DATA PROCESSING SYSTEMS AND PRODUCT GENERATION

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Introduction

The Department of Space (DOS), considering the need for remote sensing technology in India, planned a series of Remote Sensing satellites to be built indigenously. To receive and process the data from remote sensing satellites, facilities were set up at National Remote Sensing Agency (NRSA) at Hyderabad, India.

At NRSA/DOS, since 1979, facilities were established for receiving and processing data from Landsat and Metsat satellites. Gradually, these facilities were upgraded to handle SPOT, IRS and ERS-1 data. Over the years NRSA/DOS has gained expertise in the development of indigenous hardware and software for data processing and reception.

The data from Remote sensing satellites are received at the Data Acquisition Facility at Shadnagar, on High Density Tapes (HDT) Digital linear tape (DLT) and CD-ROM and are sent to Balanagar Data Processing facility for further analysis. Based on the user request, the NRSA Data Centre processes the data in users defined format through an Integrated Information management System (IIMS). Depending on the request either for photo or digital products, the data are generated to meet the user's need. Typical sequence for photo products generated include; data processing, film recording and processing, quality check and photo products generation. Finally, the product is quality-checked and dispatched to the users. Similarly, for digital products, the data request is processed at data processing system and then sent for digital quality control, after which the data are made available to the respective users. All the activities, as mentioned above, are carried out under the control of IIMS. The following sections provide the details of each of the systems as well as the data products-generation mechanism.

Data Processing System

Data processing system (DPS) is a very important element in the data products generation chain. Its main, function is to convert the raw video data of various sensors of Remote Sensing satellites recorded on HDTs, DLTs and CD-ROMs at the Lewvel-0 system facility (Earth station, Shadnagar) into different types of products after performing radiometric and geometric corrections.

Based on the load, a master scheduler distributes work orders to Data Processing Chains 1 & 2 for products generation. This master scheduler performs functions like normal request queuing, priority request queuing (for out-of-turn generation of urgent products), and initiation of jobs on multiple DPSs.

Specified numbers of products requested by users which are registered by NRSA Data Centre (NDC) reach DPS through IIMS when master scheduler is invoked. The next step in DPC is to ingest the raw data from HDT onto the hard disk connected to computer system via an in-house developed hardware or ingest data from DLT or CD-ROM. Radiometric and geometric corrections are applied to raw data and required user products are generated.

Types of data products

Different types of data products for LISS-III, PAN and WiFS sensors have been categorized into three groups, viz. Standard products, special products and stereo products.

Standard products: Standard products are corrected for the following errors to the extent possible through prior knowledge and orientation parameters which are updated using orbit/attitude model. (i) Scene-related errors: It includes earth rotation, earth shape, earth curvature and map projection.

(ii) Sensor related errors: It includes mainly detector response non-uniformity, detector array alignment related and sensor tilt. (iii) Platform-related errors: These errors mainly include spacecraft altitude, spacecraft attitude, and sensor alignment.

Special products: Data products with any one of the following characteristics are referred to as special products: Special radiometric data manipulation, High geometric accuracy products, registration between multi-sensor data sets, mosaicing of multiple data sets to cover the district, state, country etc.

Stereo products: Stereo products are defined to take advantage of the stereo data acquisition capability by tilting the PAN camera. These products are characterized by: Possibility to get a 3-D view of the area under consideration, capture of 3-D topographic data, removal of image distortions due to height variations.

Data corrections

(a) Radiometric errors: Different sources for radiometric distortions for sensors include: Non-uniformity response across detector arrays, non-uniformity response across multiple arrays, non-uniformity response over time, radiometric variation due to mosaicing of multiple scenes, and scan line losses.

(b) Geometric correction: This is accomplished by using a dynamic imaging model which consists of a number of transformations involving payload coordinate system, spacecraft coordinate system, orbital coordinate system and earth centered inertial coordinate system.

Products generation

The output products are generated either in photographic or digital format. The digital data are supplied with various levels of processing such as raw, standard, special and stereo. The file formats and structures in User CCT (UCCT) are the same for all levels of processing. The formats in which the digital data are supplied include fast and super structure formats. Digital data products are available in CD-ROM, CCT, DAT media.

