

DEVELOPMENT OF IRS-HISTOGRAM DATABASE USING IRS-P6 AWIFS IMAGERY

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ABSTRACT

With ever increasing demand for accurate radiance values and high signal to noise ratio (SNR), new strategies need to be employed for optimal operations of space-borne sensors. The optimal operations include not only the *a priori* knowledge of the scene dynamics of interest but also inputs like sensor saturation radiances, sun illumination and sensor view angles etc. The objective of this paper is to make use the advantage of 100% albedo gain setting in visible-near IR bands of Advanced Wide-Field Sensor (AWiFS) of RESOURCESAT-1 in order to develop histogram database for multispectral imagery for any region within the country. This paper proposes the developmental procedure adapted for histogram database generation and retrieval to derive the statistics of spectral radiances expected within the selected part of the scene for appropriate gain settings, required for some sensors (e.g., IRS LISS sensors) equipped with variable gain settings.

1. Introduction

Rapid advances in satellite technology, with increase in the number of satellite sensors taking more frequent measurements and with increased awareness of the need for global environmental observation has progressively made remote sensing data as inevitable source of information for the environment and planners community. In particular, earth observation by in-orbit remote sensing cameras is essential for monitoring natural phenomena like vegetation, forests, snow cover, climate, etc. which have economic aspects and ecological aspects. For most applications, one needs accurate values and good image dynamics. But to correctly design the sensors and adapt their dynamics in order to increase the signal-to-noise ratio and thus the accuracy, it is necessary to know as precisely as possible, the spectral radiances of all the different places in the world and their variation with the seasons and viewing conditions.

With the launch of IRS-P6 (RESOURCESAT-1) during October 2003 (NRSA 2003), the opportunity of recording 100% albedo was possible using Advanced Wide field Sensor (AWiFS) over a wide swath of 740 km in four spectral bands (visible, NIR, SWIR) at a GSD of 56 meters with 10-bit quantization. The AWiFS realizes its wide field of view by employing two separate sensor modules named as AWiFS-A and AWiFS-B tilted by 11.94° to the left and right of nadir. The two modules have a small overlap of coverage in the centre, approximately 7 kilometres.

Histogram is one of the best graphic representations of the information content of a remotely sensed image, it not only provides brightness and contrast information, allows to estimate the minimum, maximum radiance encountered by the sensor on particular area in corresponding spectral bands in a given season. Effort was made to calibrate the SPOT HRV sensors by building the database of histograms Aime (1997). The objective is to develop the histogram database, methodology to store the histograms of AWiFS scenes and

derive information for other smaller swath sensors about the radiances of the selected area on the earth (At present, limited to Indian region) and provide inputs to the Mission operations for optimal gains settings for a given period of time.

2. Functional description

Given the AWiFS multispectral image of a scene (size: 370 km × 370 km), in LGSOWG format (Mahammad and Jamindar, 2002) the software extracts ephemeris (Date of Pass, Path, Row, scene corner co-ordinates, operated gain setting and projection parameters) and establishes mathematical relationship, through affine transformation, between image (line and pixel) and scene co-ordinates. The image is then divided into 23 km × 23 km area grid, which is equivalent to the area coverage of L4 sensor of IRS-P6 in multi spectral mode, and histogram is computed for all bands for the segmented images. The histogram of these segments is stored along with their scene coordinates into the database. Apart from histogram data, the database also stores the permanent data like saturation radiance for all the bands of different sensors. In the retrieval process, the user needs to provide inputs viz., satellite, sensor, bands, and period of acquisition along with interested area details. All the histogram data records available bound by above inputs will be extracted and cumulative histogram will also be computed by thresholding the histograms to provide image statistics (minimum, maximum, mean and standard deviation) and corresponding top-of-atmosphere spectral radiances and apparent reflectance.

3. Hardware and software

The software was developed using Java for graphical user interface and internal computations while Oracle-9i server as backend database. The application runs on a Pentium-4 PC.

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The package is made Platform independent, Reusable, Extensible with Reduced Effort & Easy Maintenance.

All the modules are developed using Object Modelling Technique with class level implementation in Java. Modules are composed of objects. An Object has been depicted using a class. Some of the modules are listed below.

- Product View
- Format Read & Display
- Data Verification
- Data Download & Histogram generation
- Image Display with Lat/Lon
- Path/row based histogram extraction
- Latitude/longitude based histogram extraction
- Histogram display
- Seasonal variation of spectral radiances

Database provides an interface to the software (Figure 1) where information about a geographical area (lat/longs, date of acquisition, sun zenith, sun elevation angle, gain in which it was operated and of course the histogram information in all spectral bands). Thorough analysis has been done to organize the data into tables so as to ease the query processing performance and transaction volume and satisfy the needs of the application. Object oriented database design methodology is used to design the database for this application. The data is further organized into static and dynamic tables.



Figure 1. Application model

The static data is least accessed and remains static for a specific time period viz., Saturation radiance information for a sensor in all spectral bands. Dynamic data is the data most often accessed and changeable i.e., histogram information of an area. This design assures the concurrency and integrity of data. Table.1 shows the sample database structure.

Master/Detail relationship was maintained between header information common to all spectral bands and histogram information pertaining to individual spectral band. The concept of user defined object types and nested tables available in oracle database was utilized which stores the entire collection of gray value and its frequency for all 1024 gray values into a single field.

