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EARTH OBSERVATION USING RESOURCESAT-2

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ABSTRACT

RESOURCESAT-2 is an imaging satellite used for earth observation (EO) to capture images all over the world. It is launched by Indian Space Research Organization (ISRO) on 20th April 2011 using Polar Satellite Launched Vehicle (PSLV)-C16. It is a mission planned to provide continuity of services to the RESOURCESAT-1.It consists of Automatic Identification System (AIS) .This paper presents different areas of earth observation with RESOURCESAT-2. Its payload system consists of new data handling system. It Belongs to India's 'workhorse' EO Satellite series. It is providing continuity in EO data services, on operational basis, for land and water resources studies at macro, regional and micro levels. Nowadays it is used for the enhancing of multi-spectral and spatial coverage as compared with RESOURCESAT-1 Supporting applications in the areas of Agriculture, Forestry, Water Resources, and Disaster Management Support. In this paper various sections like mission objectives, mission specifications, orbital parameters, data handling, data reception and its processing are covered.

Keywords: Earth Observation (EO), surveillance ,payload ,solid state recorder (SSR), spectral.

INTRODUCTION

RESOURCESAT-1 was launched on 17th October 2003 on board Polar Satellite Launched Vehicle(PSLV) and this mission was designed to carry out studies in advanced areas of user applications like improved crop discrimination, , pest/disease, crop yield surveillance, disaster management and urban management.This mission was having drawbacks in its telecomm and software system. Thus, RESOURCESAT-2 mission was planned to overcome drawbacks and for providing the continuity of service of RESOURCESAT-1. It was Launched on 20th April , 2011 on-board (PSLV-C16).It is the satellite of Low Earth Orbiting (LEO) satellite and belongs to Earth Observation (EO) satellite series. It commonly known as IRS-P6.It has user defined sequence- programming facility with full flexibility of programming. It's Payload off timer facility providing the facility of executing commands by issuing only two commands from ground.

(Fig 1) :- Resourcesat-2

OVERVIEW OF RESOURCESAT-2 MISSION

The mission control is controlled from ISTRAC Bangalore. Station SAC of Ahmedabad is used for product s/w & engg. Further data is provided to user from NRSC data center.

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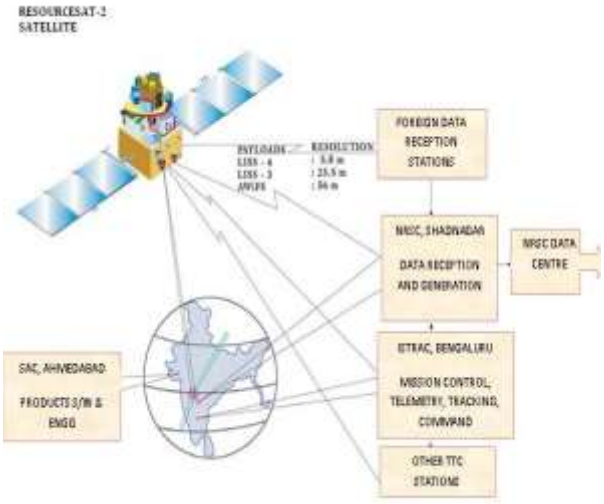

(Fig 2) Overview Of Resourcesat-2 Mission

Mission objectives

Resourcesat-2 Payload system is same as of Resourcesat-1 with certain improvement of Payloads electronics like new data handling system, MIL 1553 interface with SSR (indigenous), SPS and miniaturized Payload electronics.

Thus, following changes were taken w.r.t. Resourcesat-1:-

Configurable command block (CCB) execution facility that provides user defined sequence-programming facility with full flexibility of programming.

Payload off timer facility, which provides the facility of executing commands by issuing only two commands from ground.

Facility of execution removal of restriction of forbidden range during overflow giving total flexibility of up linking and executing at any time.

The spacecraft segment carries out following functions:-

Images in the required spectral band and provide required pointing accuracy with stability while image capturing.

Provide necessary power to subsystems and payload operations with a positive power margin.

MISSION SPECIFICATION

This mission has following specifications:-

The satellite is designed to provide both multi-spectral and panchromatic imagery of the Earth's surface.

The payload system comprises of three optical remote sensing cameras, viz., LISS-IV, LISS- III and AWiFS. LISS-IV provides 5.8m resolution in three bands with 70Km swath, LISS-III provides 23.5m resolution in four bands with 140 Km swath and AWiFS camera provides with a spatial resolution of 56m in four bands with 740Km Swath.

All the three cameras will be working on the 'pushbroom scanning' concept using linear arrays of Charge Coupled Devices (CCDs). In this mode an image is electronically scanned and contiguous lines are imaged by the forward motion of the satellite.

The LISS-IV can be operated in two modes - Mono and Multi-spectral. In this mode, data is collected either with 70 km (only over Indian region) swath or 23.5 km.

