ISSN: 0976-3104
SPECIAL ISSUE (SCMDSA)
Sevugan et al.

ARTICLE OPEN ACCESS

AN ANAGLYPH APPROACH OF GEOMETRIC CORRECTION FOR DEPTH RECONSTRUCTION OF SATELLITE IMAGERY

Prabu Sevugan[1], Balakrushna Tripathy[1*], Swarnalatha Purushotham[1], Ramakrishnan R[2], Manthira Moorthi S [2]

[1] *VIT University, Vellore-Tamilnadu, INDIA*
[2] *Space Applications Centre, Ahmedabad, INDIA*

ABSTRACT

The images acquired through remote detecting frameworks are not regularly adequate for high accuracy applications because of different misrepresentations. The misrepresentations can be because of mistakes such as geometric mistakes and so forth. Likewise multi-date satellite pictures of the same range under various conditions are hard to match due to change in atmospheric propagation, sensor reaction and enlightenments. Keeping these focuses in perspective, in this paper, we manage the primary period of pre-preparing and we make the satellite pictures free from such blunders and utilize grouping systems With Geometric Correction (WGC) and Without Geometric Correction (WOGC) connected to the satellite pictures utilizing our proposed methodology. At last, the picture is remade with depth measurement/depth map era for the anaglyph picture for better understanding of satellite symbolism. We have made test investigation of our methodology utilizing suitable satellite pictures and observed the outcomes to be extremely reassuring.

Received on: 30th-Novr-2015
Revised on: 11th-March-2016
Accepted on: 26th–March-2016
Published on: 19th–May-2016

KEY WORDS

Geometric Correction, Rough Intuitionistic Fuzzy C-Means (RIFCM) clustering algorithm, Depth Reconstruction, Anaglyph Graph, Satellite Images

***Corresponding author:** Email: sprabu@vit.ac.in, tripathybk@vit.ac.in,**Tel:** +40-9001010010; **Fax:** +40-9001010012

INTRODUCTION

Remote sensing is the securing of data around an item or wonder without reaching the article. In present day use, the term for the most part alludes to the utilization of elevated sensor advances to identify and characterize objects on Earth (both at first glance, and in the environment and seas) by method for engendered signals (e.g. electromagnetic radiation) [1]. It might be part into dynamic remote detecting, when a sign is initially discharged from air ship or satellites or inactive (e.g. daylight) when data is simply recorded. Pictures acquired through remote detecting frameworks are not regularly adequate for high accuracy applications because of different bends. The falsifications can be because of geometric mistakes, radiometric blunders and barometrical mistakes. Furthermore, contrasted with a proficient bitplane which is utilized for restorative pictures may not give precise results for satellite symbolism [2].In this paper we concentrate on geometric blunders as it were.

The geometric errors can be remedied to a specific degree by considering just orbital geometry model methodology which joins worldwide changes and considers the viewpoint proportion, earth revolution, picture introduction, and so on, [1] additionally yield poor precision. Then again, with itemized data extricated from auxiliary, one can apply the rectification handling to every pixel and subsequently get much higher precision. Pixel projection methodology will consider the instrument mutilation (measured pre-flight or in-flight), the rocket demeanor, position and speed at the moment the picture is shaped in each CCD pixel. The Earth revolution impact will be ascertained by a high-exactness earth pivot model which includes customary turn, precession, and transformation [3]. In this manner the geo-area (regarding geodetic longitude and scope) of every picture pixel can be computed. The geometric mistakes can be redressed to a specific degree with definite instrument and shuttle data (subordinate information) that gives instrument alignment information, rocket state of mind, position and speed at adequately little time interim which is key for the satellite symbolism. The writing study has been completed on pre-handling of satellite symbolism with factual methods and of geometric revision utilizing non-parametric models [4][5].

COMPUTER SCIENCE

THE IIOAB JOURNAL
ISSN: 0976-3104

The co-enlistment of three groups has been managed in paper [6] which is a special test because of the impact of circle and disposition in the time hole in the imaging succession. The co-enrollment issue of satellite symbolism might be utilized to have better translation of depth reproduction at the pre-preparing period of the creator's paper.

