A comparative study of radiometric corrections on multispectral and panchromatic images

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Abstract - Satellite images which are obtained by a satellite which is not in direct contact with surface but captures and stores the images in range of electromagnetic spectrum. Satellite images consists of numerous distortions or errors which are caused by many external factors and internal factors. Radiometric distortions (Spectral Anomalies) are due to errors in digital number (DN) of image. Radiometric corrections helps in improving the quality of image by correcting the DN values which helps in comparative studies and this is the major step in digital image processing. This study is carried out using ERDAS imagine software. This study mainly focused on haze reduction, noise reduction and periodic noise removal on multispectral data and panchromatic data. Histograms and accuracy assessment was carried out to plot the difference between processed and unprocessed image. Haze removal techniques demonstrated success compared with noise removal and periodic noise removal technique which might be due to absence of noise in the satellite imagery.

Key words - Radiometric corrections, Multispectral image, panchromatic image, Haze reduction, Noise reduction

I. INTRODUCTION

Remote sensing can be defined as the acquisition and measurement of data/information of one or more properties of a phenomenon, object, or material by a recording device not in physical contact with the feature under surveillance. Remote sensing involves the collection of data in digital or analogue forms (e.g., aerial photographs and videos) by space-based instruments or sensors without any physical contact. In general, remotely sensed data are collected from airborne platforms such as satellites, with brightness values at various wavelength regions of the electromagnetic spectrum in a variety of spectral, spatial, radiometric, and temporal resolutions [1]. Satellites collect sensed data in raw or unprocessed form. The raw spectral data or radio signals must be processed or enhanced in order to produce images or other products. Pre-processing technique is the preliminary step in digital image processing which includes geometric (Spatial anomalies) and radiometric (spectral anomalies) Radiometric corrections incorporate correcting the data for sensor anomalies and unwanted sensor or atmospheric noise, and converting the data so they precisely speak to the reflected or discharged radiation

estimated by the sensor. Radiometric correction is done to reduce or correct errors in the digital numbers of images. The process improves the interpretability and quality of remote sensed data [2]. Radiometric calibration and correction are particularly important when comparing data sets over a multiple time periods.

Main objective of this study is to apply different radiometric corrections like haze reduction, noise reduction and periodic noise removal on multispectral data and panchromatic data.

Plotting the difference between processed images and unprocessed images by histograms and accuracy assessment.

II. STUDY AREA AND DATASETS

Landsat-5 data is taken over Hyderabad city on 13-03-1990 (shown in figure 1). The Landsat Thematic Mapper (TM) sensor was carried on Landsat 4 and Landsat 5, and images consist of six spectral bands with a spatial resolution of 30 meters for Bands 1-5 and 7, and one thermal band (Band 6).

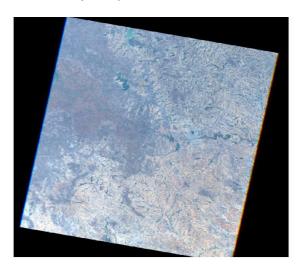


Figure 1: True colour image of Landsast-5 over Hyderabad city

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Cartosat-1 data is taken over Mangalore city (shown in figure 2). The swath covered by these high resolution PAN cameras is 30 km and their spatial resolution is 2.5 metres.

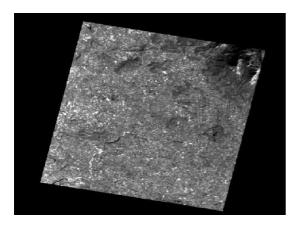


Figure 2:cartosat1 over Mangalore city

III. METHODOLOGY

A. Procedure for Multispectral Image

Landsat5 is having 7 bands in which each band is having specified wavelength range. The data available will have the images of different bands separately. The image processing is completely done using ERDAS software. Layer stacking is carried out to combine the different bands of satellite data to create colour composite image for better visual interpretation. Layer stacking is done by combining band 3, band 2 and band 1 of Landsat5 to get true colour image (RGB image). Haze reduction, noise removal and periodic noise removal are carried on the image [3]. Histograms were developed for comparison. Unsupervised classification is done using five classes and accuracy of the image is calculated.

B. Procedure for panchromatic Image

Panchromatic image is having single band grey colour. The same procedure as multispectral other than layer stacking is carried till accuracy assessment.

IV. RESULTS AND DISCUSSIONS

From the qualitative analysis we can clearly say that the haze reduction technique has improved the image quality by reducing the haze (figure 3, 4) but in case of noise removal (figure 5, 6) the image remained almost similar this is because the image is not having high amount of noise. While periodic noise (figure 7, 8, 9) is removed the results are completely in negative way that means the image is not having any periodic noise so image quality is completely interrupted destroying the available information. This can be clearly observed from histograms developed from SNR. In the haze reduction right side of the histogram is highly smoothed because of removal of unwanted pixel in the image. Histogram of SNR of stack and noise reduction are almost similar and the periodic noise removal is showing abnormal change in histogram

as well. For unsupervised classification, accuracy assessment was done for every image and the overall accuracy were calculated as

