

ENV-548

**Sensor orientation**

Skaloud Jan

Cursus	Sem.	Type
Energy Management and Sustainability	MA1, MA3	Opt.
Environmental Sciences and Engineering	MA1, MA3	Opt.
Mineur STAS Russie	H	Opt.
Robotics	MA1, MA3	Opt.
Space technologies minor	H	Opt.

Language of teaching	English
Credits	4
Withdrawal Session	Unauthorized Winter
Semester Exam	Fall During the semester
Workload	120h
Weeks	14
<b>Hours</b>	<b>4 weekly</b>
Courses	2 weekly
Exercises	1 weekly
Project	1 weekly

**Number of positions**

**It is not allowed to withdraw from this subject after the registration deadline.**

**Summary**

Determination of spatial orientation (i.e. position, velocity, attitude) via integration of inertial sensors with satellite positioning. Prerequisite for many applications related to remote sensing, environmental monitoring, mobile mapping, robotics, space exploration, smart-phone navigation, etc.

**Content****Lectures**

- Concept and principles.
- Inertial and other reference frames.
- Gyroscope and accelerometer technology.
- Attitude parameterization and modeling.
- Strapdown mechanization.
- Initial alignment.
- Random processes and noise models.
- Bayes and Kalman Filters.
- External aiding  
INS/GNSS integration and reliability.
- Application to mobile mapping and remote sensing

**Labs**

- Estimating and characterizing sensor errors in synthetic and real data (practical lab / real instruments)
- Determining trajectory from ideal and realistic inertial data
- Witnessing inertial physics (practical lab / real instruments)
- Performing Kalman Filtering with different motion models
- Setting up loosely coupled INS/GNSS integration

**Keywords**

Inertial sensors, platform orientation, sensor integration, Kalman Filtering, estimation, INS/GNSS, navigation

## Learning Prerequisites

### Recommended courses

Advanced satellite positioning, statistics, adjustment of observations

### Important concepts to start the course

basic signal processing, random processes, programming in Matlab

## Learning Outcomes

By the end of the course, the student must be able to:

- Manipulate precise as well as low-cost inertial instruments.
- Compute initial orientation from a real data.
- Integrate inertial signals via simulations.
- Predict orientation performance via covariance propagation.
- Construct a model for a gyroscope or accelerometer.
- Develop dynamic models for a particular scenario.
- Implement Kalman Filter.

## Transversal skills

- Collect data.
- Make an oral presentation.
- Use both general and domain specific IT resources and tools

## Teaching methods

Ex cathedra, exercises (part. in computer room), demonstrations

## Expected student activities

Active participation in the course and lab assignments, programming of algorithms and self-control (debugging), study and presentation of one inertial-sensor technology .

## Assessment methods

Continuous control, 3 tests at the following dates:

- 11th October 2019
- 15th November 2019
- 20th December 2019

## Supervision

Office hours	Yes
Assistants	Yes
Forum	No

## Resources

### Bibliography

Recommended literature via Moodle.

### Notes/Handbook

Sensor orientation (polycop., ~100 pages), slides via Moodle.

**Moodle Link**

- <http://Moodle: http://moodle.epfl.ch/course/info.php?id=7541>