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Satellite Impacts on Real Time Remote Sensing Applications– Technical Aspect

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Abstract: Remote sensing is the effective and efficient field in the digital world. Global usage of application with the help of remote sensing is increasing consecutively. Remote sensing applications help to spy enemy satellite in warfare, Tsunami prediction, Global warming detection, Forest Monitoring and Water management. Satellite image classification helps to agriculture assessment, Sea level prediction, Weather forecasting and Soil moisturize. Basically, Classification methods come under Supervised, Unsupervised and Object based analysis method. These methods are selected based on the satellite imagery type. Imagery type categorized based on the sensor which is used to take the earth imagery from the satellite. There is a huge number of satellites takes the earth image from space. Countries are highly focused on technological advancement and are actively engaged in ensuring the growth and security of the country through satellite. This paper helps to analyze the current satellites behavior and its applications. Satellite sensor and sensor characterization also discussed in the technological aspect.

Keywords - Classification, Data Processing, Remote Sensing, Satellite Study, Satellite Sensor
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I. INTRODUCTION

Remote sensing is generally used to observe and detect the particular objects from the distance. Technologies like aircraft-based sensor and satellite helps to sensing the objects in the numerous fields like hydrology, ecology, oceanography, geology and glaciology. Remote sensing supports many real time applications such as military, intelligence, commercial, economic and planning. The main goal of remote sensing technology is possible to make the data collections from the dangerous areas.

Remote sensing is the rapid technology in the digital world. Globally, it helps to find the depth sound of coastal areas. Also used to monitoring deforestation of areas from Arctic and Antarctic regions. Remote sensing helps to different fields to customize the works in smart and good as well.

1. Measuring soil moisture content
2. Measuring gravity level
3. Observe wind speed and directions
4. Monitoring ocean flow
5. Navigating ships
6. Detect the biodiversity
7. Improve telecom network capacity
8. Optimize the solar panel energy etc.

Remote sensing technology is working based on the sensors types. The objective of remote sensor takes the imagery from earth reflected energy. It helps optimize the problems and works towards various fields of remote sensing applications. Typically, Sensors categorized as active sensor and passive sensor. Passive sensor uses natural energy that is observed from the earth reflection. Sunlight is the source of radiation sensed by the passive sensor. Active sensor emits of own energy called electromagnetic radiation to examine the objects.

Table no 1 shows the name and use of the sensors. The sensor uses details collected from the mission official sources [1].

Table no 1: Description of the Sensors

Types of sensor	**Name of the Sensor**	**Uses**
Passive Sensors	Radiometer	Measures the electromagnetic radiations.
	Imaging Radiometer	Provides dataset image into two-dimensional array of pixels.
	Spectrometer	Detect/measure/analyze the spectral content of the incident electromagnetic radiation.
	Spectro Radiometer	Measure the radiation intensity in multispectral bands.
Active Sensors	Radar	Measure the arrival time of reflected pulses of radiation from the distant objects.
	Scattero meter	It is high speed microwave radar, used over ocean surfaces and measures the wind speed and directions.
	Lidar	Used to the accurate atmosphere of aerosols and clouds.
	Laser Altimeter	Determined the height of the platform with respect to the Earth surface.

II. SATELLITE DATA CLASSIFICATION

The main objective of classification in remote sensing is to classify the images which are already sensed. Generally, classification is categorizing all pixels of satellite imagery to monitor the current events and future predictions. To predict the land cover data, various classification techniques are designed and applied in the remote sensing field. Three major techniques are used for image classification, named as supervised classification, unsupervised classification and object-based image analysis.

1. Unsupervised Classification

The process of unsupervised classification technique is grouping the image pixels with some common characteristics. Cluster generation, Assign classes are the steps performed for classification. Cluster generation means, based on the image properties pixels are grouped into clusters, to assign clusters various image clustering algorithms are used. Clusters are created with the help of the clustering algorithm as process needed. Analysts manually identify each cluster with land cover classes. Applications of unsupervised classification include land cover classes, major vegetation types, vegetation condition, disturbed areas land use change.

