POS & LBS

EX07: Inertial Navigation

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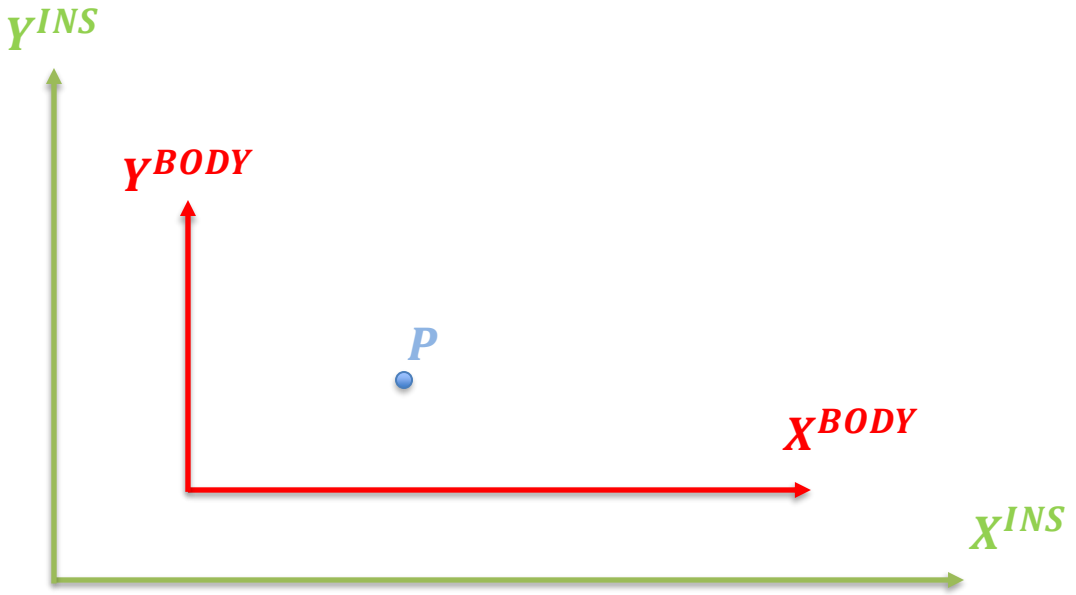
Exercise 7
Inertial Navigation

A cart (body) is moving on a rail in the 2D X-Y inertial planar system. Two accelerometers and a gyroscope are mounted on it.

The accelerometers measure the ***accelerations*** in X, Y in the body system; the gyroscope measures the ***angular velocity*** w.r.t. the Z-axis.



Exercise 7
Inertial Navigation

Input data:

- t = observation epoch [s]
- a_X^{BODY} = acceleration in the X direction in the vehicle system (body system) $\left[\frac{m}{s^2}\right]$
- a_Y^{BODY} = acceleration in the Y direction in the vehicle system (body system) $\left[\frac{m}{s^2}\right]$
- ω_Z = angular velocity in x-y plane $\left[\frac{rad}{s}\right]$

Available dataset:

- *'inertial_data.dat'* = simulated data without errors
- *'inertial_data_errors.dat'* = simulated data with errors

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Goal: Compute the trajectory of rthe vehicle in the inertial system with both the input files, plot and compare them (highlight in the plot the start and end points).

Guidelines:

- ✓ Use observed X accelerations to compute X velocities and incremental positions between epochs in the Body system:

$$v_X^{BS}(t) = v_X^{BS}(t-1) + a_X^{BS}(t) * \Delta t$$

$$\Delta X^{BS}(t) = v_X^{BS}(t) * \Delta t + \frac{1}{2} a_X^{BS}(t) \Delta t^2$$

- ✓ Clean apparent centrifugal acceleration from Y

$$a_{Y,centr}^{BS}(t) = \omega_Z(t) * v_X^{BS}(t)$$

$$a_{Y,clean}^{BS}(t) = a_Y^{BS}(t) - a_{Y,centr}^{BS}(t)$$

- ✓ Compute Y velocities and incremental positions:

$$v_Y^{BS}(t) = v_Y^{BS}(t-1) + a_{Y,clean}^{BS}(t) * \Delta t$$

$$\Delta Y^{BS}(t) = v_Y^{BS}(t) * \Delta t + \frac{1}{2} a_{Y,clean}^{BS}(t) \Delta t^2$$

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- ✓ Compute asset angle α:

$$\alpha(t) = \alpha(t-1) + \omega * \Delta t$$

- ✓ For each epoch, use the asset angle α to convert X Y incremental positions from the Body system to the Inertial system.

$$R = \begin{bmatrix} \cos(\alpha) & sin(\alpha) \\ -sin(\alpha) & cos(\alpha) \end{bmatrix}$$

$$[X^{IS}(t) \quad Y^{IS}(t)] = [X^{IS}(t-1) \quad Y^{IS}(t-1)] + R * [\Delta X^{BS}(t) \quad \Delta Y^{BS}(t)]$$

- ✓ Compute and plot the estimated trajectory of the vehicle in the Inertial system (in 2D).

