Probability

$$p(x) = P(X = x) \quad p(x, y) = P(X = x, Y = y) \; p(x|y) = \frac{p(x, y)}{p(y)}$$

Total Probability

$$p(x) = \sum_y p(x|y)p(y) \qquad p(x) = \int p(x|y)p(y)dy$$

Bayes Rule

$$p(x|y) = \frac{p(y|x)p(x)}{p(y)} \qquad p(y) = \sum_x p(y|x)p(x)$$

Dynamic State Notation

$$x_t : \text{state}, \quad u_t : \text{control}, \quad z_t : \text{measurement}$$

Markov Assumptions

$$p(x_t|x_{0:t-1}, u_{1:t}) = p(x_t|x_{t-1}, u_t) \quad p(z_t|x_{0:t}, z_{1:t-1}, u_{1:t}) = p(z_t|x_t)$$

Belief

$$bel(x_t) = p(x_t|z_{1:t}, u_{1:t})$$

Bayesian Filter

Prediction

$$\overline{bel}(x_t) = \int p(x_t|x_{t-1}, u_t)bel(x_{t-1})dx_{t-1}$$

Correction

$$bel(x_t) = \eta p(z_t|x_t)\overline{bel}(x_t)$$

Discrete Bayes Filter

$$p_{k,t} = \sum_i p(x_k|x_i, u_t)p_{i,t-1} \qquad p_{k,t} = \eta p(z_t|x_k)p_{k,t}$$

Particle Filter

$$\Psi_t = (x_t^{[i]}, w_t^{[i]})_{i=1}^M \qquad w_t^{[i]} \propto p(z_t|x_t^{[i]})$$

Effective Sample Size

$$n_{eff} = \frac{1}{\sum_i (w_t^{[i]})^2}$$

Odometry Motion Model

$$\delta_{trans} = \sqrt{(x' - x)^2 + (y' - y)^2} \quad \delta_{rot1} = \text{atan2}(y' - y, x' - x) - \theta$$

Noisy Motion

$$\hat{\delta} * rot1 = \delta * rot1 + \epsilon(\alpha_1|\delta_{rot1}| + \alpha_2|\delta_{trans}|) \quad \hat{\delta} * trans = \delta * trans$$

Beam Sensor Model

$$p(z|x, m) = \prod_{k=1}^K p(z_k|x, m)$$

Occupancy Grid Update

$$bel(m_{xy}) = \eta p(z_t|m_{xy})bel(m_{xy})$$

SLAM Posterior

$$p(x_{1:t}, m|z_{1:t}, u_{1:t})$$

FastSLAM Factorization

$$p(x_{1:t}, l_{1:m}|z_{1:t}, u_{1:t}) \quad = p(x_{1:t}|z_{1:t}, u_{1:t}) \prod_{i=1}^m p(l_i|x_{1:t}, z_{1:t})$$

EKF-SLAM State

$$x = \begin{bmatrix} R \; L_1 \vdots L_n \end{bmatrix}, \quad P = [P_{RR} \quad P_{RM} \; P_{MR} \quad P_{MM}]$$