ISSN (Online) : 2278-1021
ISSN (Print) : 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 3, Issue 5, May 2014

Relative Radiometric Normalization of Satellite Images using Frequency Domain

Manisha B. Patil[1], Dr. Manjusha Deshmukh[2]

Assistant Professor, Electronics and Telecommunication, Saraswati College of Engineering, Kharghar, India [1]

Associate Professor, Electronics and Telecommunication, Saraswati College of Engineering, Kharghar, India [2]

Abstract: Relative radiometric normalization method minimizes radiometric differences among images cause by inconsistencies of acquisition conditions rather than change in surface reflectance. Satellite images are useful for creating updated land cover maps. But the major problem in these images is that the region below the clouds is not covered by the sensor. Hence cloud detection and removal is very vital in the processing of satellite imagery. The objective of this study is to propose an approach for automatic detection and removal of cloud from Satellite Images. After detection and removal of the contamination the method will selectively replace the data from different images of the same area to minimize the cloud contamination effect. Detection is achieved by performing segmentation algorithm namely Average brightness thresholding (ABT) algorithm. Finally the detected cloud contamination is removed and replaced with the data from different images of the same area using relative radiometric normalization of no change set in frequency domain.

Keywords: Normalization, Relative, radiometric normalization, no change set.

I. INTRODUCTION

Satellite Images under different conditions of same area are difficult to study because of change in atmospheric propagation, sensor response and illuminations. To overcome this problem radiometric normalization technique is used.

The detection of clouds in satellite imagery has a number of important applications in weather and climate studies. For many applications however, clouds are a contaminant whose presence interferes with retrieving atmosphere or surface information. In these cases, the detection of cloud contaminated pixels in satellite imagery is important. For many applications however, clouds are a contaminant whose presence interferes with retrieving atmosphere or surface information. Objective of this study is to detect and remove cloud cover and normalize an image radiometrically. For the detection and removal of cloud different methods are used, such as image regression method[1], pseudo invariant feature[5],no change set(NC)[7]. For the detection of cloud average brightness algorithm is used. After cloud removal, apply the proposed NC normalization method to reduce the radiometric influence caused by non surface factors. The no change relative radiometric normalization process identifies landscape elements whose reflectance values are nearly constant over time.

II. PROPOSED METHOD FOR CLOUD DETECTION AND REMOVAL

Two types of radiometric corrections, absolute correction and relative correction, are commonly employed to normalize remotely sensed images for time-series intercomparison[1]. Absolute radiometric correction is aimed towards extracting the absolute reflectance of scene targets at the surface of the earth[2]. This method requires the input of simultaneous atmospheric properties and sensor calibration, which are difficult to acquire in many cases, especially in historic data[9]. Relative radiometric correction is aimed towards reducing atmospheric and other unexpected variation among multiple images by adjusting the radiometric properties of target images to match a base image[4], thus it is also called relative radiometric normalization. Relative radiometric normalization is an image based correction method achieved by setting the multi-temporal images into a common scale without extra parameters from other measurements. In this method, reflectance of invariant targets within multiple scenes can be used to render the scenes to appear as if they were acquired with the same sensor, with the same calibration, and under identical atmospheric condition without the need to be absolutely corrected to surface reflectance.

Most relative methods assume that radiometric relation between the target image and the base image are linear[11]. A base image, selected to represent some common scale, is not required to be the most accurate reflectance emission. The relative radiometric normalization method can correct noise deriving the atmosphere, sensor, and other sources in one process and is therefore widely used. Generally Relative radiometric normalization methods are simpler than absolute normalization methods, so relative radiometric normalization method using no change set is proposed.

A. Cloud detection

The detection of clouds in satellite imagery has a number of important applications in weather and climate studies. For many applications however, clouds are a contaminant whose presence interferes with retrieving atmosphere or surface information. In these cases, the detection of cloud

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 3, Issue 5, May 2014

ISSN (Online) : 2278-1021
ISSN (Print) : 2319-5940

contaminated pixels in satellite imagery is important. There are many techniques are used for detection of clouds in satellite images. The key to the success is lies in the selection of the thresholds for various spectral tests. We used Average Brightness Threshold (ABT) algorithm for detecting the cloud.

The clouds are brightest object in satellite images; to detect the cloud from satellite images the average brightness threshold algorithm is used.

