Digital database creation of historical Remote Sensing Satellite data from Film Archives – A case study

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ABSTRACT

National Remote sensing Agency (NRSA), India is the nodal agency for acquisition and dissemination of remote sensing satellite and aerial data to user community. NRSA provide remote sensing data in digital and photographic media. NRSA has been acquiring remote sensing satellite data since the late seventies from various foreign satellites and indigenously developed IRS satellites. The photographic masters generated since late seventies covering all IRS, Landsat and SPOT series satellites have been archived in film archives. These films contain data which are systematically corrected, geo referenced / geo coded with appropriate scene details and annotation. At present more than 75,000 masters both B/W and FCC films are archived.

These films bound to get deteriorated due to ageing and could not yield good results on a photographic media. In order to use the valuable data available in the analogue form for various applications a case study is taken up to convert the satellite films to digital images for subsequent use in digital systems. The digital data would be much useful for various remote sensing applications. The historical data would provide information content about the earth features in different stages, so that it is useful for potential GIS applications, change detection, temporal analysis , feature correlation etc. with present and future data. Creation of database of this kind would disseminate data to the concerned for their usage.

INTRODUCTION

NRSA archived more than 75,000 film masters generated since 1985 and these masters contain the satellite data applied with systematic corrections for radiometric and geometric errors. There are masters even corrected for true north orientation and geo coded which has better geometric accuracy than standard products. Also the special master films having the images of prominent cities, States, districts and area of interest (AOI) of specific places are archived. All master films are annotated with necessary scene details like satellite, sensor, date of acquisition, scene corner co-ordinates, sun elevation, azimuth and sensor heading angles. The scenes are formatted in a grid with tick marks and provided with registration marks on all four corners for dimensional measurement. A scale bar and gamma corrected gray scale are provided for further photographic printing.

Sensor	Master Scale	Output Scale
PAN	1:62500	1:12500
LISS-3,4	1:125000	1:25000
LISS-2,3,4	1:250000	1:50000
LISS-2, TM	1:500000	1:125000
LISS-1,3,MSS,TM	1:1 Million	1:250000
WiFS	1:3 Million	1:1 Million

Table-1

NRSA is the only organization in the world which provide customized satellite data in photographic media. These photographic products are compatible with SOI map sheets for interpretation. The image scales varies from 1:3 million to 1:62500 (table-1) covering large to small areas. These films can be used for reproducing the enlargement very quickly without going through the normal production chain. Among the total volume, most of the films are older than 10-15 years. Around 75% of the existing archives have color master films. These films bound to get deteriorated due to ageing and could not yield good results on a photographic media. In order to preserve the valuable information present in these films, a study has been conducted to transfer these into digital form from analog media by adopting suitable process.

DIGITISING PROCESS

When a film is scanned digitally, the amount of information retained will depend upon the spectral information extracted from the film at the spatial limits of the scanner. Light (1993, 1996) provided equations for determining spatial resolution needed to preserve the information based on the static resolving power of the system. The radiometric or spectral resolution is a function of both original image on the film and digitizing parameters.

The archived films are generated by writing the corrected digital data in 50-100 µm spot size onto the photographic film through photo write system. The information content is transformed truthfully in the film by correcting the nonlinearity components. Scanning of film could yield better results than a print as the film is a master generated from photo write system by linear transfer. Also the scanning device is capable to transfer the data in better resolution when compared to the film spot size resolution. The basic scanning procedures like setting the histogram, adjusting image brightness, scaling, etc. are similar to both B/W and color negatives. Color negatives are very different than scanning positive films as they have an overall orange mask. Subtle color casts render by this would be removed interactively through the scanner.

The resolution and scale factor numbers are typically larger when using film, because film is small. Image size and memory (table-2) can be quite huge when scanning film at very high resolution. But a film scanner allow enough quality pixels to scale to print a large image. The ratio of scanning resolution/printing resolution gives the enlargement factor which could support scanning of specific area from the film. Another major benefit is that the image data can be scanned in variable contrast levels as per the requirement.

