EKF Localizer

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Contents

1 About

This is not a final product, this is just for testing.

This program does not try to filter on live data, It will just try to filter out data from already recorded data.

Another Repo will created for the final result, with a proper and fun name

2 State Vector and Control Vector

The State Vector looks like this

$$\vec{X} = \begin{bmatrix} x \\ y \\ \theta \\ v_x \\ v_y \\ \omega \\ a_x \\ a_y \end{bmatrix}$$

θ and ω refer to the yaw and yaw velosity respectively.

The control Vector is a Twist message from ROS2, as we are working in 2D, the vector looks like this, This message tells robot to make velocities according to it's relative axis

$$\vec{U} = \begin{bmatrix} v_{rx} \\ v_{ry} \\ \omega_u \end{bmatrix}$$

3 State Transition Function

The state Transition Matrix Looks Like this

$$\vec{X_{t+1}} = g\left(\vec{X_t}, \vec{U_t}\right)$$

and the state Transation Function is:

$$g\left(\vec{X_t}, \vec{U_t}\right) = \begin{bmatrix} x + \left[\cos\theta V_r x - \sin\theta V_{ry}\right]\Delta T + \frac{a_x \Delta T^2}{2} \\ y + \left[\sin\theta V_r x + \cos\theta V_{ry}\right]\Delta T + \frac{a_y \Delta T^2}{2} \\ \theta + \omega\Delta T \\ \left[\cos\theta V_r x - \sin\theta V_{ry}\right] + a_x \\ \left[\sin\theta V_r x + \cos\theta V_{ry}\right] + a_y \Delta T \\ \omega_u \\ a_x \\ a_y \end{bmatrix}$$

This Makes The Transition Jacobian To Look Like This

$$\vec{G} = \begin{bmatrix} 1 & 0 & \Delta T\left[-\sin\theta V_{rx} - \cos\theta V_{ry}\right] & 0 & 0 & 0 & \frac{1}{2}\Delta T^2 & 0 \\ 0 & 1 & \Delta T\left[\sin\theta V_{rx} + \cos\theta V_{ry}\right] & 0 & 0 & 0 & 0 & \frac{1}{2}\Delta T^2 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & \left[-\sin\theta V_{rx} - \cos\theta V_{ry}\right] & 0 & 0 & 0 & \Delta T & 0 \\ 0 & 0 & \left[\sin\theta V_{rx} + \cos\theta V_{ry}\right] & 0 & 0 & 0 & 0 & \Delta T \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

Notice that columns of ω ˇx and v_y are all zero because PID in the robot base will make sure that the velosity is kept equal to the provided control signal