Average brightness threshold algorithm works on thresholding technique[14]. Threshold technique is one of the important technique in image segmentation. Threshold image g(x, y) can be define as

$$g(x,y) = \begin{cases} 1 \text{ if } f(x,y) > t \\ 0 \text{ if } f(x,y) \leq t \end{cases} \quad (1)$$

In this algorithm first average brightness of the image is calculated, based on this average brightness threshold value is determined. For calculation of proper threshold value following equation is used. It is also called cutoff function[7].

$$T = Avg_{Brithtness} + f * (\ln(G_{MAX}) - \ln(Avg_{Brihtness})) \quad (2)$$

Where ln( ) denotes the natural logarithm

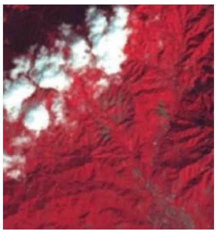
G_{MAX} is the no of gray values, f is multiplicative coefficient, determined empirically.

According to that threshold value divide image into cloudy and cloud free regions. Fig.1 and Fig.2 shows cloudy and cloud detected images for two different data sets. Dataset 1 is collected from situ atmospheric data at the time of satellite overpasses [7]. Dataset 2 is collected from http://landsat7.usgs.gov/productinfo.html[16].


(a)

(b)

Fig.1: (a) cloudy image, b) cloud detected image


(a)

(b)

Fig.2: (a) cloudy image, b) cloud detected image

B. Cloud removal

In normalization procedure first reference image and subject is divided into block of size 16×16 pixels. A block of reference image is placed over block centered on the same coordinates in the other image. Then normalized correlation between two corresponding blocks is by using frequency domain. This operation is repeated for all blocks. After this, we applied a threshold criterion, in order to select no change pixels used to find normalization coefficients. The correlation can be calculated as,

$$f(m,n) o w(m,n) = F^{-1}[F(u,v)W^{*}(u,v)] \quad (3)$$

Where,

$f(m,n)$ is the block of 16×16 pixels of reference image
$w(m,n)$ is the block of 16×16 pixels of cloudy image (m, n) are the special coordinates

$F(u,v)$ and $W(u,v)]$ are the Fourier transform of $f(m,n)$ and $w(m,n)$ respectively. o is the correlation

The Normalization correlation is derived from following equation,

$$NC = F^{-1}[F(u,v)W^{*}(u,v)] \quad (4)$$

The normalization coefficients can be obtained by,

$$ak = \frac{Syk^{(nc)}}{Sxk^{(nc)}}, b_k = \overline{y_k}^{(nc)} - a_k \overline{x_k}^{(nc)} \quad (5)$$

Where, $\overline{x_k}^{(nc)}$ and, $\overline{y_k}^{(nc)}$ are the means. Sample variance and covariance for subsect NC on two dates can be determined using equations

$$S^{(nc)}x_k x_k = \frac{1}{|NC|} \sum_{NC} (X_k - \overline{X}_K^{(NC)})^2 \quad (6)$$

$$S^{(nc)}x_k y_k = \frac{1}{|NC|} \sum_{NC} (X_k - \overline{X}_K^{(NC)})^{1/2} (y_k - \overline{y}_K^{(NC)})^{1/2} \quad (7)$$

A block is assumed to belong to no- change set if it has normalized correlation is greater than 0.9. If normalized correlation is greater than 0.9 then for normalized image select no change set of cloudy image otherwise select pixels set of reference image. This operation is repeated for all blocks and this procedure is repeated for all bans. The Fig. 3(a) shows reference image Fig. 3(b) shows cloudy image and normalized subject image is shown in Fig.3(c) for data set 1 and the Fig. 4(a) shows reference image Fig. 4(b) shows cloudy image and normalized subject image is shown in Fig.4(c) for data set 2 and Data set 1

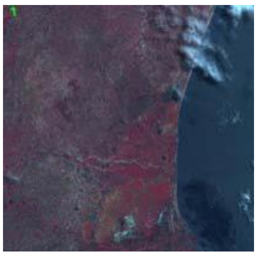
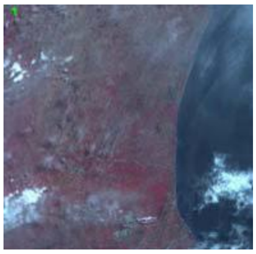
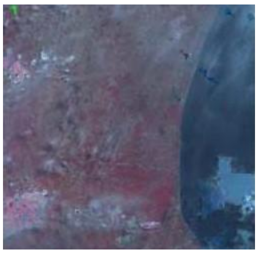
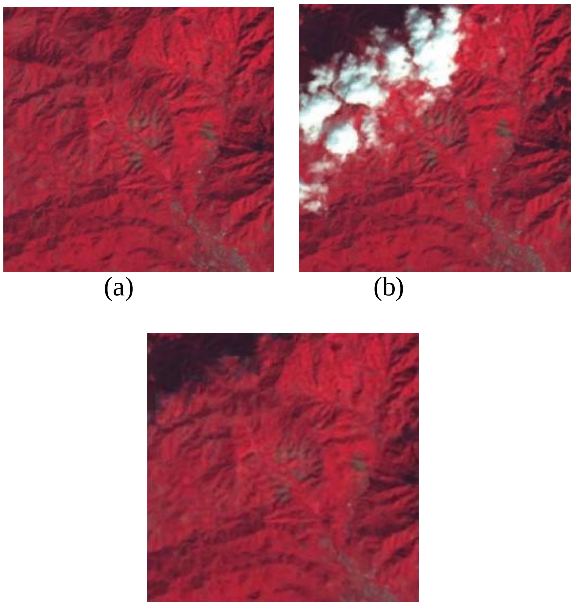

