ENV-542

Advanced satellite positioning

Cursus	Sem.	Type
Environmental Sciences and Engineering	MA2, MA4	Opt.
Mechanical engineering	MA2, MA4	Opt.
Microtechnics	MA2, MA4	Opt.
Robotics, Control and Intelligent Systems		Opt.
Robotics	MA2, MA4	Opt.
Space technologies minor	E	Opt.

Language of teaching	English
Credits	4
Withdrawal	Unauthorized
Session	Summer
Semester	Spring
Exam	During the semester
Workload	120h
Weeks	14
Hours	**4 weekly**
Lecture	2 weekly
Exercises	2 weekly
Number of positions	

Remark

Pas donné en 2023-24

Summary

All fundamental principles behind modern satellite positioning to acquire, track and evaluate direct and indirect satellite signals and process them in relation to example applications: Earth monitoring (landslides,...), high precision positioning (automated driving, robots,...) and time transfer.

Content

Concept of satellite positioning
- basic principals & reference frames
- orbit computation & simple positioning

Signal modulation and structure
- RF propagation in space
- signal structure including new Galileo modulations

Receiver technology
- signal preprocessing
- signal acquisition & tracking

Error models and differencing concepts for special and high precision applications
- code and carrier phase measurements
- linear combination of observations

Algorithms for reliable positioning
- code and carrier-phase smoothed-code
- carrier-phase cycle ambiguity determination

Algorithms for environmental sensing
- water vapor estimation
- total electron content estimation
- GNSS reflectometry

Keywords

GNSS, GPS, GLONASS, Galileo, satellite, positioning, signal modulation, detection, estimation, signal processing, ionosphere, troposphere, automated vehicles, space, time-transfer, Earth sensing, drones.

Learning Prerequisites

Recommended courses
Fundamentals of satellite positioning, signals and systems, or signal processing, estimation methods

Important concepts to start the course
Linear algebra, basic signal processing, statistics, programmation in Matlab

Learning Outcomes
By the end of the course, the student must be able to:
- Implement signal acquisition and tracking
- Develop estimation procedure for precise positioning
- Interpret and analyse error sources as signal of environment
- Apply orbit calculation and algorithms for absolute positioning
- Synthesize a particular problem in GNSS for other students
- Solve carrier-phase ambiguities for cm-level positioning and ionosphere monitoring
- Choose an appropriate method and signals according to application

Transversal skills
- Make an oral presentation.
- Summarize an article or a technical report.
- 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 algoritms and self-control (debugging), study of scientific papers.

Assessment methods
Continuous control, 3 tests on the following dates:
- 13th March 2020
- 1st May 2020
- 29th May 2020

Supervision

Office hours	No
Assistants	Yes
Forum	No

Resources
Bibliography
Recommended literature on Moodle.

Notes/Handbook
Slides, book chapter and scientific papers distributed via Moodle.

Moodle Link

- https://go.epfl.ch/ENV-542

Prerequisite for

Sensor orientation