2. Supervised Classification

Supervised classification is also called as human guided classification. In order to fulfill the classification process, three steps are needed which are selections of training areas, signature file generation and classification. Here users select pixels from the images that represent some specific classes. Training sites are selected based on the user's knowledge; software uses these training sites and applied it to entire images. Two different supervised classification algorithms are used commonly, one is maximum likelihood and another one is minimum distance classification.

3. Object-Based Image Classification

The procedure of Object-based image classification technique is to identify the objects of images and segment the pixels with similar color, texture and tone. Object based classification is more effective than the pixel based technique while classifying high resolution images. Four steps are needed to classify the images, it includes multi-resolution segmentation, add feature statistics, assign classes and select samples. Object based image classification technique grouping of pixels into respective shapes and sizes. This pixel grouping process is named as multi-resolution segmentation. Multi-resolution segmentation provides different scales of objects on the image. After the segmentation process defines the statistics to classify the image objects. Finally, nearest neighbour classification method classify the objects based on the statistical defined.

III. SATELLITE DATA PROCESSING

Satellites play a huge role to develop and connect the whole world in technological directions. Some of the advanced technological satellites are discussed in depth.

1. Landsat 8

An instrument of Landsat 8 has designed more advance in technology, providing imagery in a moderate resolution of distance ranging from 15 meters to 100 meters. Landsat 8 is capable of capturing more than 700 scenes per day and increase 250 scenes per day of Landsat 7. Landsat 8 having two push broom instruments named as Operational Land Imager (OLI) and Thermal Infrared Sensor(TIRS).

Table no 2 shows the Landsat 8 spectral band details and its applications. The details are collected from the official mission source [2].

Table no 2: Landsat 8 satellite description

OLI (Operational Land Imager)		
Spectral Band	**Wavelength (μm)**	**Application**
Band 1 - Coastal/ Aerosol	0.433 - 0.453	Observe ocean colors and tracking fine particles like dust and smoke on the coastal water.
Band 2 - Blue	0.450 – 0.515	Distinguishing soil from vegetation.
Band 3 - Green	0.525 – 0.600	Highlight the peak vegetation and assessing plant vigor.
Band 4 - Red	0.630 – 0.680	Discriminates vegetation slopes
Band 5 - Near Infrared	0.845 – 0.885	Underline biomass content and shorelines
Band 6 – Short Wavelength Infrared	1.560 – 1.660	Segregate moisture content of soil and vegetation.
Band 7 - Short Wavelength Infrared	2.100 – 2.300	Penetrates thin cloud and enhance moisture content of soil and vegetation.
Band 8 - Panchromatic	0.500 – 0.680	Provides sharper image definition from 15 meter distance
Band 9 - Cirrus	1.360 – 1.390	Improved detection of cirrus cloud contamination.
TIRS(Thermal Infrared Sensor)		
Band 10 – Long Wavelength Infrared	10.30 – 11.30	Used to estimate soil moisture from 100 meter resolution.
Band 11 – Long Wavelength Infrared	11.50 – 12.50	Provides 100 meter resolution, enhanced thermal mapping and estimated soil moisture.

2. WorldView-4

Worldview-4 is called as GeoEye-2 in earlier. It is a commercial Earth Observation satellite and Digital Globe is operated with spacecraft of 0.31m as a maximum resolution. WorldView-4 works with two sensor bands such as panchromatic and 4 multispectral bands. Worldview 4 is capable of collecting 30 cm resolution imagery with better clarity and also contributes 600, 00 sq km to the image library every day. Table no 3 shows the WorldView-4 spectral band details and its applications. The details are collected from the official mission source [3].

Table no 3: WorldView-4 band details

Sensor Bands	**Wavelength**	**Resolution**
Panchromatic	450-800	0.31 m
Multispectral		
Red	655-690 nm	1.24 m
Green	510-580 nm	1.24 m
Blue	450-510 nm	1.24 m
Near Infrared	780-920 nm	1.24 m

3. AVHRR

Advanced Very-High-Resolution Radiometer (AVHRR) instrument is a space-borne type of sensor. This sensor can remotely measure earth surface temperature, the upper surface of clouds, and the surface of a water body. Moreover, AVHRR senses the outgoing radiation of the Earth surface from the horizon. It takes the imagery in six channels, three of them from visible near infrared region and remaining three channels from the thermal infrared region. These instruments are used on different satellites named as TIROS-N and NOAA-11. Use of AVHRR, the visible data used to map large areas, measure the degree of snow ice, monitoring vegetation. The infrared data can be used to measure the temperature of the sea surface [4], scientists will be better able to determine the effects of global climate changes by monitoring these variables. Table no 4 shows the band specifications of AVHRR.