LITERATURE SURVEY

1. S.N. Goward et al in research paper 'Comparison between Resourcesat-2 AWiFS and Landsat TM sensor' compares the result between AWiFS and Landsat TM sensors which nominally evaluate equivalent portions of the electromagnetic spectrum at similar times of day and they find that AWiFS sensor is better than the Landsat TM sensor because of the way these sensors were designed and operated they produce somewhat different records of the same land surface spectral coverage and produce different results.

2. V. Adithya Pothan Raj in research paper 'Enhanced methodology for change detection using Resourcesat-2 LISS-IV multispectral remote sensing images' proposed a new methodology to solve the change detection problem using the concepts of Interactive Segmentation, Support Vector Machine, Markov Random Field, Level Set etc. The pixels in the image are initially processed using the training set generated using SVM. The usage of Markov random Field improves the performance and decision to locate the Change region. This improves the visual recognition of Multi spectral Images under realistic imaging.

ORBIT, COVERAGE AND ORBITAL PARAMETERS

ORBIT /PATH

Orbit is the course of motion taken by the satellite, in space and the descending ground trace of the orbit is called a 'Path'. The orbit being similar to Resourcesat-1, the satellite completes 341 orbits in 24 days with 101.35 minutes of an orbital period.

This way, the satellite completes 14 orbits per day and designated path number in the referencing scheme and the orbit number are not the same. On day one (D1), the satellite covers orbit numbers by the path numbers.

During operation , actual path may be vary from nominal path due to variation in orbit by different gravities. Thus, orbit is adjusted periodically by adding

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drift by engines and path variation of 1 km can be covered.

ORBITAL PARAMETERS

The primary objective is to provide systematic and repetitive acquisition of data of the earth's surface under nearly constant illumination conditions.The satellite takes 101.35 minutes to complete one revolution around the earth and completes about 14 orbits per day. It has 341 orbitsduring a 24 day cycle.

All the orbital parameters are shown in the table given below:-

Table:- Orbital Parameter

Orbits/ cycle	341
Repeat cycle	24 days
Altitude	817 Km
Semi-major axis	7195.11 Km
Inclination	98.689 deg
Eccentricity	0.001
Orbit period	101.35 min
Distance between adjacent traces	117.5 Km
Distance between successive ground tracks	2820 Km
Ground Trace Velocity	6.65 Km/Sec

SYSTEM OVERVIEW

Resourcesat-2 is a three axes body stabilized spacecraft launched by PSLV into a Sun Orbit situating at 817 Km altitude. The mission has the life of five years Synchronous Resourcesat-2 carries three optical cameras as payload.

Linear Imaging Self Scanning Sensor (LISS-III)

Camera-140 Kg

The LISS-III camera is functionally identical to the LISS-III flown in Resourcesat-1 spacecraft except that the 10 bits data is transmitted using Delta Pulse Code Modulation (DPCM) technique. It has Swath of 141 km.

Advanced Wide Field Sensor (AWiFS) camera-740kg

AWiFS operates in four spectral bands identical to LISS- III covering a swath of 737 Km. The payloads can be operated either in real time mode by direct transmission to ground station or in record and playback mode using an on-board 2X240 GB capacity Solid State Recorder(SSR).

Linear Imaging Self Scanning Sensor(LISS-IV) Camera-70 Kg

LISS-IV provides a ground resolution of 5.8 m (at Nadir). In the multi-spectral mode (Mx), a swath of 23.5 Km (selectable out of 70 Km total swath) is covered in three bands.In mono mode, the full swath of 70 Km can be covered in any one single band is selectable by ground command.

BDH for LISSIII and AWIFS Payload camera

LISSIII payload camera of Resourcesat-2 consists of four bands B2, B3, B4 (VNIR) and B5 (SWIR) with output encoded according to Differentially Pulse Code Modulation(DPCM).

DPCM encodes ten bit pixel information to seven bits and receives seven bit DPCM encoded data, multiplexes them to different bands of data and formats them in to frames along with auxiliary information.

BDH for LISS-IV Payload camera

LISS-IV payload camera of Resourcesat-2 consists of three bands B2, B3, B4 with output encoded Code Modulation (DPCM).

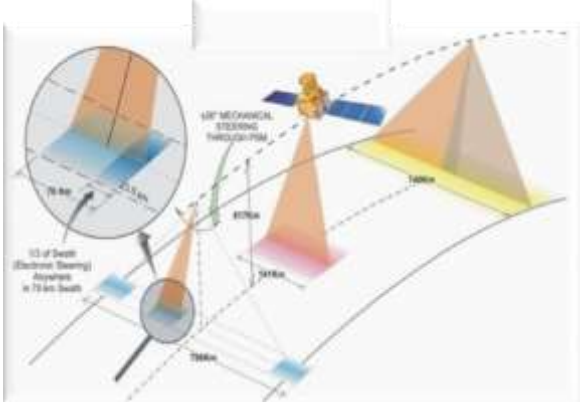
DPCM encodes ten bit pixel according to Differentially Pulse information in to seven bits.

