LAB 4 – Coarse alignment of a high accuracy IMU (1 week)

Objective:

Finding a coarse initial orientation of high-end IMU from its data.

Task:

I. Read gyro and accelerometers input measurements from the navigation-grade IMU (XSEA)[1]. Note: use only the timespan that was assigned to you by the assistant.

II. Calculate the norm of three gyro channels and compare it to the reference signal (Earth rotation at EPFL's latitude – see "*Hints*"). Observe the differences and answer the following questions:

1. What are the differences you observe?

2. How could these differences be used for estimating the approximate accuracy of the gyroscopes? (Specify the estimate.)

III. Calculate the norm of three accelerometers and compare it to the referenced gravity field at EPFL. Observe the differences and answer the following questions:

3. *What are the differences you observe?*

4. *How could the observed differences be used for estimating the approximate accuracy of your accelerometers? (Specify the estimate).*

IV. Perform *accelerometer leveling* and calculate **roll** and **pitch** with respect to the chosen local-level frame.[2]

5. *What is the value of roll in degrees and how does this correspond to the reference value (real-time solution noted during acquisition*)?*

6. *What is the value of pitch in degrees and how does this correspond to the reference value (real-time solution noted during acquisition*)?*

[1] The data and the MATLAB/Python script for data reading are on the Moodle.
[2] You can use either NED or ENU frame, (or both), but be sure to specify your choice.

V. Perform *gyrocompassing* to estimate IMU's **yaw** and transform the gyroscopic reading to the leveled frame. Answer the following question:

7. *What is the value of yaw in degrees and how does this correspond to the reference value (real-time solution noted during acquisition*)?*

8. *Do you recommend calculating the coarse alignment from instantaneous observation (1 epoch) or do you suggest performing data averaging? Why?*

9. *Is it possible to determine IMU's latitude from the 'leveled' gyroscopic signal? If yes, what is your estimate from these data, how it was obtained and how well it corresponds to the reference value (real-time solution noted during acquisition*)?*

Numerical:

Use the data that can found on moodle. Please use the time interval that was assigned to you. This is also listed on a sheet on Moodle

Hint:

- *Latitude at EPFL: $\boldsymbol{\varphi}_{ref}$ = N46˚ 31' 17"*
- *Mean Earth rotation: $\boldsymbol{\omega}_{ref} = 7.2921150 * 10^{-5}$ rad/s.*
- *Gravity at EPFL: $g_{ref} = \boldsymbol{g}_{EPFL} = - 9.8055\ m/s^2$*

!!! IMPORTANT!!!

* As explained during the acquisition, there is a difference between the axis frame used for displaying the results and the selected local-level frame

Deliverables:

1. Clear answers to the questions 1-9 in a report. You can supplement your answers with plots and tables if necessary. Don't forget to refer to them within the text.

2. Code

Lab weight: 5%
Deadline: 28/04/2024 (without penalty)