Sensor Orientation

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Fall semester

Section SSIE, Faculty ENAC
Section SYSCOM, Faculty I&C
Section SEL, Faculty STI

Fr 12:15-17:00 GR-**A331** / GR-**C02 (**or **GCD0383)**

Agenda – details per session

Navigation / Lecture	Estimation/LAB
1. Intro, LS review, Random proc. 1	L1a: noise gener.:WN, RW, GM1
2. M+P: Seq. LS, Random proc. 2	b: noise characteristics
3. Ref. systems 1+2, Sensors (1*)	L2a: collect real IMU data
4. T1, Eq. i-frame	b: analyze & characterize
5. DC:e-frame, Attitude Sol. Sens.(2*)	L3 : dR/dt
6. Alignment, Sensors(3*)	L4/5 : 2D INS – ideal + realistic
7. Align + Schuler, Sensors(3*)	L5 : 2D INS – realistic case
8. KF-intuitive , Sensors (4*)	L6: INS physic – initialization
9. **T2**, $\Phi = e^{F\Delta t}$	L7 : KF of GPS – model a=0
10. observability, EKF Sensors (5*)	L8 : KF of GPS – model a=con.
11. INS/GNSS integration	L9 : KF of GPS – model rdot=0
12. Total x vs. Δx, GPS/INS in 2D	L10a: GPS/INS – theory
13. Direct sensor orientation, demo	implementation
14. T3	

* = presented by students, practical labs

DC=Davide Cucci

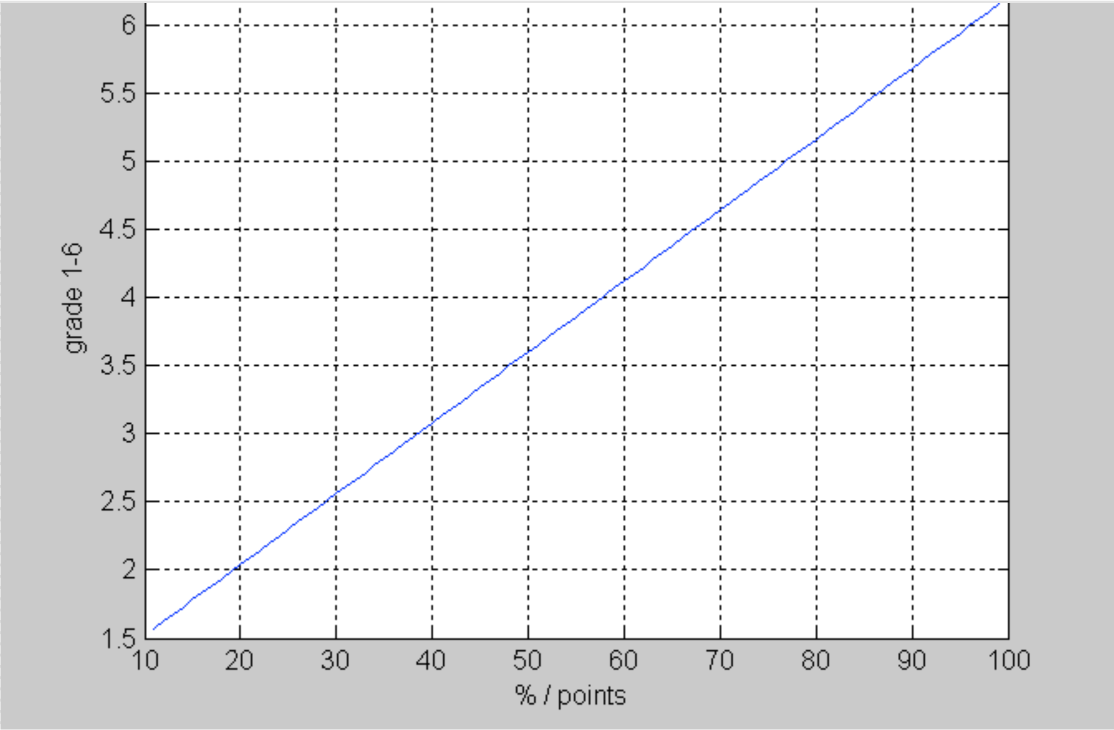
M+P=Mehran+Philipp

Control

Test 1 (lecture 4, 14.10.)		20%	
Test 2 (lecture 9, 18.11.)		20%	
Test 3 (lecture 14, 23.12.)		20%	60%
Participation/presentation	10%		
Labs		30%	40%
TOTAL		100%	

