Robotics

Estimation and Learning with Dan Lee

Week 4. Localization

4.1 Odometry Modeling
4.2 Sensor Registration
4.3 Particle Filter

Penn Engineering

Week 4.
Localization

4.1 Odometry Modeling

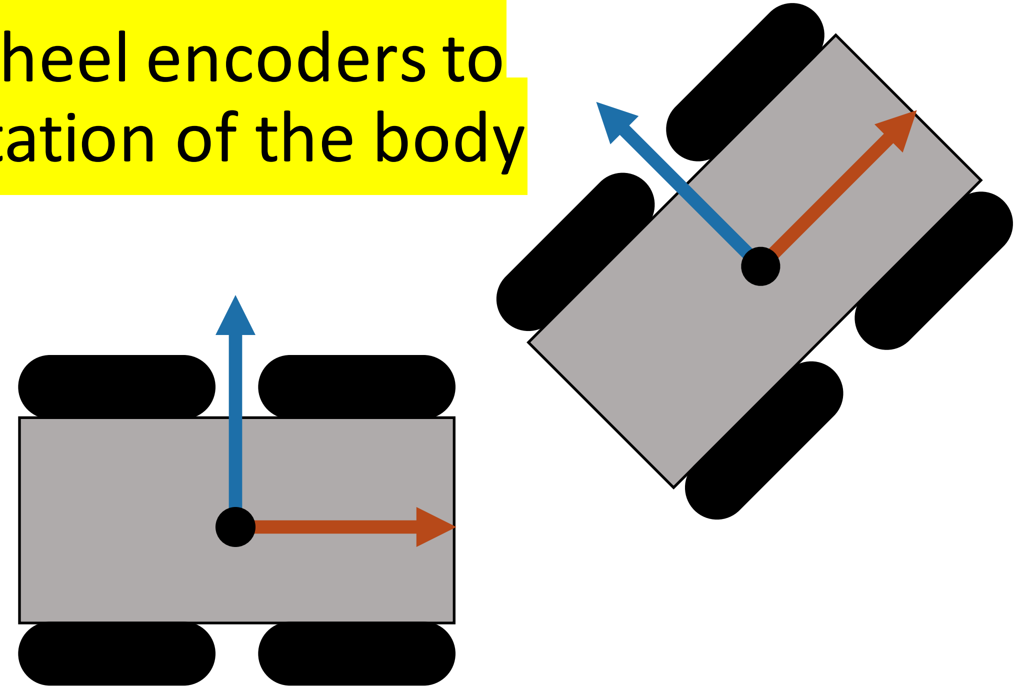
Localization

- Encoder and local sources of information can be very precise ~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

