



Texas A&M University

Dept. of Ecosystem Science and Management

Course title **Advanced Remote Sensing**

Course number **ESSM 656**

Course date **Spring Semester 2017**

Location and **Lectures:** Monday, Wednesday: 12:40 to 1:30pm, Centeq 214

meeting times **Lab:** Wed 1:40 to 3:40pm, Centeq 214 (lab room B 214)

Course description

The goal of this course is to introduce students with a basic knowledge of remote sensing to advanced topics in digital remote sensing applications and active sensors, such as lidar. The course emphasizes a hands-on learning environment, with in depth insights into theoretical and conceptual foundations to allow students to use remote sensing data from terrestrial, airborne, and spaceborne platforms for a wide range of environmental applications. Primary focus will be placed on advanced active (lidar) and digital image analysis techniques, such as object oriented image classification and machine learning techniques. Ultimately, the course will empower students to delve more deeply into advanced issues in remote sensing and to customize and develop image processing tools for their particular area of interest.

Prerequisites: Approval of instructor or one of the following: ESSM 655, RENR 444, GEOG 651, GEOG 661.

Learning outcomes

Upon completion of the course, students are expected to:

1. Compare remote sensing systems characteristics and select appropriate imagery for environmental applications
2. Perform pixel-based and object-oriented image classification; compare results of various classification techniques and select the most accurate classifier
3. Select appropriate segmentation parameters when using object-oriented classification
4. Understand and use effectively machine learning techniques for image processing
5. Understand principles of active sensors data, such as lidar data, including discrete return, full waveform, and photon counting lidar data
6. Process lidar and optical remote sensing data and understand data fusion
7. Report in writing and orally present the remote sensing approach to problem solving
8. Critically review remote sensing literature and develop skills to distill the scientific essence of remote sensing data, applications, methodologies, and results

Instructor information

Name	Sorin Popescu
Email	s-popescu@tamu.edu
Office location	Centeq B221D
Phone	862-2614
Elearning	http://ecampus.tamu.edu
Office hours	Open door policy, though I recommend emailing or calling for appointments. Please put “ 656 ” in the subject of email messages regarding this class to receive prompt attention. Please avoid “drop-ins” just before class time; you are welcome any other time.
Laboratory Instructor	Tan Zhou, tankwin0@tamu.edu ; Office: Centeq B 217. Office hours: Friday, 1:00-2:00pm, Centeq B 217

Textbook

Recommended No mandatory textbook; Class uses instructor assigned readings
Introduction to Remote Sensing, 5th Edition, James B. Campbell and Randolph H. Wynne, The Guilford Press, 2011
ISBN-10: 160918176X | ISBN-13: 978-1609181765

Remote Sensing Digital Image Processing: An Introduction, John A. Richards and Xiuping Jia, Springer, 4th edition, 2006, ISBN 3-540-251128-6

Lecture materials and references posted on eCampus

Grading

10 point break-out system	90.0 – 100 = A Excellent 80.0 - 89.9 = B Good 70.0 – 79.9 = C Satisfactory 60.0 – 69.9 = D Passing 00.0 – 59.9 = F Fail
Lab assignments	25 % (due at the beginning of the following lab period)
Project	25 %
Paper presentation	15 % (includes grading of <u>asking</u> and <u>answering</u> questions)
Visualization	10 %
Final exam	25 %

Lab assignments: All lab work is due at the **beginning** of the following lab period. All laboratory and homework assignments are to be completed in a neat, logical, and clear fashion.

Late assignments: A 10% reduction in grade, up to a maximum of 50%, will be assessed for each weekday an assignment is handed in late. Assignments will not be accepted if more than 5 weekdays late, unless documented excuse is presented as per Texas A&M University rules.

Important dates

		% of project grade
Project proposal:	Feb 22	5%
Project progress report:	March 22	10%
Visualization	March 29	
Project presentations:	April 26	15%
Project paper due:	May 3 at noon	70%
Final exam:	May 5, Friday, 10:30 a.m.-12:30 p.m., online, in the lab	

Student paper presentation dates: check schedule on eCampus

Tentative course and laboratory outline

Week	Topic
1	Definition of terms; Visualization of remote sensing data; Electromagnetic spectrum and radiation laws as they relate to remote sensing. Review of ENVI image processing.
2	Active and Passive sensors, sensor platforms (airborne & satellite). Review of the remote sensing process. Understanding the capabilities of today's sensors for various types of applications. Decision tree analysis. Decision tree classifiers.
3	Advanced image processing. Review of basic concepts and methods of image classification. Hybrid classifiers. Object-oriented image classification (1).
4	High resolution imaging satellites and applications. High-resolution digital airborne imagery. Image analysis and processing issues. Object-oriented image classification (2).
5	Image statistics, spatial statistics. Image processing considerations and processing techniques, machine learning techniques: SVM classifiers.
6	Machine learning: Random Forest. Random Forest implementation.
7	Active sensors: lidar. Sensor types: waveform vs. small footprint with intensity. Lidar instrumentation. Basic lidar concepts. Terrestrial lidar scanning. Airborne lidar data processing.
8	Lidar-derived elevation: bare Earth DEMs and applications in urban areas, topographic mapping, forestry. Lidar forest measurements.
9	Lidar image geometry. 3D feature extraction. FUSION – lidar data processing.
10	Planning a lidar acquisition; deciding upon data collection characteristics. Fusion with multispectral data. Lidar data visualization.
11	Structure from motion, 3D point generation from aerial imagery, UAV/UAS
12	Hyperspectral remote sensing. Current sensors and applications in natural resources. Hyperspectral information extraction.
13	The digital revolution in remote sensing: What's next? Final exam review
14	Project presentations.

