Pancake Robot Modeling

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1 Unicycle Motion Model

We simulate a 2D ground robot, the kinematics of which are represented by a unicycle. Let x_k and u_k represent the system state and control input at time step k respectively.

$$x_{k+1} = f(x_k, u_k, w_k) = \begin{pmatrix} \mathsf{x}_k + (V_k + n_v)\delta t \cos\theta_k \\ \mathsf{y}_k + (V_k + n_v)\delta t \sin\theta_k \\ \theta_k + (\omega_k + n_\omega)\delta t \end{pmatrix}, \tag{1}$$

where $x_k = (\mathsf{x}_k, \mathsf{y}_k, \theta_k)^T$ describes the robot state (position and yaw angle). $u_k = (V_k, \omega_k)^T$ is the control vector consisting of linear velocity V_k and angular velocity ω_k. We denote the process noise vector by $w_k = (n_v, n_\omega)^T \sim \mathcal{N}(0, \mathbf{Q}_k)$ (zero-mean Gaussian noise with covariance $\mathbf{Q}_k$).