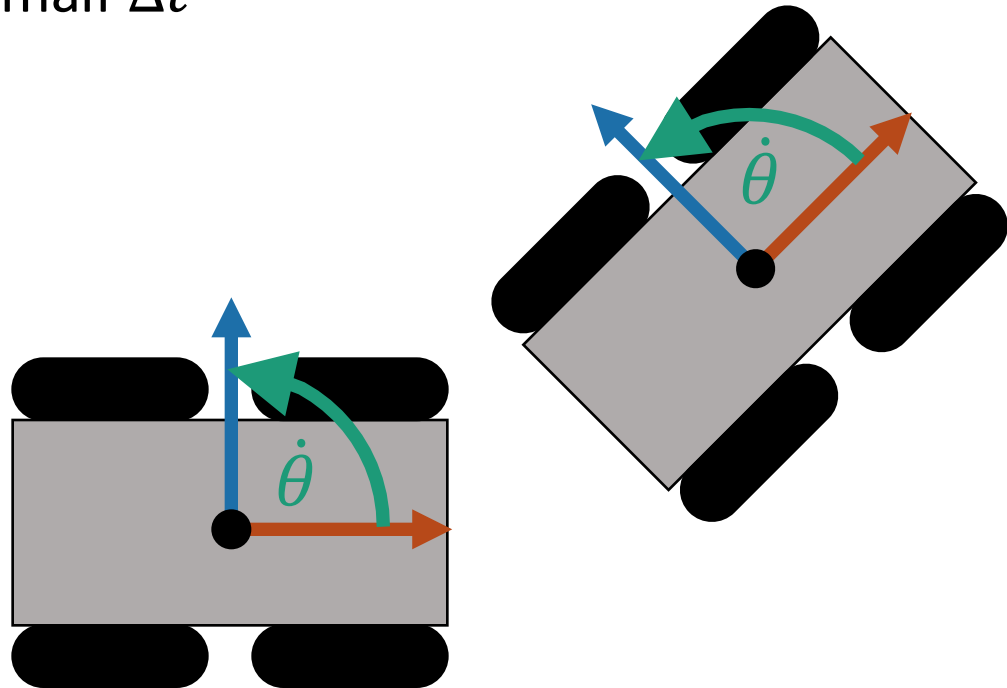
Aiding Pure Encoder Odometry

- Encoder measurements can be noisy
- Angular estimate feeds into translation, propagating error
- *Solution:* Utilize more precise gyroscope for angular change
- Gyroscope is accurate for small Δt

$$\theta = \dot{\theta} \Delta t$$

$$y = \frac{e_o + e_i}{2} \cos \theta$$

$$x = \frac{e_o + e_i}{2} \sin \theta$$



Simple Approach Characteristics

- Local frame of reference of the robot starting point
- *Issue:* Encoders suffer from slippage, missing counts
- *Issue:* Gyroscope integration suffers from drift
- Utilizing maps of the world can correct localization errors