Syllabus for

CCE 6516 / EEL 5934: Airborne Laser Scanning: Data Processing and Analysis

Fall 2006	Tue: periods 4 (10:40 am - 11:30 am) Thr: period 4 – 5 (10:40 am - 12:35 pm)	Location: LAR 330

Instructor: K. Clint Slatton, Assistant Professor
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Office hours: Tue: periods 5 – 6, Thr: period 6 (NEB 459)

Objectives and Description:

This 3 credit class is a follow on to the graduate remote sensing class CGN 6381/EEL 5934 Airborne Sensors and Instrumentation. CGN 6381/EEL 5934 covers a wide range of remote sensing topics from microwave to optical modalities, electromagnetic interactions with terrestrial media, and geometric and radiometric corrections. CCE 6516, by contrast, is focused on airborne laser ranging. It is primarily suited for students in the Electrical & Computer Engineering Department and the Civil & Coastal Engineering Department. However, it is also relevant to students in Environmental Engineering, Agricultural & Biological Engineering, Mechanical & Aerospace Engineering, Geology, Forestry, and other departments who wish to utilize high-resolution topographic measurements of the Earth.

Airborne laser ranging is becoming the dominant technology for measuring the 3D structure of the Earth's surface at high resolution. However, significant knowledge of GPS position estimation, signal processing, and photonics is needed in order to process the data into a useful form and successfully analyze it. The primary objective of this course is to teach students how acquire, process, and analyze laser ranging data acquired from an airborne platform. The resulting data are very important for modern hydrology, geomorphology, forestry, shoreline monitoring, construction, urban planning, and other environmental disciplines.

Grades will be determined primarily by a semester project in which the students will work on designing a flight plan, processing raw laser data, and analyzing that data for a specific application of their choice, such as estimating land surface (soil) properties and extracting buildings and roads from the data for urban planning. **Interdisciplinary teaming on the projects is strongly encouraged.** Data sets will be provided for the projects.

Prerequisites:

For students enrolled in the Geosensing Area in the Civil and Coastal Engineering Department, the prerequisite is CGN 6381/EEL 5934: Airborne Sensors and Instrumentation (*Remote Sensing*) or permission of the instructor. For all other students, there is no prerequisite.

Textbook:

None. We will have assigned readings from several sources including books and journal papers in the areas of signal processing, photonic devices, optics, attitude dynamics, and pattern recognition.

Course Outline:

1. *Part I: Subsystem performance overview*
    a. pulsed lasers (wavelength, transmit energy, and pulse frequency)
    b. optical elements and scanners (galvanometers, dual-wedge Risley prisms, etc.)
    c. photon detectors (avalanche photo diodes and photo multiplier tubes)
    d. timing electronics (range gating, data rates, range gate interval effects)
    e. GPS receiver (kinematic processing)
    f. Inertial measurement unit (IMU)
    g. Data capture and i/o between lidar system and storage devices
2. *Part II: Modeling and raw data processing*
    a. Predicting performance using simplified subsystem models
    b. Simulating laser pulse interactions with terrain and landcover
    c. Laser propagation ("the lidar equation")
    d. Processing of airborne laser data
        i. Blended GPS/IMU trajectory solutions using the Kalman filter
        ii. Geolocated point cloud generation (3D data)
        iii. Calibration issues
3. *Part III: Data analysis*
    a. Cast study 1: UF's airborne laser swath mapping system
    b. Cast study 2: UF's coastal area tactical mapping system
    c. Basic image processing
        i. Interpolating 3D point cloud data into 2D (images)
        ii. Using morphological operations to detect objects (e.g. buildings)
    d. Statistical characterization
        i. Numerical pdf estimation
        ii. Data segmentation
4. *Part IV: Selected applications*
    a. Shoreline change monitoring
    b. Hydrologic parameter (soil drainage) estimation
    c. Tree detection and timber parameter estimation
    d. Building and road extraction

Course Grading:

Grades will be assigned based upon

homework assignments:	20%
take-home midterm exam:	30%
class project (multiple parts):	50%.

There is no final exam.

Students with Disabilities:

For information on classroom accommodation and requirements for instructor notification, please see (http://www.dso.ufl.edu/drp/faqs.htm).

Attendance:

Perfect class attendance is not required, but regular attendance is expected. It is the student's responsibility to independently obtain any missed material (including handouts) from lecture.

Late Assignments:

First late assignment = grade reduction of 25% , if it is received before the solutions are posted. (Otherwise, the grade will be zero). All other late assignments = grade of zero .

Academic Honesty:

All students admitted to the University of Florida have signed a statement of academic honesty committing themselves to be honest in all academic work and understanding that failure to comply with this commitment will result in disciplinary action. This statement is a reminder to uphold your obligation as a student at the University of Florida, and to be honest in all work submitted and exams taken in this class and all others. For more information, please see the academic honor code.