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“STUDY OF SATELLITE SENSORS AND THEIR IMPLEMENTATION IN ROUTE ANALYSIS USING CONCEPT OF IMAGE ANALYSIS”

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ABSTRACT

The current scenario we can use the satellites in image analysis . By which we can analysis the image of land then although many of the weather satellite systems are also used for monitoring the Earth's surface, they are not optimized for detailed mapping of the land surface. the first satellite designed specifically to monitor the Earth's surface, Landsat-1, was launched by NASA in 1972. Initially referred to as ERTS-1, (Earth Resources Technology Satellite), Landsat was designed as an experiment to test the feasibility of collecting multi-spectral Earth observation data from an unmanned satellite platform. Since that time, this highly successful program has collected an abundance of data from around the world from several Landsat satellites. So we can say that in the image analysis we can use different types of satellites for the analysis of land.

KEYWORDS: Land, Satellite, Landsat ,Earth, Data , Program etc.

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TM BANDS		
CHANNEL	WAVELENGTH RANGE (μM)	APPLICATION
TM 1	0.45 - 0.52 (blue)	soil/vegetation discrimination; bathymetry/coastal mapping; cultural/urban feature identification
TM 2	0.52 - 0.60 (green)	green vegetation mapping (measures reflectance peak); cultural/urban feature identification
TM 3	0.63 - 0.69 (red)	vegetated vs. non-vegetated and plant species discrimination (plant chlorophyll absorption); cultural/urban feature identification
TM 4	0.76 - 0.90 (near IR)	identification of plant/vegetation types, health, and biomass content; water body delineation; soil moisture
TM 5	1.55 - 1.75 (short wave IR)	sensitive to moisture in soil and vegetation; discriminating snow and cloud-covered areas
TM 6	10.4 - 12.5 (thermal IR)	vegetation stress and soil moisture discrimination related to thermal radiation; thermal mapping (urban, water)
TM 7	2.08 - 2.35 (short wave IR)	discrimination of mineral and rock types; sensitive to vegetation moisture content

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1. INTRODUCTION ABOUT SATELLITES SENSORS

The satellites sensors are originally managed by NASA, responsibility for the Landsat program was transferred to NOAA in 1983. In 1985, the program became commercialized, providing data to civilian and applications users.

Landsat's success is due to several factors, including: a combination of sensors with spectral bands tailored to Earth observation; functional spatial resolution; and good areal coverage (swath width and revisit period). The long lifespan of the program has provided a voluminous archive of Earth resource data facilitating long term monitoring and historical records and research. All Landsat satellites are placed in near-polar, sun-synchronous orbits. The first three satellites (Landsats 1-3) are at altitudes around 900 km and have revisit periods of 18 days while the later satellites are at around 700 km and have revisit periods of 16 days. All Landsat satellites have equator crossing times in the morning to optimize illumination conditions.

A number of sensors have been on board the Landsat series of satellites, including the Return Beam Vidicon (RBV) camera systems, the MultiSpectral Scanner (MSS) systems, and the Thematic Mapper (TM). The most popular instrument in the early days of Landsat was the MultiSpectral Scanner (MSS) and later the Thematic Mapper (TM). Each of these sensors collected data over a swath width of 185 km, with a full scene being defined as 185 km x 185 km.

The MSS senses the electromagnetic radiation from the Earth's surface in four spectral bands. Each band has a spatial resolution of approximately 60 x 80 metres and a radiometric resolution of 6 bits, or 64 digital numbers. Sensing is accomplished with a line scanning device using an oscillating mirror. Six scan lines are collected simultaneously with each west-to-east sweep of the scanning mirror. The accompanying table outlines the spectral wavelength ranges for the MSS.

data, starting on Landsat 4, superseded the MSS. The TM sensor provides several improvements over the MSS sensor including: higher spatial and radiometric resolution; finer spectral bands; seven as opposed to four spectral bands; and an increase in the number of detectors per band (16 for the non-thermal channels versus six for MSS). Sixteen scan lines are captured simultaneously for each non-thermal spectral band (four for thermal band), using an oscillating mirror which scans during both the forward (west-to-east) and reverse (east-to-west) sweeps of the scanning mirror. This difference from the MSS increases the dwell time (see section 2.8) and improves the geometric and radiometric integrity of the

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data. Spatial resolution of TM is 30 m for all but the thermal infrared band which is 120 m. All channels are recorded over a range of 256 digital numbers (8 bits). The accompanying table outlines the spectral resolution of the individual TM bands and some useful applications of each.

