Syllabus: GEOG660 - Advanced Remote Sensing using Lidar - Winter 2016

Instructor
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Office Hours: On-campus: Wednesdays, 3 to 5 pm (Also available most days by appointment)
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Teaching Assistant
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Office Hours: Online After Lab Sessions
About the Course
Time: 5:30 to 8 pm Wednesdays (Lectures); 5:30 to 7:30 pm Thursdays (Labs)
Location: Online: http://elms.umd.edu; Campus Location: 1171 LeFrak Hall (Lectures)

Description
This course will expand on remote sensing concepts with a focus on light detection and ranging (lidar) technology. Lidar, also known as laser scanning, is an active remote sensing tool that can produce high-resolution point clouds. It is widely used today in many different fields, ranging from surveying to forestry. Lidar is being applied to problems such as terrain modeling, biomass estimation, change detection, feature extraction, and measuring tree canopy. This course will cover the fundamentals of lidar, explore current developments in lidar technology, and discuss different applications where lidar is being used. Students will get hands-on learning about lidar data management, processing, and analysis.

The format of this course will consist of lectures, lab assignments, readings, and a final project. The lectures will be presented online via the Live Classroom on the Enterprise Learning Management System (ELMS). All lectures involve the interaction between students and instructor in real-time. Lectures will be archived into videos which will be made available on ELMS. Please note that video archives are only intended for occasional or backup use in case students have to miss lectures due to personal, business, or medical reasons. Real-time, online participation is strongly recommended. The reading and lab assignments will also be posted on ELMS.

Prerequisites
Students should be proficient in GIS and have taken at least an introductory course in remote sensing (GEOG652: Digital Image Processing and Analysis). Additionally, students should have a background in programming using Python (GEOG656: Programming and Scripting for GIS). It is also helpful to have some background in modeling (GEOG654: Spatial Modeling).

Textbooks
There are no required textbooks. The following is a list of useful resources involving lidar data:

1. USGS Earth Explorer - http://earthexplorer.usgs.gov/
2. National Ecological Observatory Network (NEON) Tutorials - http://neondataskills.org/lidar/
3. LAStools Tutorials - https://rapidlasso.com/category/tutorials/
4. Renslow, M. 2013. Manual of Airborne Topographic Lidar. https://www.asprs.org/press-releases/order-the-asprs-airborne-topographic-lidar-manual.html
5. Heritage, G. and A. Large. 2009. Laser Scanning for the Environmental Sciences.
6. Shan, J. and C. K. Toth. 2008. Topographic Laser Ranging and Scanning.
7. Keranen, K. and R. Kolvoord. 2015. Making Spatial Decisions Using GIS and Lidar: A Workbook. http://esripress.esri.com/display/index.cfm?fuseaction=display&websiteID=291

Lab Assignments
There are a total of seven (7) lab assignments and each account for 10% of the final grade. The due date will be specified in the lab document. Late submission of lab reports may result in a deduction of points. However, in some situations (e.g. medical or family emergency), extension is possible if you contact the instructor before the due date. All labs must be completed by the end of the quarter.

Final Project
A final project is required to complete this course. It will provide students an opportunity to work on a small project involving lidar that is closely related to their area of study. The project must be carried out individually and independently. The project will consist of a (1) proposal, (2) poster, and (3) presentation.

Example Projects:
-Using lidar data as high-resolution input for a spatial model
-Producing digital surface models or digital terrain models
-Creating canopy height models or other forestry metrics
-Comparing lidar data to other remotely sensed data
-Extracting height and boundary information to create a 3-D city model
-Calculating the change in elevation before and after an event

Grading
The distributions of grade are:
Lab Assignments = 70%
Final Project = 20% (Proposal = 5% and Poster / Presentation = 15%)
Participation and Discussion = 5%
Weekly Quizzes = 5% (The lowest quiz grade will be dropped)
The plus/minus grading system will be used to assign student grades. Minor adjustments to this scale might be made based on the performance of the class as a whole.

Software
You can use either a PC or Mac to access ELMS. Whichever you choose, it should be equipped with headphones and microphone. You should also have the following plug-ins installed: Java, Real Media, Flash Player, and Quicktime.

The following software will be utilized during this course:

- ESRI ArcGIS 10.X
- Python 2.7
- LAStools (https://rapidlasso.com/lastools/)
- R (https://cran.r-project.org/) or RStudio (https://www.rstudio.com/)
- GRASS (https://grass.osgeo.org/)
- FUSION (http://forsys.cfr.washington.edu/fusion/fusionlatest.html)

The software required for this class is ESRI ArcGIS 10.X (ArcInfo) which is available in the open lab (located in 1136 and 1138 LeFrak Hall). If you need a personal copy of ArcGIS for your computer, please contact me by e-mail before class. Note: The free software that comes in books and other venues does not have the ArcInfo license and cannot be used to complete most labs.

Communication
Email
Both the TA and the instructor will always be available by email. Use the email link in the sidebar to send us an email at any time. We will try to answer within 24 hours and usually sooner.

Offline and Online Office Hours
I will be available to meet on campus for face-to-face office hours at specified times. You can also email either the TA or the instructor to set up individual office hours by appointment.

