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MCT Project -4

Exercise 1.

Process Model :-

$$x_{t+1} = x_t + \delta t(\dot{x}_t \cos\varphi_t - \dot{y}_t \sin\varphi_t) + w_t^x$$

$$y_{t+1} = y_t + \delta t(\dot{x}_t \sin\varphi_t + \dot{y}_t \cos\varphi_t) + w_t^y$$

$$\varphi_{t+1} = \varphi_t + \delta t\,\dot{\varphi}_t + w_t^{\varphi}$$

$$\therefore x_{t+1} = f(x_t, u_t) + w_t$$

$$\therefore f = x_t + \delta t\,\dot{x}_t$$

$$= \begin{bmatrix} x_t \\ y_t \\ \varphi_t \\ m_x \\ m_y \\ \vdots \\ m_x \\ m_y \end{bmatrix} + \delta t \begin{bmatrix} \dot{x}_t \\ \dot{y}_t \\ \dot{\varphi}_t \\ 0 \\ \vdots \\ 0 \end{bmatrix}$$

$$f = \begin{bmatrix} x_t + \delta_t(\dot{x}_t \cos\varphi_t - \dot{y}_t \sin\varphi_t) \\ y_t + \delta_t(\dot{x}_t \sin\varphi_t + \dot{y}_t \cos\varphi_t) \\ \varphi_t + \delta t\, \dot{\varphi}_t \\ m_x^1 \\ m_y^1 \\ \vdots \\ m_x^n \\ m_y^n \end{bmatrix}$$

$$\therefore F = \frac{df}{dx}$$

$$F_t = \begin{bmatrix} 1 & 0 & -\delta t(\dot{x}_t \sin\varphi_t + \dot{y}_t \cos\varphi_t) & 0 & \cdots & 0 \\ 0 & 1 & \delta t(\dot{x}_t \cos\varphi_t - \dot{y}_t \sin\varphi_t) & 0 & \cdots & 0 \\ 0 & 0 & 1 & 0 & \cdots & 0 \\ 0 & 0 & 0 & 1 & 0 \cdots & 0 \\ 0 & 0 & 0 & 0 & 1 \cdots & 0 \\ \vdots & \vdots & \vdots & & & \\ 0 & 0 & 0 & 0 & \cdots & 1 \end{bmatrix}$$

(rows: 3, 2n; columns: 3, 2n)

Measurement Model :-

$$y_t = \begin{bmatrix} \left[(m'_x - x_t)^2 + (m'_y - y_t)^2\right]^{1/2} \\ \left[(m^2_x - x_t)^2 + (m^2_y - y_t)^2\right]^{1/2} \\ \vdots \\ \operatorname{atan2}(m'_y - y_t, m'_x - x_t) - \psi_t \\ \operatorname{atan2}(m^2_y - y_t, m^2_x - x_t) - \psi_t \end{bmatrix} + v_t$$

$2n \times 1$

$\downarrow$

$h(x_t)$

$$\therefore H = \underset{3}{\frac{\partial h}{\partial x}}$$

$2n$

$$H = \begin{bmatrix} \frac{-(m'_x - x_t)}{\|m' - p_t\|} & \frac{-(m'_y - y_t)}{\|m' - p_t\|} & 0 & \frac{m'_x - x_t}{\|m' - p_t\|} & \frac{m'_y - y_t}{\|m' - p_t\|} & 0 \cdots 0 \\ \frac{-(m^2_x - x_t)}{\|m^2 - p_t\|} & \frac{-(m^2_y - y_t)}{\|m^2 - p_t\|} & 0 & 0 & 0 & \frac{m^2_x - x_t}{\|m^2 - p_t\|} \quad \frac{m^2_y - y_t}{\|m^2 - p_t\|} \quad 0 \cdots 0 \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ \frac{m'_y - y_t}{\|m' - p_t\|^2} & \frac{x_t - m'_x}{\|m' - p_t\|^2} & -1 & \frac{y_t - m'_y}{\|m' - p_t\|^2} & \frac{m'_x - x_t}{\|m' - p_t\|^2} & 0 \cdots 0 \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \end{bmatrix}$$

n rows

n rows

Rough work :-

$$\tan^{-1}\left[\frac{m_y' - Y_t}{m_x' - X_t}\right]$$

wrt X_t

$$= \frac{m_y - Y_t}{(X_t - m_x)^2\left[\frac{(Y_t - m_y)^2}{(X_t - m_x)^2} + 1\right]}$$