Data from both the TM and MSS sensors are used for a wide variety of applications, including resource management, mapping, environmental monitoring, and change detection (e.g. monitoring forest clearcutting). The archives of Canadian imagery include over 350,000 scenes of MSS and over 200,000 scenes of TM, managed by the licensed distributor in Canada: RSI Inc. Many more scenes are held by foreign facilities around the world.

2. SPOT

SPOT (Système Pour l'Observation de la Terre) is a series of Earth observation imaging satellites designed and launched by CNES (Centre National d'Études Spatiales) of France, with support from Sweden and Belgium. SPOT-1 was launched in 1986, with successors following every three or four years. All satellites are in sun-synchronous, near-polar orbits at altitudes around 830 km above the Earth, which results in orbit repetition every 26 days. They have equator crossing times around 10:30 AM local solar time. SPOT was designed to be a commercial provider of Earth observation data, and was the first satellite to use along-track, or pushbroom scanning technology.

The SPOT satellites each have twin high resolution visible (HRV) imaging systems, which can be operated independently and simultaneously. Each HRV is capable of sensing either in a high spatial resolution single-channel panchromatic (PLA) mode, or a coarser spatial resolution three-channel multispectral (MLA) mode. Each along-track

The viewing angle of the sensors can be adjusted to look to either side of the satellite's vertical (nadir) track, allowing off-nadir viewing which increases the satellite's revisit capability. This ability to point the sensors up to 27° from nadir, allows SPOT to view within a 950 km swath and to revisit any location several times per week. As the sensors point away from nadir, the swath varies from 60 to 80 km in width. This not only improves the ability to monitor specific locations and increases the chances of obtaining cloud free scenes, but the off-nadir viewing also provides the capability of acquiring imagery for stereoscopic coverage. By recording the same area from two different angles, the imagery can be viewed and analyzed as a three dimensional model, a technique of tremendous value for terrain interpretation, mapping, and visual terrain simulations.

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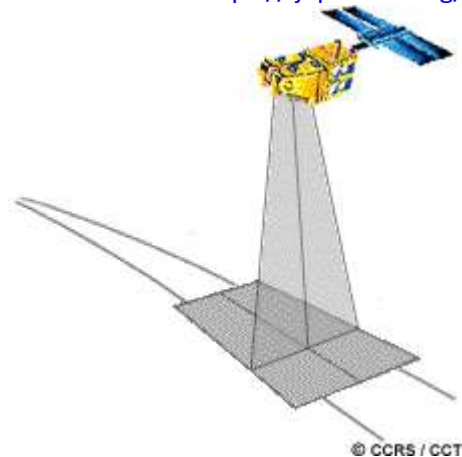


Fig-1, Satellites Image working on Land.

This oblique viewing capability increases the revisit frequency of equatorial regions to three days (seven times during the 26 day orbital cycle). Areas at a latitude of 45° can be imaged more frequently (11 times in 26 days) due to the convergence of orbit paths towards the poles. By pointing both HRV sensors to cover adjacent ground swaths at nadir, a swath of 117 km (3 km overlap between the two swaths) can be imaged. In this mode of operation, either panchromatic or multispectral data can be collected, but not both simultaneously.

SPOT has a number of benefits over other spaceborne optical sensors. Its fine spatial resolution and pointable sensors are the primary reasons for its popularity. The three-band multispectral data are well suited to displaying as false-colour images and the panchromatic band can also be used to "sharpen" the spatial detail in the multispectral data. SPOT allows applications requiring fine spatial detail (such as urban mapping) to be addressed while retaining the cost and timeliness advantage of satellite data. The potential applications of SPOT data are numerous. Applications requiring frequent monitoring (agriculture, forestry) are well served by the SPOT sensors. The acquisition of stereoscopic imagery from SPOT has played an important role in mapping applications and in the derivation of topographic information (Digital Elevation Models - DEMs) from satellite data.

