GEOP 5336: DIGITAL IMAGE PROCESSING

The University of Texas at El Paso Department of Geological Sciences
Spring Semester 2020

Instructor:

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Class Online Materials:

Check the Blackboard site for this course often for updates and announcements. The online materials are a key part of the class and Blackboard will be the venue for a lot of important class business. In addition, we will use a server on the Department network for access to a shared drive for submission of course work.

Class Meetings:

Lecture/Lab: Tues and Thurs., 1:30-2:50 pm (Geology 320 or Geology 409)
Office Hours: Mon. and Wed. 1-3 pm (Geology 301A) or by appointment

Text:

There is no required text to purchase. Course materials will be provided in the form of PDF readings and class notes as well as journal articles from the literature, and these will be made available via the class website and/or the class shared drive.

The following books, while recommended, are not required purchases:

Jensen, 2016, *Introductory Digital Image Processing: A Remote Sensing Perspective* (4th edition): Pearson (ISBN 9780134058160, 013405816X)

Jensen, 2007, *Remote Sensing of the Environment: An Earth Resource Perspective* (2nd edition): Pearson, p. (ISBN 9780131889507)

Gonzalez and Woods, 2018, *Digital Image Processing* (4th edition): Pearson, 1168 p. (ISBN: 9780133356724)

Gonzalez, Woods, and Eddins, 2020, *Digital Image Processing Using MATLAB* (DIPUM) (3rd edition): Gatesmark Publishing, 1009 p. (ISBN: 9780133356724)

In addition, the documentation for Python, JavaScript, QGIS, Google Earth Engine, MATLAB, and ENVI will be critical resources during the semester. The following websites will also be good resources:

- The Remote Sensing Tutorial: https://geoinfo.amu.edu.pl/wpk/rst/rst/Front/overview.html
- NRC Remote Sensing Tutorials: https://www.nrcan.gc.ca/maps-tools-publications/satellite-imagery-air-photos/tutorial-fundamentals-remote-sensing/9309
- The Remote Sensing Core Curriculum: https://rscc.umn.edu/
- USGS Spectroscopy Laboratory: https://www.usgs.gov/labs/spec-lab
- Spectroscopy of Rocks and Minerals, and Principles of Spectroscopy: https://archive.usgs.gov/archive/sites/speclab.cr.usgs.gov/PAPERS.refl-mrs/refl4.html (Clark, 1999)
- Companion website to the DIP and DIPUM books: http://www.imageprocessingplace.com
- Google Earth Engine Developers Page: https://developers.google.com/earth-engine

Grading:

Lab assignments (45%); midterm exam (15%), final exam (15%); final project (15%), participation (10%).

Lab work will normally be assigned and due on Thursdays. Note that most assignments will be turned in electronically. Storage space, data, and software will be made available to you on the Geology department computer system. Therefore, you will all need accounts to access to the UTEP open-lab PCs on the 4th floor. Contact me AND the system administrator, Carlos Montana (montana@geo.utep.edu), if you do not have access already. Also be sure to contact BOTH of us for any technical problems throughout the semester. Carlos will be the one to fix things, but also I need to know what is going on.

Graduate students will be held to a higher standard than undergraduates. For example, selected homework assignments/problems/tasks and selected exam problems may be designated as required for graduate students and extra credit for undergraduates, there may be different exam questions, etc.

Policies:

Show up, show up on time, and show up prepared! Do each reading assignment before attending class, and come to class meetings with questions about what you read and about material from the previous class meeting. Attendance and class participation in both lecture and lab are required. **I reserve the right to drop you from the course if you have excessive absences.** Please **contact Dr. Hurtado about any concerns, schedule conflicts, missed work, etc. ASAP and, whenever possible, in advance.** Valid excuses include illness, absence with the instructor's prior approval, official University business, etc., but **all require documentation**. Unless other arrangements with the instructor are made, **late work will lose 50% of its value for each day it is late, and work will not be accepted more than one week late**. In general, **make-up exams and assignments will not be given**.

If you are a military student with the potential of being called to military service and /or training during the course of the semester, you are encouraged to contact as soon as possible.

If you think you may have a disability or if you are experiencing learning difficulties, please contact the Disabled Student Services Office (DSSO) at (915) 747-5148. They're located in Union East room 106 or you can reach them by e-mail at dss@utep.edu. The student is responsible for presenting to the instructor any DSS accommodation letters and instructions.