Resolution (microns)	**Image size (Pixels)**	**Memory (MB)**	**Scanning time (minutes)**
8	17408x 23296	1140	20
16	8704 x 11776	296	10
32	4352 x 5888	75	6

Table-2

DATABASE CREATION

The digital files will be stored in a database systematically which would provide selection of historical remote sensing data available for study of natural resources. Database provide a coherent view of a number of images depicting the information of various terrain features of earth. This will be categorized into satellite wise like IRS-1A,1B,P3,P4,1C,1D with scene details. Data base allows to search the individual files category wise.

Each category is further broken down by a number of sub categories like standard and special products. One of the reasons for deciding to create a digital database of historical remote sensing data is to overcome the difficulties in preservation of films and quick access to the corrected data. Creating database of above nature would increase the utilization of remote sensing data significantly. Each scanned output will be passed through a QC process and checked for image quality before populated in the database. During the scanning and database entry phase, each image is identified by a unique identifier based on the satellite, sensor, date of acquisition and type of product. A small image like thumb nail would be produced for each film and is embedded within the database record.

CASE STUDY

As part of the study, an old FCC master film of IRS-1C data (fig-2) generated in 2001 is taken up as case study. Using a High precision scanner, the film is scanned at different resolutions varying from 8 microns to 32 microns. The software enables to adjust density and histogram values to make the brightness of the image for visual presentation. The digital file size is varying depending on scanning resolution. The higher scanning resolution would result high quality output with larger file size. Optimum scanning resolution could be decided keeping in view of the requirements and limitations.

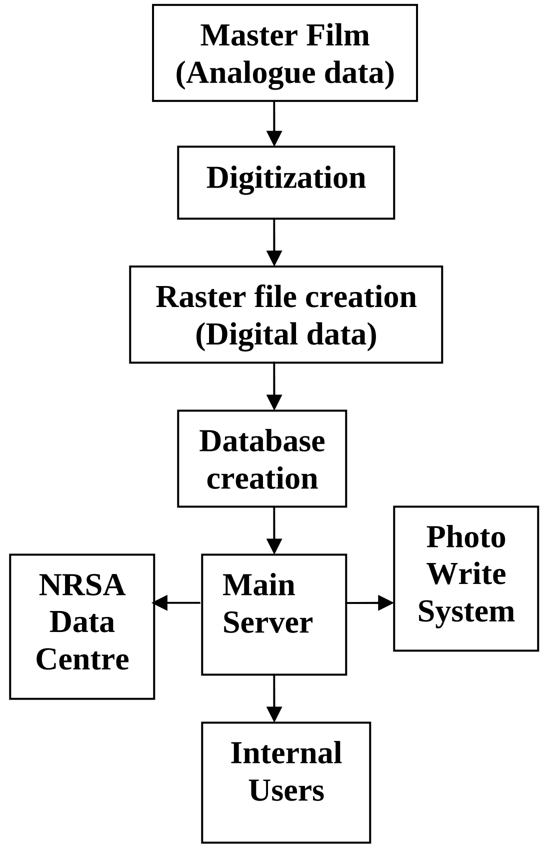

Fig-1. Work Flow chart

TONE REPRODUCTION AND IMAGE QUALITY

A comparison study of the scanned data and photographically generated output is carried out to evaluate the image transformation quality. Tone Reproduction refers to the degree to which an image can convey the luminance ranges of an original image. It is one of the single most important aspect of image quality. Tone reproduction will show how the system works with respect to density values. Here linearity means that the relationship of tonal values of the image is not distorted.

As the part of the exercise, tone reproduction curve is plotted with the grayscale densities of original master film and photo print to establish the reproducibility. Also the scanned output grayscale densities are plotted and compared (fig-3). Some printouts are generated from laser printer resulted with good quality output and comparable to photo quality. The overall image transformation and the data quality are analyzed objectively / subjectively and observed that this is providing desirable results. This gives confidence that all master films can be converted into digital media and populated as database for user community. The quality of output products generated using the scanned image file is very good and comparable with the existing mode of product generation quality.

