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Program : **B.Tech**

Subject Name: **Remote Sensing and GIS**

Subject Code: **CE-504**

Semester: **5th**

Unit I

Remote Sensing & GIS

Syllabus

Basic concept of Remote sensing, Data and Information, Remote sensing data collection, Remote sensing advantages & Limitations, Remote Sensing process. Electromagnetic Spectrum, Energy interactions with atmosphere and with earth surface features (soil, water, and vegetation), Resolution, image registration and Image and False color composite, elements of visual interpretation techniques.

Principle

Detection and discrimination of objects or surface capabilities means detecting and recording of radiant strength pondered or emitted by means of objects or surface material. Unique objects go back extraordinary quantity of energy in extraordinary bands of the electromagnetic spectrum, incident upon it. This relies upon on the assets of cloth (structural, chemical, and physical), floor roughness, angle of occurrence, intensity, and wavelength of radiant electricity.

Components:

I. **Power supply or Illumination (A) - the primary requirement for faraway sensing is to have a power supply which illuminates or affords electromagnetic electricity to the goal of hobby.**

II. **Radiation and the atmosphere (B) - because the electricity travels from its supply to the target, it'll are available contact with and interact with the atmosphere it passes via. This interplay may take area and time because the energy travels from the target to the sensor.**

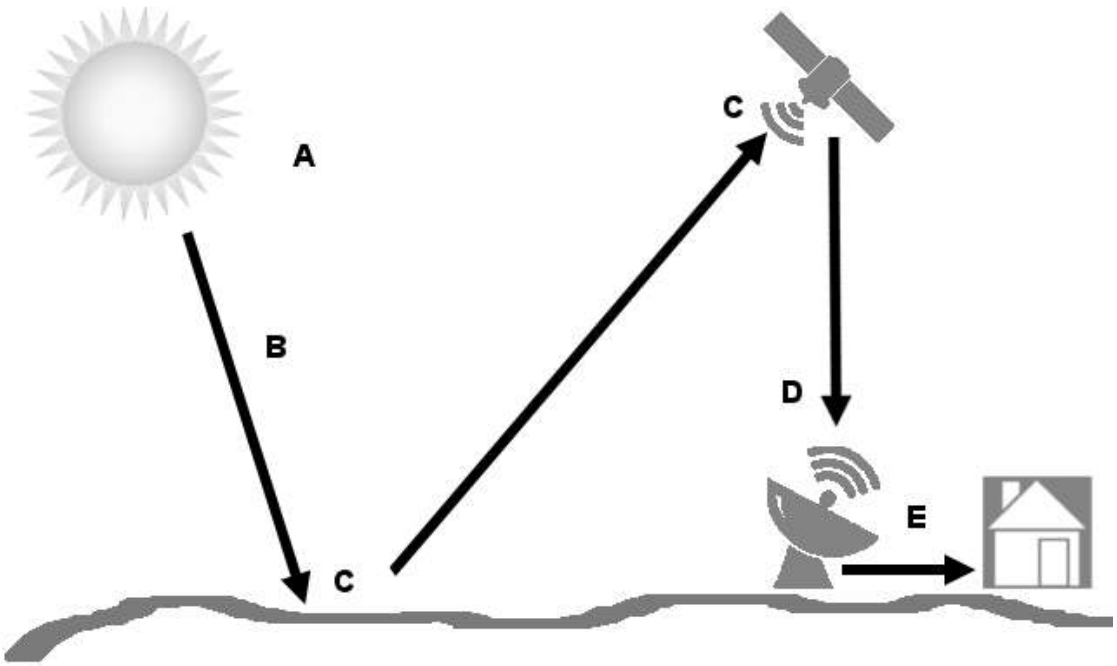
III. **Interaction with target (C) - once the power makes its way to the goal through the environment, it interacts with the target depending on the residences of each the target and the radiation.**

IV. **Recording of power by the Sensor (D) - after the electricity has been scattered by way, or emitted from the goal, we require a sensor (Remote - no longer in touch with the target) to collect and document the electromagnetic radiation.**

V. **Transmission, Reception, and Processing (E) - the power recorded by using the sensor must be transmitted, frequently in electronic form, to a receiving and processing station wherein the records are processed into an image (hardcopy and/or digital).**

VI. **Interpretation and analysis (F) - the processed picture is interpreted, visually and/or digitally or electronically, to extract data about the target which changed into illuminated.**

VII. **Application (G) - the final element of the faraway sensing technique is finished when we observe the records we have been capable of extract from the imagery approximately the goal a good way to higher recognize it, reveal some new facts, or help in solving a particular problem.**



Classification:

It could be cut up into "active" Remote sensing (i.e., while a sign is emitted by way of a satellite or plane and its mirrored image by using the item is detected through the sensor) and "passive" remote sensing (i.e., while the reflection of sunlight is detected by way of the sensor).

