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Research Paper

Remote Sensing in 21st Century: Its Process and Application

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ABSTRACT: *In present world the most discussed topic is sustainability and precision. There is an increasing need of use of technology which can give information about any present and upcoming phenomenon from a distance. Due to this the concept of remote sensing came into picture which is useful tool to get information about any object or phenomenon from a distance. As the science enhanced the remote sensing became more meaningful as after the launch of satellitesit is now useful tool to get information about any target source from any part of world. The remote sensing process includes emitting of energy from source, its reflection by target objects, capture of reflected energy by sensors to ground platforms where its interpretation is done and finally is used for benefit of mankind. It is being increasingly used in various fields such as land use planning, agriculture, water management, Geology, forestry as well as atmospheric phenomenon study. It can be a useful tool in future to mitigate various natural calamities that can happen with prior warning and proper disaster management. It is really a boon to mankind.*

KEYWORDS: *History, Process of Remote Sensing, Platforms, Satellites, Sensors, Scanning in Remote Sensing, Resolution, Spectral Signatures, Image Interpretation, Application of Remote Sensing*

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I. INTRODUCTION

Remote sensing refers to the science and art of obtaining information about an object, area, or phenomenon through analysis of data acquired by a device that is not in contact with the object, area, or phenomenon under investigation (L & K, 1994). Remote sensing is basically collection of two words, Remote meaning from a distance and Sensing meaning detection of various forms of energy. It allows us to observe and study about the nature and its phenomenon in ways which would have otherwise been difficult of even beyond human capabilities to measure, across great distance and at wavelengths of light which is invisible to human eyes (IIRS, ISRO) [9].

It refers to science of identification of earth surface features and estimation of their geo-bio-physical properties using electromagnetic radiation as a medium of interaction (Navalgund *et al.*, 2007) [4]. Remote sensing techniques acquire information by detecting and measuring changes that the object imposes on surrounding field, be it an electromagnetic, acoustic or potential (Loisel *et al.*, 2014) [3].

Since the launch of an earth observation satellite, remote sensing is used increasingly to acquire information about various environmental process such as agriculture crops, vegetation cover, water quality, urban growth, agriculture water management, disaster management etc. It is being increasingly used to develop our understanding on ecological system of earth (Jong *et al.*, 2004) [2]. Beside this it is very useful in detecting the complex dynamics of ocean circulation phenomenon such as El Nino, El Nina and others which is caused by northern Atlantic oscillation and is very useful in accessing global and regional climate and extremities of events.

Remote sensing is becoming very useful tool in 21st century as each and every sector is now dependent on it fully and partially like present day agriculture demands more precision and in that sense we cannot think of precision without involvement on remote sensing. It is also useful tool in disaster management as we can locate area of damage from a distance. Likewise every sector needs sensing so that efficiency of work can be increased.

In extended tem the word remote not only means distant but also indirect. So, we can say that remote sensing is art and science of measuring objects or phenomenon which are not in direct contact with us. It can be a science or an art, a tool or a technique and also a functional activity (Fussell *et al*., 1986)[1].

II. HISTORY OF REMOTE SENSING

Remote sensing is not very old in this world. It started back in 1827 when first photograph was taken. In year 1858, first aerial photo was captured using the hot air balloon. After that in American civil war which occurred during 1861-65, the balloon photography was used in large scale. In year 1888, "Rocket Cameras" were introduced after which in year 1903, pigeon- mounted cameras were patented to be used. In year 1906, photography using kites was introduced. During World War I & WWII, plane mounted cameras were used to keep an eye on enemies. Inyear 1956, U2 spy planes were introduced. Sputnik I was launched in year 1957. In year 1960, 1st meteorological satellite "TIROS-1" was launched while in year 1967, NASA "Earth Resource Technology Satellite" programme was started after which ERTS (Landsat I) was launched in year 1972. India launched Earth observation satellite namely IRSID 95 & 97 and CARTOSAT I & II (IIRS, ISRO) [9].