CONCLUSIONS

The above results could give confidence to carryout the digitization of the historical data, so that the old image data can be well stored in digital form for easy retrieval. The same may be transferred to photo write system for the generation of photo prints as and when required with improved turn around time. Additionally, the centralized data storage facility would cater to the internal users for various applications. Users can select the available data directly and use for their applications such as GIS applications, change detection, temporal analysis, feature correlation etc. in the form of digital / photographic media. This would also reduce the turn around time for supply of old archived data to the users.

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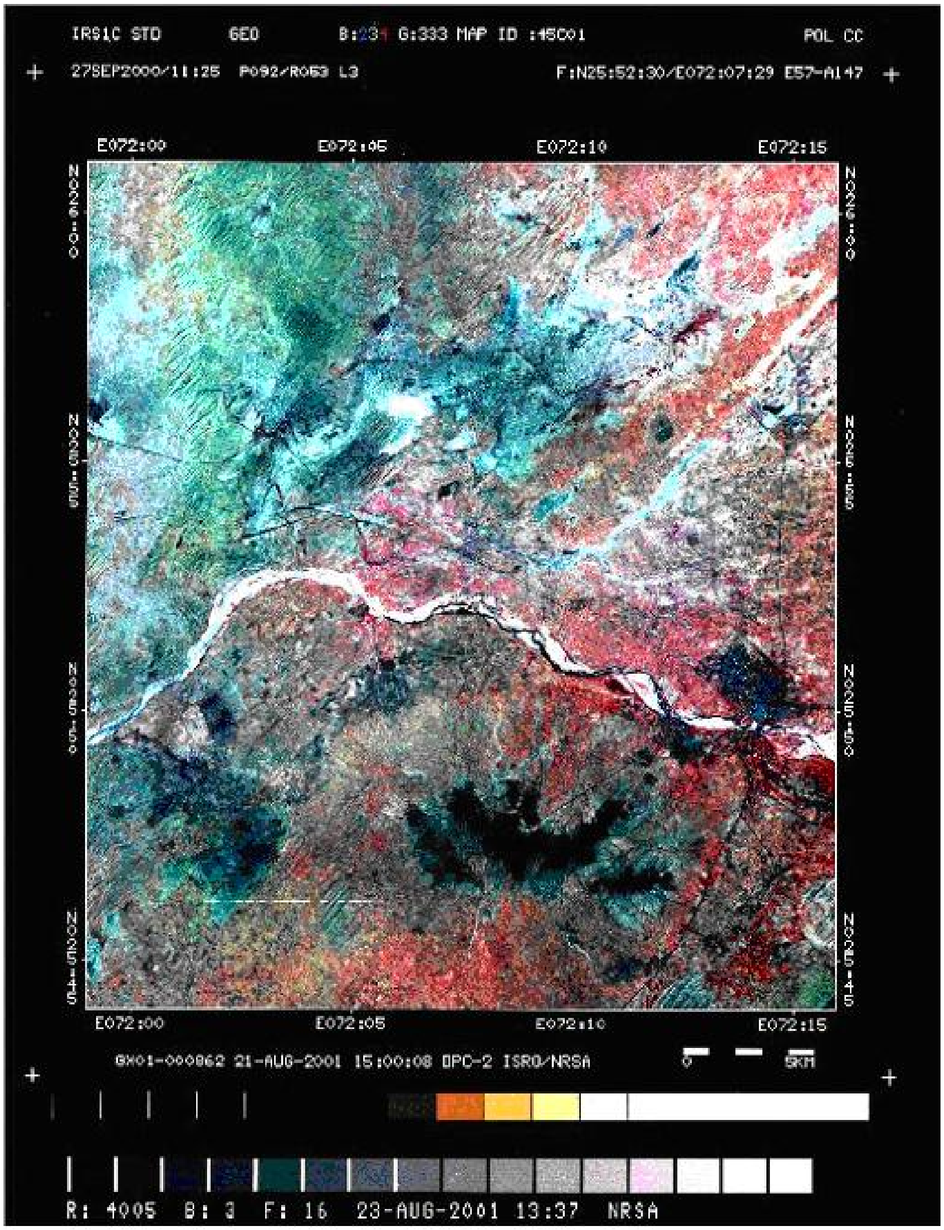

