GGS 470/590 – **Drone-Based Remote Sensing;** Credits: 3
4:30 – 7:10 pm Monday; Exploratory Hall 2310
August 26, 2019 - December 16, 2019

Syllabus

Objectives: To educate students on the use of drones to acquire scientific remote sensing data and process various drone-based sensor data sets for multiple applications. The course will involve hands-on experience with drone vehicles, sensors, imagery software and applications.

Gain hands-on experience with drone vehicles, sensors, image processing software and applications. With the proliferation of drones there are increasing opportunities to use drones for scientific remote sensing data acquisition and applications. This advanced course focusses on understanding the fundamentals behind acquiring scientific remote sensing imagery with drone-based cameras (e.g. multi-spectral and thermal) and processing the data for various applications.

Learning outcomes:

- Understand how to use drones as a platform to acquire scientific remote sensing data
- Understand components and functions of a drone system
- Understand the photogrammetric principles of drone-based image acquisition and processing
- Participate in application-specific flight planning and data acquisition with a drone
- Develop insight into regulations and qualifications for safe and legal drone operation.
- Understand how to operate various drone-based sensors, RGB camera, Multispectral, Thermal, LiDAR
- Develop the ability to process drone-derived raw data imagery (RGB camera, Multispectral, Thermal, LiDAR) to various products and applications.
- Gain oversight of the complete mission pipe-line, from planning to final product.
- Learn to present research proposals and complete a project as a team member

Note:

- Students will not be required to acquire their own data as the data will be acquired by the qualified instructors.
- This course will not lead directly to certification of students for operating a drone.
- The course is not about flying drones, but about understanding how to acquire and process remote sensing data for scientific purposes.

Prerequisites: GGS 379, or GGS 412, or GGS 416, or other equivalent remote sensing course.

Instructors:

Dr. Konrad Wessels Telephone: 703-993-4238
Office: Exploratory Hall–Room 2203 E-mail: kwessel4 at gmu.edu
Office Hours: Wednesday & Friday 10-11am

Dr. Paul R. Houser Telephone: 301-613-3782
Office: Exploratory Hall–Room 2209 E-mail: phouser at gmu.edu

Office Hours: by appointment, or before/after class

Diana 'Pat' Guillen-Piazza Email: Dguille2@gmu.edu
Office Number: 703.849.0359 Mobile Number: 703.897.8616
Office Hours: Monday until 4:30pm, Thursday from 4-6pm.

Communication: Please correspond via email. We shall respond within 24h during the week.

Recommended text: Small-Format Aerial Photography and UAS Imagery, ISBN: 9780128129425
NOTE: The book has a delayed release date of Sept 20. The instructors will provide any required reading, and the book is optional.

Procedure: Material will be covered by lectures, not necessarily restricted to the text/supplemental and handouts. Students are expected to read the text and other assignments thoroughly prior to the lecture.

Performance: Material covered on the final exam will include handouts, lecture notes and outside readings.

Evaluation: All work must be your own. A grade of "0" will be assigned for any work which is clearly not your own or cheating of any type. Refer to GMU plagiarism policy and definitions.

Homework	25 points (5 per assignment)
Paper Presentation	10 points (Graduate Students Only)
Final Exam	25 points
Pop Quizzes	10 (2 Points per quiz)
Team Project	30 points
TOTAL	100 points (90 points for Undergraduates)

Grades are assigned using a ten percent scale (+/- grades determined at instructor discretion):
A= 90 – 100 B = 80 – 90 C= 70 – 80 D= 60 – 70 F= 0 – 60

Homework assignments: All assignments should be done neatly and professionally. All homework should be submitted on Blackboard by the due date. The problem should be defined, diagrammed (if appropriate), and the solution should be developed in a step-by-step procedure. Spreadsheet answers can be included. The final solution should be reported to the appropriate significant figures and underlined. You are encouraged to work together in study groups; however, identical (copied) homework will be awarded a grade of zero (0). Incorrect homework may be neatly reworked and resubmitted for re-evaluation and partial credit.

Team Project: The project will consist of a drone remote sensing data analysis exercise to investigate a well-posed hypothesis or question. Project deliverables will consist of: 1. A brief project proposal presentation; 2. a final project report presentation (20-minute oral). Project teams should consist of 3-5 students, and project complexity should scale with team size. Projects may use already collected drone remote sensing data, or can arrange to collect new drone remote sensing data as part of this course.

Here are a few ideas:

- Thermal IR Freeze/Thaw image calibration and landscape analysis (Colorado).