The database contains 12350 histograms corresponding to 85 AWiFS full scene imageries covering the entire Indian landmass for four seasons. Continuous efforts are being made to store and analyze histograms of all season's data.

The disk space occupied for the above-mentioned set data is 3 GB; the 20GB of disk space available with in the system should satisfy all the application's operational requirements in all seasons.

4. Operating the Database

This process involves two steps, the selection of geographical area and the selection of parameter.

	Fieldname		Fieldname
1	Histdb_No	11	Scene Center Time
2	Satellite_Id	12	Sun Elevation Angle
3	Sensor	13	Latitude (NE, NW, SE, SW)
4	Date of pass	14	Longitude (NE, NW, SE, SW)
5	Path	15	Center Latitude
6	Row	16	Center Longitude
7	Product_Type	17	Suspend
8	Gain	18	Timestamp
9	Band no	19	Remark
10	Temperature	20	Histogram Details

Table 1. Database structure

Facility is made to select the area of interest for which the radiance value is to be calculated by path/row based, Lat/Long based or it can be a polygon. Figure 2 shows the selection of area of interest.

User has to select the prime inputs like satellite, sensor, band and the period along with the interested area. Providing optional inputs like sun elevation angle, camera tilt is being planned. The Parameter to be displayed for the selected geographic region can be

- Top of atmosphere radiance
- Top of atmosphere apparent reflectance
- Suitable gain settings for the selected Sensor
- Seasonal variation of spectral radiances over selected geographical area

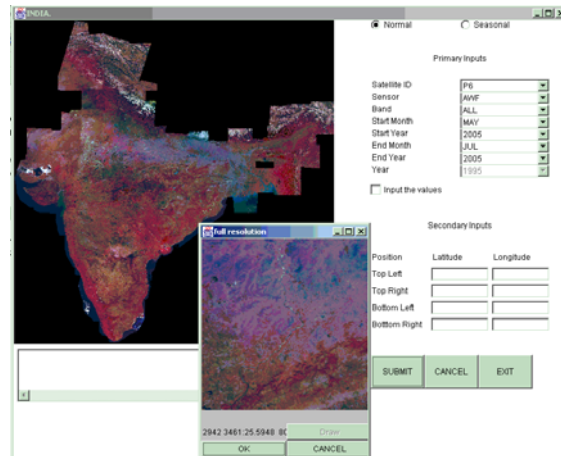


Figure 2 Geographical area selection by polygon.

All the histogram data records available bound by above latitude and longitude inputs were extracted and cumulative histogram was also computed to provide image statistics (minimum, maximum, mean and standard deviation) and corresponding top-of-atmosphere spectral radiances and apparent reflectance and optimum gain in which it has to be operated were suggested.

5. Applications

The system now is being utilized not only to study the temporal variation of spectral radiance/reflectance during a period, Maximum and minimum observed radiance of selected. Figure 3 shows the example of seasonal variations in top of atmosphere spectral radiances over the area around $25.38^{\circ} / 79.93^{\circ}$ (Lat/ Lon) during the year 2005.

Knowledge of all possible observed radiances allows a new sensor to be correctly designed for its mission. Sensitivity of the sensors can be characterized by observing the reflectance over highly stable targets.

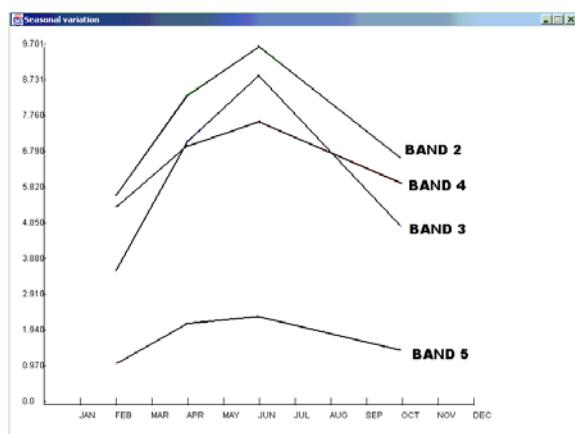


Figure 3. Seasonal variation map of top of atmosphere radiances

6. Scope

As histograms are computed only on Cloud free (less than 5%) image, some regions, which are generally cloudy, are not being filled for all seasons. Efforts are being made to fill the gaps using other IRS satellite data and to build the radiance map for all seasons. Software is being developed for automatic detection of uniform areas, which have narrow dynamic range through out the period. The software currently supports real-time pass data of AWIFS imagery, and extension to support global histogram database is straightforward with the AWIFS imagery, acquired for any region across the globe and stored in solid state recorder memory onboard the RESOURCESAT-1 satellite.

7. Conclusions

IRS Histogram database system was developed to store the huge amount of data from number of images for optimal use of IRS sensors capabilities. It was designed, developed and made operational and now providing optimal gain settings information for other IRS smaller swath sensors viz. L-3 and L-4 well in advance to the mission operations over the Indian landmass, Analysing the results from this histogram database system, gain 2 was suggested to all spectral bands of L-3 and L-4 in northern hemisphere for the period April to September

and in turn facilitated the accurate radiometric measurements with high signal to noise ratio. The Collection of worldwide AWiFS data can suggest appropriate global gain settings even to smaller geographical regions through out the period optimally.

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