Environmental Remote Sensing

Satellite, airborne and field

Lecturers: Dr. Shimrit Maman, Dr. Sivan Isaacson

4 hours once a week • 4 credits • Undergraduate

Course description

Remote Sensing is technology-enabled data collection from an area or object without direct physical contact. Various types of remote sensing make use of aerial photographs (nowadays mostly by UAVs), satellite images, and field spectroscopy.
This course aims to provide students with both remote sensing theory and practical applications using examples of environmental research and applications. The science and technology of remote sensing will be covered alongside hands-on measurements linking satellite, airborne, and field data.

GRADING

Your performance in this class will be assessed through discussion, writing, and presenting your final project. Assessments are based on the following components:

Class assignments	25%
Final project and presentation	30%
Final exam	30%
Participation, attendance, punctuality	15%

SYLLABUS

Lecture 1: From pigeons to CubeSats

- Course overview, expectations and learning styles
- Earth observations: History, present and future
- Environmental applications and research using RS
  Readings: Jenssen (2006) Remote Sensing of the Environment: An Earth Resource Perspective (2nd Edition) Chapter 1&3.

Lecture 2+3: Physical basis of remotely sensed data

- Definitions: EM spectrum and radiation, reflection and thermal emission

- Interaction of EM radiation with matter: reflection, absorption and transmission
- Interaction of EM radiation and the atmosphere including atmospheric scattering, and atmospheric windows.
- Characteristics of remotely sensed data: physical principles behind the interaction of EM radiation and multiple types of land cover (vegetation, water, minerals, rocks, etc.)
  Readings: Jenssen (2006) Remote Sensing of the Environment: An Earth Resource Perspective (2nd Edition) Chapter 2.

Lecture 4: Satellites and Sensors

- Modes of acquisition
- Acquisition platforms and orbits
- Multispectral vs hyperspectral scanners and imaging devices
  Readings:
  Selva, D., & Krejci, D. (2012). A survey and assessment of the capabilities of Cubesats for Earth observation. Acta Astronautica, 74, 50-68.
  Belward, A. S., & Skøien, J. O. (2015). Who launched what, when and why; trends in global land-cover observation capacity from civilian earth observation satellites. ISPRS Journal of Photogrammetry and Remote Sensing, 103, 115-128.

Lecture 5: Resolutions

- Spectral, spatial, radiometric and temporal
- Spectral response curves (using Spectool)
  Readings: Campbell, J. B., & Wynne, R. H. (2011). Introduction to remote sensing. Guilford Press..Chapter 3, 4&5.

Lecture 6: Acquiring Data 1. Imagery and Terrain

- Choosing the appropriate sensor – class assignment.
- Preparation for field measurements
  Readings: Campbell, J. B., & Wynne, R. H. (2011). Introduction to remote sensing. Guilford Press..Chapter 6&7.

Lecture 7: Acquiring Data 2. Field Measurements and validation

- Collecting field data (multi- and hyper-spectral) – **outdoor measurements**
- Spectroscopy and field validation.
- Thermal imaging.

Readings: Arthur AM (2006). Field guide for the ASD FieldSpec. Irradiance Measurements in Raw DN Mode, FSF Edinburgh.

Lecture 8: Introduction to Image processing and interpretation

- Integration of RS with GIS & GPS.
- Georeferencing techniques
- Basic image enhancement techniques
  Readings: Gorelick, N., Hancher, M., Dixon, M., Ilyushchenko, S., Thau, D., & Moore, R. (2017). Google Earth Engine: Planetary-scale geospatial analysis for everyone. Remote Sensing of Environment, 202, 18-27.

Lecture 9: Environmental applications 1: Vegetation, Forestry and Agriculture

- Indices and band ratios
- Normalized Difference Vegetation Index (NDVI)
  Readings: Isaacson, S., Ephrath, J. E., Rachmilevitch, S., Maman, S., Ginat, H., & Blumberg, D. G. (2017). Long and short term population dynamics of acacia trees via remote sensing and spatial analysis: Case study in the southern Negev Desert. Remote Sensing of Environment, 198, 95-104.

Lecture 10: Environmental applications 2: Land, Geology, Climate & Meteorology, Oceanography and water bodies

- Classifying imagery and derived image products: LULC
- Change detection
  Readings: Maman, S., Orlovsky, L., Blumberg, D. G., Berliner, P., & Mamedov, B. (2011). A landcover change study of takyr surfaces in Turkmenistan. Journal of arid environments, 75(9), 842-850.

Lecture 11: Microwave and Lidar sensing

- Active vs. passive RS
- Optical vs. radar image interpretation
- Surface topography and deformation
  Readings: Bhardwaj, A., Sam, L., Bhardwaj, A., & Martín-Torres, F. J. (2016). LiDAR remote sensing of the cryosphere: Present applications and future prospects. Remote Sensing of Environment, 177, 125-143.

Lecture 12: Student presentations & Next generation of Earth observations

- From theory to observations to environmental applications – **project presentation**
- CubeSats, BGUSAT
- Advanced hyperspectral future missions

- Course conclusion

Lecture 13: Final Exam

COURSE READINGS

- August, Y., & Stern, A. (2013). Compressive sensing spectrometry based on liquid crystal devices. Optics Letters, 38(23), 4996-4999.
- Ben-Dor, E., Patkin, K., Banin, A., & Karnieli, A. (2002). Mapping of several soil properties using DAIS-7915 hyperspectral scanner data-a case study over clayey soils in Israel. International Journal of Remote Sensing, 23(6), 1043-1062.
- Borengasser, M., Hungate, W. S., & Watkins, R. (2010). Hyperspectral remote sensing: Principles and applications Crc Press.
- Campbell, J. & Wynne, H. "Introduction to Remote Sensing", (5th Ed.), The Guildford Press, New York, 2012.
- Clark, R. N. (1999). Spectroscopy of rocks and minerals, and principles of spectroscopy. Manual of Remote Sensing, 3, 3-58.
- Drury, S. A., "Image Interpretation in Geology", 2nd Ed, Allen & Unwin, 1993.
- Cracknell, A.P., "Introduction to Remote Sensing", (2nd Ed.), Tylor & Francis, London, 1991.
- Goetz, A. F., Vane, G., Solomon, J. E., & Rock, B. N. (1985). Imaging spectrometry for earth remote sensing. Science (New York, N.Y.), 228(4704), 1147-1153. doi:228/4704/1147 [pii]
- Govender, M., Chetty, K., & Bulcock, H. (2007). A review of hyperspectral remote sensing and its application in vegetation and water resource studies. Water Sa, 33(2).
- Gupta, R. P., "Remote Sensing Geology", 2nd Ed., Springer, 2003.