% → grade conversion

- Mark ~= [%] * 5.2/100 + 1



Labs – rules

- Lab weight 3% per lab, 10 labs in total

- Evaluation
  - Completeness ~ 1%
  - Correctness (plots) ~ 1%
  - Answers (questions) ~ 1%
  - Penalty -0.5% per day past deadline

- Content
  - Written ~1 page: **answers** with analysis (poss. synthesis)
  - Plots (relevant)
  - Code (all)

- Hand in
  - Printed version, bring it to the course or give to the assistant

Assistant support

- Merhan Khaghani
  - main assistant (labs & consulting)

- Philipp Clausen
  - present in labs

Inertial sensors – student distribution

- Gyroscopes
  - Rigid rotors gyros (RRG)
  - Nuclear resonant (NMRG)
  - Ring laser gyro (RLG)
  - Fibro optic gyro (FOG)
  - Hemispherical resonator (HRG)
  - MEMS:
    - Vibrating fork-quartz (QRS)
    - Resonant ring
- Accelerometers
  - Force/mass rebalance
  - MEMS: vibrating (QRS)
- Magnetometers

- Students
  - 1:
  - 2:
  - 3:
  - 4:
  - 5:
  - /
    - 6:
    - 7:
- /
  - 9:
  - 10:
  - 11:

First group in 2 weeks (3rd session)

Sensor presentation

- Prepare
  - 1. Presentation (~10-12 min)
  - 2. Document to be handed to colleagues (16) + PDF (slides or extended abstract with references)

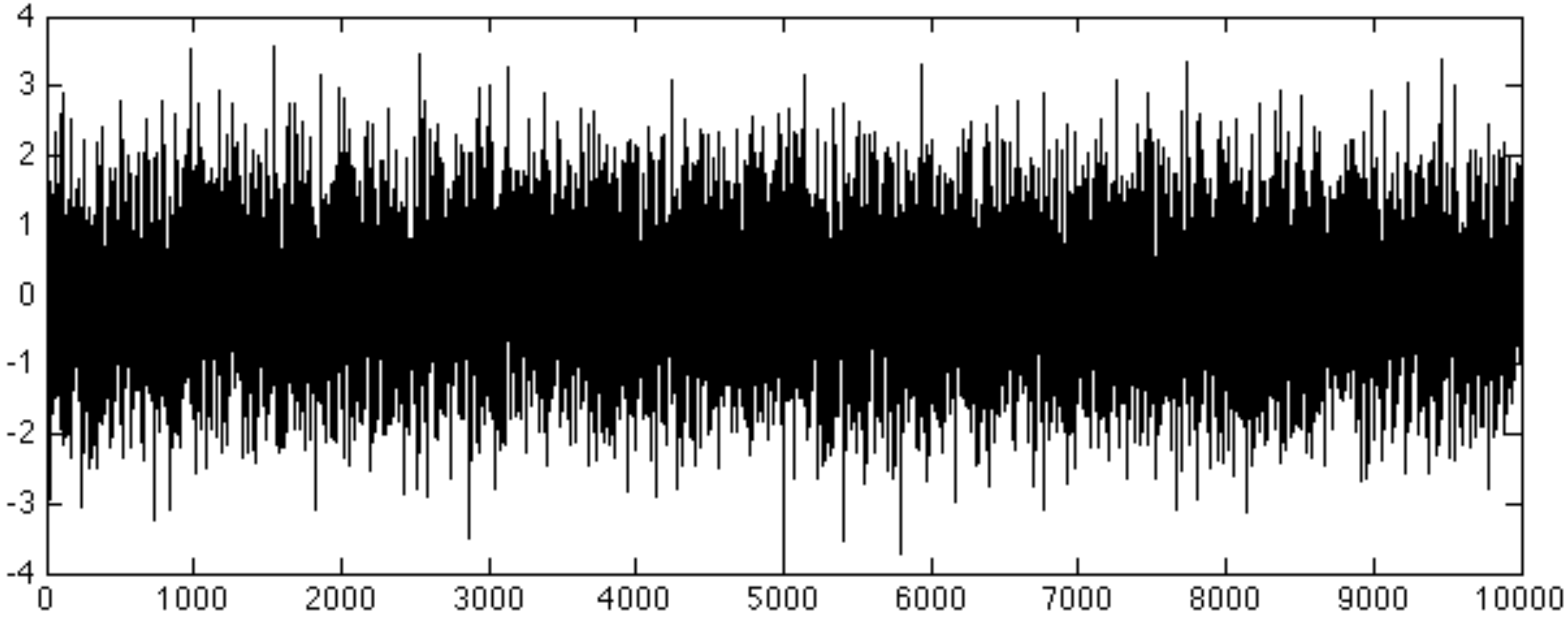
- Content
  - Clear **physical concept**
  - Mathematical relations
  - **Limits** – physical and in realization/fabrication
  - **Advantages** and disadvantages (environment, size, cost, **accuracy ranges**)