Multi-date satellite pictures under various states of the same zone are hard to analyze in light of progress in environmental spread, sensor reaction and enlightenments. Channels are generally utilized for such things as edge upgrade, clamor evacuation, and the smoothing of high recurrence information. As a result, in this paper we first evacuate these sorts of mistakes in the pre-applying so as to handle stage With Geometric Correction (WGC). Yet, we likewise continue without geometric adjustments additionally, so as to give a relative examination and get results for the WGC.

A novel methodology of fuzzy c-means implies has been proposed in the paper [7] where the Bit Plane Filter(FCMBP) separates a picture into planes utilizing different scientific systems. The outcomes demonstrated quality ordered pictures contrasted with customary edge methods with expansion in the proficiency by lessening in the epsilon estimations of bit planes. What's more, in future, the creator point is to apply other clustering techniques for recreation of the picture with the assistance of the grouped picture of the paper to show signs of improvement understanding of third measurement.

The proposition has been made in [8] utilizing rough c-means for examination of satellite pictures with/without Bit Plane Filter (RCMBP-Rough C-Means Bit Plane) which sections the satellite picture into planes utilizing different scientific procedures. Furthermore the depth calculation for all conceivable outcomes utilizing with and without bit plane procedures have been done. On comparison, utilizing using rough c-means yields better depth calculation with least time multifaceted nature. In future, the creators point is to apply other grouping procedures for further preparing of satellite pictures.

The depth map (divergence picture or Z-picture) is a picture which contains data about the depth of the photo and serves to change over a two-dimensional picture into a three-dimensional one coming about depth reproduction. In the depth delineate dim shading degree demonstrates every pixel's separation from the viewer. The lighter zone in the depth map compares to the ranges closer to the viewer, the darker one relates to more removed territories [9].

Anaglyph 3D pictures contain two diversely separated hued pictures, one for every eye which can be acquired by applying parallax calculation is utilized which is a dislodging or contrast in the evident position of an item saw along two unique observable pathways, and is measured by the edge or semi-edge of slant between those two lines [10][11].

Clustering strategies are utilized as a part of picture division and reproduction of pictures after that produces upgraded pictures for examination. Subsequent to a considerable measure of vulnerability is included in the picture investigation we discover a great deal of instability based clustering procedures which are more suited for such sort of picture grouping. In [12] an exceptionally uncertainty based hybrid algorithm has been set up and tried, called RIFCM, which joins intuitionistic fuzzy set and rough set methodologies.

The method in [13], deals with the determination of the areas that have and don't have changes. The determined area is grouped as two parts by Fuzzy C-Means Clustering method. With the method of principal component analysis, eigenvector space is gained and from here, principal components are reached. Finally, feature vector space consisting principal component is partitioned into two clusters using Fuzzy C-Means Clustering and after that change detection process has been done for clustering of images. This can also be used to extract the cloud from a satellite image which deals with R, G, and B components of a true color satellite image and convert a true color satellite image [14].

In [15], a Comparative Study has been carried out using RIFCM with Other Related Algorithms from the point of view of their suitability in analysis of satellite images with other supporting techniques which deals with proving the superiority of RIFCM with RBP in clustering with other clustering methods and other supporting metrics with and without refined which integrates judiciously RIFCM with RBP. The superiority of the RIFCM using RBP is demonstrated, along with a comparison with other related algorithms, on a satellite images with NASA.org images(Hills, Drought) and national geographic photographic images(Freshwater, Fresh water valley).

THE IIOAB JOURNAL ISSN: 0976-3104

For two depth reconstruction was stretched out to various depth reconstruction in a way like that of other [16, 17]. The utilization of various pictures gives more precise depth results by alleviating the impact of picture noise. The movement obscure estimation issue is presently spoken to by the depth estimation issue [18]. The obscure strength of the proposed calculation is checked by contrasting the depth remaking results and the ordinary variational depth reconstruction to utilize various pictures which is executed the obscure taking care of parts of the proposed technique and accordingly accomplished enhanced results [19].

A True Color Composite is connected for satellite symbolism for appropriate bunches which manages a real nature picture which is recovered when a multispectral picture comprises of the three visual essential shading groups (red, green, blue). groups might be consolidated to deliver a "genuine nature" picture coming about shading composite picture which is seen by the human eyes for better representation of satellite symbolism [19].

