COUNT
CONSORTIUM OF OHIO UNIVERSITIES ON NAVIGATION & TIMEKEEPING

2015 Short Course Series

May 13-15, 2015

Hilton Garden Inn
3520 Pentagon Blvd.
Beavercreek, OH 45431

Wednesday, May 13th	
8:30 – 9:00	Short Course Registration
9:00 – 12:00	Array Signal Processing for Geolocation of RF Emitters Dr. Inder (Jiti) Gupta, The Ohio State University, ElectroScience Laboratory
12:00 – 13:00	Lunch (provided)
13:00 – 13:30	Short Course Registration
13:30 – 16:30	Radionavigation and Timing with LF/VLF Technology Dr. Wouter Pelgrum and Dr. Frank van Graas, Ohio University, Avionics Engineering Center
Thursday, May 14th	
8:30 – 9:00	Short Course Registration
9:00 – 12:00	Sensors and Sensor Integration in Navigating PN and UAS Platforms Dr. Charles K. Toth, The Ohio State University, SPIN Laboratory
12:00 – 13:00	Lunch (provided)
13:00 – 13:30	Short Course Registration
13:30 – 16:30	GPS/GNSS Receiver Fundamentals Dr. John Raquet, Air Force Institute of Technology
Friday, May 15th	
8:30 – 9:00	Short Course Registration
9:00 – 12:00	Ionospheric Scintillation and GNSS Signals and Receivers Dr. Jade Morton, Colorado State/Miami University
12:00	Adjourn

2015 COUNT Short Course Series

Wednesday May 13, 2015 9:00 – 12:00
Array Signal Processing for Geolocation of RF Emitters
Dr. Inder (Jiti) Gupta, The Ohio State University ElectroScience Laboratory

There is significant interest in locating RF emitters using a single platform. To accomplish this objective, an antenna array is mounted on the platform and the digitized signals received by various elements of the antenna are processed to geolocate the RF emitters. The conventional approach is based on Angle of Arrival (AoA) estimation at various locations and orientation of the platform, multiple target tracking and drawing lines of bearing. Note that AoA estimation is the backbone of the conventional approach. In this short course, we will discuss various methods for AoA estimations. The discussion will include spectral-based techniques as well as parametric methods. We will describe the degradation in the performance of these methods due to mismatches in the available antenna array manifold and true in situ array manifold of the antenna. The discussion will include polarization of the signals incident on the antenna. Finally, we will present a novel method called 'Direct Mapping Method' for the geolocation of the RF emitters. This method bypasses the AoA estimation step and multiple target tracking. The method is quite robust to mismatches in the antenna array manifold.

Wednesday May 13, 2015 13:30 – 16:30
Radionavigation and Timing with LF/VLF Technology
Dr. Wouter Pelgrum and Dr. Frank van Graas, Ohio University, Avionics Engineering Center

This short course will discuss Low-Frequency (LF) and Very Low Frequency (VLF) radionavigation with an emphasis on Loran. First an overview of LF/VLF technology will be presented, outlining transmitter, transmit/receive antennas (electric field and magnetic field), modulation, timing, propagation, and receiver considerations. Next, various systems will be characterized, including eLoran, Chayka, and Omega. Civilian navigation and timing requirements are discussed and new techniques are introduced to increase the potential and performance of LF/VLF systems in the areas of signal structure, propagation modeling, antenna and receiver design.

Thursday May 14, 2015 9:00 – 12:00
Sensors and Sensor Integration in Navigating PN and UAS Platforms
Dr. Charles Toth, The Ohio State University SPIN Laboratory

Navigation and imaging sensor technology advancements as well as integration methods have recently seen remarkable developments, fueled by rapidly advancing sensor performance, increasing processing power, and, most importantly, by growing need from a large number of applications. The classical Extended Kalman filter-based GPS and IMU integration model, introduced two decades ago, has been extended with new sensor input and error models. Moreover, alternative integration solutions have been developed.

This course will provide a review of sensors and sensor error models, the theoretical foundation of integration models, and some typical applications in navigation and remote sensing with a focus on Personal Navigation (PN) and Unmanned Airborne Systems (UAS).

Thursday May 14, 2015, 13:30 – 16:30
GPS/GNSS Receiver Fundamentals
Dr. John Raquet, Air Force Institute of Technology

This course will cover the fundamentals of GNSS receiver processing, including front end processing, code and carrier tracking loops, acquisition, bit/frame synchronization, and measurement generation. The theory will be presented, followed by a demonstration of the theory using a Simulink GNSS receiver using both simulated and real data. Use of the Simulink receiver will enable the students to see how various design decisions affect receiver performance and provide increased understanding of the internal operations of GNSS receivers.

Friday May 15, 2015 9:00 – 12:00
Ionospheric Scintillation and GNSS Signals and Receivers
Dr. Jade Morton, Colorado State/Miami University

The ionosphere is a weakly ionized plasma bathed in the geomagnetic field. It is a dynamics medium with high variability in both space and time and is greatly affected by the solar activities. One particular important characteristic of the ionosphere is the irregular ionization structures which occur most frequently in the F layer of the magnetic equatorial and the polar regions. These irregular structures cause scattering and refraction of the radio waves traversing the ionosphere, leading to fast varying diffraction patterns on the receiver’s antenna plane. The results are signal amplitude fading and random phase fluctuations which we collectively refer to as ionosphere scintillation.

Ionosphere scintillation imposes serious challenges on the GNSS receiver carrier tracking loop design. For weak and mild scintillations, the sub-optimal tracking loop performance will produce larger position and timing errors. Under strong and severe scintillation conditions, a GNSS receiver will lose lock. In order to develop robust GNSS tracking algorithms to maintain quality tracking of the GNSS signals during ionosphere scintillation, it is critical to have a good understanding of the scintillation mechanisms and scintillating GPS signal structures. This short course will discuss these fundamental issues as well as strategies to improve GPS receiver tracking performance under scintillation conditions and effective utilization of scintillation features to study ionosphere processes.