EPFL

ENV-548

Sensor orientation

Skaloud Jan

Cursus	Sem.	Type
Energy Management and Sustainability	MA1, MA3	Opt.
Environmental Sciences and Engineering	MA1, MA3	Opt.
Robotics, Control and Intelligent Systems		Opt.
Robotics	MA1, MA3	Opt.
Space technologies minor	H	Opt.

Language of teaching	English
Credits	4
Withdrawal	Unauthorized
Session	Winter
Semester	Fall
Exam	During the semester
Workload	120h
Weeks	14
Hours	**4 weekly**
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, programmation 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, programmation of algoritms and self-control (debugging), study and presentation of one inertial-sensor technology .

Assessment methods

Continuous control, 3 tests at the following dates:
- 9th October 2020
- 13th November 2020
- 18th December 2020

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