In the later part of this paper, the picture is recreated with depth measurement/depth map era for the anaglyph picture for better elucidation of satellite symbolism. We have made exploratory investigation of our calculation utilizing suitable satellite pictures and observed the outcomes to be extremely reassuring.

The part I of the paper manages the presentation and overview of remote detecting, geometric remedy, grouping, depth map era, anaglyph picture. Furthermore, part II examine about the technique of the paper. Results and the examination of the paper has been clarified in part III. The conclusion and future work of the paper is managed in part IV took after with affirmation and references referred to for the paper

METHODOLOGY

The proposed methodology deals with three phases of satellite imagery for depth map generation for better interpretation of images which is discussed in **Figure–1** as given below:

1. Initially, the satellite symbolism has been given as data for geometric revision which comprises of extraction of Ground Control Points(GCPs) for 35, 100 and 150 in three distinct reaches to get least rate of root mean square blunder as yield picture expressing with geometric correction(WGC) and analyzed without geometric correction (WOGC).

2. Secondly, the yield of WGC and WOGC is considered as input for clustering calculation (Rough Fuzzy Intuitionistic C-Means) coming about WOGC-C(clustered) and WGC-C(clustered) pictures.

3. Thirdly, clustered pictures are given as information for depth map era as reproduced picture with anaglyph approach for better understanding of satellite symbolism.

a. Geometric Correction

The pre-handled information is then utilized as the beginning condition for the remedy preparing utilizing GCP. The three stages must be handled for geometric remedy as

GCP extraction (using GRASS GIS)

GCPs have been separated by GRASS GIS for three classes (35,100,150 GCPs). The RMS mistake is appeared for each GCPs. The two sorts of RMS mistakes are shown over the GCP director board. They are named as forward mistake and in reverse mistake which has been shown with two boards as source image(left) and target image(right) for each GCPs classification in **Figure- 2.a, b, and c**. The execution has been tried by applying peak signal noise ratio and root mean square error measurements (figure 3) coming about least RMS for 150 GCPs contrasted with 35 GCPs and 100 GCPs

