Basics.

- State vector, ~~and~~ 2D - $x, \dot{x}$

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

y = altitude above Earth Surface

$\dot{y}$ = velocity in vertical

- State transition Model.

$$A = \begin{bmatrix} 1 & \Delta t \\ 0 & 1 \end{bmatrix}$$ → constant velocity. in next state.

- $g = -\frac{GM_{earth}}{y^2}$ gravitational acceleration.

- $B = \begin{bmatrix} 0.5\Delta t^2 \\ \Delta t \end{bmatrix}$ use gravitational acceleration to update position & velocity.

- State prediction.

$$\hat{x}^- = Ax + Bu + w$$

- Covar Prediction.

$$P^- = APA^T$$ process noise neglidgible.

$APA^T + Q$ with noise

- Update step.

1. Measurement model. H

$$H = [1 \quad 0].$$

2. Noise Covariance. → s.d. of measurement noise.

$$R = [\sigma^2_{meas}]$$

how much predictions should be corrected

3. ~~mm~~ Update: Gain K $K = P^- H^T (H P^- H^T + R)^{-1}$

- Updated state $\hat{x}$

$$\hat{x} = \hat{x}^- + K(z - H\hat{x}^-)$$

actual measurement.

4. Cov update.

reduced uncertainty.

$$P = (I - KH)P^-$$

3D model:

$$x = \begin{bmatrix} x \\ y \\ z \\ \dot{x} \\ \dot{y} \\ \dot{z} \end{bmatrix} \quad A = \begin{bmatrix} x(t+\Delta t) \\ y(t+\Delta t) \\ z(t+\Delta t) \\ \dot{x}(t+\Delta t) \\ \dot{y}(t+\Delta t) \\ \dot{z}(t+\Delta t) \end{bmatrix} \quad H = eye(6).$$

$$x_k = A_k x_{k-1} + B_k u_k + w_k.$$

$$F = -\frac{G M_{earth} m_{sat}}{r^3} r$$

G – const Earth.

M_{earth}, m_{sat} = satellite

magnitude of

r = distance from centre to ~~ear~~ satellite

$m_{sat} \ddot{r} = F$

r = position vector

$$\ddot{r} = -\frac{G M_{earth}}{r^3} r$$

$(x^2 + y^2 + z^2)^{\frac{3}{2}}$