Lecture 12

Observer

- Run a second system in parallel and try to estimate the internal state
- $\widetilde{x_{m+1}} = A\widetilde{x_m} + Bu_m = L(y_m - \widetilde{y_m})$

- Pick the L such that it goes ot 0

Plant

- $x_{m+1} = Ax_m + Bu_m$

- $u_m = -kx_m$

- $= -k\widetilde{x_m}$

- $= x_m - e_m$ where $e_m = x_m - \widetilde{x_m}$

- e_m approaches 0, x_m approaches 0

Learning and Fusion

- $\widetilde{x_{m+1}} = A\widetilde{x_m} + L(y_m\widetilde{y_m})$

- Want a finite memory filter because we don't want to remember all previous values.
- Predict -> Observe -> Update
- $S - N = \frac{1}{N}\sum_{k=1}^{N} y_k$

- $S - N = \frac{1}{N}\sum_{k=1}^{N-1} y_k + \frac{1}{N}y_N$

- $\frac{N-1}{N}\frac{1}{N-1}\sum_{k=1}^{N-1} y_k + \frac{1}{N}y_N$

- $S_{N-1} + \frac{1}{N}(y_m - S_{N-1})$

Example

- Everything is gauss noise

- $VAR(x) = \sigma_x^2$

- How do you use fuse 2 guassian observations

- x,y -> E(x), E(y)
  - Choose 0 <= K <= 1
  - $kx + (1 - k)y$
  - Want to minimize the variance
  - $VAR(kx + (1 - k)y)$
  - $E((E(ax + by) - ax - by)^2)$
  - $E((aE(x) + bE(y) - ax - by)^2)$
  - $(a(E(x) - x) + b(E(y) - y))^2$
  - $VAR(ax + by) = a^2 VAR(x) + b^{@} VAR(y) + 2abCO - VAR(x, y)$
- $k^2 \sigma_x^2 + (1 - k)^2 \sigma_y^2$
- Minimize
  - $k^2 \sigma_x^2 + \sigma_y^2 - k\sigma_y^2 + k^2 \sigma_y^2$
  - $\frac{d}{dk} = 2k\sigma_x^2 - \sigma_y^2 + 2k\sigma_y^2 = 0$
  - $k = \frac{\sigma_y^2}{\sigma_x^2 + \sigma_y^2}$