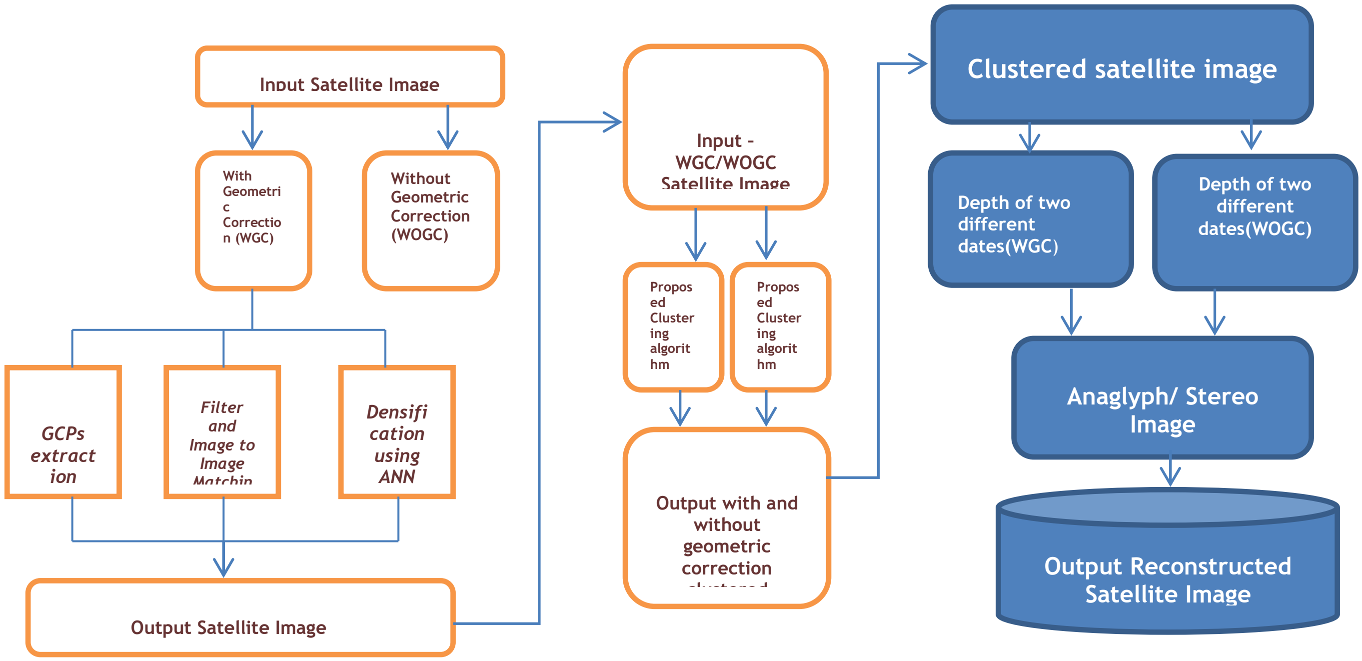


Fig: 1. Architecture of proposed methodology with anaglyph approach of WOGC – C-D and WGC-C-D

Table: 1. GCP extraction of 1-35,1-100,1-150 for 4th Jan-May

Month	GCP	RMS
a. 4th Jan-May	35	0.034272
b. 4th Jan-May	100	0.037071
c. 4th Jan-May	150	0.036559

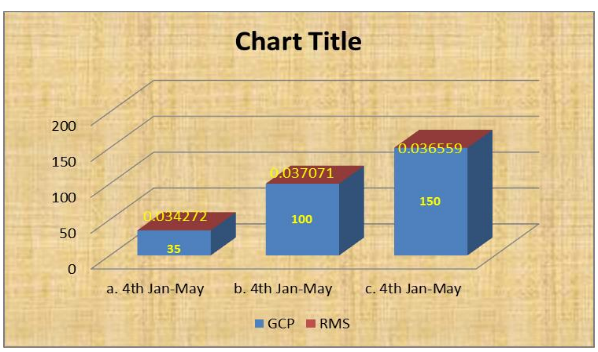


Fig: 2. Performance of PSRN & RMSE for GCPs

THE IIOAB JOURNAL ISSN: 0976-3104

Filter and Image to Image Matching

Invert filter is applied with neighborhood analysis and Image to Image matching process is done using Cross Correlation Coefficient with Resampling Techniques (fourier transform, matrix/convolution and Neighborhood Analysis (Average)) in GRASS GIS Open Source Software. The results of resampling techniques have been given in **Figure 3(a)** fourier analysis**, 3(b)** matrix /convolution and **3(c)** neighborhood analysis (average) for further process.

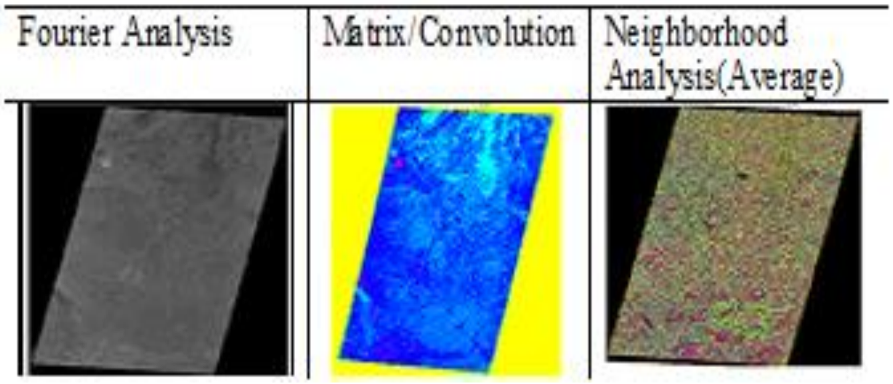


Fig: 3(a). Fourier Analysis Fig.No.4.b. Matrix/Convolution Fig..4.c. Neighborhood Analysis(Average)

Densification by ANN

Densification process is used to add vertices to a line at specified distances without altering the line's shape. This operation densifies geometries by points between existing vertices. And Densification Total Error Network Graph is applied to compute for two different months data to calculate Mean Square Error of Relative Geometric Corrected Image with least value of MSE of 0.0158**[Figure- 4]**.