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3. *SATELLITE CHARACTERISTICS: ORBITS AND SWATHS*

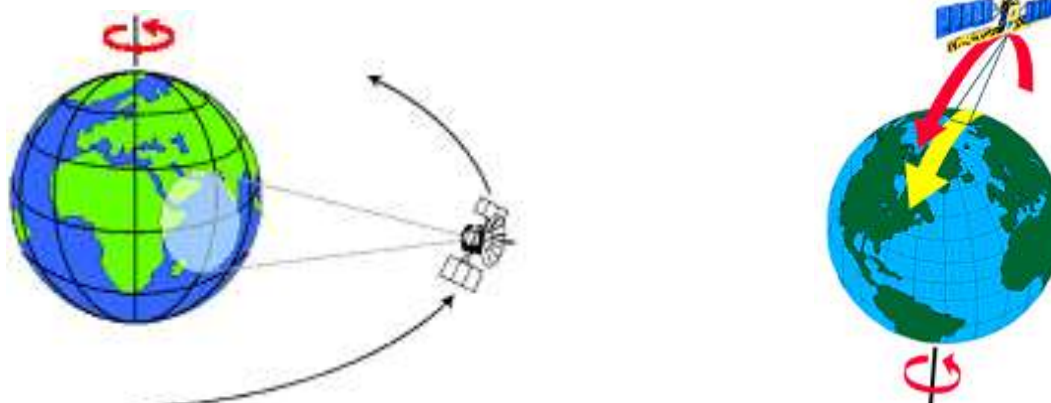


Figure -2 GEOSTATIONARY ORBITS AND NEAR-POLAR ORBITS

Remote sensing instruments can be placed on a variety of platforms to view and image targets. Although ground-based and aircraft platforms may be used, satellites provide a great deal of the remote sensing imagery commonly used today. Satellites have several unique characteristics, which make them particularly useful for remote sensing of the Earth's surface.

The path followed by a satellite is referred to as its orbit. Satellite orbits are matched to the capability and objective of the sensor(s) they carry. Orbit selection can vary in terms of altitude (their height above the Earth's surface) and their orientation and rotation relative to the Earth. Satellites at very high altitudes, which view the same portion of the Earth's surface at all times have geostationary orbits. These geostationary satellites, at altitudes of approximately 36,000 kilometers, revolve at speeds that match the rotation of the Earth so they seem stationary, relative to the Earth's surface. This allows the satellites to observe and collect information continuously over specific areas. Weather and communications satellites commonly have these types of orbits. Due to their high altitude, some geostationary weather satellites can monitor weather and cloud patterns covering an entire hemisphere of the Earth.

Many remote sensing platforms are designed to follow an orbit (basically north-south), in conjunction with the Earth's rotation (west-east), allows them to cover most of the Earth's surface over a certain period of time. These are near-polar orbits, so named for the inclination of the orbit relative to a line running between the North and South poles. Many of these satellite orbits are also sun-synchronous such that they cover each area of the world at a constant local time of day called local sun time. At any given latitude, the position of the sun in the sky as the satellite passes overhead will be the same within the same season. This

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ensures consistent illumination conditions when acquiring images in a specific season over successive years, or over a particular area over a series of days. This is an important factor for monitoring changes between images, as they do not have to be corrected for different illumination conditions.

Most of the remote sensing satellite platforms today are in near-polar orbits, which mean that the satellite travels northwards on one side of the Earth and then toward the southern pole on the second half of its orbit. These are called ascending and descending passes, respectively. If the orbit is also sun-synchronous, the ascending pass is most likely on the shadowed side of the Earth while the descending pass is on the sunlit side. Sensors recording reflected solar energy only image the surface on a descending pass, when solar illumination is available. Active sensors which provide their own illumination or passive sensors that record emitted (e.g. thermal) radiation can also image the surface on ascending passes.

As a satellite revolves around the Earth, the sensor "sees" a certain portion of the Earth's surface. The area imaged on the surface, is referred to as the swath. Imaging swaths for space borne sensors generally vary between tens and hundreds of kilometers wide. As the satellite orbits the Earth from pole to pole, its east-west position wouldn't change if the Earth didn't rotate. However, as seen from the Earth, it seems that the satellite is shifting westward because the Earth is rotating (from west to east) beneath it. This apparent movement allows the satellite swath to cover a new area with each consecutive pass. The satellite's orbit and the rotation of the Earth work together to allow complete coverage of the Earth's surface, after it has completed one complete cycle of orbits.

If we start with any randomly selected pass in a satellite's orbit, an orbit cycle will be completed when the satellite retraces its path, passing over the same point on the Earth's surface directly below the satellite (called the nadir point) for a second time. The exact length of time of the orbital cycle will vary with each satellite. The interval of time required for the satellite to complete its orbit cycle is not the same as the "revisit period". Using steerable sensors, a satellite-borne instrument can view an area (off-nadir) before and after the orbit passes over a target, thus making the 'revisit' time less than the orbit cycle time. The revisit period is an important consideration for a number of monitoring applications, especially when frequent imaging is required (for example, to monitor the spread of an oil spill, or the extent of flooding). In near-polar orbits, areas at high latitudes will be imaged more frequently than the equatorial zone due to the increasing overlap in adjacent swaths as the orbit paths come closer together near the poles.

