CE G9500: Remote Sensing In Water Resources and Environmental Engineering

Fall 2021
Monday, 6:30-9:00 PM
Instructor: **Nir Krakauer**

Bulletin Description: Techniques and instruments used for collecting information for civil engineering applications. Radiative emission and transfer principles. Satellite Instrument and orbit considerations. Spectral signatures from Earth's surface and atmosphere (optical, thermal infrared, microwave). Remote sensing applications for land cover and vegetation mapping, soil and snow sensing, water resources, aerosols and air quality. Processing, analyzing, classifying, and applying satellite-based information for applications. 3 hr/wk; 3 cr

Prerequisites: Graduate standing

Course Learning Outcomes: By the end of this class, the student should be able to:

1. Describe the capabilities of remote sensing systems based on physical principles
2. Evaluate the usefulness of given remote sensing products for engineering applications
3. Find, download, process, display, and interpret remote sensing data
4. Select remote sensing products suitable for addressing given engineering problems, and explain the limitations of each product
5. Understand and critique primary literature on remote sensing applications.

Topics list (approximate):

Introduction to remote sensing and data acquisition and applications; Characteristics of common scanning strategies, satellite instruments, and orbits

Electromagnetic radiation principles: spectra, irradiance, resolution, solid angles

Sun and Earth emission spectra; Radiant flux components; Planck, Stefan-Boltzmann, Wien laws

Scattering; Target and path radiation; Reflectance factor (rf); Bidirectional reflectance distribution function (brdf)

Multi-spectral and hyper-spectral imagery; Color composite images; Spectral signatures from earth's surface and atmosphere

Principles of aerial photography; Optical and thermal remote sensing and their applications

Physics and applications of passive microwave and radar/lidar imagery; Aerosol and air quality sensing; gravitational sensing

Remote sensing of water: Spectral response of water constituents and water quality; Sensing of water vapor, clouds, and precipitation

Remote sensing of vegetation: Photosynthesis pigments and spectra; Vegetation stress responses and indices

Remote sensing of soil: Soil properties; Soil moisture estimation

Remote sensing of snow coverage and amount

Atmospheric correction and preprocessing; Supervised and unsupervised classification methods; Principal components

Image registration, projections, and resampling

Project presentations

Assessment Tools:

1. **Short essays and problem sets** 20%
   Short essays: Each week, choose one of the Review Questions at the end of the textbook chapter to do some additional research on and answer as a 1-page short essay.
   Problem sets: There will be 1-2; do as assigned.
2. **Paper presentation** 15%
   Sign up to outline a journal article of your choice on the science or applications of remote sensing in a 15-20 minute class presentation (share the paper and your slides or notes with the class ahead of time)
3. **Programming presentation** 15%
   Sign up to show the class how to process and visualize a remote sensing dataset of your choice using Python in a 15-20 minute presentation (post your code ahead of time at https://github.com/ or a similar repository and share with the class)
4. **Project** 50%
   Analyze one or more remote sensing datasets to help answer a WREE-related question. This will have 3 stages:
   Proposal: suggest a topic and submit a literature review of 8-10 papers, with a paragraph for each summarizing its main point and how its relevant to your topic
   Code review: while you're working on the project, submit your code and a statement of what you've accomplished and what you're still planning to do.
   Final project: do a 15 minute presentation and 10-page report

Try to follow reproducible research guidelines: upload step-by-step instructions and programs for downloading and processing the data you work with, and making the maps and plots you show

Textbooks:

- S Khorram, CF van der Wiele, FH Koch, SAC Nelson, MD Potts, P*rinciples of Applied Remote Sensing* (Springer, 2016)
- L Wasser, N Nathan, J Palomino, M Morrissey, C Chris, *Use Data for Earth and Environmental Science in Open Source Python* (v1.0) (Earth Lab CU Boulder, 2021)