



Location

CCG-Center, Technologiepark Argelsrieder Feld 11,
D-82234 Wessling-Oberpaffenhofen

A list of nearby accommodations, a description of the location and hints for travel will be mailed to the participants upon registration. Please make your own hotel accommodation.

Fee

EUR 1.870,-

Please pay by non-cash means after receiving the invoice.

CCG is a non profit organisation, exempt from value-added tax.

Members of CCG receive a 10 % discount and students a 75 % discount when they present their student card. If several employees of a company / department register for the same seminar, each receives a 10 % discount. The discounts cannot be combined.

Registration

Please write or call (up to 14 days before the seminar) to

Carl-Cranz-Gesellschaft e.V.; P.O. Box 11 12, D-82230 Wessling

Tel. +49 (0) 8153 / 88 11 98 -12, Fax -19, E-Mail: anmelden@ccg-ev.de

Internet: www.ccg-ev.de

After receipt of registration, a confirmation letter will be sent.

Further Information

For more information about our organization please do not hesitate to contact the CCG at Oberpaffenhofen at the phone number given above.

For more information on the content of the seminar please contact

Prof. Dr.-Ing. Bernd Eissfeller

University of the Federal Armed Forces, Munich, Neubiberg,

Institute of Geodesy and Navigation, D-85577 Neubiberg

Tel. +49 (0) 89 / 6004-3017, E-Mail: bernd.eissfeller@UniBw.de

Substitutions and Cancellations

Substitutions may be made at any time. Cancellation of an accepted registration made up to 7 days prior to the start of the seminar is subject to a EUR 25,- administrative fee. Participants canceling after that date are responsible for the entire seminar fee.

CCG reserves the right to cancel a course up to 10 days before the course's beginning in case of low number of participants or for other significant reasons. Furthermore, CCG reserves the right, against the announcement in the programme, to possibly replace at short notice a lecturer and also the lecturer's topic. Any claims for damages shall be excluded.

Who Should Attend

Project Managers and System Engineers, Scientists of different disciplines, Engineers, Developers and other Technicians, who would like to get a broad overview on modern multisensor integration and navigation and the underlying technologies and concepts.

Focus

Availability, continuity, integrity and accuracy requirements lead to the fact that no commercial navigation system can solely rely on a single sensor technology. Thus, the seminar is focused on the architecture of state-of-the-art and future integrated multi-sensor navigation systems. In the first part of the course the key sensor and algorithmic technologies are presented (strapdown inertial technology, GPS, Kalman Filter, map matching, terrain-based navigation). In the second part specific multi-sensor integration architectures for future-oriented application fields will be outlined. The seminar should help to understand, design and evaluate the performance and cost-efficiency of GPS/INS and integrated multi-sensor systems.

Language

English

Course Book

Each attendant will be provided with detailed course material in English.

Lecturers

B. Eissfeller	Univ.-Prof. Dr.-Ing.	
H. Niedermeier	Dipl.-Ing.	University of the Federal
M. Kriegel	Dipl.-Ing.	Armed Forces Munich,
T. Schueler	Dr.-Ing. habil.	Neubiberg
A. Schulte	Univ.-Prof. Dr.-Ing.	
J.-H. Won	Dr.	
V. Koehler	Dr.-Ing.	Ingenieurbüro Dr. Koehler, Buxtehude
T. Köhler	Dr.-Ing.	EADS Military Aircraft, Ottobrunn
O. Montenbruck	Dr. rer. nat. habil.	DLR-GSOC, Oberpaffenhofen
S. Bedrich	Dr.-Ing.	Kayser-Threde GmbH, Munich
J. Dambeck	Dr.-Ing.	MBDA, Schrobenhausen
G. Heinrichs	Dr.-Ing.	IFEN GmbH, Poing
T. Pany	Mag. Dr.	
V. Schwieger	Univ.-Prof. Dr.-Ing. habil	University of Stuttgart

Seminar SE 3.05

GPS/INS-Integration and Multisensor-Navigation

November 14 – 18, 2011

Oberpaffenhofen near Munich

Scientific Coordination

Prof. Dr.-Ing. Bernd Eissfeller

University of the Federal Armed Forces

Munich, Neubiberg, Germany

Seminar Outline

Monday, November 14, 2011

10.00 – 16.30

- 10.00 – 10.15 **Welcome, Organization**
- 10.30 – 12.00 **Introduction to Inertial Navigation**
B. Eissfeller
History, mathematical & physical fundamentals, basic principles & assumptions, Schuler tuning, accuracy classes, platform & strapdown systems, initial & transfer alignment, simplified error propagation, vertical channel problem, status of inertial technology, integrated navigation, rationale for integrated navigation, basic principles, examples, outlook and future trends, demonstration of SAGEM Sigma 30 INS
- 13.00 – 14.30 **Inertial Sensors**
B. Eissfeller
Mechanical gyroscopes (SDF, TDF, ESG, DTG), optical gyroscopes (FOG, RLG), MEMS (vibrating beam, vibrating plate, vibrating ring & shell) technology and performance, pendulum accelerometer
- 15.00 – 16.30 **Strapdown Algorithms**
J. Dambeck
Reference systems, nonlinear 6DoF kinematic differential equations of motion, Euler angles, quaternions, singularities, integration algorithms