Remote sensing structures which degree power this is naturally available are known as Passive Sensors. Passive sensors are most effectively be used to detect strength when the evidently taking place power is available. For all meditated energy, this wills simplest take vicinity throughout the time while the solar is illuminating the Earth.

There's no reflected energy available from the sun at night time. Power this is obviously emitted (such as thermal infrared) may be detected day or night, as long as the quantity of energy is huge sufficient to be recorded.

- **Active sensors, on the other hand, transmit brief bursts or 'pulses' of electromagnetic energy within the path of interest and file the starting place and electricity of the backscatter obtained from gadgets inside the system's field of view. Passive systems experience low stage microwave radiation given off by way of all gadgets inside the natural environment.**

Advantages for active sensors consist of the capability to obtain measurements anytime, irrespective of the time of day or season. Lively sensors can be used for examining wavelengths that are not sufficiently provided by the solar, inclusive of microwaves, or to better manipulate the way a target is illuminated.

Remote sensing facts acquisition process:

Interpretation and evaluation of Remote sensing records entails the identity and dimension of various goals in an image for you to extract useful records approximately them. There are two main methods may be use to interpret and extract statistics of interpretation from photographs:

- ✓ **Visual interpretation of Photos that is based totally on characteristic tone (shade), sample, form, texture, shadow and affiliation. The identification of goals completed through a human interpreter**
- ✓ **Virtual processing and analysis may be accomplished the usage of a laptop (without manual intervention by a human interpreter). This approach can be used to decorate records, to accurate or restore the photo, to robotically become aware of objectives and extract facts and to delineate one of kind areas in an picture into thematic lessons.**

In many case virtual processing and evaluation is done as a complete substitute for manual interpretation. Often, it is carried out to complement and help the human analyst. making use of a mixture of each strategies we can use guide and digital strategies benefits.

Virtual processing and analysis

The most common photograph processing features may be positioned into the subsequent 4 classes:

1. Pre-processing

2. Photo Enhancement

3. Picture Transformation

4. Photograph classification and analysis

features involve those operations which can be typically required prior to the primary statistics evaluation and extraction of statistics, and are normally grouped as radiometric or geometric corrections. Some popular correction strategies can be finished inside the ground station before the records is brought to the user. Those procedures consist of radiometric correction to correct for choppy sensor response over the whole image and geometric correction to correct for geometric distortion because of Earth's rotation and other imaging situations (which includes indirect viewing).

Remote sensing advantages & Limitations

1. **Large area coverage: Remote sensing allows coverage of very large areas which enables regional surveys on a variety of themes and identification of extremely large features.**
2. **Remote sensing allows repetitive coverage which comes in handy when collecting data on dynamic themes such as water, agricultural fields and so on.**
3. **Remote sensing allows for easy collection of data over a variety of scales and resolutions.**
4. **A single image captured through remote sensing can be analyzed and interpreted for use in various applications and purposes. There is no limitation on the extent of information that can be gathered from a single remotely sensed image.**
5. **Remotely sensed data can easily be processed and analyzed fast using a computer and the data utilized for various purposes.**

6. **Remote sensing is unobstructive especially if the sensor is passively recording the electromagnetic energy reflected from or emitted by the phenomena of interest. This means that passive remote sensing does not disturb the object or the area of interest.**
7. **Data collected through remote sensing is analyzed at the laboratory which minimizes the work that needs to be done on the field.**
8. **Remote sensing allows for map revision at a small to medium scale which makes it a bit cheaper and faster.**
9. **Color composite can be obtained or produced from three separate band images which ensure the details of the area are far much more defined than when only a single band image or aerial photograph is being reproduced.**
10. **It is easier to locate floods or forest fire that has spread over a large region which makes it easier to plan a rescue mission easily and fast.**
11. **Remote sensing is a relatively cheap and constructive method reconstructing a base map in the absence of detailed land survey methods.**

Electromagnetic Spectrum

The electromagnetic spectrum **ranges from the shorter wavelengths (including gamma and x-rays) to the longer wavelengths (including microwaves and broadcast radio waves). There are several regions of the electromagnetic spectrum which are useful for remote sensing.**