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4. INDIAN SPACE PROGRAMME

4.1 GOAL

The goal of the Indian Space Program is to harness space technology for applications in the areas of communications, broadcasting, meteorology, disaster warning, search and rescue operations and remote sensing. Operational systems have been realized in all the above areas during the past two decades. The remote sensing component of the program, in particular, has successfully achieved global acceptance. Operational satellites have been indigenously built and launched, which cater to land and ocean applications.

5. INDIAN REMOTE SENSING (IRS) PROGRAM

Remote sensing is an important part of the Indian Space Program and the Department of Space (DOS), Government of India, is the nodal agency for the realization of the National Natural Resources Management System (NNRMS), the National Resources Information System (NRIS) and the Integrated Mission for Sustainable Development (IMSD), besides several other national level application projects like Crop Acreage and Production Estimation (CAPE), National Drinking Water Mission and Wasteland Mapping etc., In close collaboration with the user agencies. As a part of this program, DOS has acquired the capability to design, develop and operate state-of-art multi-sensor satellite based systems comprising of space, ground and application segments to meet domestic and international requirements. The department also successfully operationalized the launch vehicle program for the remote sensing satellites.

6. INDIAN REMOTE SENSING SATELLITES

The following satellite missions are the important milestones, which have been crossed, in the realization of indigenous end-to-end remote sensing capabilities. Bhaskara 1 and 2: These were experimental remote sensing satellites launched in June 1979 and November 1981 respectively. Their payload consisted of TV cameras and radiometers. These satellites provided hands-on experience in achieving the goal of the Indian Space Program.

IRS-1A and 1B: These two satellites, launched in March 1988 and August 1991 respectively, were the first generation, operational remote sensing satellites. The two identical satellites carried Linear Imaging and Self Scanning sensors (LISS-1 and LISS-II (2)) for providing data in four spectral bands with a resolution of 72.5m and 36.25m respectively with a repetivity of 22 days. These two satellites, during a period of more than a decade of operations, provided vital data for several national level projects. IRS-P2: This satellite was launched in October 1994 using the indigenously developed Polar Satellite Launch Vehicle (PSLV-D2). IRS-P2 carried a modified LISS camera.

IRS-1C and IRS-1D: These two satellites, launched in December 1995 and September 1997 respectively, are the second generation, operational remote sensing satellite missions with

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improved sensor and coverage characteristics.

The three sensors on-board the satellites are:

- * A PAN sensor with a spatial resolution of 5.8m (at nadir) in a single band in the visible region, with a swath of 70 Km (at nadir) and across track steerability of +/- 26 degrees.
- * A LISS-III multi-spectral sensor with a spatial Resolution of 23.5m, operating in the visible, near Infra-red bands and 70.5m resolution in the shortwave Infra-red band, with a swath of 141Km.
- * A Wide Field Sensor (WiFS) sensor with a spatial resolution of 188m, two spectral bands in the visible and near infra-red regions, with a swath of 810 Km. These two satellites are providing data that can be used for resource mapping up to 1:25,000 scales. Several applications have exploited the improved Capabilities of these two missions.

IRS-P3: This satellite was launched in April 1996 by the PSLV-D3. The payload consists of two imaging sensors and one non-imaging sensor. The Wide Field Sensor (WiFS) sensor is providing data with a spatial resolution of 188m in three spectral bands, in the visible and near infra-red regions, with a swath of 810 Km. The other two sensors on-board are a Modular Opto-electronic Scanner (MOS) and an X-ray astronomy payload. WiFS and MOS data products are being disseminated to users.

OCEANSAT-1 (IRS-P4): This satellite, the eighth one in the IRS program, was launched in May 1999. The payload consists of an Ocean Color Monitor (OCM) operating in eight spectral in the visible and infra-red region and a Multi-frequency Scanning Microwave Radiometer (MSMR), operating in four frequencies namely 6.60, 10.61, 18 and 21 GHz. These sensors are providing data for measuring the physical and biological parameters of oceans.

CARTOSAT-1 (IRS-P5): This satellite has Two PAN sensors with 2.5m resolution and fore-aft stereo capability. The payload is designed to cater to applications in cartography, terrain modeling, cadastral mapping etc.