Fig-2. IRS-1C Satellite Geocoded data (scanned output)

Photographic Density Table and Tone Reproduction Curve

	Master film densities			Photo Output densities			Digital Output densities		
Gray Level	RED	GREEN	BLUE	RED	GREEN	BLUE	RED	GREEN	BLUE
1	0	0	0	2.3	2.29	2.17	1.95	1.92	2
2	0.04	0.05	0.04	2.29	2.23	2.13	1.95	1.91	1.99
3	0.1	0.11	0.12	2.24	2.13	2.04	1.91	1.81	1.91
4	0.16	0.18	0.18	2.15	1.94	1.88	1.79	1.61	1.75
5	0.21	0.24	0.24	2.02	1.74	1.73	1.66	1.5	1.64
6	0.26	0.31	0.3	1.8	1.49	1.55	1.48	1.34	1.49
7	0.31	0.37	0.34	1.48	1.24	1.32	1.25	1.18	1.33
8	0.38	0.43	0.4	1.16	0.98	1.1	0.93	0.97	1.06
9	0.43	0.48	0.46	0.88	0.78	0.9	0.81	0.84	0.94
10	0.48	0.53	0.53	0.64	0.6	0.73	0.73	0.76	0.87
11	0.54	0.58	0.58	0.45	0.45	0.57	0.54	0.59	0.71
12	0.6	0.64	0.65	0.29	0.32	0.43	0.37	0.45	0.54
13	0.65	0.69	0.71	0.17	0.22	0.32	0.25	0.34	0.43
14	0.7	0.75	0.78	0.09	0.14	0.23	0.12	0.23	0.34
15	0.75	0.8	0.84	0.04	0.04	0.12	0.02	0.14	0.27
16	0.8	0.86	0.9	0.01	0.04	0.12	0	0	0.18
17	0.82	0.92	0.95	0.01	0.02	0.1	0	0	0.03

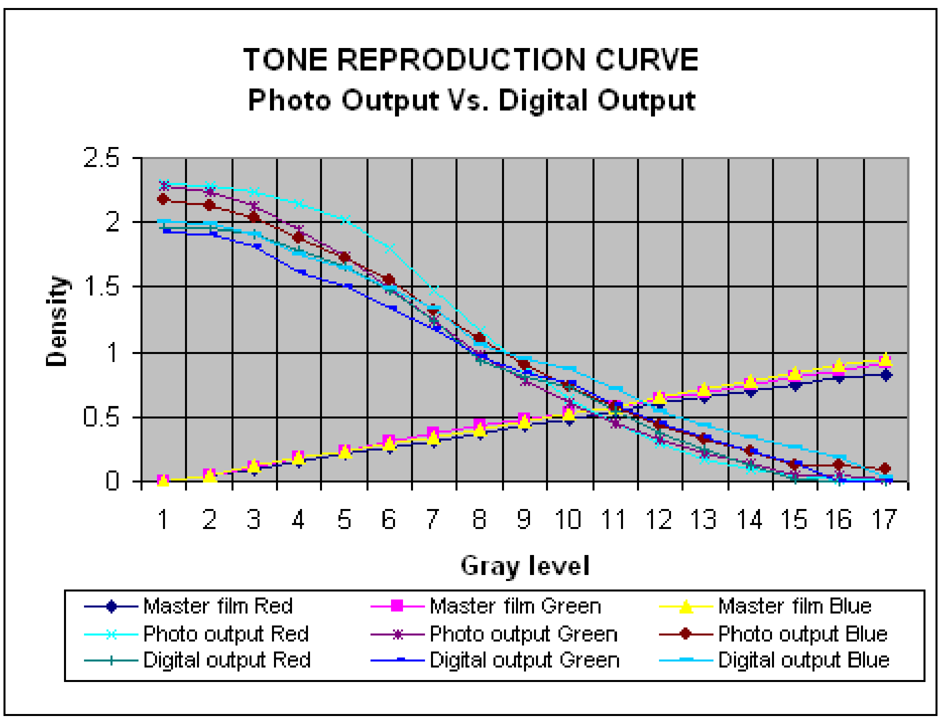

Fig-3