Lecture summary

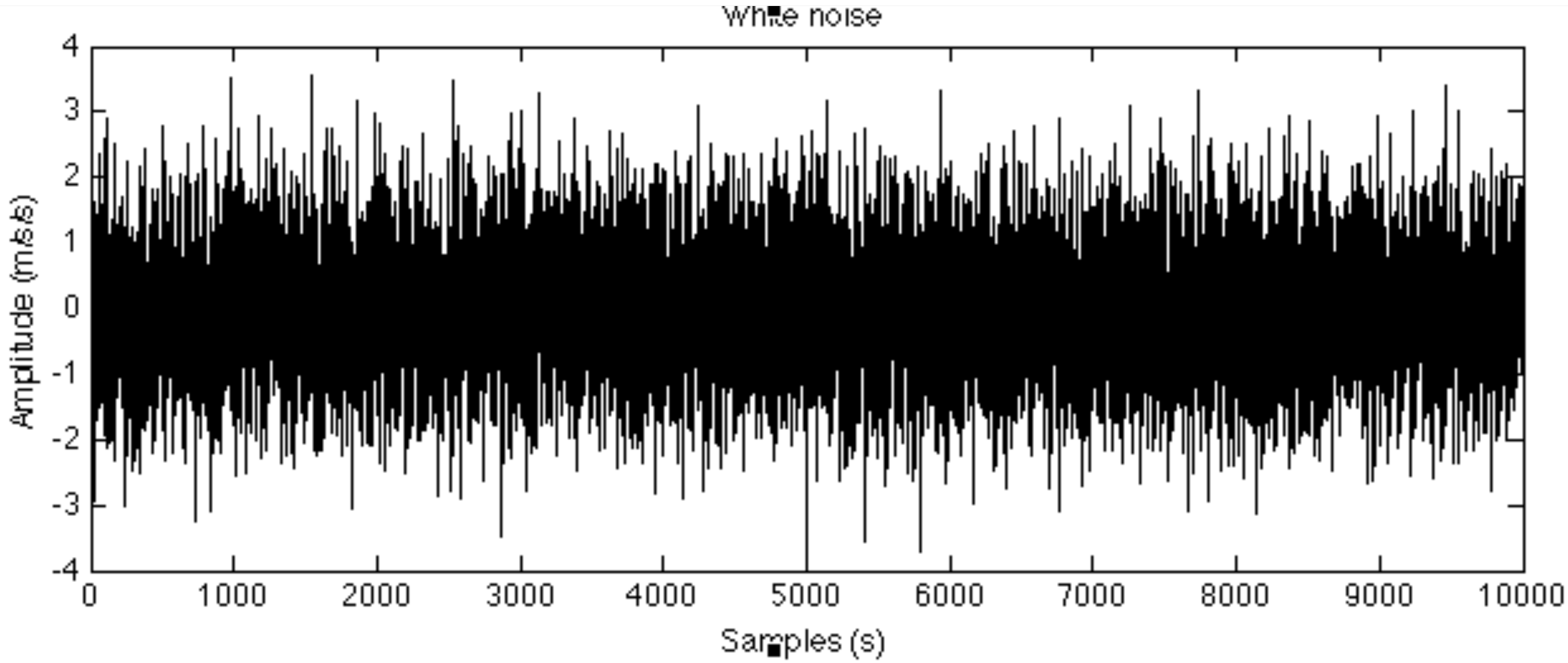
- Each student presents (at least ones) brief summary of the previous lecture

- Summary:
  - Slides 1-2 max
  - Or on blackboard (prepare before lecture starts)
  - 3-4 minutes max

Plots


4
3
2
1
0
-1
-2
-3
-4
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000

Plots



White noise
Amplitude (m/s/s)
4
3
2
1
0
-1
-2
-3
-4
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
Samples (s)

Lab - evaluation

- **C**ompleteness – 1/3
- **C**orrectness – 1/3
- **A**nswers – 1/3

- Later delivery – 50% (of the lab weight)

- Reports:
  - Description (plots) – n pages
  - Answers – max 1 page
  - Code (with all functions)