$$= \frac{m_y - Y_t}{(Y_t - m_y)^2 + (X_t - m_x)^2}$$

wrt Y_t

$$= \frac{1}{(X_t - m_x)\left[\frac{(Y_t - m_y)^2}{(X_t - m_x)^2} + 1\right]}$$

$$= \frac{1}{\frac{(X_t - m_y)^2}{X_t - m_x} + X_t - m_x}$$

$$= \frac{1}{\frac{\|m^1 - \mu_t\|^2}{x_t - m_x}}$$

$$2(\text{row}) + 3$$

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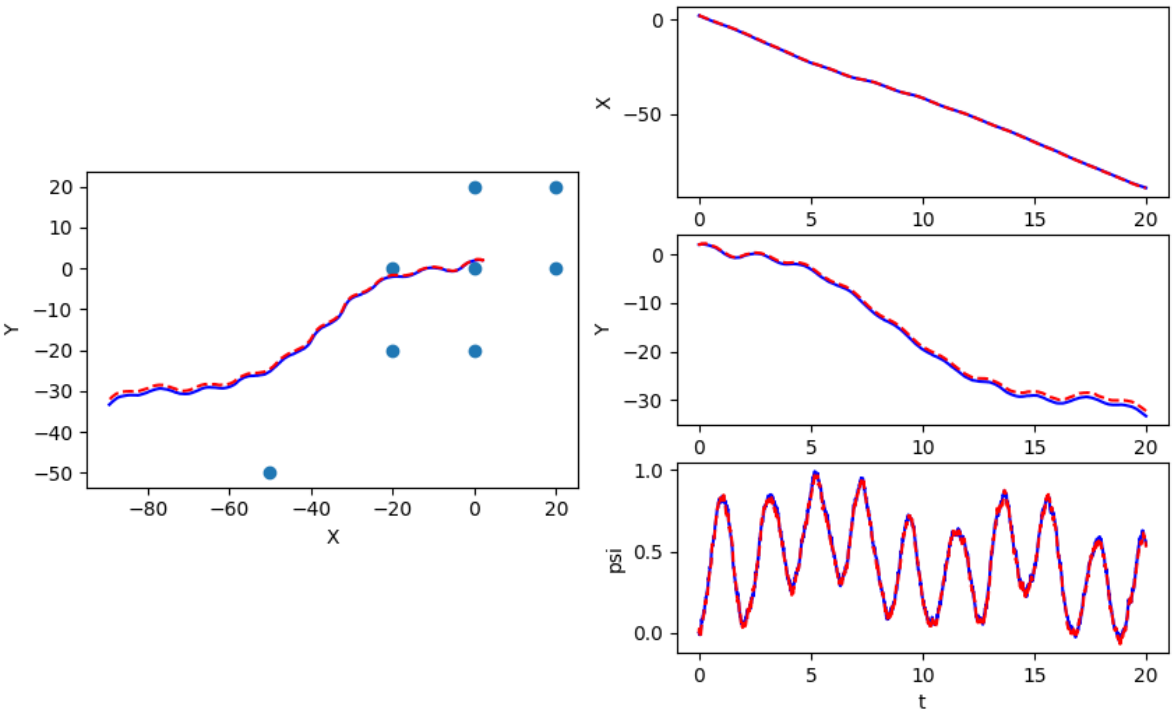
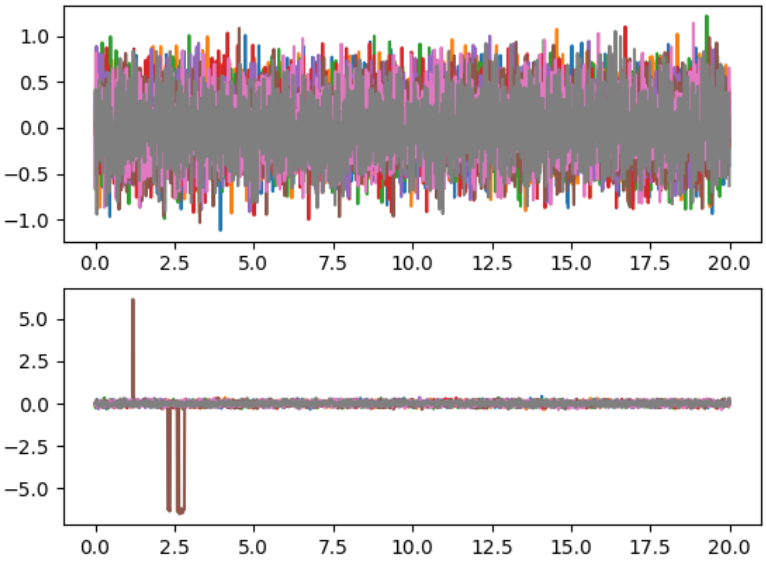