Mono mode provides 70 Km of swath and any one of the band may be selected for download. In 23KmMx mode, all three bands for selected position in 70Km may be downloaded.

Solid State Recorder (SSR)

There are two Solid State Recorders with each capacity of 200 Gbit and two chains for recording and playback. It command, payload data can be recorded in either of SSR and data may be played through any of the two available X band RF chain. The system records the data as files and at a given time there can exists maximum of sixteen files in each chain.

Satellite Positioning System and tier imaging



(Fig 3):-3-Tier imaging with combination of cameras

The Satellite Positioning System (SPS) on-board Resourcesat-2 consists of 10/8 channel GPS receivers operating at 1575.42 MHz frequency..

Use of synchronization command :- The playback data is transmitted to a ground station at a rate of 16kbps after PSK modulation on 128 KHz sub-carrier. Through MIL-1553B interface, OBT (on-board timer of AOCE system) is synchronized to GPS time once every 60

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seconds through a time synchronization command.

GROUND SYSTEM

Different ground station along with their function as follows:-

Telemetry Tracking and Command (TTC) functions are carried out by ISRO with its ground stations located at Bangalore, Lucknow, Mauritius.

The reception and recording of payload data are done at the earth station of the National Remote Sensing Centre (NRSC), located at Shadnagar, near Hyderabad.

Mission control support is provided from ISTRAC, Bangalore. Data is also transmitted to different International Ground Stations (IGS).

Mission of the ground segment

To maintain the spacecraft in polar sun synchronous orbit providing 24 days repetivity cycle .The orbit height and path pattern to match Resourcesat-1 path pattern. The payload system for imaging any area on the ground with their specified characteristics and transmit data to ground for producing Data products for use by the user agencies.

It supervises altitude and orbit control, power supply, data formatting and transmission, data storage,Telemetry, Telecommand, tracking functions. The bus in addition to have necessary propulsion.

Ground Segment Overview

To support Resourcesat-2 mission the schedules for ISTRAC Ground Stations and SCC operations are generated weekly as general schedules and communicated via Text/Fax/E-Mail messages to all ground stations and spacecraft consoles. Fig provides the flow of scheduling and reporting procedure for the TTC and Mission Control Centre operations. Different types of schedule messages, reporting messages and their formats are given in Resourcesat-2.

DATA RECEPTION SYSTEMS

Antenna & Feed system

The Antenna system consists of 7.5 meter dual shaped parabolic reflector in a cassegrain configuration.

The feed & sub-reflector are mounted on the main reflector with a quadric pod support structure assembly. Aviation warning lights and lightening arrestor are mounted on the reflector. Sub-reflector is hyperboloid supported by four aluminum quadripods.

The Shaped antenna system together with Gallium Arsenide Field Effect Transistor (GaAs FET) low noise amplifiers provide a G/T of better than 31.5 dB/^{0}K at 5 deg. Elevation.

The Feed produces both tracking and data outputs in Right Hand Circular (RHC) polarization and capable of receiving S and X band signal.

Finalized product after processing

Images taken from RESOURCESAT-2

LISS-4 IMAGE(part of Delhi,India)

LISS-3 IMAGE(Dubai Palm island)

APPLICATION

It is used for studies in advanced areas like improved crop discrimination, crop yield, crop stress, pest/disease surveillance, disaster management and urban management.

The Areas around world were severely affected by flood and landslides triggered due to various causes. With the help of RS-2, damage assessment due to the event was carried out using high resolution satellite data.

Analysis of relationships between water spread in major vs. regional rainfall scenarios, medium reservoirs and smaller irrigation tanks. This helps in understanding water storages and utilization across the time periods.

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FUTURE SCOPE

ISRO and Antrix are dedicated to providing IRS data through 2018.Following systems will be operational till 2017 and Next generation systems will carry into 2018.

1. Resourcesat-3 series

More spectral bands and increased resolution:-
AWiFS (A & B) at 25m resolution, 600km swath,Liss-III at 23.5m resolution and 2 additional bands, Liss-IV at 5.8m with 25km swath.
New sensors with 25km swath:-
Liss-V (PAN) at 2.5m resolution, Hyperspectral at 25m resolution (~20 Bands), 5 day revisit cycle.

2.Resourcesat-4 series

Addition of new sensors with 13.5km swath based on 550mm optics:-
Liss-IV*n* at 2.5m, swath 50 km, 5 day revisit, Liss-V*n* swath 850 km, 5 day revisit, HSI*n* at 12.5m, 25 bands, 5 day revisit.

CONCLUSION

Resourcesat-1 mission was planned to carry out studies in advanced area of earth surveillance. But, it was having few problems in its telecommand facility and having fewer features in its payload. Thus, with improvement in the telecommand and payload facility Resourcesat-2 mission has been started to provide continuity of service to resourcesat-1.It has more developed system such as CCB and more stability in image capturing. Thus, in the above paper different sections like system, orbital parameters , data handling system, payload system , data reception and data processing to get finalized product has been covered.

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