DRIVE KINEMATICS

Drive update

- get encoder values of all wheel positions
- do (change in wheel positions)/(change in time) for each wheel to determine the wheel velocity
- **Tank Kinematics**

  x pointing forward, y pointing left

  We have

  S_L, S_R = left distance and right distance

  r = turn radius from inner wheel

  b = track width

  θ is turn in radians

  $S_L = r\theta$

  $S_R = (r+b)\theta$

  $S_M = (r+b/2)\theta$

  We are now interested in how the x and y coordinates and heading change with respect to time.

  $\frac{dx}{dt} = m(t)\cos(\theta(t))$

  $\frac{dy}{dt} = m(t)\sin(\theta(t))$

  Derivation

  Frame of reference: center point of left wheel

  We have the following equation:

  $\frac{d\theta}{dt} = \frac{(V_R - V_L)}{b}$

  Integrating and setting $\theta(0) = \theta_0$ we find a function for calculating the robot's orientation as a function of wheel velocity and time:

  $\theta(t) = \frac{(V_R - V_L)t}{b} + \theta_0$

  The velocity of the robot is the average of tHe two wheels: $\frac{(V_R - V_L)}{2}$

  We now have the following differential equations:

  $\frac{dx}{dt} = \frac{(V_R - V_L)}{2}\cos(\theta(t))$

  $\frac{dy}{dt} = \frac{(V_R - V_L)}{2}\sin\theta(t)$

Mecanum Kinematics

Each wheel has an additional x and y velocity component due to the vehicles rotational velocity ω_v given by

$$V_x r = -Y_n \cdot \omega_v$$

$$V_y r = X_n \cdot \omega_v$$

The total linear velocity given by the vector componenets is

$$V_{x_n} = V_x + V_{x_{rn}} = V_x - Y_n \cdot \omega v$$

$$V_{y_n} = V_y + V_{y_{rn}} = V_y - X_n \cdot \omega v$$

$\omega = \frac{V_x + V_y \cdot \tan\theta}{r}$ = wheel velocity

Odometry

We have our target velocity as

$$v(t) = (V_x \cos(\theta_0 + \omega\tau) - v_y \sin(\theta_0 + \omega\tau), V_x \sin(\theta_0 + \omega\tau) + v_y cos(\theta_0 + \omega\tau)$$

Integrating results in

$$x(t) = \int_0^{\Delta t} v(\tau)\, d\tau = (\frac{v_x}{\omega}[\sin\theta_1 - \theta_0] + \frac{v_y}{\omega}[\cos\theta_1 - \cos\theta_0]), (-\frac{v_x}{\omega}[\cos\theta_1 - \cos\theta] + \frac{v_y}{\omega}[\sin\theta_1 - \sin\theta_0])$$

our updated robot pose (x and y component)