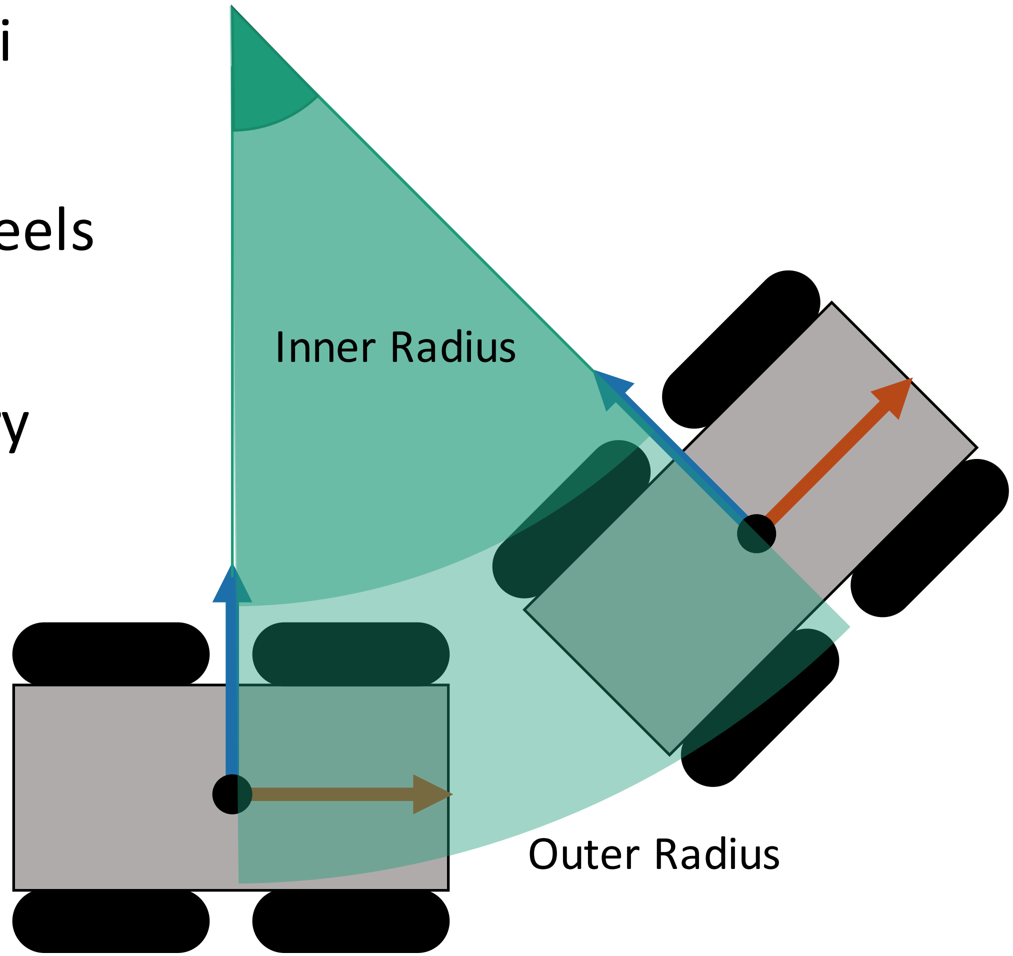
$$e_i = \theta r_i \qquad e_o = \theta r_o$$