III. REMOTE SENSING PROCESS

The remote sensing process involves various components like energy source, target, sensors, ground receiving and processing stations. The process begins when the energy emitted by the source (Sun or other sources) falls on the target. The incident energy in form of electromagnetic radiation is either absorbed, transmitted or reflected by the target. The reflected radiations are then absorbed by the sensors which are mounted on satellites or other aerial objects and it then transfers data to ground receiving and processing stations where raw data is received and processed in understandable form and then it is stored in form of big data or is used in different circumstances.

IV. PLATFORMS USED IN REMOTE SENSING

There are mainly three types of platforms used in remote sensing named ground based platforms, airborne platforms and spaceborne platforms. The ground based platforms are placed closed to ground mainly on tall buildings, ladders, cranes etc. It gives more detailed and clear view of area as compared to other two but the area coverage is very small. The airborne platforms are mounted in wings of aircraft or helicopters and can be useful to cover any area at any time. Area coverage is however less than spaceborne platforms. The space remote sensing is generally done using space shuttles as well as satellites. For this purpose either geo stationary or polar satellites are used. They give wide area coverage

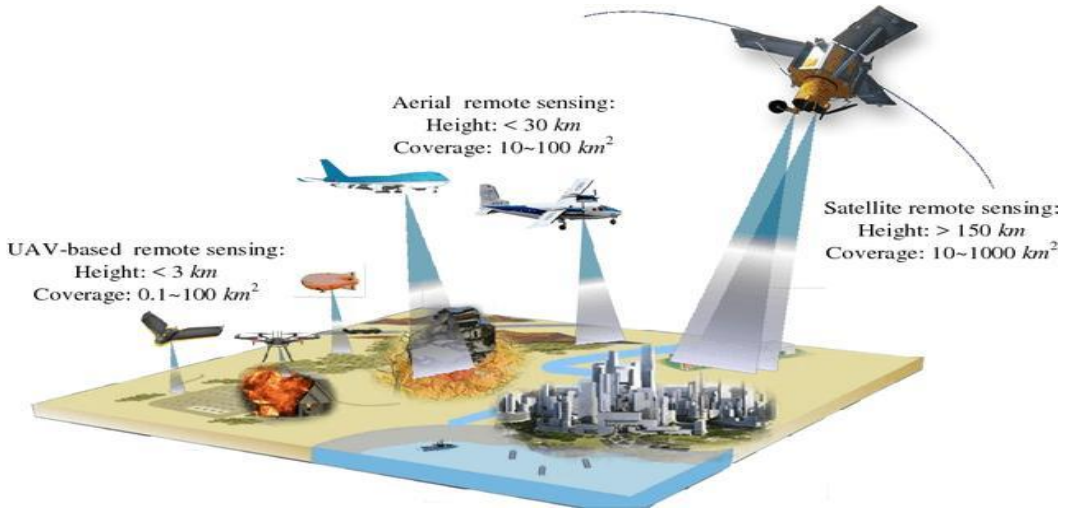

Figure 1: Platforms used in Remote Sensing

V. SATELLITES USED IN REMOTE SENSING

In remote sensing process, satellites play an important role in absorbing and transmitting radiations to ground stations. The satellites which are generally used in remote sensing are "Geo Stationary" and "Sun Synchronous". The altitude of geo stationary satellites are 36000 kilometres while that of sun synchronous satellites are 700-800 kilometres. The geo stationary satellite has orbit inclination of zero degree while that of sun synchronous satellite is 98.7 degrees. The orbital period of geo stationary satellite is 24 hours (1 day) while that of sun synchronous satellite is only 90 minutes which means geo stationary is useful for repetitive observation while sun synchronous is useful for spatially detailed data. The geo stationary satellites orbits in

west- east direction while sun synchronous orbits in north- south direction and crosses equator at 10:30 AM local time. LANDSAT, NOAA, SPOT, IRS are some of the sun synchronous satellites while GOES, METEOSAT, INSAT are some of the geo stationary satellites.

VI. SENSORS USED IN REMOTE SENSING

Generally two types of sensors are used in remote sensing namely imaging sensors which generate image output and non imaging sensors which gives output in digital form. In both imaging and non imaging sensors passive as well as active sensing is used. In imaging sensors passive sensing is done using photographic cameras, optical sensors as well as thermal scanners while in non imaging it is done using spectro- radiometer. The active sensing in imaging sensors are done using SAR (Synthetic Aperture Radar) & LIDAR (Light Detection and Ranging) while in non imaging it is done using Laser Distance Meter, Laser Water Depth Meter & Microwave Altimeter. The passive sensors uses optical remote sensing while the active sensors uses microwave remote sensing.