(a)

(b)

(c)

Fig. 3: (a) Reference image(May 26,2004) , (b) Cloudy image(May 26,2006), (c) Normalized subject image

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 3, Issue 5, May 2014

ISSN (Online) : 2278-1021
ISSN (Print) : 2319-5940

Data Set 2



(a) (b) (c)

Figure 4: (a) Reference image, (b) Cloudy image, (c) Normalized subject image

III. RESULTS AND DISCUSSION

In this report cloud is detected by using Average Brightness Thresholding algorithm. In ABT algorithm the threshold value is calculated based on the average brightness. Then based on threshold value image is divided into cloudy and cloud free regions. The results of ABT are as shown in Fig. 5 and Fig.6 for two different data sets

Fig.5: cloud detected subject image (data set 1)

For this data set 1 the average brightness value is 94.8438 and threshold value is 116.6886

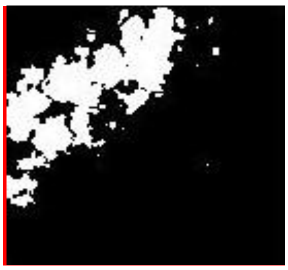


Fig.6:cloud detected subject image(data set 2)

For this data set 2 the average brightness value is 186.7446 and threshold value is 193.6842 The root-mean-square error (RMSE) is used to measure the statistical agreement of the normalized image with the reference image, as follows:

$$RMSE_k = \sqrt{\frac{1}{|n|}\sum_n (s_k' - R_k)^2} \quad (8)$$

Where s_k' is radiometrically normalized digital no. in the subject image on date 1, R_k is the digital no. of reference image on date 2, and $|n|$ is the total no of pixels of the scene. Thus the digital no of the radiometrically normalized image are compare with those of the reference image. If the difference between these numbers is small the RMSE will be small. Result shows that obtained RMSE values are small for different bands. This implies that normalized subject image is radiometrically closer to the reference image. The results obtained for before and after normalization using frequency domain for RMSE values for different data sets are shown below for different bands

Table 1: RMSEs values before and after normalization for data set 1

Band	RMSE	
	Before Normalization	After Normalization
Band1	0.6656	0.2951
Band2	6.4639	6.5160
Band3	8.2319	7.1117
Band4	6.4275	5.1226
NIR Band	6.3202	4.9979
VRB Band	5.8009	5.6207

Table 2 : RMSE values before and after normalization for data set 2

Band	RMSE	
	Before Normalization	After Normalization
Band1	22.1222	1.4907
Band2	18.1488	12.5111
Band3	12.8927	12.8995
Band4	11.1638	11.3228
NIR Band	8.5548	6.9920
VRB Band	11.8710	8.4403

IV. CONCLUSION AND FUTURE SCOPE

CONCLUSION

The Average Brightness Threshold Algorithm successfully detects the cloud from cloudy image, for that purpose proper threshold value is chosen that separates the cloudy and uncloudy regions. Here the relative radiometric normalization technique using no change is proposed. The subject image block set is compared with the block set of reference image, by finding no change set and selecting the proper threshold the cloudy block sets from subject image are removed. The quality of radiometric

ISSN (Online) : 2278-1021
ISSN (Print) : 2319-5940
International Journal of Advanced Research in Computer and Communication Engineering
Vol. 3, Issue 5, May 2014

normalization is statistically assessed by Root Mean Square Error, which is small here. The proposed scheme successfully normalized cloudy subject image by using frequency domain so that normalized image looks similar to reference image after normalization.

Future Scope

Future scope includes use of image segmentation using Otsu's method. In this method, the detected cloud is removed and replaced with data from another image of the same area. Instead of this, the pixels in cloud removed area can be replaced with estimated pixel values obtained from regression of same image.

