A Review on Remote Sensing Technique: Concept and Principles

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ABSTRACT
Remote sensing is a phenomena of acquiring the information about the object without making any physical contact with the object e.g. Ariel photography. Ariel photography now a days is playing a vital role by providing applications such as monitoring forests, disaster management, weather forecasting, atmospheric characteristics, agricultural activities and many more. Remote Sensing is an application best use for surveying the land mass, for example, calculating the percentage area of land, populated area, water bodies etc. As the technology is upgrading day by day, number of factors are including in a particular technology, such as the phenomena of image processing is at peak in remote sensing. This paper includes understanding remote sensing, basic principles related to remote sensing, working of remote sensing, analysis stages of it and the basic concept of image processing.

Keywords: Remote sensing, electromagnetic radiations, image processing, image analysis, sensors.

1. INTRODUCTION

Remote sensing is an aerial sensor technology that is used to detect and classify various objects or features of objects on earth, all with the help of various signals such as electromagnetic radiations [2]. It is very useful in collecting the data from the area which is inaccessible and even dangerous for human beings to reach. Generally, it is very costly and slow process to collect data from and perform any sort of survey from ground, by just visiting a place; remote sensing plays a very important and useful role in such cases. It makes it possible at very less rate with fast process and even it ensures that the process will not disturb the area of objects. It takes help of satellite or aircrafts to collect data of earth and atmosphere [3]. The basic factor of concern that is the part of remote sensing is Image. Satellite captures the signals then performs various functions and processes on it to gather the information. The quality of image does matters here so image processing is done to enhance the image.

1.1 Understanding Remote Sensing
Remote sensing is an art of obtaining data or information about the object from a distance without the physical contact with the object. Technically it works as the measuring of electromagnetic energy that is emitted or may be reflected by the object. The signals can be Analogue or Digital therefore, the requirement of analogue and digital sensor is necessary for the purpose of measuring these signals. The best example that is related to the similarity of remote sensing is human vision system. It works same as human eye, to analyze and capture the data. Remote sensing is very useful in collecting the data from the areas which are even inaccessible for human beings to reach. Generally, remote sensing technique is used for collecting the data of earth and atmosphere especially with the help of satellite.
2. BASIC PRINCIPLES AND TERMS IN REMOTE SENSING

2.1 Energy Source

To capture the image and for the purpose of analyzing the data, first we do require energy source because only at the presence of energy we can gather information. It can be direct or indirect. Example: Radar is an example of direct source of energy and sunlight is an indirect source of energy.

2.1.1 Direct Energies refer to the sort of energy which people consumes through their own activities e.g.: amount of electricity used to run electronic devices of gadgets, amount of gasoline used for vehicles to run etc. such energies consumption can be easily calculated. We can control our direct sources of energies [4].

2.1.2 Indirect Energies are not consumes by humans by their own e.g.: wind energies, water energy, sunlight etc. they may vary with time and location as they are nature dependent [4].

2.2 Electromagnetic Spectrum

As human eye is restricted to some extent up to which it is possible for it to see. We can only see objects which reflect the light up to a particular range. Visible light which ranges up to: 400 to 700 nm. Sensors are required to sense the image [5]. Sensors senses the sensitivity of image and even the patterns that are reflected by light, but human eye is not that much sensitive to other EM spectrum except visible range but sensors are. Thus, in other applications to measure other variations of the em-spectrum, sensors are required.

2.3 Interaction of EMR

2.3.1 EMR interaction with Atmosphere

Interaction of EMR with that of the atmosphere will leads to atmospheric noise. The noise can be in any form, it depends on number of factors, for example: dust particles in atmosphere, fog in atmosphere and many more. When EMR interacts with atmosphere some of the portion of it is absorbed by the atmosphere and is scattered by the atmosphere [5].

2.3.2 EMR Interaction with Target or Earth Feature

There are number of ways by which EMR can interact with the features of earth. It includes the concepts of Reflection, Absorption, Transmission and Emission. It totally depends on the nature and properties of object at earth that what amount of EMR they reflect, absorb, transmit and emit [5].

2.4 Capturing Image

Let us take an example of the objects as buildings, road, water, plants and soil. The energy source is the natural source that is sunlight. Let us see how it works:

During the entire process EMR changes its properties that might be due to energy loss or any sort of alteration in wavelength. This will normally affect the sensing of EMR by sensors. The reflected amount of radiation is sensed by a sensor and forms the Image of that scene [7].