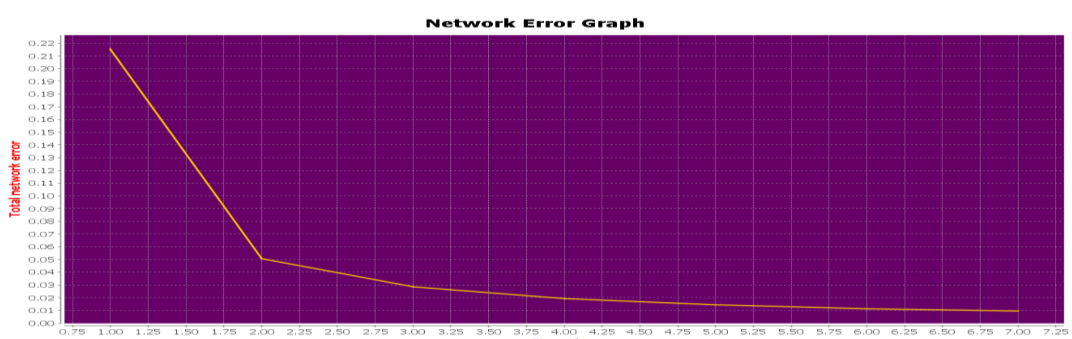


Fig: 4. January-Total Mean Square Error-0.0158

RIFCM

The Rough Intuitionistic Fuzzy C-Means clustered technique has been applied for WOGC and WGC with PSNR and RMSE metric of performance validation.

Rough Intuitionistic Fuzzy C-Means

The rough intuitionistic fuzzy c-means (RIFCM) , uses the concept of rough sets, fuzzy sets and as well as intuitionistic fuzzy sets, thereby making it a perfect combination of IFCM and RCM. It can also be considered to be RFCM with IFS, hence adding the concept of lower and upper approximation of rough set, fuzzy membership of fuzzy set, non-membership and hesitation value of intuitionistic fuzzy set. It provides a holistic approach to

THE IIOAB JOURNAL ISSN: 0976-3104

clustering of data as it deals with uncertainty, vagueness, incompleteness which, enables the efficient handling of overlapping partitions and improves accuracy.

In RIFCM, each cluster can be identified by three properties, a centroid, a crisp lower approximation and an intuitionistic fuzzy boundary. If an object belongs in the lower approximation of a cluster then its corresponding membership value is 1 and hesitation value is 0. The objects in the lower region have same influence on the corresponding cluster. If an object belongs in the boundary of one cluster then it possibly belongs to that cluster and potentially belongs to another cluster. Hence the objects in the boundary region have different influence on the cluster. Thus we can say that in RIFCM the membership value of objects in lower region is unity $(\mu_{ij}^{'} = 1)$ and for those in boundary region behave like IFCM.

The objective of this algorithm is to reduce the cost function given in [20].The parameters w_{low} and w_{up} have the standard meanings. Also $\mu ij'$ has the same definition as in IFCM.

The steps that are to be followed in this algorithm are as given below

1. Assign initial means v_i for c clusters by choosing any random c objects as cluster.
2. Calculate d_{ik} using Euclidean distance formula (1)
3. Compute U matrix

   if $d_{ik} = 0$ or $x_j \in \underline{B}U_i$ then

   $$\mu_{ik} = 1$$

   else compute $\mu_{ik} = \frac{1}{\sum_{j=1}^{c}\left(\frac{d_{ik}}{d_{jk}}\right)^{\frac{2}{m-1}}}$

4. Compute π_{ik}

$$\pi_A(x) = 1 - \mu_A(x) - \frac{1-\mu_A(x)}{1+\lambda\mu_A(x)} \mid x \in X$$

5. Compute $\mu_{ik}^{'}$ and normalize $\mu_{ik}^{'} = \mu_{ik} + \pi_{ik}$
6. Let $\mu_{ik}^{'}$ and $\mu_{jk}^{'}$ be the maximum and next to maximum membership values of object x_k to cluster centroids v_i and v_j.

   if $\mu_{ik}^{'} - \mu_{jk}^{'} < \varepsilon$ then $x_k \in \overline{B}U_i$ and $x_k \in \overline{B}U_j$ and x_k cannot be a member of any lower approximation. else $x_k \in \underline{B}U_i$