Laboratory, Homework, and Exam policy

The University policy on Scholastic Dishonesty will be enforced in this course. While you are encouraged to help each other understand concepts and techniques, all work submitted should be your own. Exceptions to this policy will be explicitly noted by the instructor and should not be assumed by students. Make-up exams will not be offered. If you are going to

miss an exam for a valid reason (documented per University rules), **contact the instructor** well in advance.

All laboratory assignments are to be completed in a neat, logical, and clear fashion. A 10% reduction in grade, up to a maximum of 50%, will be assessed for each weekday an assignment is handed in late. Assignments will not be accepted if more than 5 weekdays late, unless documented excuse is presented as per TAMU guidelines.

Note: your lab teaching account is deleted at the end of the semester. Please save all class data before semester ends.

Laboratory reports

Unless otherwise indicated, all laboratory exercises must contain a brief report following the format guidelines given below. The report should be divided into **Introduction, Methods, Results and Discussion, and Conclusions** sections, and should tie together and synthesize the lecture, readings, and practical exercises. In the Methods section do not include a list of ENVI/eCognition or other software commands that you have used. Give instead the big picture of your approach and the remote sensing/image processing methods that you have used. You may include an appendix of software menus/commands used, for future references. Figures and tables inserted in the text are encouraged. When appropriate, include snapshots of your imagery in the report, mainly in the Results section, but no larger than half a page. Each laboratory exercise will be due the following laboratory period, at the beginning of class, unless otherwise indicated. Instructor may give extra credit to students that engage in developing the assignment beyond the required tasks, e.g., extra programming developments, extended literature search and citations on the topic, etc.

Projects

Each student is required to design and implement a class project as a **group** project, ideally 2 students in a group. Single-student projects are acceptable. The project must use digital image source data and the student must develop a specific output product useful in his own field of interest for applying remote sensing. The project is designed to (1) build upon and synthesize techniques or concepts demonstrated in class, and (2) let you explore your own data sets and research objectives using your developing remote sensing "toolkit." Work that contributes to your thesis research or current employment is encouraged. All projects require instructor approval.

A proposal (150-word maximum) and outline describing the project and **proposed methods** must be turned in by the date indicate in the *Important dates* section. However, students are encouraged to turn in proposals as soon as is feasible. The proposal/outline should contain at least **five** preliminary references. The final report must be no more than twenty pages in length including figures and references, and the final report and summary/outline must follow the format guidelines for papers and laboratory reports. Failure to follow these guidelines will result in the paper not being accepted. The final report must include an **abstract** of no more than **150 words** that is succinct and informative without reference to the text. This should be followed by the **Introduction (including a thorough literature review, with Background and Objectives), Methods, Results, and Discussion/Conclusions.**

Keep in mind that these are semester projects. Laboratory time will be provided for work on your project during the semester, but will be insufficient by itself. A 2-5 page project progress report is required at the start of class as indicated in the *Important dates* section. Well-chosen student projects may be suitable for **subsequent publication** in either

conference proceedings or the peer-reviewed literature. Please keep this goal in mind as you develop and carry out your projects, and particularly as you prepare your final reports.

Format Guidelines for Papers and Laboratory Reports

Papers and lab reports must be double-spaced (using a 12-point proportionally-spaced font) with 1 inch margins all around. Captions, references, footnotes, appendices, tables, etc. may be single-spaced. Figures and tables are encouraged when they serve to illustrate or clarify a point and they should be inserted in the text. Each page following the first full page of text should have a page number in the upper right corner or bottom center. A title page may be supplied; however, reports in special binders of any kind will generally not be accepted. In text citations and references should follow the guidelines for manuscripts submitted for publication to the *American Society of Photogrammetry and Remote Sensing* (<http://www.asprs.org/publications.html>), for *Photogrammetric Engineering and Remote Sensing (PE&RS)*. Lab reports should be emailed to the TA and placed in the class drop-box (TA will provide additional instructions). Final projects must be prepared using the same criteria. Students are required to keep **electronic** copies of all work submitted.

Student paper presentations

Each student will present at least one scientific paper published in a remote sensing **refereed journal** throughout the course (approx. **20 min**, including questions (15+5min)). Students should consult the presentation dates in the “Important dates” section and decide by the second week of classes when they intend to present. Instructors may assign presentation dates, as well. Each student is expected to find **three** research papers published in **peer-reviewed** remote sensing journals that fit the topic of interest for his/her research and ideally **match** lecture topics covered during the week of the presentation. At least one week before the scheduled presentation date, the student should make the three papers available to the instructor and consult to decide on **one of the three** papers to be presented in class. Students will make the chosen paper available as **pdf** to the instructor, to be posted on eCampus a week in advance of the presentation date. Each student is required to prepare at least **one question** for the presenter and email it in advance of the presentation date. Questions should indicate depth of thought and familiarity with the topic covered in the paper. Presentations should clearly present research objectives, methods, results, conclusions, and implications for his/her own research. It is expected that the presenter will critically evaluate the work presented in the paper. The presenter should best address questions from class mates on the last few slides of the presentation. Grades reflect on both the presentations and the questions asked throughout the semester. Recommended journals: *Remote Sensing of Environment*, *Photogrammetric Engineering & Remote Sensing*, *Canadian Journal of Remote Sensing*, etc.

Aggie Code of Honor

***Aggies do not lie, cheat, or steal,
nor do they tolerate those who do.***

The Aggie Code of Honor functions as a symbol to all Aggies, promoting understanding and loyalty to truth and confidence in each other. <http://www.tamu.edu/aggiehonor>

Americans with Disabilities Act

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, currently located in the Disability Services building at the Student Services at White Creek complex on west campus or call 979-845-1637. For additional information, visit <http://disability.tamu.edu>.