1. **For most purposes, the** ultraviolet or UV **portion of the spectrum has the shortest wavelengths which are practical for remote sensing. This radiation is just beyond the violet portion of the visible wavelengths, hence its name. Some Earth surface materials, primarily rocks and minerals, fluoresce or emit visible light when illuminated by UV radiation.**
2. **The light which our eyes - our "remote sensors" - can detect is part of the** visible spectrum**. It is important to recognize how small the visible portion is relative to the rest of the spectrum. There is a lot of radiation around us which is "invisible" to our eyes, but can be detected by other remote sensing instruments and used to our advantage. The visible wavelengths cover a range from approximately 0.4 to 0.7 µm. The longest visible wavelength is red and the shortest is violet. Common wavelengths of what we perceive as particular colours from the visible portion of the spectrum are listed below. It is important to note that this is the only portion of the spectrum we can associate with the concept of** colours**.**
3. **The portion of the spectrum of more recent interest to remote sensing is the** microwave region **from about 1 mm to 1 m. This covers the longest wavelengths used for remote sensing. The shorter wavelengths have properties similar to the thermal infrared region while the longer wavelengths approach the wavelengths used for radio broadcasts. Because of the special nature of this region and its importance to remote sensing in Canada, an entire chapter (Chapter 3) of the tutorial is dedicated to microwave sensing.**

Energy interactions with atmosphere and with earth surface features

Energy Interactions The radiation from the energy source passes through some distance of atmosphere before being detected by the remote sensor as shown in Fig. Interactions in the atmosphere The distance travelled by the radiation through the atmosphere is called the path length. The path length varies depending on the remote sensing techniques and sources. For example, the path length is twice the thickness of the earth's atmosphere in the case of space photography which uses sunlight as its source. For airborne thermal sensors which use Remote Sensing: Introduction and Basic Concepts Energy interactions in the atmosphere D Nagesh Kumar, IISc, Bangalore 3 M1L3 emitted energy from the objects on the earth, the path length is only the length of the one way distance from the Earth's surface to the

sensor, and is considerably small. The effect of atmosphere on the radiation depends on the properties of the radiation such as magnitude and wavelength, atmospheric conditions and also the path length. Intensity and spectral composition of the incident radiation are altered by the atmospheric effects. The interaction of the electromagnetic radiation with the atmospheric particles may be a surface phenomenon (e.g., scattering) or volume phenomenon (e.g., absorption). Scattering and absorption are the main processes that alter the properties of the electromagnetic radiation in the atmosphere.

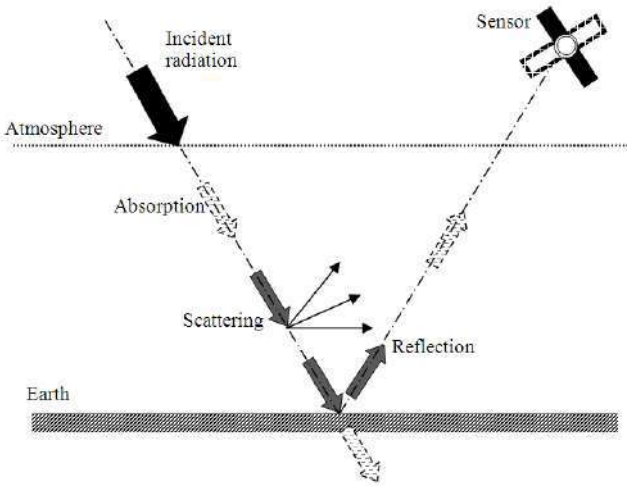
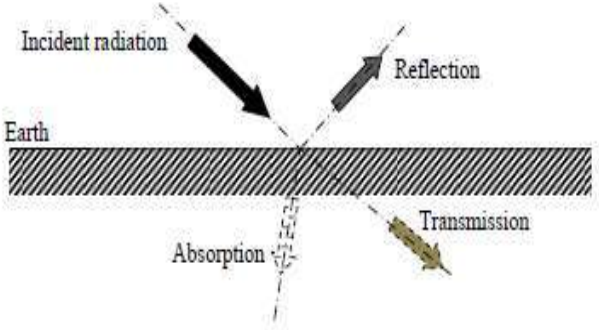


Fig. Interactions in the atmosphere

Energy incident on the Earth's surface is absorbed, transmitted or reflected depending on the wavelength and characteristics of the surface features (such as barren soil, vegetation, water body). Interaction of the electromagnetic radiation with the surface features is dependent on the characteristics of the incident radiation and the feature characteristics. After interaction with the surface features, energy that is reflected or re-emitted from the features is recorded at the sensors and are analysed to identify the target features, interpret the distance of the object, and /or its characteristics.