While **collaboration on assignments is encouraged**, the intent is to foster problem-solving skills and mastery of the subject matter, not just a quick way to get "answers". **All work is expected to be your own!** The University guidelines for acceptable student conduct are very specific and will be strictly followed. Please read the guidelines (see http://studentaffairs.utep.edu/dos), and contact the Dean of Students or Professor Hurtado if you have any concerns.

Expectations:

The goal of this course is for you to attain a firm understanding of the processing of (remotely-sensed) digital images in the context the Earth and environmental sciences. You will learn how, why, and when to apply digital image processing techniques in order to produce image products of value in answering scientific questions in your own research. The emphasis in this course will be on applications and basic concepts, but there will be mathematical treatments of topics in statistical analysis, Fourier analysis, and principal components analysis, among other topics. Students will be given access to state-of-the-art computer facilities and some instruction on how to use the popular image processing software ENVI* and Google Earth Engine in conjunction with QGIS. Students can also expect to gain proficiency in basic MATLAB, JavaScript, and Python programming in the course of the laboratory work**. There will be emphasis on independent work towards a term project. Students are expected to be active participants in the class and laboratory discussions and will be asked to make presentations in class. In particular, the results of term projects will be presented orally.

**Nominally, students will be assumed to have taken the prerequisite course GEOP 4335 (Remote Sensing), or equivalent, and have some experience with ENVI or similar software. This is not a hard requirement, though.*
***Note that there is no expectation of prior experience or proficiency with MATLAB, JavaScript or Python.*

Course Outline:

Note that the details of our schedule are likely to change as the semester progresses. Please be flexible, and let Professor Hurtado know if you have any concerns or suggestions. A preliminary, detailed schedule is attached.

Week #	Meeting Dates (TTh)	Lecture Topics (TTh) (readings and handouts to be provided)	Lab Assignment (Th)
Week 1	Jan. 21, 23	Review of Remote Sensing; Introduction to Signal and Image Processing (Jensen Ch. 1, 6; DIP Ch. 1; DIPUM Ch. 1)	Lab 1: Introduction to MATLAB
Week 2	Jan. 30; No class Jan. 28	Review of Remote Sensing; Introduction to Signal and Image Processing <continued>	Lab 2: Introduction to Google Earth Engine
Week 3	Feb. 6 No class Feb. 4	Digital Images; Image Math and Statistics; (Jensen Ch. 4, 5; DIP Ch. 2; DIPUM Ch. 2)	Lab 3: Image Pre-Processing with Google Earth Engine
Week 4	Feb. 11, 13	Image Pre-processing (Geometric and Radiometric) (Jensen Ch. 7; DIP Ch. 2, 3; DIPUM Ch. 2, 3, 6)	Lab 4: Image Processing with Google Earth Engine, Part I
Week 5	Feb. 18 No class Feb. 20	Spatial-Domain Filtering (Jensen Ch. 8; DIP Ch. 3; DIPUM Ch. 3)	Lab 5: Image Processing with Google Earth Engine, Part II
Week 6	Feb. 25, 27	Frequency-Domain Processing (Jensen Ch. 8; DIP Ch. 4, 8; DIPUM Ch. 4, 7)	Lab 6: Image Enhancement (MATLAB)
Week 7	Mar. 3 No class Mar. 5	Image Enhancement and Reconstruction (Jensen Ch. 8; DIP Ch. 5; DIPUM Ch. 5)	Lab 7: Spatial and Frequency Domain Processing (MATLAB)
Week 8	Mar. 10, 12	Image Transforms; Principal Components (Jensen Ch. 8)	Lab 8: Image Statistics and Principal Component Analysis (MATLAB)
Week 9	Mar. 24, 26	Morphology and Segmentation; Classification; Color Image Processing (Jensen Ch. 8, 9, 11, 12; DIP Ch. 6, 9, 10; DIPUM Ch. 7, 10, 11)	*Lab 9: Multispectral Classification, Machine Learning*
Week 10	Mar. 31, Apr. 2	Morphology and Segmentation; Classification; Color Image Processing (Jensen Ch. 8, 9, 11, 12; DIP Ch. 6, 9, 10; DIPUM Ch. 7, 10, 11)	*Lab 10: Image Segmentation, Object Detection, Computer Vision*
Week 11	Apr. *7*, *9*	*No class meetings*	
Week 12	Apr. 14, 16	Change Detection (Jensen Ch. 12)	*Lab 11: Change Detection*
Week 13	Apr. 21, 23	*TBD*	
Week 14	Apr. *28*, *30*	*No class meetings*	
Week 15	May 5, 7	Present final projects	