- Known width between wheels

$$\mathrm{w} = r_o - r_i$$

- Calculate angular odometry

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

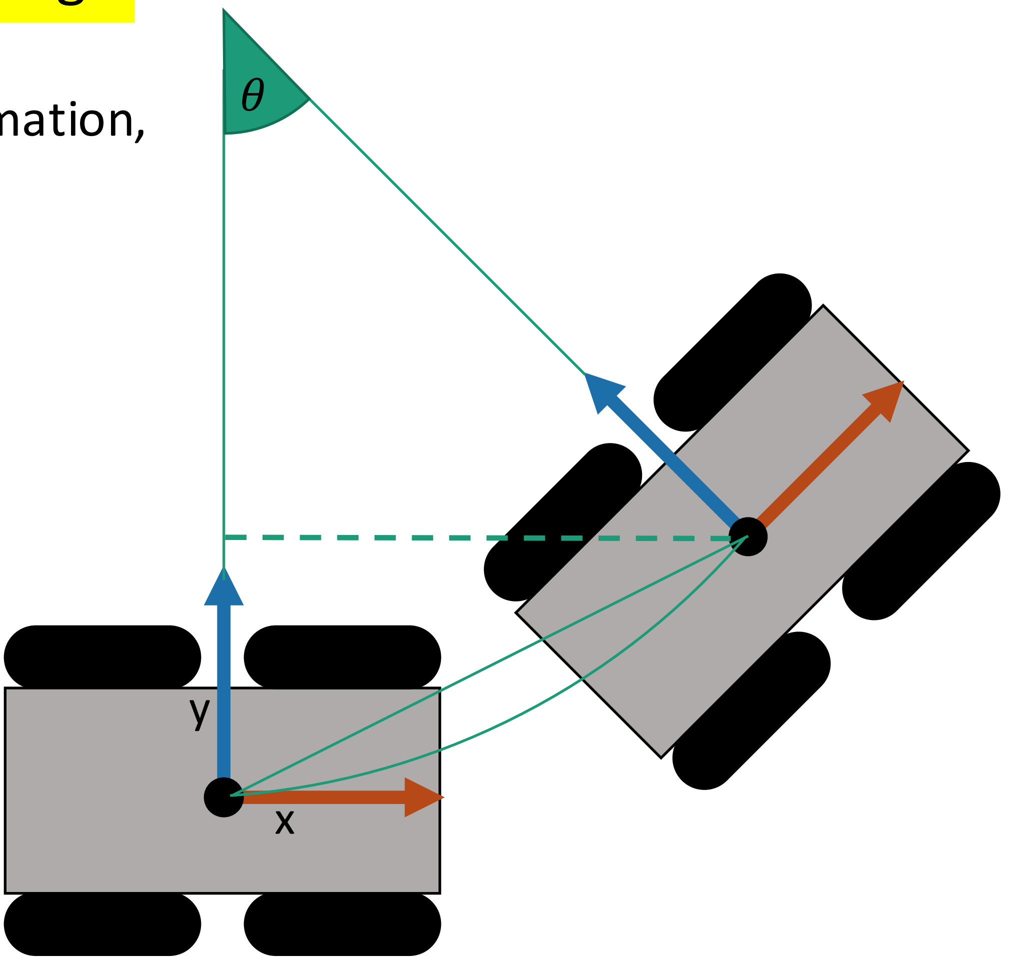


Tracking Translational Motion

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

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

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



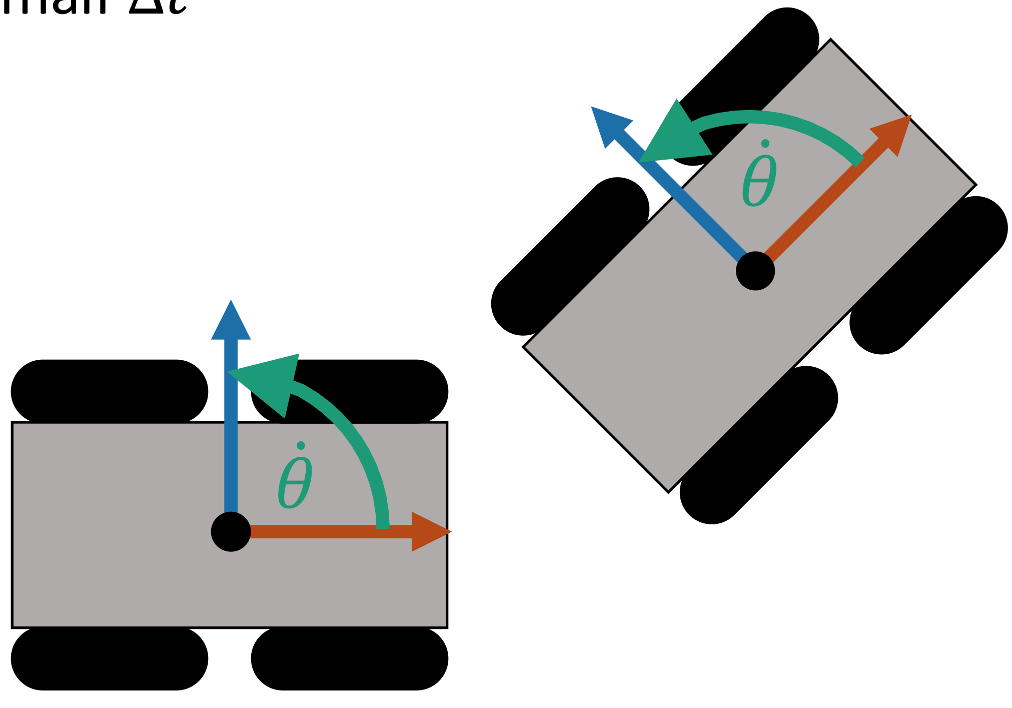
Aiding Pure Encoder Odometry

- 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

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

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

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



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