Table no 4: AVHRR Band details

Sensor Bands	Wavelength (μm)	Applications
1(Visible)	0.58-0.68	Clouds and land surfaces cartography(day)
2(Near Infrared)	0.725 – 1.00	Clouds and land surfaces cartography(day)
3A(Near Infrared)	1.580 – 1.64	Snow and ice detection
3B(Infrared)	3.550 – 3.93	Clouds and sea surface temperature mapping (night)
4(Infrared)	10.30 – 11.30	Clouds and sea surface temperature mapping (night)
5(Infrared)	11.50 – 12.50	Sea surface temperature

4. Sentinel 5

Sentinel 5 is launched to monitor the aerosols in the atmosphere. It traces gas concentrations to operating some services related to air quality in real time applications. Sentinel 5 mission uses a unique instrument named as UVNS. The main objective of this mission is air quality measurements, stratospheric Ozone monitoring, solar radiation measurements and climate monitoring [1][7].

The below table no 5 is used to tabulate the Sentinel 5 bands and its wavelength.

Table no 5: Sentinel 5 band details

Spectral Bands	Wavelength (nm)
UV-1	270-300
UV-2	300-370
VIS	370-500
NIR-1	685-710
NIR-2	755-773
SWIR-1	1590-1675
SWIR-3	2305-2385

IV. SATELLITE SPECIFICATIONS

Satellites are designed and launched to supports various applications and functionalities. The satellites are compared with its specifications and it tabulated in table no 6. This section describes various distinct satellites and its technology.

Table no 6: Comparison of Satellite Specification.

Name of the Satellite	Spectral Bands	Orbit Height [km]	Mission Period [m]	Mission Objectives	Date of Launch	Mission Cost[crores]
Landsat 8	9[OLI], 2[TIRS]	705	96	Earth Imaging	11-02-2013	85.5
WorldView -4	1[Panchromatic] 4[Multispectral]	617	96.93	High resolution and color imagery	11-11-2016	83.5
Sentinel 5	4[ultraviolet(UV), visible (VIS), near(NIR), short-wavelength infrared(SWIR)	824	798	Atmospheric composition, air pollution, ozone layer monitoring.	13-10-2017	$9.5 billion
GSAT 18	24[C-band] 12[extended C-band] 12[k_u – band]	14,843 - 35,802	996	Communications	5-10-2016	153 million dollar

Astrosat	5[visible, near UV, far UV, soft X-ray, hard X-ray]	643.5-654.9	97.6	Monitoring of intensity variations in a broad range of cosmic sources	28-09-2015	180

V. MAJOR APPLICATIONS OF REMOTE SENSING

1. Water Resource Management

Remote sensing field supports the water resource management. It helps to monitor the quality of water using some parameters like water color, temperature, Soil moisture, land surface characteristics etc. Remote sensing applications in water resource management are rainfall studies, drought monitoring, flood forecasting, irrigation management, rain water harvesting, watershed planning and management and groundwater studies. Satellite remote sensing technique helps to detect the onset of drought, magnitude and its duration [5]. Infrared and Microwave bands are used to detect the flooded areas to find the depth of the water. Satellite sensor helps to provide accurate estimation of the flooded damaged area[9]. Irrigation advisory services, crop classification, performance evaluation of the irrigation system, irrigated area mapping are the applications of the irrigation management system. Based on the assessment of the soil moisture and crop health the irrigated area growth level can be identified from the remotely sensed satellite images.

Table no 7: Rainfall observation details

Rainfall		
Satellite	**Spectral Bands**	**Resolution**
MTSAT,NOAA-19	VIS,IR	Spatial:1-4km Temporal:30min
TRMM	VIS,IR, Passive & Active Microwave	Sub-daily, 27 km spatial resolution
GEOS-8,10,GMS,TRMM, NOAA-15,16,17	IR	Spatial: -27 km Temporal: 30min.
AQUA,TRMM,NOAA-15,16,17,18	Microwave	Spatial:8km Temporal:30min

Table no 7 describes the list of satellites which are commonly used for water resource management. Flood level monitoring is one of the important applications of water resource management. The table no 8 describes the details about satellites, which are used to monitor flooding area.