REFERENCES

[1] Yang, X.J., and C.P. Lo. "Relative radiometric normalization performance for change detection from multi-date satellite images." Photogrammetric Engineering and Remote Sensing, Vol. 66, No. 8, pp. 967-980, 2000.
[2] ww.ncl.ac.uk/tcmweb/bilko/module7/lesson3.pdf.
[3] Todd A. Schroeder a,⁎, Warren B. Cohen b, Conghe Song c, Morton J. Canty d, Zhiqiang Yang , "Radiometric correction of multi-temporal Landsat data for characterization of early successional forest patterns in western Oregon" Department of Forest Science, Oregon State University, Corvallis, OR 97331, United States Forestry Sciences Laboratory, Pacific Northwest Research Station, USDA Forest Service, 3200 SW Jefferson Way, Corvallis, OR 97331, United States c Department of Geography, University of North Carolina, Chapel Hill, NC, 27599, United States Systems Analysis and Technology Evaluation, Jülich Research Center, D-52425 Jülich, Germany Received 2 November 2005; received in revised form 10 March 2006; accepted 11 March 2006
[4] Xuexia Chen, Lee Vierling, Don Deering "A simple and effective radiometric correction method to improve landscape change detection across sensors and across time", Remote Sensing of Environment ,May 2005
[5] Munmun Baisantry , Dr.D.S.Negi, O.P.Manocha "Automatic Relative Radiometric Normalization for Change Detection of Satellite Imagery", ACEEE Int. J. on Information Technology, Vol. 02, No. 02, April 2012.
[6] R.N. Sahoo, R.K.Tomar, "Radiometric scene correction of temporal multi-spectral satellite for crop discrimination." Indian Journal of radio and Space Physics Vol. 35, April 2006,pp. 116-121
[7] Seema Biday, Udhav Bhosle "Relative Radiometric Correction of Cloudy Multitemporal Satellite Imagery" International Journal of Civil and Environmental Engineering 2:3 2010
[8] Seema Gore Biday and Udhav Bhosle "Radiometric Correction of Multitemporal Satellite imagery" Journal of Computer Science 6 (9): 1027-1036, 2010 ISSN 1549-3636
[9] Gang Hong, Yun Zhang, "Radiometric Normalization Of Ikonos Image Using QuickbirdImage For Urban Area Change Detection", Department of Geodesy and Geometrics Engineering, University of New Brunswick, 2002
[10] John Rogana, DongMei Chen "Remote sensing technology for mapping and monitoring land-cover and land-use change." 61 (2004) PP. 301–325)
[11] J Yuan, D. and Elvidge, C.D., 1996, "Comparison of Relative Radiometric Normalization Techniques", ISPRS Journal of Photogrammetry and Remote Sensing, vol. 51, pp. 117-126.
[12] Dr. Mohamed Mansoor Roomi, R.Bhargavi, T.M.Hajira Rahima Banu "Automatic Deintification Of Cloud Cove Regions Using Surf", International Journal of Computer Science, Engineering and Information Technology (IJCSEIT), Vol.2, No.2, April 2012
[13] Ruhul Amin, Richard Gould, Weilin Houa, Zhongping Leeb and Robert Arnone " Automated Detection and Removal of Cloud Shadows on HICO Images",Ocean Sensing and Monitoring III, edited by Weilin W. Hou, Robert Arnone, Proc. of SPIE Vol. 8030,803004, 2011
[14] Salem Saleh Al-Amri, N. V. Kalyankar and Khamitkar S.D. "Image Segmentation By Using Threshold Techniques", Jornal of computing, Vol.2, issue 5, May 2010, ISSN 2151-9617
[15] Tracey A. Dorian, " Tracey A. Dorian National Weather Center Research Experiences for Undergraduates Program & Pennsylvania State University" MICHAEL W. DOUGLASNOAA's Office of Oceanic and Atmospheric Research & National Severe Storms Laboratory Corresponding author address, 1409 Allan Lane West Chester, PA 19380, tad240@psu.edu
[16] E.H. Helmer and B. Ruefenacht "Cloud-Free Satellite Image Mosaics with Regression Trees and Histogram Matching", Photogrammetric Engineering & Remote Sensing Vol. 71, No. 9, September 2005, pp. 1079–1089.0099-1112/05/7109–1079/$3.00/0 © 2005 American Society for Photogrammetry and Remote Sensing.

BIOGRAPHIES

Manisha Patil, B.E. in Electronics from North Maharashtra University, Jalgaon, 2002. Currently pursuing M. E. in Electronics and Telecommunication from Mumbai University. She had one International conference, one International paper and one International Journal.

Dr. Mansjusha Deshmukh, B. E. (Electronics and Telecommunication) , Amravati University, 1994, MBA (Finance and Marketing), Nagpur University, 1997, M.E. Amravati University, 2004, Ph. D in Electronics and Telecommunication , SNDT Mumbai University, 2013 She had 18 International Journals, 15 International conferences and 8 National conferences.