2.5 Sensors

Sensors measure the magnitude and frequency of the radiations and records them that is reflected by the object. After recording the spectrum, data is compared with the known objects or identifying and classifying the objects. The basic concept of sensor is to sense the radiation.

Generally there are two types of Sensors: Active and Passive
2.5.1 Passive Sensors: the energy that is naturally emitted is gathered by passive sensors. Passive Sensors gathers the natural radiation that is either emitted or has been reflected by the object. Passive sensors can only be used for detecting the energy when only the natural energy is available, e.g. Sunlight [6].

2.5.2 Active Sensors: Active Sensors provides their own source of energy for the illumination. The incoming radiation can be detected and measured by the sensors [6]. Examples: LiDAR (Light Detection and Ranging), SAR (Synthetic Aperture Radar).

2.6. Data Transmission and Processing

The EMR which has been recorded by the sensors is transmitted to data processing stations for the purpose of processing it. After processing the data the EMR is transmitted into desirable output that might be digital or analogue, depends on human perception. Data after collection is given in the form of an image. Numbers of operations are performed to analyze an image to reach up to the information or conclusions.

3. STEPS FOR ANALYZING THE IMAGE

To reach up to the conclusion some image analysis is done, for this some steps are there:

Steps for Analysis:

Step1. Data Acquisition: The data is collected by the sensors and has been transmitted to data process station where the data has to be in analyzing process to reach up to the conclusion.

Step2. Data Processing: The image captured is initially in analogue form so it is required to digitize that with the help of AD convertor. For manipulating the images it is first required to digitize the image by using convertor.

Step3. Land Cover Analysis: After the image is digitized now on the basis of color segments or area acquired the analysis is done about the land. The area covered is calculated or judged over here. We can analyze either the land is acquired by humans example any construction over the area or it is forest area and number of objects can be studied here and the total percentage of land area covered is calculated.

Step4. Training Data Collection: For the purpose of studying the particular area some sample data can be chosen on the basis of research. For this sampling technique is used. Simple random sampling or other techniques can be used for selecting the samples.

Step5. Interpretation: By having training data or the area under the research also called sampled data one can reach up to the conclusion of the research and hence leads to the result.

Step6. Result: The final output of the data analysis is result or we can say the required information.

4. IMAGE PROCESSING

Image processing is a sort of signal processing for which the input is an image or video and the output after being processed is again the image or video, depends on the requirement. Now a days, it is also refers to the digital image processing but analogue image processing is also possible. There are number of techniques for interpreting the remote sensed images and extract the information as possible from the images [7]. The main factor in remote sensing technique is capturing the image and for the purpose of gathering the information from an image the quality of an image does matters, so image processing is done to enhance the image. Well, there are
number of applications of image processing, for example, image processing can be used in pattern recognition, object recognition, medical field, machine vision and remote sensing is also an application of image processing technique.

There are 2 types of processing is done in remote sensing: preprocessing and post processing

a) **Preprocessing**: before the image actually has to be processed some functions or corrections has to be done. For example: Atmospheric Correction [7].

b) **Post processing**: After preprocessing, the post processing is done over images. It includes:
- Image enhancement process
- Image restoration process
- Image classification
- Change detection process

4.1. **Image enhancement**: it is the phenomena to yield better quality image for the purpose of some particular application which can be done by either suppressing the noise or increase the image contrast [7].

Classification of image enhancement techniques:
- Spatial domain method
- Transform domain method

4.1.1 **Spatial domain method**: in this method the enhancement technique operates on pixels [8].

One of the methods if enhancement in spatial domain is **POINT OPERATION**.

4.1.2 **Point operation**: in this method each pixel is modified one by one and it is not dependent on other pixel value.[1]

\[ M(x,y) = F[n(x,y)] \]

4.1.3. **Brightness Adjustment**: it depends on the value associated with the pixel of the image. While changing the brightness of the image a constant is added or subtracted to the image.

4.1.4. **Increase the brightness**: a constant is added to each pixel of the image.

\[ M[x,y] = N[x,y] + k \]

4.1.5. **Decrease the brightness**: a constant is subtracted from each pixel of the image.

\[ M[x,y] = N[x,y] - K \]

4.1.6. **Contrast Adjustment**: it is done by scaling all pixels of image by a constant K.

\[ M[x,y] = N[x,y] * k \]

While we change the contrast of the image, the range of luminance value also changes in the image.