Table no 8: Flood monitoring satellite details

Flood Monitoring			
Satellite	**Sensors**	**Resolution**	**Temporal Coverage**
NOAA	AVHRR	~1.1 km	Daily coverage, poor cloud penetration
Terra	MODIS	250 m	Daily coverage, poor cloud penetration
Landsat 4,5	Landsat TM	30 m	16 days once, poor cloud penetration
ERS1,2	SAR	20-30	1 to 3 days, good cloud penetration

2. Forestry Resource Management

Satellite images are used to monitor the forest resources, planning and predicting the problems which are occurred due to natural disaster. To manage natural disaster recovery, remote sensing satellite images provides exact expulsion routes to avoid maximum of problems during fire events. It also provides accurate data about the forest status like forest extend, stand density, operational monitoring etc [6][10]. To monitoring the forest events, some of the high resolution sensors acting as a backbone such as MSS (Multi Spectral Sensor), TM (Thematic Mapper), HRG (High Resolution Geometrical), HVR (High Resolution Visibility), HRVIR (High Resolution Visible and Infrared), ALI (Advance Land Imager), IRS (Indian Remote Sensing Satellite).

Table no 9: Forestry Management satellite details

Satellite	Spectral Bands	Spatial resolution[km]	Spectral Resolution	Application
NOAA-AVHRR	Red, NIR, MWIR,Thermal	1.1	daily	Detection of thermal emissions from active fires.
DMSP- OLS	Visible, Thermal	2.7	daily	Detection of light emissions from night time fires.
Terra-MODIS	MWIR, Thermal IR	1	daily	Burn scars mapping, land cover mapping.
Landsat-TM	Blue,green,red, NIR, SWIR,	30 m	Once in 16 days	Detection burn scars, classification and mapping of vegetation.
SPOT-HRV	Green, Red, NIR, SWIR,	20 m	daily	Find the location of fire, burn scars detection and mapping, classification of vegetation.

The table no 9 describe the satellites used to monitor and manage the forestry health [22][8].

3. Agriculture

Agriculture plays a crucial role to override the problems of nation developments and poverty alleviation. Remote sensing technology significantly works to improve the productivity of the crops and cultivation. For cultivation, crop health is based on its temperature, irrigation, soil health condition. To monitoring crop health, GIS provides various vegetation indices such as NDVI, TVI, and FPAR. Remote sensing technology supports the applications to find crop damage assessments, estimation of crop production, condition assessment of crop and detection of stress, monitoring of climate change, estimation of air moisture, analysis of crop health, soil mapping, weather data collection, mapping of water resources, identification of diseases etc.

Table no: 10 Agriculture satellite details

Satellite	Sensor	Mission Objective
Sentinal-1A	C-band SAR	Biomass, stem volume, soil moisture, land deformation[7,8,9,10]
Landsat 8	OLI and TIR	Qualitative vegetation, soil moisture.[11,12]
RapidEye	Multi-spectral Push broom imager	Vegetation information, forest biomass.[13,14,15]
Sentinal-2A	Multispectral Imaging Spectrometer	Vegetation water content, phenology, soil moisture and color information.[16,17,18]
OCO-2	Spectrometer	Detection and monitoring of sources. [19]
WorldView-2,3	Multi-spectral push broom imager	Indirect information of soil. [20,21]

Agriculture satellites and its applications[5] are tabulated in Table no 10.

VI. CONCLUSION

The technological world entirely depends on the satellites to connect and communicate with one another. The study focused on the satellites which have been launching and working concurrently. Satellites are works well for various distinct applications based on its specifications. It enriches all fields of our nation includes telephony, television and radio, mobile satellite technology, satellite broadband, weather reporting, earth observation, agriculture, forestry, geology, space exploration etc. This paper concentrates on the satellites with its sensor and spectral band combinations based on the appropriate applications. Comparisons are taken over along with satellite specifications in the aspect of spatial and spectral resolution. Each and every satellite exhibits the functionality, which is based on its configuration. This technological phase survey helps to study the satellite characterization with technical aspects.

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