LAB 2 – Analysis and Modeling of Observed Stochastic Processes (2 weeks)

Objective: Apply the knowledge in analyzing and characterizing stochastic processes on data collected from inertial measurements units (IMUs) of different size, quality (and cost) in static environment.

Available IMU:

No	Name/Fabricant	Class-grade	Gyros	Accels	In 'readimu.m'
1	AIRINS/XSEA	Navigation	FOG	Mechanical	'IXSEA'
2	LN200/Nortrop G.	Tactical	FOG	Silicon	'LN200'
3	FSAS/IMAR	Tactical	FOG	Silicon	'IMAR'
4	STIM318/Sensonor	Industrial	MEMS	MEMS	'NAVCHIP_FLT'
5	NavChip/Intersense	Industrial	MEMS	MEMS	'NAVCHIP_FLT'
6	MTi-G /Xsens	Automotive	MEMS	MEMS	load (*.txt) (*.mat)
7	Smart-Phone/yours	Low cost	MEMS	MEMS	load(*.txt) (*.csv)

Part A (Week 3):

1. **Data collection** (*in group*): Together with your colleagues and a TA collect a data series of *20 minutes duration* for each instrument. Collect (individually) a data series of ~20 min with your smartphone using the MATLAB app.

Part B (Week 4):

2. **Data plotting** (individual): You will work (in groups) only on **one type** of data (i.e. *gyros* or *accelerometers*) according to the assignment sheet. Altogether, you will have 2 time series. Use the provided routine 'readimu.m' (for MATLAB) or 'readimu.py' (for Python) (distributed via Moodle) to read the collected data (.imu extension) and plot the series for the selected data type (MTiG and Smartphone data are stored as txt or .mat files).

3. **Analysis**: Analyze the available data for both instruments by means of one or **more (optional)** characteristic functions you used in Lab 1 (e.g. autocorrelation, PSD, Allan or Wavelet Variance).[i]

Report Content

I. **Modeling**: Can you explain how you would suggest modeling the noise present in the given sensor measurements using different stochastic processes? Please emphasize the selection of one **characteristic function**, whether it be the Autocorrelation function (AC), Power Spectral Density (PSD), Allan Variance (AV), or Wavelet Variance (WV). Additionally, determine or compute the parameters (empirically) of the identified stochastic processes (variance/std of white noise or correlation time for example).

II. **Verification**: Can you simulate synthetic observations using the noise model suggested in Question I? Then, calculate the **characteristic function** from the simulated data and compare it with the one obtained from the real data above. After comparison, answer the question: Does the **characteristic function** obtained from the real data match the synthetic one? If not, what suggestions do you have for improvement?

III. **Optional:** Employ more than one **characteristic function** for determining the stochastic process component/s and compare the result of the different methodologies.

Lab weight: 3% + **1% (for optional exercise)**
Distributed: Week 3
Deadline without penalty: 2 weeks after distribution (i.e. lecture of week 5)

Hint 1: Examine the data and select the most suitable segment to perform the analysis

Hint 2: Be aware of deterministic components within the acquisition (e.g. gravity, Earth rotation rate, random bias)