Inertial Navigation

-Exercise 1-

Part A: Initial Aligment and orientation representation

Deadline: 15.11.2023

In inertial navigation, measurement of specific forces and turn rates are integrated to estimate position, velocity and attitude of an object.
In order to integrate those values, integration constants are needed, which are gained with GNSS for position and velocity for instants. The attitude of the IMU can be provided by an initial alignment.

<u>Tasks:</u>

1. Calculate the **initial roll, pitch and yaw** angle from the given IMU dataset. Estimate the direction cosine matrix C_n^b with the help of the Euler angles.
2. Now estimate the local gravity **g**, as well as the **Earth rotation rate** with the given data. What are the results you would expect and why may they be different?

3. Express the initial orientation by the **rotation axis/angle representation** and by the corresponding **quaternion**. Given the fact that the orientation is nearly horizontal, how can you read the approximated **yaw-angle** out of both representations?

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Part B: Attitude Update

Deadline: 15.11.2023

To transform the specific forces measured in the body-frame into an arbitrary target-system, the attitude of the object has to be provided at any time.
This task is solved by the gyroscope and its turn rate measurement, which is used to compute the rotation matrix of the b-frame to the n-frame.

Tasks:

4. Determine the DCM now **directly** from the raw IMU data. **Compare** the matrix with the DCM calculated in part A. Check if the new matrix is still orthogonal, and if needed **reorthogonalize** it with one of the methods presented in the lectures! Is this alternative calculation method for the DCM possible anywhere around the globe?

5. Finally solve the **attitude problem**, based on the solution of the matrix differential equation in a closed form.

$$\dot{C}_b^n = C_b^n \Omega_{nb}^b$$

What is the assumption to hold for the closed form solution?
We assume that the IMU is not moving in the n-frame. Reuse the dataset from the initial alignment again and plot the evolution of the three Euler-angles over time. Estimate the final orientation of the sensor. Evaluate the results, i.e. **what effects** are visible in the timeseries of the orientation?

Please send your results (report, .csv and code) to:

weddig@ife.uni-hannover.de

Email subject:	Report_inav_ex01
Report name:	ex01_surname_name_matrikel.pdf
Results file:	ex01_matrikel.csv
Code:	ex01_matrikel.zip