GR/NR 503
Remote Sensing and Image Analysis

Course number and title: GR/NR 503

Credits: 4

Term(s) to be offered: Fall (MWF with lab on Thursday)

Prerequisite(s): None

Course Description: Interpretation and analysis of photographic, multispectral scanner, and radar data; sensor systems; applications to resource management.

Illustrative Course Content: Remote sensing theory and practice, systems and applications; characteristics of sensors and data; image processing; integration with GIS. Course is delivered mainly as a lecture course; labs provide hands-on learning and provide the student the opportunity to work through case study material related to lecture material.

Instructor: Stephen Leisz or Michael Lefsky. (Taught by each in alternating years)

Text(s): Aronoff, Remote Sensing for GIS Managers, ESRI Press, or Lillesand, Kiefer, and Chipman Remote Sensing and Image Interpretation, Wiley

Additional Class Material: ERDAS Imagine software, ArcGIS software, handouts on specific topics (on RamCT); Articles from the International Journal of Remote Sensing and Photogrammetric Engineering and Remote Sensing.

Course Objective(s): After this class, students will: (1) know the physical principles underlying remote sensing; (2) know how the primary remote sensing data collection systems work (e.g. satellite sensors, aerial photographic systems, radar, lidar, etc.); (3) master and apply methods of interpreting and analyzing remote sensor data; (4) be able to apply some of the many varied uses and applications of remote sensing to various disciplines across the social and natural sciences, in the modern work place, and in the natural resource management and social science research communities.

Course Topics/Weekly Schedule (Note: (1) italics indicate course material that goes beyond what is covered in GR/NR 323; (2) there is an extra lecture each week for graduate students students in GR/NR 503 that provides added material beyond what is covered in GR/NR323; (3) two extra quizzes are given to graduate students in GR/NR 503, not included in GR/NR 323):

Week 1: Introduction: The history and evolution of remote sensing
Week 2: Basics of Remote Sensing: The foundation of aerial photography and satellite remote sensing: the principles of electromagnetic radiation and its interaction with the earth’s atmosphere; Introduction to ERDAS. (handout)
Week 3: Basics of Remote Sensing: Photographic systems: photographic cameras, digital cameras, filters, film, and videography; Data Models – Quiz 1

Week 4: Basic principles of photogrammetry: the geometry of air photos, scale, area measurement, relief displacement, radial displacement, parallax; digital photogrammetry – Quiz 2

Week 5: The fundamentals of visual interpretation for air photos and satellite images; spatial analysis

Week 6: Multispectral, hyperspectral, and thermal remote sensing systems; Spectral analysis - MID-TERM 1

Week 7: Spaceborne sensors: Characteristics of satellite based sensors; spectral transformation

Week 8: Digital image analysis: Introduction to images; remote sensing of vegetation – Quiz 3

Week 9: Digital image analysis: Image enhancement; radiometric correction I

Week 10: Digital image analysis: image classification 1 – unsupervised classifications; radiometric correction II – Quiz 4

Week 11: Digital image analysis: image classification 2 – supervised classifications; continuous approaches to thematic analysis - MID-TERM 2

Week 12: Digital image analysis: image classification 3 – hybrid classifications; hyperspectral remote sensing I

Week 13: Digital image analysis: Change analysis; hyperspectral remote sensing II

Week 14: Accuracy assessment and error propagation; Advanced LIDAR I – Quiz 5

Week 15: Microwave remote sensing: RADAR and LIDAR; Advanced LIDAR II

Week 16: FINAL EXAM

Instructional Methodology: Two days a week the class will meet in a mixed lecture/discussion format. The lecture will focus on the key points of each week’s topic and make use of computer displayed examples and demonstrations. Discussion and questions will be encouraged. Each week’s two lab sessions will provide (1) additional information on and enhanced opportunities for investigating in greater depth the weeks subject, and (2) practice in applying the methods demonstrated in the class lecture period. Examples of how remote sensing is applied to social science research, international development work, disaster relief, natural resource management, and in the contemporary workplace will be interwoven throughout the lectures. Labs will utilize cases drawn from the real-world as much as is possible.

Mode of Delivery: Classroom instruction via lecture / discussion format and remote sensing laboratory work on computer platforms.

Methods of Evaluation: Students will be evaluated on the basis of their weekly lab work, three quizzes, and three exams. Note that lab work, quizzes and exams for GR/NR 503 will cover additional material that is presented beyond what is covered in GR/NR 323 as reflected in the above course topics/weekly schedule.

Quizzes: Five quizzes will be given during the semester. The date of each is indicated on the schedule, but is subject to change. Question format will be varied, and may include multiple-choice, fill-in, matching, true and false, problems, essay, and identification type questions. In general, each quiz will emphasize the material covered
since the previous quiz or exam, including the material discussed in the previous lecture period.

Examinations: Three examinations will be given. The first two exams will include all materials assigned or presented through the previous week. The question format for all tests will be similar to that on the quizzes. The Final Exam will be given during the regular final exam week (16th week of the semester). It will include all material covered during the semester, but will emphasize the material covered since the second Exam.

Lab work: Each lab will explore a concept related to remote sensing that is covered in lecture. As an example the first lab will explore how a spectral signature is interpreted from a Landsat Thematic Mapper Image; the second lab will task the student with creating an uncontrolled photo mosaic in the ArcGIS environment and a controlled photo mosaic in the ERDAS Imagine computer environment; the third lab will have the student doing specific photogrammetric measurements manually and in a digital environment; the fourth lab will have the student visually interpreting land cover using Landsat Thematic Mapper Imagery and aerial photographs, the fifth lab will have the student carrying out an unsupervised classification of a Landsat Thematic Mapper Image and of an ASTER Image; the sixth lab will have the student carrying out a supervised classification of a Landsat Thematic Mapper Image and a Landsat MSS Image; the seventh lab will have the student carrying out an accuracy assessment of the unsupervised and supervised classifications; the eighth lab will have the student do a land cover change analysis using outputs from lab 6 and 7; the ninth lab will have the student carry out an object oriented classification of Ikonos high resolution imagery and carry out an accuracy assessment on the outputs; the tenth lab will have the student investigate the properties of hyperspectral satellite imagery; and the eleventh lab will have the students utilize LIDAR information to determine elevation gradients over a landscape. All labs will be graded on a 0 to 50 scale. 50 will indicate a total mastering of the material presented in the lab. Decreasing scores will indicate less of a mastery of the material. (Note: the following is a list of the extra lab material in GR/NR 503 that is not covered in GR/NR 323: (1) lab 2 includes students creating a controlled photo mosaic in the ERDAS Imagine computer environment; (2) lab 6 includes working with Landsat MSS Imagery; (3) lab 8; (4) Lab 10; (5) Lab 11.)

Course Grade: Final course grades will be assigned on the basis of the following weights:

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight</th>
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<tbody>
<tr>
<td>Quizzes</td>
<td>25%</td>
</tr>
<tr>
<td>First and second exams</td>
<td>25% (12.5% each)</td>
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<tr>
<td>Final exam</td>
<td>25%</td>
</tr>
<tr>
<td>Laboratory exercises</td>
<td>25%</td>
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Grading scheme:
A = 90 – 100%
B = 80 – 89%
C = 70 – 79%
D = 60 – 69%
F = < 60%

(no plus / minus)