Cubature Kalman Filter

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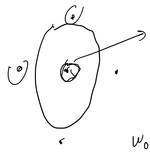

W_0

same weighted.

n-d

$x = \begin{bmatrix} \\ \\ \end{bmatrix}$

$n \in R^1$

$[I_n] = \begin{bmatrix} 1 & -1 & & \\ 0 & 0 & 1 & -1 \\ 1 & 1 & & \\ & & & \end{bmatrix}$

~~2n*1~~ $n \times 2n$

$\left[\begin{matrix} I_n \\ 2 \end{matrix}\right] = \begin{bmatrix} 1 & -1 & 0 & 0 \\ 0 & 0 & 1 & -1 \end{bmatrix}$

$\xi_i = I_i \times \sqrt{n}$

$\hat{x}_{k-1|k-1}$ $P_{k-1|k-1}$

Time Update

$S_{k-1|k-1} S_{k-1|k-1}^T = P_{k-1|k-1}$

Cubature Points

$X_{i,k-1|k-1} = S_{k-1|k-1} \cdot \xi_i + \hat{x}_{k-1|k-1}$ $2n\ X_i$

propagated cubature points.

$X_{i,k|k-1} = f(X_{i,k-1|k-1})$

$\hat{x}_{k|k-1} = \frac{1}{2n} \sum X_{i,k|k-1}$

$P_{k|k-1} = \frac{1}{2n} \sum X_{i,k|k-1} X_{i,k|k-1}^T - \hat{x}_{k|k-1} \hat{x}_{k|k-1}^T + Q$

Measurement Update.

$S_{k|k-1} S_{k|k-1}^T = P_{k|k-1}$

$X_{i,k|k-1}^* = S_{k|k-1} \xi_i + X_{k|k-1}$

$Z_{i,k|k-1} = h(X_{i,k|k-1}^*)$

$\hat{z}_{k|k-1} = \frac{1}{2n} \sum Z_{i,k|k-1}$

$P_{zz,k|k-1} = \frac{1}{m} \sum Z_{i,k|k-1} Z_{i,k|k-1}^T - \hat{z}_{k|k-1} \hat{z}_{k|k-1}^T + R$

$P_{xz,k|k-1} = \frac{1}{m} \sum X_{i,k|k-1}^* Z_{i,k|k-1}^T - \hat{x}_{k|k-1} \hat{z}_{k|k-1}^T$

$K = P_{xz,k|k-1} \cdot P_{zz,k|k-1}^{-1}$

$\hat{x}_{k|k} = \hat{x}_{k|k-1} + K(z - \hat{z}_{k|k-1})$

$P_{k|k} = P_{k|k-1} - K P_{zz,k|k} K^T$

① Numerical inaccuracy.

$\Sigma |w_i| / \Sigma w_i$

UKF $\Sigma |w_i| = \frac{2n}{3} - 1$ $\Sigma w_i = 1$

CKF $\Sigma |w_i| = 1$ $\Sigma w_i = 1$

n ↗

② ~~Sqcp~~ UKF

cholesky

UKF ~~Wi~~ w_i

pseudo square root ~~of~~ version of UKF

~~scaled~~ scaled UKF

SCKF chol → P

→ Q, R $S_Q S_Q^T = Q$ $S_R S_R^T = R$

qr $[X_{i,k|k-1}\ S_R]$ → Time

↓ S_R in M

R

↘ $S_{k|k-1}$