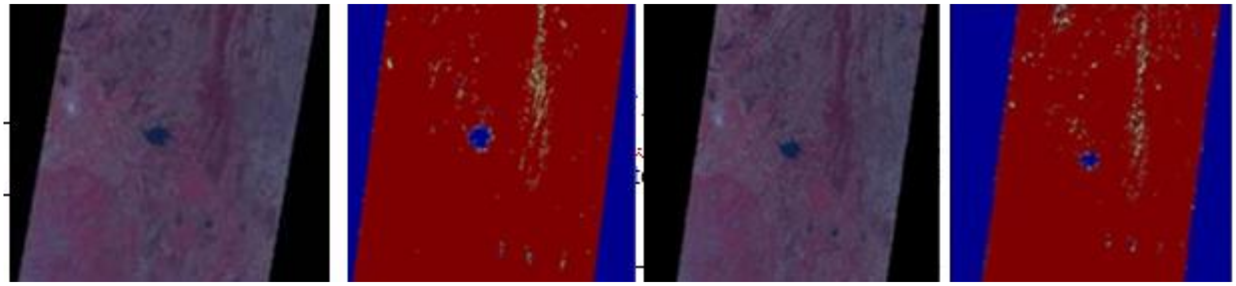
7. Calculate new cluster means by using (2)
8. Repeat from step 2 until termination condition is met or until there are no more assignment of objects.

$$d(x,y) = \sqrt{(x_1-y_1)^2 + (x_2-y_2)^2 + \cdots + (x_n-y_n)^2} \ldots\ldots\ldots(1)$$

$$v_i = \begin{cases} w_{low}\dfrac{\sum_{x_k \in \underline{B}U_i} x_k}{|\underline{B}U_i|} + w_{up}\dfrac{\sum_{x_k \in \overline{B}U_i - \underline{B}U_i} \mu_{ik}^m x_k}{\sum_{x_k \in \overline{B}U_i - \underline{B}U_i} \mu_{ik}^m} & if\ |\underline{B}U_i| \neq \phi\ and\ |\overline{B}U_i - \underline{B}U_i| \neq \phi \\ \dfrac{\sum_{x_k \in \overline{B}U_i - \underline{B}U_i} \mu_{ik}^m x_k}{\sum_{x_k \in \overline{B}U_i - \underline{B}U_i} \mu_{ik}^m}, & if\ |\underline{B}U_i| \neq \phi\ and\ |\overline{B}U_i - \underline{B}U_i| \neq \phi \\ \dfrac{\sum_{x_k \in \underline{B}U_i} x_k}{|\underline{B}U_i|} & ELSE \end{cases} \ldots\ldots(2)$$

THE IIOAB JOURNAL
ISSN: 0976-3104

The **Figure 5(ai**.) deals with the Original image of Ahmedabad a.ii.Clustered image of Ahmedaba and the figure 6.b.i. Original corrected image of Ahmedabad b.ii.Clustered corrected image of Ahmedabad where the performance of satellite imagery has been calculated which is given in **Table– 2** and **Tigure– 11**.



ai **bi** **aii** **bii**

Fig: 5.a.i. Original image of Ahmedabad Fig: 6.b.i. Original Corrected image of Ahmedabad
a. ii.. Clustered image of Ahmedabad b.ii. Clustered corrected image of Ahmedabad

DEPTH RECONSTRUCTION

The third dimension of the affected portion [21][22] is very vital as the degree to which the component has been deteriorated which can be calculated approximately. The angle of incidence of X-rays and the thickness of the component are taken as an input from the user. The third dimension of the component can be calculated using the formula given below.
The formula for calculating third dimension is:

$$Depth = \left(\frac{L/2 + x}{Tan\alpha} + \delta\right) - \frac{W}{Sin\alpha} \qquad \text{..................(3)}$$

L = Length of the third dimension affected region, x = 0; Assuming that the third dimension is exactly in the centre = Angle of incidence of the X-rays, W = Width of the dimension, δ = Thickness of the component
If the third dimension of the affected portion is greater than the thickness of the component then the component is fully affected and it has to be replaced with another one. Based on the three parameters (length, width and depth), the papers aims to reconstruct an image which may be possible as given below:-

Depth map generation algorithm (Depth Reconstruction) and Anaglyph Technique

The third dimension map generation (Z-dimension) which is a gray-scale image should possess the resolution that is same as to the original input image for consideration of Depth Map Generation given in **Figure– 6**.

