Geo382- Remote Sensing and Imagery Analysis
Fall 2009

Course Objectives:

This class is designed to help you become a savvy remote sensing analyst who can:

1. Determine the appropriate imagery to solve a geospatial problem (GPO 1.1, 5.3)*
2. Acquire and manipulate imagery to enhance analysis of surface materials (GPO 1.1, 1.2)
3. Produce and evaluate a map of surface materials extracted from imagery (GPO 1.3)

In order to do these you are going to need to acquire the following knowledge:

A. How electromagnetic radiation interacts with the earth's surface at different wavelengths
B. The response of common surface materials (e.g. water) at different wavelengths
C. How satellite and airborne platforms record and store this response
D. How to correct for this storage process
E. The spectral, spatial and temporal resolutions of various satellite platforms
F. How to use band combinations, histograms and band ratios for image enhancement
G. Classification methods for extracting information into maps
H. How to assess the accuracy of the resulting maps

*These are the Geospatial Program Objectives that list the skills our majors should have at the end of their 4 years at USAFA. See end of Syllabus for complete list.

Course Plan:

You will demonstrate your mastery of the course objectives through Exams and a Final Project.

Exams: The two exams in the course are open book. Why? Because they are testing decision-making and application, rather than memorization. They will be focused on using your knowledge of remote sensing for selecting and evaluating the correct technique or imagery to solve a problem. There will be closed-book quizzes during the semester to serve as checkpoints in preparation for the exams.

Final Project: The final project is an analysis of any Landsat image of your choice. The final project is a write-up that discusses all the analysis techniques that you have learned in the class. You will get practice for the final project from the 6 lab exercises due throughout the course.

Class time: Class time will be a mixture of lecture, discussion, and practice exercises.

Required textbook

Remote Sensing and Image Interpretation, T.M. Lillesand, R.W. Kiefer, and J.W. Chipman. *(2008)* John Wiley & Sons. Sixth Edition ISBN 978-0-470-05245-7

This text is a resource for you, both for this class and beyond. I will provide reading questions to guide your reading and as a basis for class discussion. There are no points attached to the questions, but I encourage you to keep up with them as practice for the exams.

Have questions? Need to contact me?

Sarah Robinson, Ph.D.
Assistant Professor of Geosciences
Phone: 333-9287
Email: sarah.robinson@usafa.edu

Course Outline:

Lesson	Objectives	Reading Due	Due Dates	Notes	Objectives
1	**Why remote sensing?** • Introductions • Outline of course • Advantages of Remote sensing • Case Study-pre test				1
2	**History of Remote Sensing** • Quiz Syllabus • Trends in remote sensing history • Why Landsat was such a watershed event. • Key terms	Campbell Intro Chapter			1, C
3	**Electromagnetic radiation principles** • Parts of the EM spectra • Paths of EM energy from source to sensor • Equations that control source energy	LK 1-12			1, A
4	**How sensors record information** • Resolutions • Common materials • Reference libraries • RGB combinations	LK 12- 24			1,A,C,D
5	**RGB practice** • Intro to Imagine • RGB practice			4J17	2, F
6	**Multispectral Analysis -Sensors** • Landsat Bands • Ikonos • Quickbird • SPOT • Temporal resolution vs. pixel size • Ground swath vs. pixel size	LK 397-419 Plate 18 432-481 for reference			1, E
7	**Lab Exercise** • Landsat Bands • Lab 1	LK 411		4J17	1, E
8	**DN-Radiance-Reflectance** • Atmospheric interactions • Convert DN-radiance-reflectance	LK 23-24, 490-494			1, D
9	**Lab Exercise** • Lab 2		Lab 1 due	4J17	1, C, D
10	**Histograms** • Quiz on EM basics and sensors • What is a histogram	LK 499-509	Quiz		2, F
11	**Histograms** • Histogram stretches • Choosing a stretch • Lookup Tables	LK 499-509			2, C, F
12	**Lab Exercise** • Histogram stretches			4J17	2, F
13	**Final Project time** • Select your image	LK 414-419, 406-409	Lab 2 due	4J17	1, C, D