If needed, I can provide online office hours if you are unable to meet on campus. To do so, simply send me an e-mail to request a time to meet online.

Discussion Board
The discussion board is a place on the ELMS site for you to visit your classmates. This is an open forum for discussion about course material and for casual conversation. We encourage any general questions about the course material or lab assignments to be posted here so that students can help learn from each other. We will try to help answer any course-related questions that are posted here. In addition, there will be study rooms set up for you to form study groups. We will not be monitoring these rooms. Remember that the University Code of Academic Integrity specifies that you are free to work together and to discuss the assignments, but that you must produce your own original and independent work.

Class Attendance and Environment
You are strongly recommended to attend every lecture in real time at the online site. We will meet online at the announced time for a live audio/video lecture. During this time you can follow along with the lecture and ask any questions that you may have. The lecture will be archived for anyone who absolutely must miss a class, but I encourage you to join the class online at the appointed time so that you can ask questions and keep up with the course schedule.

In this class, students will meet in a virtual space online which will be treated as a classroom. Our class will meet within the Enterprise Learning Management System (ELMS), the university's online learning system. Go to http://elms.umd.edu to access the course. After login, the course will be listed in the right column under "My Courses".

It is important to recognize that the classroom is an environment that requires respect for all participants. Therefore, students are expected to conduct themselves in a considerate manner.

Disabilities and Religion
Any student with a disability is encouraged to meet with the instructor privately during the first week of class to discuss accommodations. I will make every effort to accommodate students who are registered with the Disability Support Services (DSS) Office and provide a DSS accommodation form.

Please refer to the Online Undergraduate Catalog Policy on Religious Observance.

Academic Integrity
The University of Maryland, College Park has a nationally recognized Code of Academic Integrity, administered by the Student Honor Council. This Code sets the standards for academic integrity at Maryland for all undergraduate and graduate students. As a student, you are responsible for upholding these standards for this course. It is very important for you to be aware of the consequences of cheating, fabrication, facilitation, and plagiarism. For more information on the Code of Academic Integrity or the Student Honor Council, please visit http://www.shc.umd.edu.

Within our class, students may work together to review class notes and lab assignments. However, labs must be done individually. Students must turn in their own work without assistance from another student.

Course Schedule

This is a tentative schedule and may be adjusted. Changes will be announced and posted on Blackboard.

Week	Date	Lecture Topics	Readings	Assignments
1	Nov. 30	Introduction to Lidar Lidar Data Formats	(Wehr, 1999) (Young, 2011) NEON Tutorials	Lab 1 Out
2	Dec. 7	Lidar Data Collection Lidar Data Preprocessing ArcGIS Tools and LAStools	(Wandinger, 2005) (Stoker, 2006) (Crawford, 2013)	Lab 1 Due Lab 2 Out
3	Dec. 14	Digital Elevation Models Digital Terrain Models Digital Surface Models	(Kraus, 2001) (Reutebuch, 2003) (Brovelli, 2001)	Lab 2 Due Lab 3 Out Proposal Out
4	Dec. 21	Alternatives to Aerial Lidar Data Fusion	(Henning, 2006) (Brooks, 2013) (Abdalati, 2010)	Lab 3 Due Exercise 1 Out
	Dec. 28	Winter Break		
	Jan. 4	Winter Break		
5	Jan. 11	Lidar Accuracy; Change Detection Case Study: Streambank Retreat Using R with Lidar (DEMs of Diff.)	(Hodgson, 2004) (Chen, 2006) (Resop, 2010)	Proposal Due Lab 4 Out
6	Jan. 18	Lidar Classification; Feature Extraction ArcGIS Tools and LAStools Case Study: In-stream Rock Delineation	(Popescu, 2003) (Resop, 2012)	Lab 4 Due Lab 5 Out
7	Jan. 25	Unmanned Aerial Vehicles (UAVs) Ecological Applications - Ecosynth Hydrological Applications - GRASS	(Mundt, 2006) (Turner, 2004) GRASS Tutorials	Lab 5 Due Lab 6 Out Exercise 2 Out
8	Feb. 1	Urban Applications - 3-D Models Forestry Applications - FUSION Using R with Lidar (Linear Regression)	(Lim, 2003) (Priestnall, 2000) NEON Tutorials	Lab 6 Due Lab 7 Out
9	Feb. 8	Full Waveform Lidar Profiling Lidar; Atmospheric Lidar Using R with Lidar (Random Forests)	(Nelson, 2012) (Mallet, 2009)	Lab 7 Due
10	Feb. 15	Multispectral Lidar Photon Counting Lidar Flash Lidar		Project Due *

** Presentations will be during the last lecture of class. Final Projects will be due before **Feb. 19**.*

Lab Assignment Topics

Lab 1 - Introduction to Lidar
Lab 2 - Lidar Data Preprocessing using ArcGIS and LAStools
Lab 3 - Detrending Terrain and Canopy Height Models
Exercise 1 - Reading LAS Files using Python
Lab 4 - Change Detection using Terrestrial Lidar
Lab 5 - Feature Extraction using Lidar
Lab 6 - Generating 3-D Models using UAVs
Exercise 2 - Hydrological Modeling using Lidar and GRASS
Lab 7 - Modeling Forest Inventory Statistics using Lidar