Tuesday, November 15, 2011

08.30 – 15.45

- 08.30 – 10.00 **Error Propagation in Inertial Navigation Systems**
J. Dambeck
Total vs. error state space, linearization, discretization, dynamic system in state space formulation, stability, observability, stochastic inertial measurement error models
- 10.30 – 11.15 **Terrain Aided Navigation**
J. Dambeck
Altimeters, principle of terrain contour matching, alternative realizations, error sources, digital terrain elevation data, integration with IMU/GPS
- 11.15 – 12.00 **Autonomous Navigation for Stand-Off Weapons**
J. Dambeck
Autonomous navigation, navigation system architecture and design for cruise missiles, interrelation with guidance & control, system test principles, Example: Taurus KEPD 350

- 13.00 – 14.30 **Kalman Filter Theory**
B. Eissfeller
History, stochastic processes, least-squares unbiased estimator principle (Gauss), continuous versus discrete dynamic system, discrete observation equations, prediction and estimation error, heuristic derivation of linear Kalman algorithm, exercise, connections with Wiener and least-squares filter, modifications for special cases, numerically stable forms
- 15.00 – 15.45 **Kalman Filter Demonstration**
H. Niedermeier
Elementary example, GPS/INS integration examples, transfer alignment example
- approx. 17.30 **Social Event**
Guided tour through the city center of Munich (optional)

Wednesday, November 16, 2011

08.30 – 15.45

- 08.30 – 10.00 **GNSS Receivers and Errors**
T. Pany
Brief introduction to GNSS (GPS, Galileo, GLONASS) segments, GNSS receiver signal flow, tracking-loops, jamming and interference, trends in civil and military receiver technology, error theory, observation equations: Pseudorange, delta-range, Doppler, carrier-phase, presentation of real-world data
- 10.30 – 12.00 **GPS/INS Integration**
B. Eissfeller
Motivation for GPS/INS integration, overview on coupling principles w.r. to accuracy, availability, integrity, continuity, GPS P-V-A filter, GPS/INS Filter, coupling principles in detail: separate, loosely (position, raw data), tightly, deeply, advantages and disadvantages, examples for commercially available systems and developments, typical applications
- 13.00 – 13.45 **Deep Coupling Architectures**
J.-H. Won
Terminology, performance comparison and enhancements, deeply/ultra-tightly coupling approaches: Basic scalar aided tracking, vector-based centralized filter, vector-based cascaded/federated filter, overview on national/international developments
- 13.45 – 14.30 **Map Matching Applications**
15.00 – 15.45
V. Schwieger
Digital maps, matching and aiding techniques, accuracy considerations for road and rail, car navigation systems, quality models, quality assurance

Thursday, November 17, 2011

08.30 – 16.30

- 08.30 – 10.00 **Space Systems**
O. Montenbruck
Orbit & attitude determination of spacecraft, AOCSS design and sensors for satellites at different orbits, rendezvous & docking, launchers
- 10.30 – 12.00 **Unmanned Aerial Vehicles (UAVs)**
M. Kriegl
UAV Demonstrator System Architecture (system requirements & concept, system architecture, component description, experimental safety concept), UAV Demonstrator Research Application (outer loop flight guidance, human supervisory control issues, cognitive & co-operative automation, manned-unmanned teaming)
- 13.00 – 13.45 **Rail Navigation Systems**
S. Bedrich
Design of rail navigation systems, special requirements, GNSS, Eurobalise, speed measurements, detection of slippage, digital track maps, train control
- 13.45 – 14.30 **Civil and Military Aviation**
15.00 – 15.45
T. Köhler
Modern integrated aircraft navigation systems, typical multi-sensor scenario, civil versus military transport aircraft, Flight Management System fighters
- 15.45 – 16.30 **Integrated Navigation Systems for Commercial Shipping**
V. Koehler
Requirements for marine navigation system integration, sensors, Radar, ECDIS, automatic track keeping, alarm management, eNavigation

Friday, November 18, 2011

08.30 – 12.00

- 08.30 – 10.00 **Location Based Services**
G. Heinrichs
Personal navigation and mobility, special features & systems (in-door), integration of sensors in mobile phone platforms (MEMS), hybridisation with GNSS and wireless systems (UMTS/GSM, WLAN, UWB)
- 10.30 – 12.00 **Gravity Field & Airborne Gravimetry**
T. Schueler
Role of gravity field in inertial navigation, gravity induced errors, importance for submarine and airborne navigation, separation of inertial and gravity accelerations, gradiometry, determination of gravity vector