LAB 2 – Inertial Navigation in 2D / Errorless Signal (1 week)

Objective:

Determine the position, velocity and attitude (**PVA**) of a rigid body undergoing uniform circular motion using "2D" strapdown inertial navigation system with perfect measurements.

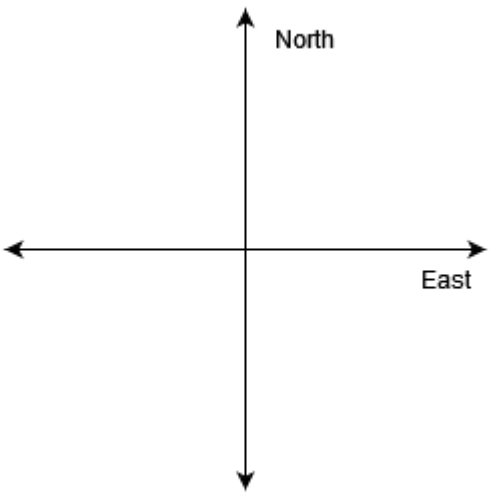
Task:

1. Simulate the nominal (i.e., errorless) measurements for a gyro and 2 orthogonal accelerometers, strapped altogether to the body, when subjected to uniform circular motion in a plane,whose coordinate system is spanned by the North and East axes and represents a 2D – inertial – frame.

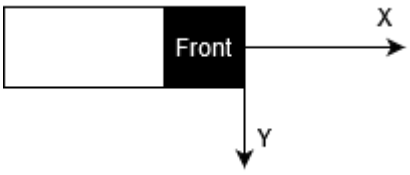
2. Considering the initial conditions to be known, apply strapdown inertial navigation to calculate the true trajectory variables (i.e. the attitude (azimuth), 2D velocity and position vectors, respectively).

3. Solve the navigation-differential equations (in Task 2) for two sampling rates (i.e. 10Hz, 100Hz) using two integration methods (i.e. 1st order and 2nd order) for one revolution (i.e. complete circle).

4. For each solution compare the deduced trajectory (in terms of PVA) to the true values and plot the **errors** in
   a) Azimuth (unit: degree)
   b) Velocity (m/s) in x and y
   c) Position(m) in x and y



Inertial Frame



Body Frame

Numerical data:

- Circle radius: 500 m,
- Angular speed $\omega = \pi/100$;
- Initial position: on North axis
- Initial azimuth: 90˚ (measured from North axis in clockwise direction)
- Initial velocity: north-axis: 0, east-axis: $\omega \cdot$ radius

Questions:

A) What are the maximum committed errors (in x and y) in PVA after one revolution for:
   I. 10Hz and 1st (rectangular) order integration
   II. 10Hz and 2nd (trapezoid) or higher order integration
   III. 100Hz and 1st (rectangular) order integration
   IV. 100Hz and 2nd (trapezoid) or higher order integration

Present the results in a tabular form

B) Which integration method would you recommend using and why?

Report Content:

1. **Briefly** describe the computational steps, in a point-wise fashion, to accomplish the above tasks. If you use figures and/or tables to supplement your writing, please ensure that they are embedded in the text and not at the end. **All figures and tables must be referred in the text**

2. Plot the trajectory **errors** (i.e. azimuth, position (x and y), velocity (x and y)) along one revolution for all 4 cases as described in task 4.

3. Answers to the questions A & B.

Lab weight: 5%
Distributed: Week 5
Deadline: 30.03.2025 (Without penalty)