EX. Inertial navigation

Description:

A vehicle is moving in the 2D X-Y *inertial planar system*. Two accelerometers and a gyroscope are mounted on the vehicle. The accelerometers measure the accelerations in X, Y *Body system*; the gyroscope measures the angular velocity w.r.t. the Z-axis.

```
Y in
 .
 |    . x car
 |    |
 |    |____. y car
 |
 |____________. X in
```

Input data:

- File “Inertial_data.dat” containing:
    - t = observation epoch [s]
    - ax_car = acceleration in the x direction (in the *vehicle system*) [m/s^2]
    - ay_car = acceleration in the y direction (in the *vehicle system*) [m/s^2]
    - omegaz = angular velocity in x-y plane (in the *vehicle system*) [rad/s]

- alpha0 = 0 asset angle of the vehicle at first epoch [rad]

- vx0, vy0, vz0 = [0, 0] velocities of the vehicle at first epoch [m/s]

- x0, y0, z0 = [100, 100] coordinates of the vehicle at first epoch (in the *inertial system*) [m]

In this dataset, observation are simulated without errors!

- File “Inertial_data_errors.dat” containing same observations with realistic errors (see theory)

Exercise:

Compute the trajectory of the vehicle in the *inertial system* and plot it (highlight in the plot the start and end points).

Guidelines:

1) compute X Y velocities and Delta X Y positions between epochs in the *Body system* for each epoch from observed accelerations
2) compute asset angles α for each epoch

3) for each epoch, use the asset angle α to convert Delta X Y from the *Body system* to the *Inertial system*,
4) compute and plot the estimated trajectory of the vehicle in the *Inertial system* (in 2D).

Note for Delta computation in BS: general law of motion

$x(t) = x_0 + \int_{t_0}^{t} v(\tau)\, d\tau$, in case constant acceleration: $x(t) = x_0 + v_0(t - t_0) + \frac{1}{2} a (t - t_0)^2$

Apply to the interval [t-1,t] and simplify, considering constant acceleration in [t-1,t]:

$$x_t = x_{t-1} + v_{t-1}\Delta t + \frac{1}{2} a_t \Delta t^2$$

Note for Alpha computation from BS to IS: same hypothesis on constant angular rate

$$\alpha(t) = \alpha_0 + \int_{t_0}^{t} \omega(\tau)\, d\tau \qquad \Rightarrow \qquad \alpha_t = \alpha_{t-1} + \omega_t \Delta t$$

##Next year add notes for R