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Memo No.

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1. Kalman Filter

$$\begin{cases} X_{k+1} = \Phi_k^{k+1} X_k + W_k \\ Z_{k+1} = H_{k+1} X_{k+1} + V_{k+1} \end{cases}$$

X_k k时刻滤波器状态

KF方程：

$$\left.\begin{aligned} \hat{X}_{k+1|k} &= \Phi_k^{k+1} \hat{X}_{k|k} \\ P_{k+1|k} &= \Phi_k^{k+1} P_{k|k} {\Phi_k^{k+1}}^T + Q_k \end{aligned}\right] \text{递推预测}$$

$$\left.\begin{aligned} K_{k+1} &= P_{k+1|k} H_{k+1}^T \left(H_{k+1} P_{k+1|k} H_{k+1}^T + R_{k+1} \right)^{-1} \\ \hat{X}_{k+1|k+1} &= \hat{X}_{k+1|k} + K_{k+1} \left(Z_{k+1} - H_{k+1} \hat{X}_{k+1|k} \right) \\ P_{k+1|k+1} &= \left(I - K_{k+1} H_{k+1} \right) P_{k+1|k} \end{aligned}\right\} \text{测量更新.}$$

2. 采用误差状态的KF（反馈校正法）

符号代换 $x \to \boxed{\delta X}$ 滤波器状态

$z \to r$

$$P_{k+1|k} = \Phi_k^{k+1} P_{k|k} {\Phi_k^{k+1}}^T + Q_k$$

$$K_{k+1} = P_{k+1|k} H_{k+1}^T \left(H_{k+1} P_{k+1|k} H_{k+1}^T + R_{k+1} \right)^{-1}$$

$$\delta \hat{X}_{k+1|k+1} = K_{k+1} \cdot r_{k+1}$$

$$P_{k+1|k+1} = \left(I - K_{k+1} H_{k+1} \right) P_{k+1|k}$$

$r_{k+1} = Z_{k+1} - \hat{z}(\hat{X}_{k+1})$

实际测量 − 统状态的测量

Mo Tu We Th Fr Sa Su   Date / /

3. 一个完整的采用误差状态的EKF系统：

一套单独的系统状态递推方程，用来预测系统状态：

$$\hat{x}_{k+1|k} = \Phi_k^{k+1}(\hat{x}_{k|k})$$

误差状态的EKF过程，直接观测量到来时才进行计算：

$$P_{k+1|k} = f_k^{k+1} P_{k|k} f_k^{k+1\,T} + Q_k$$

$$K_{k+1} = P_{k+1|k} h_{k+1}^T (h_{k+1} P_{k+1|k} h_{k+1}^T + R_{k+1})^{-1}$$

$$\delta\hat{x}_{k+1|k} = K_{k+1} r_{k+1} = K_{k+1}(z_{k+1} - H_{k+1}(\hat{x}_{k+1|k}))$$

$$P_{k+1|k+1} = (1 - K_{k+1} h_{k+1}) P_{k+1|k}$$

其中 f 与 h 所代表的意义：

$$\begin{cases} \delta x_{k+1} = f_k^{k+1} \delta x_k + w \\ r = h \delta x + v \end{cases}$$

滤波器状态的预测与观测.

最终的系统输出：

$$\hat{x}_{k+1|k+1} = \hat{x}_{k+1|k} + \delta\hat{x}_{k+1|k+1}$$

滤波器状态比较好的近似线性时，EKF较好用.

误差状态是一个小量，线性化效果比较好！