In optical remote sensing the source of radiation is sun and it emits radiation in form of light which is reflected by the target and then is captured by the sensors while in microwave remote sensing the source of radiation is sensor itself which emits radiation in form of microwave radiations which after reflection from the target is again captured by the sensors. (Sanad, 2013)[5].

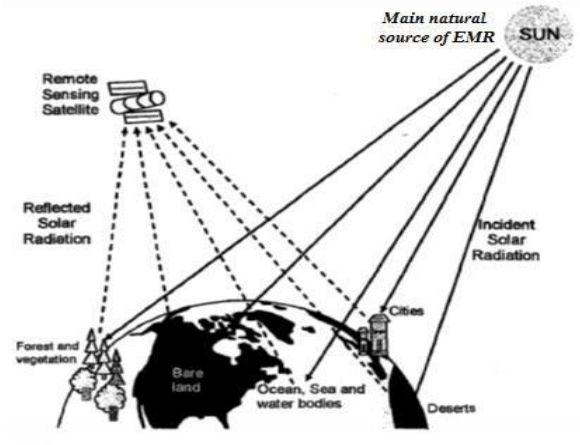

Figure 3: Optical Remote Sensing

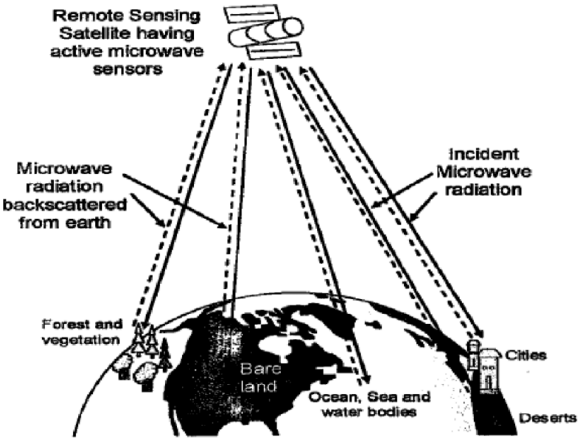

Figure 4: Microwave Remote Sensing

VII. SCANNING IN REMOTE SENSING

Scanning in remote sensing is done in two ways that is across the track also known as whisk broom scanning and along the track also known as push broom scanning. In whisk broom scanning, the scanning is done in perpendicular to line of motion and data is collected from 90 to 120 degrees within the arc below while in push broom scanning, the scanning is done parallel to direction of motion. Multispectral scanner (MSS) and thematic mapper (TM) of LANDSAT and Advanced Very High Resolution Radiometer (AVHRR) of NOAA are some of whisk broom scanners while Linear imaging self scanning (LISS) and Wide Field Sensors (WiFS) of IRS series are examples of Push broom scanners.

