$\boxed{\text{Unscented Transform}}$

i'th column of matrix square

$$\chi^0_{k-1|k-1} = \hat{x}_{k-1|k-1}$$

$$\chi^i_{k-1|k-1} = \hat{x}_{k-1|k-1} + \left(\sqrt{(L+\lambda)P_{k-1|k-1}}\right)_i, \quad i \in [1, L]$$

$$\chi^i_{k-1|k-1} = \hat{x}_{k-1|k-1} - \left(\sqrt{(L+\lambda)P_{k-1|k-1}}\right)_{i-L}, \quad i \in [L+1, 2L]$$

Prediction:

$$\chi^{*,i}_{k|k-1} = f(\chi^i_{k-1|k-1}) \quad i \in [0, 2L]$$

$$\hat{x}^-_{k|k-1} = \sum_{i=0}^{2L} W_s^i \chi^{*,i}_{k|k-1}, \quad P^-_{k|k-1} = \sum_{i=0}^{2L} W_c^i \left[\chi^{*,i}_{k|k-1} - \hat{x}^-_{k|k-1}\right]\left[\chi^{*,i}_{k|k-1} - \hat{x}_{k|k-1}\right]^T + Q_{k-1|k-1}$$

$$W_s^0 = \frac{\lambda}{L+\lambda}, \quad W_c^0 = \frac{\lambda}{L+\lambda} + (1-\alpha^2+\beta) \quad \Big| \quad W_s^i = W_c^i = \frac{1}{2(L+\lambda)}, \quad \lambda = \alpha^2(L+k) - L$$

Update

$$\chi^0_{k|k-1} = x^-_{k|k-1}$$

$$\chi^i_{k|k-1} = \hat{x}^-_{k|k-1} + \left(\sqrt{(L+\lambda)P^-_{k|k-1}}\right)_i, \quad i \in [1, L]$$

$$\chi^i_{k|k-1} = \hat{x}^-_{k|k-1} - \left(\sqrt{(L+\lambda)P^-_{k|k-1}}\right)_{i-L}, \quad i \in [L+1, \dots, 2L]$$

$$z^i_k = h(\chi^i_{k|k-1}), \quad i \in [0, 2L]$$

$$\hat{z}_k = \sum_{i=0}^{2L} W_s^i z^i_k \qquad P_{z_k,z_k} = \sum_{i=0}^{2L} W_c^i \left[z^i_k - \hat{z}^-_k\right]\left[z^i_k - \hat{z}^-_k\right]^T + R_{k|k-1}$$

$$P_{x_k,z_k} = \sum_{i=0}^{2L} W_c^i \left[\chi^i_{k|k-1} - \hat{x}^-_{k|k-1}\right]\left[z^i_k - \hat{z}^-_k\right]^T$$

$$\Rightarrow \quad K_k = P_{x_k,z_k} P_{z_k,z_k}^{-1}$$

$$\hat{x}_k = \hat{x}^-_{k-1} + K_k(z_k - \hat{z}_{k|k-1})$$

$$P_k = P_{k|k-1} - K_k P_{z_k,z_k} K_k^T$$