OCEANSAT-2: This satellite mission is conceived to provide continuity of services to the Oceansat-1 data users. This satellite has enhanced capabilities. It carries an Ocean Color Monitor (OCM) and Wind Scatterometer. Monitoring, paddy crop acreage and yield estimation, Flood inundation mapping, ship routing and snow mapping.

4. RESOURCESET-1 (IRS P6) AND ITS SENSORS

MISSION OBJECTIVES

The main objectives of IRS-P6 mission are: To provide continued remote sensing data services on an operational basis for integrated land and water resources management at micro level with enhanced multi-spectral and spatial coverage with stereo imaging capability.

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To further carry out studies in advanced areas of user applications like improved crop discrimination, crop yield, crop stress, pest/disease surveillance, disaster management and urban management.

Specification: IRS-P6 is a three axes body-stabilized spacecraft launched by PSLV-C5 into a Sun Synchronous Orbit at an altitude 817 Km. descending node. And Repetivity 341 orbits / cycle (24 days). The spacecraft is designed for a nominal mission life of five years. IRS-P6 carries three optical cameras as payload.

7. SENSORS OF RESOURCESET-1 (IRS P6)

(7.1) Linear Imaging Self Scanning Sensor (LISS-IV) Camera

LISS-IV is a high-resolution multi-spectral camera operating in three spectral bands 0.52 to 0.59 m (Green (band 2)), 0.62 to 0.68 m (Red (Band 3)) and 0.76 to 0.86 m (NIR (Band 4)). LISSIV provides a ground resolution of 5.8 m (at Nadir) and can be operated in either of the two modes. In the multi-spectral mode (Mx), a swath of 23.9 Km (selectable out of 70 Km total swath) is covered in three bands, while in mono mode (Mono), the full Swath of 70 Km can be covered in any one single band, which is selectable by ground command (nominal is B3 – Red band). The LISS-IV camera can be tilted up to $\pm 26^\circ$ in the across track direction thereby providing a revisit period of 5 days.

(7.2) LINEAR IMAGING SELF SCANNING SENSOR (LISS-III) CAMERA

The LISS-III camera is identical to the LISS-III flown in IRS-1C/1D spacecraft except that the spatial resolution of SWIR band (B5) is also 23.5 m (same as that of B2, B3, and B4). LISS-III covers a swath of 141 Km in all the 4 bands.

(7.3) Advanced Wide Field Sensor (AWiFS)

AWiFS camera is an improved version compared to the WiFS camera flown in IRS-1C/1D. AWiFS operates in four spectral bands identical to LISS-III, providing a spatial resolution of 56 m and covering a swath of 740 Km. To cover this wide swath, the AWiFS camera is split into two separate electro optic modules, AWiFS-A and AWiFS-B. The IRS-P6 spacecraft mainframe is configured with several new features and enhanced capabilities to support the Payload operations. The payloads can be operated either in Real Time mode by direct.

8. FUTURE SCOPE AND FURTHER ENHANCEMENT

There is a lot of scope of the analysis that we have done in our thesis; our analysis could be used for the purpose of monitoring the unauthorized development of the colonies, protection of the trees, the agricultural planning, because in our study area a lot of agricultural land is available. Water resource planning, infrastructures planning and so many other areas where analysis could be used, in our country hyper spectral and very high resolution satellites will

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be available in coming years so they can provide us very useful data, now it is up to us how we process it and extract the useful information from this data.

There are also certain limitations of the satellite imaging. Atmospheric effects could be dominant and information of the object could be misinterpreted. Given bands image may not be suitable for certain objects, because objects response in one band may be good but in another band it may be poor. So we are required an appropriate image for each object for right classification.

9. CONCLUSION

Route Analysis of Remote Sensing Data Integrating Spectral, Temporal and Spatial Features of Objects in the area of satellite image processing. We have used the multi-spectral remote sensing data to find the spectral signature of different objects of the Meerut city for the land cover classification, how the use of land changes according to time and also performed the temporal analysis to analyze the impact of climate over the surface. Some band combinations of remote sensed data are effective in the land cover classification. Spatial distributions of land cover types such as roads; urban area, agriculture land, and water resources can easily be interpreted by taking their Normalized difference vegetation index (NDVI). We have carried out the ground survey to obtain the threshold values of NDVI and on the basis of it we have obtained the False Color Composite (FCC) of classified objects. The classified data could be used for municipal planning and management. The long-term objective of the thesis is to optimize the land use pattern for economically and environmentally sustainable urban development.

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