PRINCIPLES OF REMOTE SENSING
ENGE 301

Lecture : 3 | **Year : III**
Tutorial : 0 | **Part : I**
Practical : 3

Course Objectives:
The objective of this course is to provide foundational principles, evolution and applications of remote sensing. It emphasizes the electromagnetic spectrum, remote sensing platforms, sensors, and data acquisition systems. By the end of the course, students will be able to apply hands-on skills in satellite image preprocessing, interpretation, enhancement, analysis, classification, and accuracy assessment for effective data analysis.

1 Introduction (4 hours)

1.1 Remote sensing: Scope, objectives and types
1.2 Historical development: Overview of remote sensing technology from its origins to current advancements
1.3 Basic concepts: Principles of electromagnetic waves, energy interactions with materials, and sensor fundamentals
1.4 Data acquisition methods: Techniques and processes for collecting remote sensing data
1.5 Applications in agriculture, forestry, urban planning and environmental monitoring

2 Electromagnetic Spectrum and Radiometry (8 hours)

2.1 Electromagnetic spectrum: Detailed study of spectral regions (Visible, infrared, microwave) used in remote sensing
2.2 Radiometric resolution: Importance of radiometric resolution in detecting energy variations
2.3 Radiation laws: Understanding Planck's law, Stefan-Boltzmann law, and Wien's displacement law
2.4 Conversion of radiance to reflectance and vice versa
2.5 Spectral signatures: Interaction between different materials with radiation through reflection, absorption, scattering and emission
2.6 Spectral bands and their applications
2.7 Solar radiation: Impact on remote sensing data; Effects of sun position and intensity
2.8 Atmospheric interference

3 Remote Sensing Platforms and Sensors (7 hours)

- 3.1 Satellite platforms: Characteristics and functions of geostationary and polar orbiting satellites
- 3.2 Aerial platforms: Features and uses of manned and unmanned aerial vehicles (UAVs)
- 3.3 Ground-based platforms: Features and uses
- 3.4 Optical sensors: Functions and applications of multispectral and hyperspectral sensors
- 3.5 Infrared sensors: Principles and applications of thermal infrared imaging
- 3.6 Radar sensors: Overview of synthetic aperture radar (SAR) and its applications
- 3.7 LiDAR sensors: Basics of light detection and ranging (LiDAR) and its uses
- 3.8 Resolution types: Spatial, spectral, radiometric, and temporal resolutions
- 3.9 Sensor calibration: Methods for ensuring accuracy and reliability of data

4 Satellite Image Preprocessing (8 hours)

- 4.1 Image corrections: Radiometric; Atmospheric; Geometric; Topographic
- 4.2 Image resampling: Nearest neighbor, bilinear and cubic convolution
- 4.3 Image mosaicking
- 4.4 Image normalization and indices
- 4.5 Image re-projection

5 Interpretation of Satellite Images and Image Statistics (8 hours)

- 5.1 Image interpretation: Techniques for visual and contextual analysis, and feature identification
- 5.2 Methods of image enhancement (Image clarity, stretching)
- 5.3 Classification: Methods for assigning pixel values to categories and object-based analysis
- 5.4 Descriptive statistics: Calculation and interpretation of mean, median, mode, and standard deviation of pixel values
- 5.5 Histogram analysis: Analysis of pixel intensity distribution through histograms

6 Digital Image Classification and Accuracy Assessment (10 hours)

- 6.1 Classification methods (Supervised and unsupervised approaches)
- 6.2 Supervised classification techniques: Maximum likelihood, Support Vector Machines (SVM), XGBoost and Random Forest
- 6.3 Unsupervised classification techniques: Clustering methods (k-means and ISODATA)
- 6.4 Post-classification refinement process
- 6.5 Sampling techniques: Ground truth data collection methods (Random, systematic, stratified and cluster sampling)

6.6 Confusion and accuracy matrices: Construction and interpretation of confusion matrices; Overall accuracy, producer's accuracy, user's accuracy, and kappa coefficient

6.7 Error analysis and improvement

Practical **(45 hours)**

1. Extraction and analysis of spectral data from raster images
2. Analysis of metadata from raster images and its significance
3. Creation and interpretation of histograms for image distribution and pixel intensity
4. Collection and analysis of spectral signatures of materials (Vegetation, built-up, snow cover, water and soil)
5. Creation of composite band images with different features
6. Image pre-processing methods (Radiometric, atmospheric, and geometric corrections)
7. Application of supervised and unsupervised classification methods
8. Design and implementation of sampling strategies for ground truth data collection and accuracy assessments

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Marks distribution*
1	4	4
2	8	10
3	7	10
4	8	10
5	8	12
6	10	14
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Lillesand, T., Kiefer, R. W., Chipman, J. (2015). Remote sensing and image interpretation. Wiley.
2. Jensen, J. R. (2015). Introduction to remote sensing. CRC Press.
3. Schott, J. R. (2007). Remote sensing: The image chain approach. Oxford University Press.
4. Mather, P. M., Koch, B. (2011). Computer processing of remotely-sensed images: An introduction. Wiley.
5. Pettorelli, N. (2013). The normalization of remote sensing data. Wiley-Blackwell.
6. Kramer, G. (2002). Observing the earth and the universe: The relevance of remote sensing for global change research. Springer.