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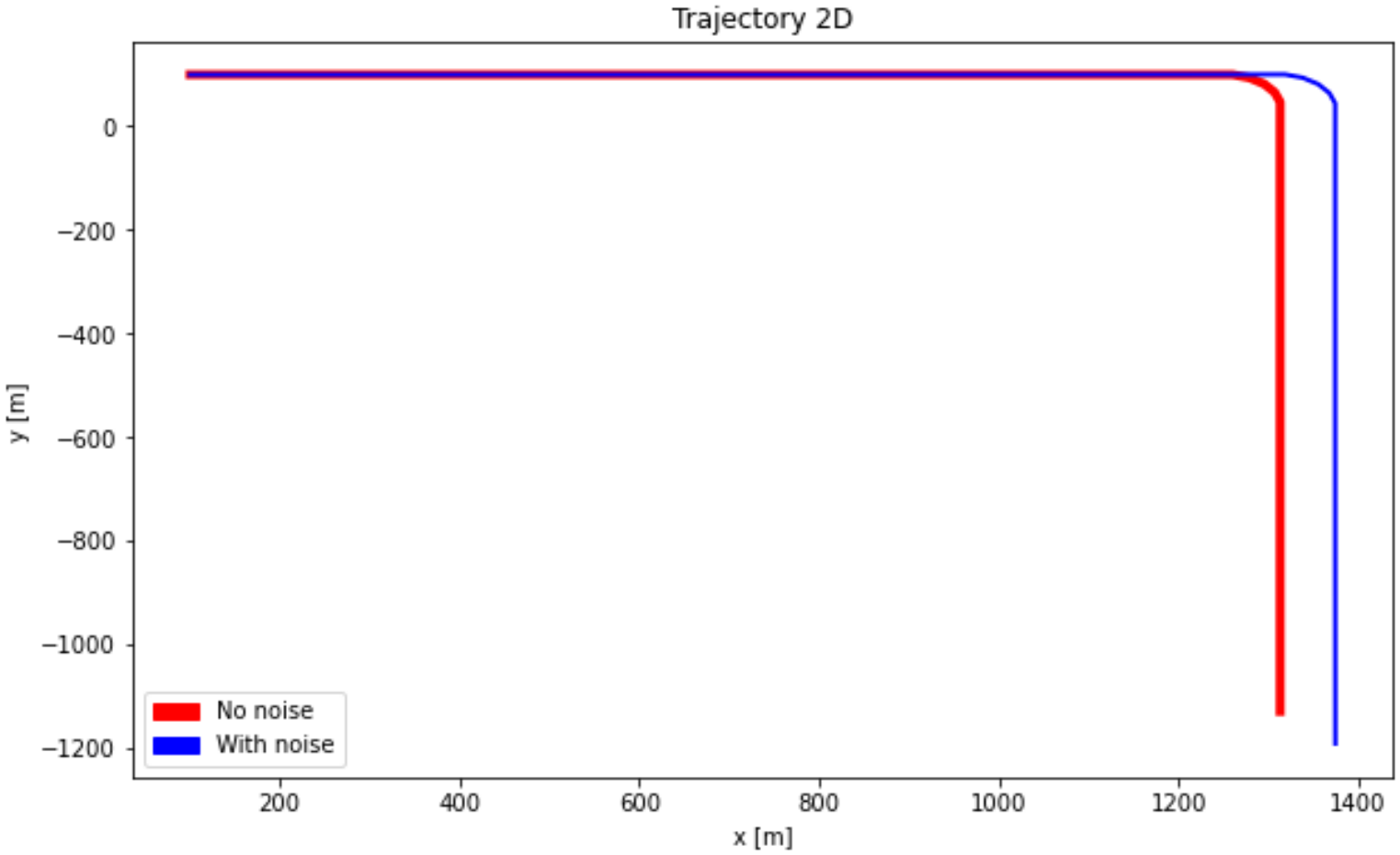
Initial conditions:

- $\alpha_0 = 0$
- $\left[v_{X_0}, v_{Y_0}\right] = [0,0]$
- $[X_0, Y_0] = [100,100]$

Exercise 7
Inertial Navigation



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