Overall accuracy for stack image=68%

Overall accuracy for haze reduction=80%

Overall accuracy for noise reduction= 72%



Figure 3: Qualitative analysis of Haze reduction

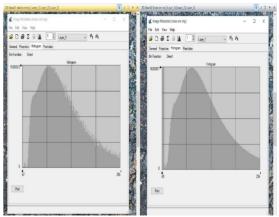


Figure 4: Quantitative analysis of haze reduction

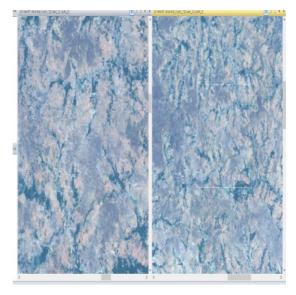


Figure 5: Qualitative analysis of noise reduction

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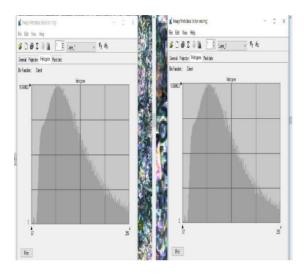


Figure 6: Quantitative analysis of noise reduction

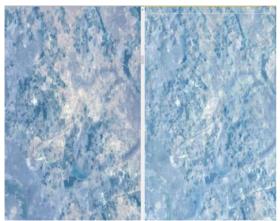


Figure 7: Qualitative analysis of periodic noise removal

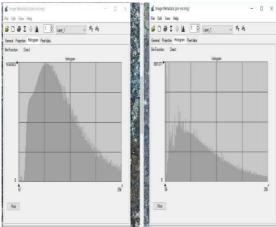


Figure 8: Quantitative analysis of periodic noise removal

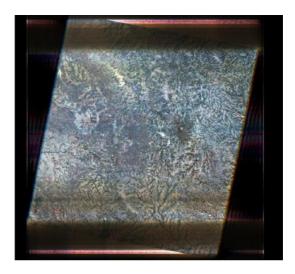


Figure 9: SNR of periodic noise removal

Panchromatic data

Haze reduction in panchromatic images is tough to identify (figure 10, 11). After haze reduction the colour composition of the image is decreased but the feature extraction became easier. Noise reduction (figure 12, 13) sometimes leads to missing of the necessary information in the main image. In the comparison of histograms haze reduction is clearly visible as the histogram is clearly defined with the peak value representing no loss of useful image and removal of bad pixel. Noise removal has reduced the histogram evenness representing loss of data. This image is also showing negative impact due to periodic noise removal (figure 14, 15, 16). For unsupervised classification, accuracy assessment was done for every image and the overall accuracy were calculated as

Overall accuracy for original image=88%

Overall accuracy for haze reduction=92%

Overall accuracy for noise reduction= 76%

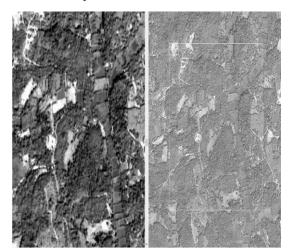


Figure 10: Qualitative analysis of Haze reduction

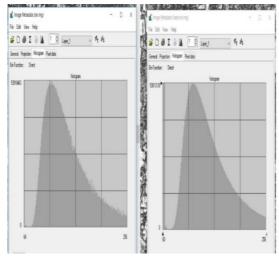


Figure 11: Quantitative analysis of haze reduction

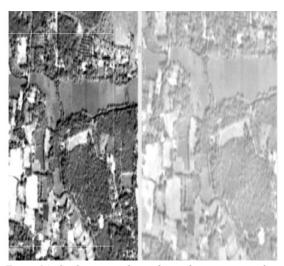
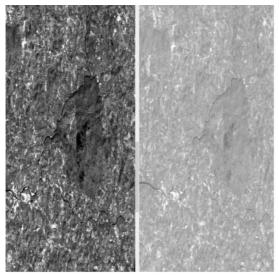


Figure 14: Qualitative analysis of periodic noise removal



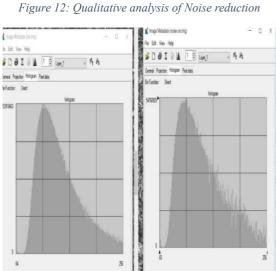


Figure 13: Quantitative analysis of noise reduction

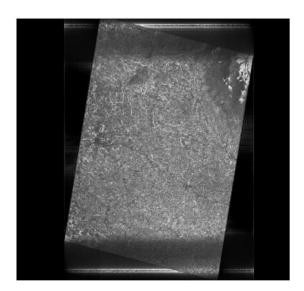


Figure 15: SNR of periodic noise removal

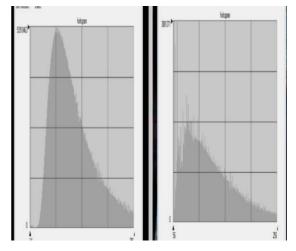


Figure 16: Quantitative analysis of Periodic noise removal

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V. CONCLUSIONS

There are many pre-processing techniques for digital image processing and radiometric corrections. For every image there are different techniques depending on the property of the image and the noise or haze presence in an image. It is always trial and error process. Depending on these results it can concluded that

Haze removal techniques worked well on both images by improving image quality and accuracy Noise removal, due to absence of noise or the presence of less noise has kept the image unchanged and sometimes loss of data also took place. In such cases we ignore that preprocessing step and we move on to try another for better outcome. Periodic noise is the presence of uniform lines continuously in the image. Two satellites doesn't have that kind of noise. So the removal technique showed completely destroyed images.

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