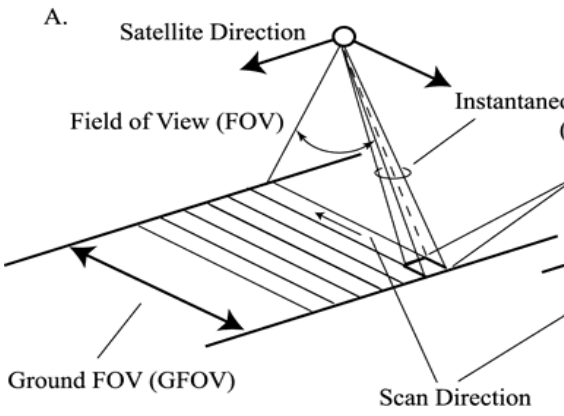

Figure 5: Across the track scanning

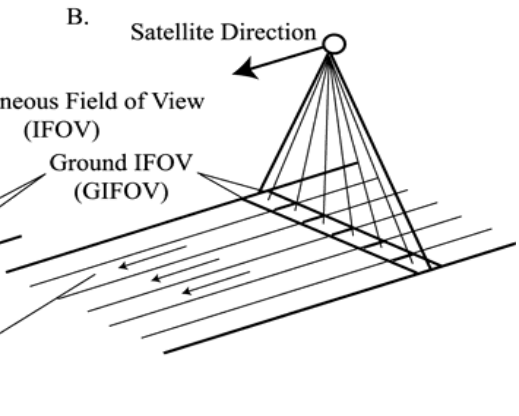

Figure 6: Along the track scanning

VIII. RESOLUTION IN REMOTE SENSING

Resolution refers to smallest or discrete unit of an image. It is ability of system to give information at smallest discrete unit in terms of distance (Spatial), wavelength of EMR (Spectral), radiation (radiometric) and time (temporal).

The spatial resolution refers to the physical dimension of earth that is recorded by the sensors. It is required in great precision for detailed mapping of land use practices.

IFOV (Instantaneous Field Of View) refers to solid angle through which detector is sensitive to radiation.

IFOV= D/F radian

Where, D= Detector dimension

F= Focal length

GRE= IFOV* H

GRE= Ground Resolution Element

H= Flying Height

The spectral resolution refers to identify fine wavelengths of radiations by sensors. It refers to number of bands of radiation in which instrument that is sensors can take radiation. Higher the spectral resolution better is the ability to identify difference in spectral signatures.

The temporal resolution refers to revisiting time of the satellite that is how frequently a satellite passes through the area. The temporal resolution has various application demands in different sectors like in meteorology hourly visit is needed, in oceanography repetivity at 2-3 days is must, in vegetation monitoring 5 days repetivity is needed while in stereo viewing daily repetivity is required.

The radiometric resolution refers to amount of information in each pixel, that is, the number of bits representing the energy recorded. It describes the actual information content of system. The radiometric resolution needs to be finer to measure the slight change in magnitude of energy. (www.earthdata.gov.in) [7]

IX. SPECTRAL SIGNATURES

The spectral signature is a pattern of electromagnetic radiation with distinguishing characteristics that is gathered at sensors located across the spectrum from land cover.(Sherbinin *et al*., 2002) [6]. It is very useful tool in identification of object as different objects have different spectral signatures.

The spectral reflectance in leaves mainly occurs due to chlorophyll which reflects green portion of radiation, the reflectance also depends on thickness of leaves. The reflectance in leaves is greatly reduced at wavelengths of 1.4, 1.9 & 2.7 micrometer due to absorption by three major water absorption bands and at 0.96 & 1.1 micrometer due to presence of minor water absorption bands. The needle shaped and immature leaves reflect less infrared light as compared to broad and mature leaves.

The spectral reflectance in soil is dependent on water content, organic content, iron content as well as its structure. Increasing soil moisture, highly decomposed organic content in soil and clayey soil have low reflectance while low soil moisture, less decomposed organic matter as well as sandy soil have high reflectance. The reflectance in green region decreases with increase in iron content of soil while it increases in red region.

The majority of radiation incident on water is not reflected but is either absorbed or transmitted. Water generally reflects very little radiation in both visible as well as in infrared regions.