14	**Band ratios** • Band ratios- two bands in one • Advantages disadvantages	LK 523-527			2, F
15	**Band Ratios** • NDVI • Mineral ratios • Choosing a ratio	Egypt Paper			2, F
16	**Lab Exercise** • Lab 3		FP part 1 due	4J17	2, F
17	**Classification** • Why? • Types of classification • Advantages	LK 7.7, 7.11, 7.16			3, G
18	**Classification** • QUIZ sensors, histograms, ratios • Density Slicing • Unsupervised classification	LK 7.8-7.10	QUIZ		3, G
19	**Classification** • Unsupervised • Supervised	LK 7.8-7.10			3, G
20	**Lab Exercise** • Lab 4			4J17	3, G
21	**Lab Exercise** • Lab 4		Lab 3 due	4J17	3, G
22	**Accuracy assessment** • How good is your map? • Omission vs. Commission • The myth of “overall” accuracy	LK 7.17			3, G, H
23	**Accuracy assessment** • Sampling • Effects on accuracy	LK 7.17			3, G, H
24	**Lab Exercise** • Lab 4			4J17	3, G, H
25	**Project Time**		Lab 4 Due	4J17	1,2,E, F
26	**Project Time**			4J17	1,2,E, F
27	**QUIZ and Project Time** • Quiz on Classification	LK 5.9-5.13	Quiz	4J17	3, G, H
28	**Thermal Imagery** • Emissivity vs. reflectance • Temperature	LK 5.9-5.13			1, A, B, C
29	**GR** • Up to and including accuracy assessment		GR		
30	**Thermal Imagery** • Diurnal temperatures • Application to Geology	LK 5.9-5.13			1, A, B, C
31	**Lab Exercise** • Lab 5			4J17	1, A, B, C

32	**Radar** • Active vs. Passive sensor • Polarizations • Surface Roughness • Corner Reflectors	LK 8.1-8.7	FP part 2 due		1, A, B, C
33	**Radar:** • Relief displacement • Applications to archaeology • Soil/Veg/Water/Urban response	LK 8.8			1, A, B, C
34	**Lab Exercise** • Lab 6	LK 5. 14, 7.19		4J17	1, A, B, C
35	**Aerial Photography** • Distortions • Calculating height	LK 3.1-3.6			1, A, B, C
36	**Aerial Photography** • Calculating area • Orthophotos	LK 3.1-3.6	Lab 5 and 6 due		1, A, B, C
37	**New Frontiers** • Hyperspectral • Lidar	LK 8.23, 5.14			1, A, B, C
38	**Quiz/New Frontiers** • Quiz Thermal/ Radar and Aerial photography • Hyperspectral • Lidar		Quiz		1, A, B, C
39	**Course Review** • Case Study • Course evaluations		FP part 3 due	4J17	1,2,3 A-H
40	**GR2**		GR		1,2,3 A-H

Graded Events

9*	Lab 1	40
10*	Quiz 1	55
13*	Lab 2	40
16*	FP part 1	50
18*	Quiz 2	55
20*	IP	15
21	Lab 3	40
25	Lab 4	60
27	Quiz	55
29	GR	140
32	FP part 2	150
36	Lab 5 and 6	50
38	Quiz	55
39	FP part 3	40
40	GR	140
40	IP	15
	TOTAL	1000

* PROG

Assignments

Lab Exercises: These are assignments designed to reinforce concepts discussed in class and prepare you for the final project. There will be class time to work on these labs, but many of them will require you to spend additional time outside of class to complete them. You can discuss these labs with anyone, but the answers and processing must be your own (ie your fingers on the keyboard!!). You must document any discussion you have, including those during class time.

Quizzes: The quizzes are closed book and designed to be road checks on your knowledge. They are 30 minutes in length and include multiple choice, short answer, and fill in the blank questions.

GRs- GRs are open-note/open book. They are open ended questions and scenarios designed to assess your ability to apply class knowledge.

Final Project- The final project is a report on a Landsat image of your choice using the analysis techniques learned in class and practiced in the lab. You will identify and acquire a Landsat scene, preprocess it to remove any distortions, apply several analytical techniques, create a map of the area, and assess the quality of the map. In addition, you will assess the applicability of thermal and radar imagery to your area.

Administration

Attendance:

You are expected to be at each class; class is a crucial component in successfully learning and achieving the course objectives and is a mandatory military duty. As with any duty, you are expected to show up on time, in proper uniform, and ready to participate.

Inform me of absences or late arrivals ahead of time BY EMAIL. Put the word "Absence" or "Late" and the lesson number (ex. T36) in the email subject line; include the reason for the absence, SCA, etc. in the body of the email. Do not combine these absence emails with other questions; if you have questions about the class put them in another email. Again, email me about absences, even if you tell me about them in class. Missing class for an illness or injury may only be authorized by your AOC or medical provider.

If you will be absent from a GR or in-class assessment, you must inform your instructor in advance to arrange a make-up. If absent (unexcused) on a lesson in which an assessment was administered, you will receive a 25% penalty and an AFCW Form 10 (per USAFA FOI 36-173) and must take the makeup by the following lesson.

Extra Instruction (EI):

You know best when you are falling behind or don't clearly understand the material and need EI. You are expected to come to EI with specific questions or problems that are confusing. These questions need to be more specific than "I don't understand Remote Sensing."

