SYLLABUS

AAE523: Introduction to Remote Sensing

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Motivation

Observing changes in the Earth's oceans, atmosphere and land masses is a very important activity for understanding both the long-term evolution of our planet and its climate, as well as for near-term prediction of weather and natural disasters. Although some variables describing these processes can be measured directly, with "in situ" sensors, frequent global or regional sampling will require indirect observation using electromagnetic radiation. Robotic exploration of the solar system also makes use of remote sensing techniques and instrumentation. In both Earth and planetary sciences, remote sensing from satellite or aircraft involves a complex system of interacting components, each of which can have a defined effect on the accuracy, resolution, and sampling of the desired quantities. A proper understanding of the errors, biases, and limitations of these products requires an understanding of this processing chain starting with the fundamental phenomenology of the measurement, the basic operating principles of the instrument that made the measurement, the required calibration/validation approach, and the inversion of the observations to produce the data product.

A broad goal of this course is to show the interrelationship between the science needs and the engineering approach to design space and airborne systems meeting those needs. On the other hand, scientists in a variety of fields, including oceanography, hydrology, agriculture, planetary sciences and even some social science fields, make use of remote sensing data. The proper application of remote sensing data to observe changes on the Earth or other planets and to assimilate these data into models requires an understanding of their sources.

Course Objectives

To provide students an overview of the key elements of Earth remote sensing systems, including instruments, satellite (and to a lesser degree, airborne) platforms, data processing and orbit/mission design.

Intended Audience

This course is intended for students in both engineering and the sciences who have interests in either the design and development of remote sensing systems, or in the application of remote sensing to their field of study.

Prerequisites

Graduate standing in engineering or science. AAE301, ECE301 or equivalent (linear signals and systems), and AAE203 or equivalent (classical mechanics), or permission of the instructor. No prior background in electromagnetism is required.

Text and References

Required text: *Physical Principles of Remote Sensing,*W.G. Rees, Cambridge University Press, 2013, Third Edition: ISBN 978-1-107-00473-3 (Hardback), ISBN 978-0-521-18116-7 (Paperback), also available in a Kindle Edition. Lecture presentation slides, example research papers, and some additional notes will also be provided.

Course Format

Class lectures, using prepared slides, will be given three times a week. Approximately 5 homeworks will be assigned. Homeworks will generally place an emphasis on more "real-world" problems vs. "text book" examples, and involve some amount of computer programming.

Students must also complete a course project on a topic of their choice, selected in consultation with the instructor. The project will consist of a thorough literature review of a remote sensing technique, application, or instrument with some original work. Examples of original work could include; processing of actual remote sensing data, a basic simulation, or a mission design study. A written report will be submitted in the format of a journal article.

Course Outline

- Introduction: Science requirements for Earth Observation, History or remote sensing, examples of current missions
- Fundamentals of electromagnetic propagation
- Fundamentals of scattering
- Microwave systems: scatterometers (active)
- Microwave systems: radiometers (passive)
- Microwave systems: altimeters (active)
- Optical systems
- Satellite platforms (satellite systems, attitude control, mass/power/thermal budgets)
- Mission design and orbit selection (coverage, revisit time)
- Data processing
- Model function development
- Calibration and validation (Cal/Val)
- End to end error analysis
- Non-technical considerations: cost, schedule, regulatory issues.