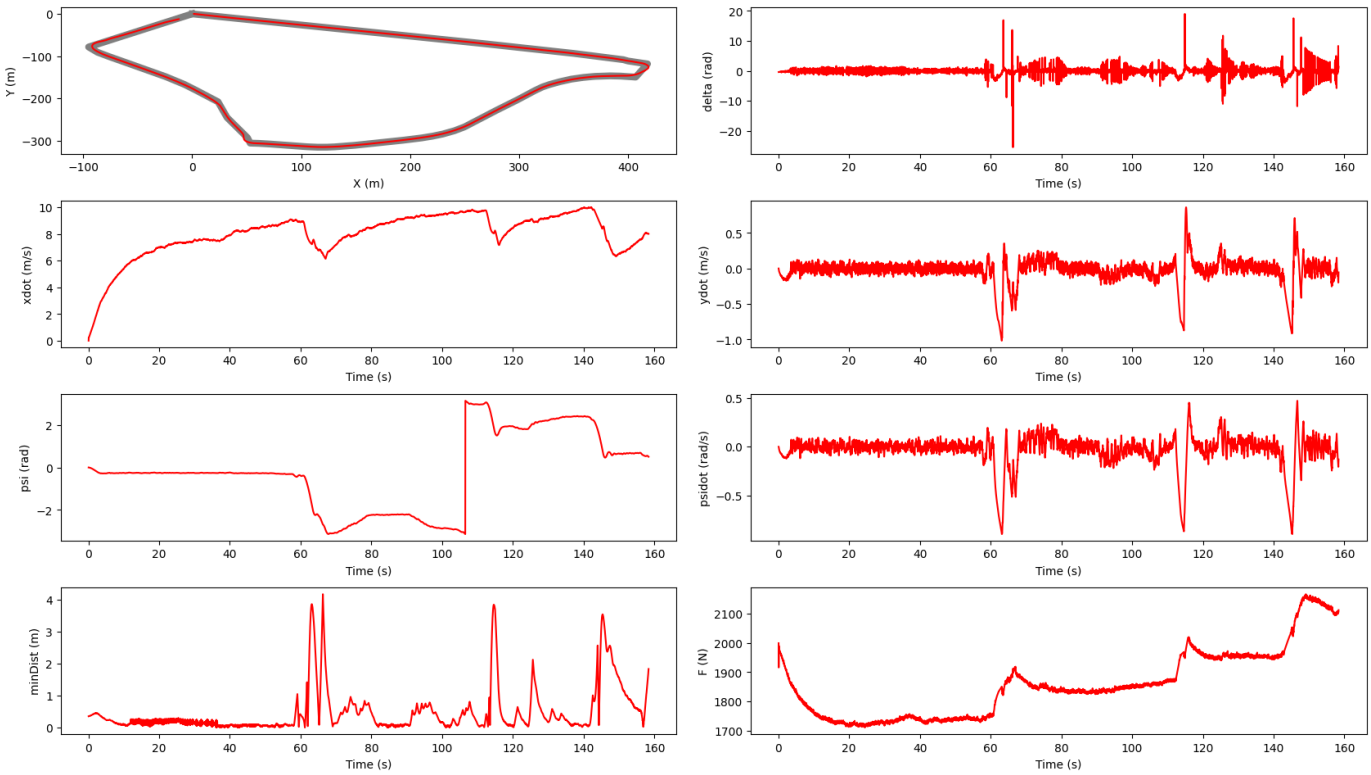
PROJECT-4

Exercise 2.







Console - All

```
Score for completing the loop: 30.0/30.0
Score for average distance: 30.0/30.0
Score for maximum distance: 30.0/30.0
Your time is  158.368
Your total score is : 100.0/100.0
total steps:  158368
maxMinDist:  4.171348433108599
avgMinDist:  0.48647716041721717
INFO: 'main' controller exited successfully.
```