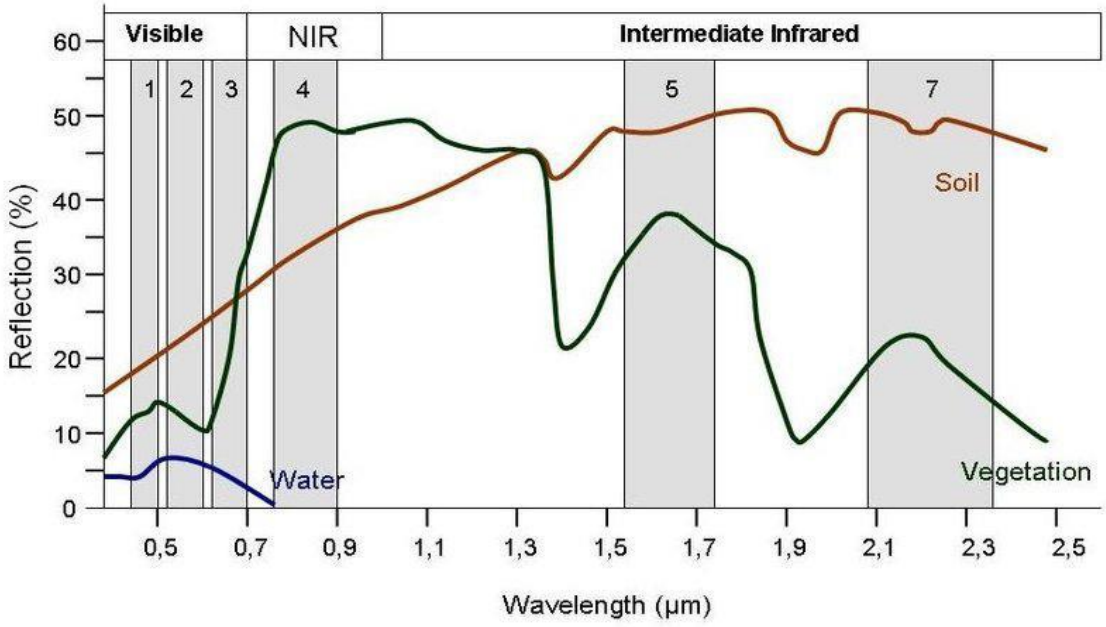

Figure 7: Spectral reflectance curve of vegetation, soil and water (https://seos-project.eu) [8]

X. IMAGE INTERPRETATION

Image is a pictorial representation of any object. Interpretation is made of physical nature of object. So, the image interpretation can be defined as extraction of information from image using knowledge, skills and experience so that it gives a meaningful picture to image with help of different methods and equipments.

Methods of image interpretation included visual and digital interpretation while elements include recognition of targets and observing its difference from surrounding objects.The digital image interpretation generally means grouping of similar pixels, separation of dissimilar pixel and assigning class level to pixel to make it meaningful. It is done using both technical as well as mannual skillsThe elements of image interpretation are; tone, shape, size, pattern, texture, shadow & association. Tone refers to relative brightness of object with respect to surrounding objects. It is fundamental element to distinguish between two objects. Shape refers to form or outline of object whereas size of an object is function of scale. Size helps to distinguish how small or big an object is with respect to its surrounding. Pattern refers to spatial arrangement if visibly discernible objects. Orderly repetition of tone or texture creates pattern. Texture refers to tonal variation arrangement and frequency in an area whereas shadow provides idea about height of object. Association considers the relationship between other identifiable things and the object of attention. (IIRS, ISRO) [9]

XI. APPLICATIONS OF REMOTE SENSING

Remote sensing has various applications in today's world. With advancement of science and increasing use of satellites it is useful to get information about any phenomenon occurring on earth using remote sensing. It gives a clear idea about any surface phenomenon occurring on Earth. It has found its use in various sectors like agriculture, water management, disaster management, geology, forestry as well as monitoring atmosphere. In agriculture it is demand of future as due to increasing population and decreasing agricultural land there is need to increase productivity in which sensor based precision agriculture can be useful tool. It gives idea about El Nino, El Nina and other oceanic phenomenon which is useful in predicting monsoon especially in India (Jong *et al.*, 2004) [2]. It can be a very useful tool in land use planning as it can help to generate idea about class of wasteland and how it can be used in future. In water management it is useful as pure water has zero reflectance and if there is high reflectance absorbed by sensors it indicates that the water is unfit for consumption and requires purification. It is also useful tool to measure forest cover of an area or world. So, we can say that it is now a days useful in all the sectors of economy directly or indirectly. It can be really a boon to mankind in upcoming days.

XII. CONCLUSION

Remote sensing is an useful tool for every sector directly or indirectly. Today's world of science needs precision in every field for which it is a very useful tool. The remote sensing is not so old to this present world but has evolved greatly over time. It generally means getting information about something from a distance for which a source of energy, a target about which we need to get information, a sensor to trap reflected energy from target and ground stations to process information from sensors is needed. The satellites used in this can be geostationary or sun synchronous on which sensors are mounted which are either optical or microwave. The sensors scan surface, obtains energy transfers it to ground stations where its interpretation is done and finally it is used to get various information. It has very complex mechanism but the data generated is of great help to mankind. So, we can say that remote sensing is a boon for 21st century.

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