4.1.7. **Transform Domain method**: this method operates on Fourier Transform of an image then transform it back to spatial domain [8]. Linear transformation of an image is a function that maps each pixel value into another grey level at same position.[1]

\[ M(x,y) = T [N(x,y)] \]

4.2. **Image Restoration**: it is a technique that aims at reversing the degradation undergone by an image to recover the true image. Images may be corrupted by degradation such as noise. It consists of two processes- to determine Blur and Random Noise. Blur may be due to motion, defocussing and atmospheric turbulence. Noise may originate in image formation process or transmission process. [1]
\[
m(x,y) = h(x,y) * n(x,y)
\]

Error = \[n^*(x,y) - n(x,y)\]

Objective of restoration technique is to minimize error so that there would be a very little difference in between the input image and the processed image.

In Spatial Domain the degraded image \(N(x,y)\) is created through the convolution of the input image \(M(x,y)\) with the degradation function \(H(x,y)\) [1].

\[
M(x,y) = H(x,y) * N(x,y)
\]

In frequency domain this can be represented as:

\[
M(x,y) = H(x,y) \times N(x,y)
\]

In general, the equation can be represented as

\[
M(x,y) = n(x,y) * h(x,y) + \eta(x,y)
\]

If we ignore the coordinates of images then,

\[
M = HN + \eta
\]

Error can be calculated as noise which can be represented as \(\eta = m - Hn\)

If we ignore noise and use \(n^*\) to let \(Hn^*\) approximate it under the least square sense

Then error function will be

\[
J(n^*) = |m - Hn^*|^2
\]

\[
J(n^*) = |m - Hn^*|^2 = m^2 + H^2 n^*^2 - 2mHn^*
\]

The above equation is differentiated with respect to \(n^*\) and equating it to 0, to find the minimum of the \(J(n^*)\), we get

\[
As \ n^* = (H^T H)^{-1} H m = H^{-1} m
\]

Taking Fourier transformation on both sides [1]

\[
N^*(i,j) = \frac{M(i,j)}{H(i,j)}
\]

4.3. Image Classification

Classification of a pixel of an image generally based on spectral information and hence called a spatial Pattern Recognition. The image pixel is categorized on the basis of spatial relationship to the surrounding pixel. In an image the classes of pixels are made depending on some correlation [7].

Digital Image Classification has 2 methodologies: Supervised Methodology and Unsupervised Methodology

4.3.1 Unsupervised Methodology: here the pixels are classified according to the statistical grouping of pixels that have similar numerical information. If pixel or group of pixels satisfies with similar spectral characteristics based on some statistical pattern then they come under unsupervised methods [7].

4.3.2 Supervised Methodology: In such method the analyst take number of information classes and then perform identification strategy of homogeneous samples. Here analyst has to work, he has to select pixel or group of pixels then recognize the pattern and enter to the class that is specified. The selected pixels or group of pixels are termed as training samples. Grouping of finite number of classes is actually based on spectral values of pixels. There are some set of criteria or decision rules which are defines if pixel satisfies that, it will be assigned to the correspondence class. Recognition with the help of machine is done by these two methods. Human eye do pattern recognition by viewing class, grayscale image etc. but machine need classification based on supervised or unsupervised methods. Results of supervised and unsupervised methods are signatures. The classification actually based on the decision rules [7].

4.4. Change Detection

It is a process of taking two images of same object at same location on different dates then they are compared to measure physical shape, location or spectral properties.

5. CONCLUSION

Remote sensing can be of great help in survey process by manipulating the image with the help of image processing technique. For the purpose of surveying the land mass, it has to deal with the manipulation of an image, which is again a part of image processing. Remote sensing plays an important role by providing applications such as Geology and Mineral exploration, Hazard assessment, Oceanography, Agriculture
and forestry, Land degradation, Environmental monitoring, 
Weather forecasting, Atmospheric characteristics and many 
more. Though human being can gather information through 
images but the concept of image manipulation helps to 
enhance the information present in the image. Simply, we can 
extract information from the images with the help of some 
image processing technique.

REFERENCES