Energy Interactions

The incident electromagnetic energy may interact with the earth surface features in three possible ways: Reflection, Absorption and Transmission. These three interactions are illustrated in Fig.



Energy interactions with earth surface features

Resolution, image registration and Image and False color composite

Image Registration is the first step towards using remote sensed images for any purpose. Despite numerous techniques being developed for image registration, only a handful has proved to be useful for registration of remote sensing images due to their characteristic of being computationally heavy. Recent flux in technology has prompted a legion of approaches that may suit divergent remote sensing applications. This paper presents a comprehensive survey of such literatures including recently developed techniques.

False color composites allow us to visualize the wavelengths the human eye does not see (near the infrared range). The use of bands, such as near infrared, increases spectral separation and can enhance the interpretability of data. False color images are a representation of a multispectral image created using ranges other than visible red, green and blue, such as red, green and blue image components. There are many different false color compositions that can distinguish many different functions.

This combination is used to obtain pseudo-natural colors under certain conditions when the image is visualized similar to the natural one and allows you to analyze the atmospheric haze, the state of suspensions in the atmosphere, its smoke.

One application of this combination is the monitoring of forest fires. Surfaces with elevated temperatures, such as forest fires and calderas of volcanoes, saturate the image in medium IR channels and are displayed in shades of red or yellow.

elements of visual interpretation techniques.

As we noted in the previous section, analysis of remote sensing imagery involves the identification of various targets in an image, and those targets may be environmental or artificial features which consist of points, lines, or areas. Targets may be defined in terms of the way they reflect or emit radiation. This radiation is measured and recorded by a sensor, and ultimately is depicted as an image product such as an air photo or a satellite image.

Recognizing targets is the key to interpretation and information extraction. Observing the differences between targets and their backgrounds involves comparing different targets based on any, or all, of the visual elements of tone, shape, size, pattern, texture, shadow, and association**.**

1. Tone **refers to the relative brightness or colour of objects in an image. Generally, tone is the fundamental element for distinguishing between different targets or features. Variations in tone also allows the elements of shape, texture, and pattern of objects to be distinguished.**
2. Shape **refers to the general form, structure, or outline of individual objects. Shape can be a very distinctive clue for interpretation. Straight edge shapes typically represent urban or agricultural (field) targets, while natural features, such as forest edges, are generally more irregular in shape, except where man has created a road or clear cuts. Farm or crop land irrigated by rotating sprinkler systems would appear as circular shapes.**

3. Size **of objects in an image is a function of scale. It is important to assess the size of a target relative to other objects in a scene, as well as the absolute size, to aid in the interpretation of that target. A quick approximation of target size can direct interpretation to an appropriate result more quickly. For example, if an interpreter had to distinguish zones of land use, and had identified an area with a number of buildings in it, large buildings such as factories or warehouses would suggest commercial property, whereas small buildings would indicate residential use.**
4. Pattern **refers to the spatial arrangement of visibly discernible objects. Typically an orderly repetition of similar tones and textures will produce a distinctive and ultimately recognizable pattern. Orchards with evenly spaced trees, and urban streets with regularly spaced houses are good examples of pattern.**
5. Texture **refers to the arrangement and frequency of tonal variation in particular areas of an image. Rough textures would consist of a mottled tone where the grey levels change abruptly in a small area, whereas smooth textures would have very little tonal variation. Smooth textures are most often the result of uniform, even surfaces, such as fields, asphalt, or grasslands. A target with a rough surface and irregular structure, such as a forest canopy, results in a rough textured appearance. Texture is one of the most important elements for distinguishing features in radar imagery.**
6. Shadow **is also helpful in interpretation as it may provide an idea of the profile and relative height of a target or targets which may make identification easier. However, shadows can also reduce or eliminate interpretation in their area of influence, since targets within shadows are much less (or not at all) discernible from their surroundings. Shadow is also useful for enhancing or identifying topography and landforms, particularly in radar imagery.**
7. Association **takes into account the relationship between other recognizable objects or features in proximity to the target of interest. The identification of features that one would expect to associate with other features may provide information to facilitate identification. In the example given above, commercial properties may be associated with proximity to major transportation routes, whereas residential areas would be associated with schools, playgrounds, and sports fields. In our example, a lake is associated with boats, a marina, and adjacent recreational land.**

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