Remarque
MA3 only

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, programation 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 algorithms and self-control (debugging), study and presentation of one inertial-sensor technology.

Assessment methods
Continuous control, 3 tests

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