You are encouraged to take advantage of this valuable resource. To maximize your time and ensure instructor availability, the best method is to schedule EI ahead of time via email. I teach M2, M3, and M4 so will be unavailable for EI during these times.

Late Policy:

Turning in assignments late will hurt your grade in this course. Unless documented otherwise by your instructor, assignments are due at the beginning of the hour that your section meets on the due date. If you will be absent, you must make arrangements to turn in your assignment at or before this time. Late assignments will be penalized as follows:

- Turned in by beginning of class- considered on time.
- Turned in by close of business on due date: 10% penalty

- Turned in by beginning of first lesson after due date: 25% penalty
- Turned in by beginning of second lesson after due date: 50% penalty
- No credit for work turned in after second lesson after due date

If you are turning in an assignment and I am not in my office, write the time/date you are turning in the assignment and put it under my office door.

Documentation Statements required on all assignments.
Place a documentation statement on all assignments turned in for grading, except GRs, personal journals, and no-notice homework (per USAFA FOI 36-173). If you did not receive help from outside sources, you MUST still include the statement, "Documentation: None." If you fail to do so, I reserve the right to take points off the assignment for failure to provide a documentation statement. The bottom line is that all sources used must be properly documented.

Academic Integrity/Academic Standards:
Instructors and students will comply with all policies and procedures regarding academic integrity and academic standards. You will accomplish your own academic work unless otherwise stated in writing for a specific assignment. If you are in violation of academic standards, you may receive 0 points for an assignment that is not original work or properly documented (whether or not an Honor Code violation is suspected).

Do not plagiarize:
Representing the words or ideas of others, including other cadets, as your own is plagiarism. Document your sources properly, and grant credit where credit is due. Either quote directly or paraphrase the material of others. Understand that replacing a couple of words with synonyms does not constitute paraphrasing. You have paraphrased when you have understood and synthesized another's thoughts and restated these ideas in your own original, unique way. Remember, even a paraphrase of another's work must be acknowledged by proper documentation. Penalties are stiff: an "F" (0 points) for the assignment, and the possibility of an "F" for the course.

Program Outcome*: The Geospatial Science Program is designed to develop officers who can:

1.0 communicate spatial information by
- *1.1 locating and acquiring primary geospatial data,*
- *1.2 manipulating and analyzing geospatial data, and*
- *1.3 interpreting and presenting geospatial information through written, oral, and graphical presentation;*

2.0 analyze the Earth's physical form, processes, and biota by
- 2.1 identifying the components of the four physical spheres for any given geographic location;
- 2.2 identifying the importance and spatial distribution of natural resources; and
- 2.3 analyze the relationship between the Earth's physical form and biota;

3.0 synthesize the spatial characteristics, distributions, cultural differences, and interactions of human populations by
- 3.1 identifying the characteristics, distribution, and migration patterns of human populations,
- 3.2 comparing and contrasting the characteristics, distribution, and complexity of global cultures, and
- 3.3 interpreting and applying environmental and resource allocation data to human patterns;

4.0 synthesize how relationships between humans and the physical environment impact the battle space by
- 4.1 illustrating how humans modify the physical environment and
- 4.2 illustrating how the physical environment impacts human settlement; and

5.0 solve ill-defined geospatial problems by
- 5.1 identifying and defining a geospatial problem,
- 5.2 formulating potential solutions and a hypothesis,
- *5.3 identifying applicable geospatial resources,*
- 5.4 determining a solution, and
- 5.5 evaluating the solution.

USAFA Outcomes: USAFA outcomes provide faculty and cadets focus to ensure that, together with the military and athletic components of your academy experience, we produce officers of character ready to lead our Air Force in service to the nation. The USAFA Outcomes are to produce officers who are:

1.0 Committed to Societal, Professional, and Individual Responsibilities
- 1.1 Ethical Reasoning and Action
- 1.2 Respect for Human Dignity
- 1.3 Service to the Nation
- 1.4 Lifelong Development and Contributions
- 1.5 Intercultural Competence and Involvement

2.0 Empowered by integrated Intellectual and Warrior Skills
- *2.1 Quantitative and Information Literacy*
- *2.2 Oral and Written Communication*
- *2.3 Critical Thinking*
- *2.4* Decision Making
- 2.5 Stamina
- 2.6 Courage
- 2.7 Discipline
- 2.8 Teamwork

3.0 Grounded in essential Knowledge of the Profession of Arms and the Human & Physical Worlds
- 3.1 Heritage and Application of Air, Space, and Cyberspace Power
- 3.2 National Security and Full Spectrum of Joint and Coalition Warfare
- 3.3 Civic, Cultural and International Environments
- 3.4 Ethics and the Foundations of Character
- 3.5 *Principles of Science and the Scientific Method*
- 3.6 Principles of Engineering and the Application of Technology

*Italicized outcomes are specific to this course