Browsing facility

Data from IRS satellites are acquired daily and repeatedly on a regular basis from the same geographical region to enable the study of spatial and temporal behavior of the data. The repetitive period is a characteristic of the specific satellite and is determined by the orbit in which it is placed. In order to pick the right data set from the archived data, it is essential to scan through the archives. A facility to meet the above requirement is initially set up at NDC and subsequently available to various user agencies through Internet.

The browse facility consists of: (i) browse processing system, (ii) browse archival system, and (iii) browsing workstation (s).

Master film generation

Conversion of digital data to visual data is done using film recorder. In the film recorder, the digital data are converted into optical signals using light modulator. The output of the light modulator is proportional to the input digital data. This corresponds to the ground scene data from the tape.

In case of high resolution data received from panchromatic band the images are generated using Large Format Photowrite. In Large Format Film Recorder (LFFR), the large-scale outputs are obtained by exposing 40” x 40” B/W paper and colour outputs are generated using FIRE 240 film recorder.

Photo Processing Facility

The sophisticated Photo Processing Facility (PPF) at NRSA is equipped with state-of-the-art technology systems such as photographic processors, contact printers, auto focus enlargers and quality evaluation and measuring devices, in addition to process monitoring and control systems, sensitometric lab, analytical lab, etc. The facility is specially designed and custom made for processing all types of satellite photo products.

Digital product quality Check

All data products generated need to go through a quality check process in order to ensure the quality as per preset quality criteria. Digital product quality check system, checks the errors related to product media. This system extends a facility to check the media related errors in, CD-ROM, CCT. DAT.

Photographic products quality

The photographic products are verified against established specifications. Any product deviating from the specifications is rejected at the quality control and is put through another cycle of generation till good quality product is generated. i.e., only those products which confirm to the specifications are accepted and supplied to users.

Data quality evaluation

The basic objective of data quality evaluation scheme is to evaluate radiometric and geometric quality of data products. Radiometric quality is a measure of radiometric uniformity. Geometric quality is a measure of geometric inaccuracies caused due to platform attitude/orbit, sensor behavior.

(a) Geometric parameters: These parameters quantify impact of (a) platform stability (orbit/attitude), (b) sensor/platform registration geometry using RCPs (relative control points) and GCPs (geometric control points), (c) Mapping accuracy of scene coordinates of a point on the image to a corresponding point on the ground.

The platform stability and mapping accuracy parameters are computed using GCP library. This library is a pre-defined database with latitude/longitude of known, measured ground control points. Video chip around GCPs of size 128x128 pixel area is stored. The parameters are location/tick mark accuracy, scale and internal distortion, side lap/overlap of scene. The side lap/overlap of two adjacent scenes of successive paths of the same cycle and same scene repeatability in two successive cycles is monitored.

Sensor-related registration parameters are band-to-band registration for LISS-III, WiFS and array registration for PAN. Results are stored in databases to analyse the performance of the system and to monitor product accuracy.

Additional geometric parameters are height estimation and tilt angle verification from basic stereo pair acquired with different B/H ratio and anisomorphism (which measures ratios of major/minor axis imaged by sensor and the same target measured on ground.

(b) Calibration analysis: This quantifies detector performance of all bands/arrays of LISS-III and PAN sensors. The execution of onboard calibration scheme is scheduled by the mission at night. The data are acquired at Shadnagar, CAL-ANL S/W is executed in near real time. This flags deviated detector behavior depending on Chi-square threshold value and compares current cycle detector performance with previous and ground observed detector performance. The calibration DQE package computes standard/relative error, S/N ratio, dynamic range, LED intensity distribution over an array, LED status, dark current. This quantifies detector performance without using optics.

Integrated Information Management System

The Integrated Information Management System (IIMS0 supports and links the chain of operations from data acquisition through data distribution. The development of this system was carried out as a part of the IRS mission requirement and it is capable of handling all IRS missions.

The objectives of IIMS are for archiving the information of images and products and to provide product retrieval facilities.

References

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