- Snow volume determination using multi-angle visible change detection (Colorado).
- Site characterization for snow meteorological field studies (Colorado).
- Vegetation characterization for agricultural management.
- 3D characterization of forest structure with LiDAR.
- Printing of 3D drone images or 3D goggle interpretation.
- Urban building measurements with drones.
- Building heat signatures using IR drone data.
- Search and rescue automatic image detection.
- Comparing Digital Surface Models derived with LiDAR vs. 3D construction with high resolution imagery

Paper Presentation: Each graduate student will be required to present and lead a discussion on a published drone-based remote sensing research paper. The 15 minute presentation should be generally relevant (but not redundant) to the topic covered during that class session. Grading will be based on (1) relevancy and creativity of chosen paper/topic, (2) quality of presentation and visuals, (3) assessment of methods and drone-based sensors used and (4) responses to questions and discussion. ***Any review materials should be sent out to the class by the Friday before the presentation. Please select a date for your paper presentation – preference will be given on a first come first served basis.***

Late Work: All work is expected to be completed on time.

Disabilities: Students with disabilities that require accommodation should present the instructors with accommodation letter at the start of the semester so that all arrangements can be made in advance.

Course Outline

Date	Topic
Aug 26	Introduction: Course Requirements, Basic Drone Remote Sensing Concepts -Course syllabus and expectations (Paul) -Drone, UAV, UAS definitions and history (Konrad) -Introduction to GGS's drone platforms (Pat) -Drone remote sensing applications (Paul)
Sept 9	Drone System Components (Lance Sherry – James Buchanan Hall D003) Overview of Drone data processing software and AWS (Pat) Homework #1: (Due Sept 23)
Sept 16	Drone Systems, Platforms and Licensing (Konrad & Paul) Overview of Drone data processing software and AWS (Pat) 15min Student Presentation Homework #1: (Due Sept 23)
Sept 23	Drone Photogrammetry 1 (Arie Croitoru) Processing drone imagery (Pat) 15min Student Presentation Homework #2: (Due Oct 7)
Sept 30	Drone Photogrammetry 2 (Arie Croitoru) Processing drone imagery continued (Pat) 15min Student Presentation
Oct 7	Team Project Proposal Presentations (Paul) Mission Planning 1 (Paul) Homework #3 (Due Oct 21)
Oct 15 (Tuesday)	Mission Planning 2 (Konrad) Drone deployment (software and procedures) (Pat) Flight demonstration (Pat) 15min Student Presentation: Homework #4 (Due Oct 28)
Oct 21	Multi-spectral sensing with UAV's (Konrad) Sensor calibration (Paul) Collection and Processing multi-spectral imagery (Konrad) 15min student Presentation:
Oct 28	Drone-based LiDAR data collection and processing (Konrad) 15min student Presentation: Homework #5 (Due Nov 11)

Nov 4	Drone Remote Sensing Analysis-Science and application questions (Paul) 15min Student Presentation: Flight demonstration 2 (Pat)
Nov 11	Drone Remote Sensing Applications 1 - science and applications (Paul) Possible Guest Lecture (s) Team project mentoring by instructors 15min Student Presentation:
Nov 18	Drone Remote Sensing Applications 2 - case studies (Konrad) Possible Guest Lecture(s) 15min Student Presentation:
Dec 2	Team Project Presentations (Paul) Review for Final (Paul & Konrad) Course Evaluations

December 16: 4:30 pm – 7:15 pm Final Exam

NOTE: This is a course outline and is subject to revision at the discretion of the instructor. You will be informed in class if changes are made.

WEB RESOURCES:

ACADEMIC INTEGRITY: GMU is an Honor Code university; please see the University Catalog for a full description of the code and the honor committee process. The principle of academic integrity is taken very seriously and violations are treated gravely. What does academic integrity mean in this course? Essentially this: when you are responsible for a task, you will perform that task. When you rely on someone else's work in an aspect of the performance of that task, you will give full credit in the proper, accepted form. Another aspect of academic integrity is the free play of ideas. Vigorous discussion and debate are encouraged in this course, with the firm expectation that all aspects of the class will be conducted with civility and respect for differing ideas, perspectives, and traditions. When in doubt (of any kind) please ask for guidance and clarification.

GMU EMAIL ACCOUNTS: Students must activate their GMU email accounts to receive important University information, including messages related to this class.

COURSE MATERIAL CONTAIN MATERIAL WITH COPYRIGHTS FROM PUBLISHERS and may not be distributed and reproduced without permission.

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OFFICE OF DISABILITY SERVICES: If you are a student with a disability and you need academic accommodations, please see me and contact the Office of Disability Services (ODS) at 993-2474. All academic accommodations must be arranged through the ODS. http://ods.gmu.edu

OTHER USEFUL CAMPUS RESOURCES:

WRITING CENTER: A114 Robinson Hall; (703) 993-1200; http://writingcenter.gmu.edu
UNIVERSITY LIBRARIES "Ask a Librarian" http://library.gmu.edu/mudge/IM/IMRef.html
COUNSELING AND PSYCH SERVICES (CAPS): (703) 993-2380; http://caps.gmu.edu

UNIVERSITY POLICIES: The University Catalog, http://catalog.gmu.edu, is the central resource for university policies affecting student, faculty, and staff conduct in university affairs.