Algorithm: Generation of Depth Map (Depth Reconstruction)with Anaglyph Image

1. Start
2. Initialize images
   2.1 First image has been taken as a original img,2D image (Oi) and
   2.2 Second image is considered as a processed image (clustered image), 2D image (Ci),then
3. Two images are opened in the interface: left and right frames of a stereo pair. And
   3.1 A depth map (depth reconstruction) will be created from the two images
4. Generate frames with the parallax method which characterizes the distance of the object's projections on the plane for the left and right eyes (disparity).
5. Iterate the frames till anaglyph image is obtained from the third dimension map generated for better visualization of an image . Finally,
6. Anaglyph Image from third dimension map has been resulted
7. Stop

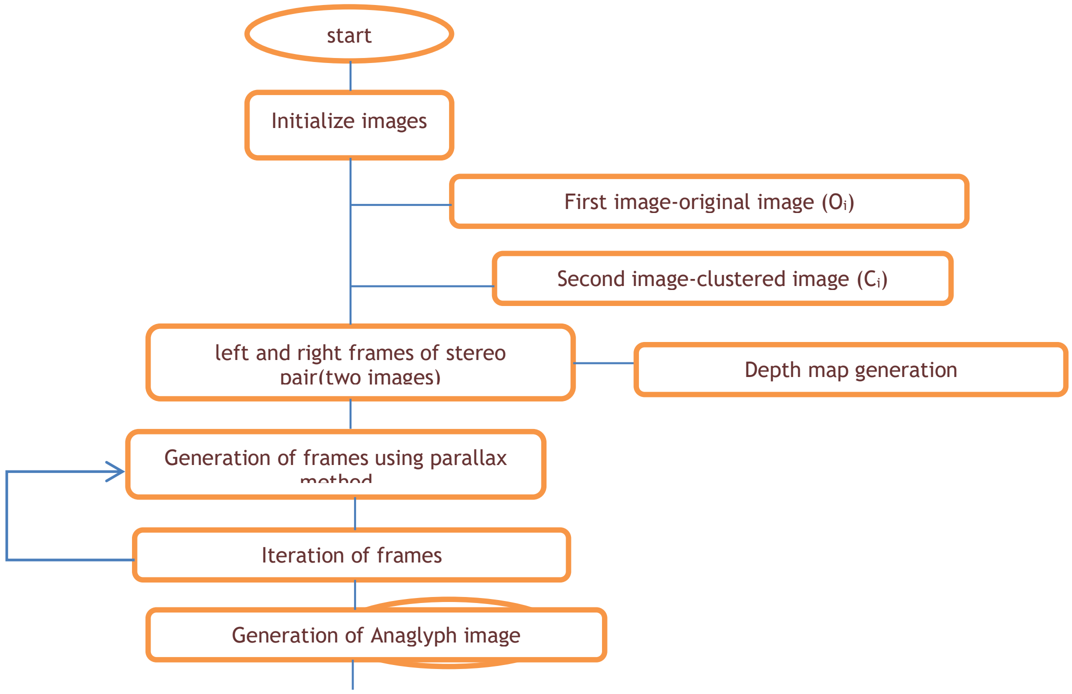


Fig: 6. Flow chart of Depth Map Generation Algorithm

……

To support the third dimension map generation, the parallax algorithm may be used where the results has been made in figure 8.a.WOGC-C-D and figure 8.b.WGC-C-D, which characterizes the distance of the object's projections on the plane for the left and right eyes (disparity). And the method, Parallax [23] which is a dislocation or dissimilarity in the apparent position of an entity viewed along two dissimilar lines of sight, is calculated by the point of view or semi-angle of leaning between those two lines.

A third dimension (Z) map generation serves to exchange the original image into a depth map one. Intensity of a pixel in a third dimension map shows the space from the similar pixel in the original image to the watcher. The lighter areas in depth map match to the regions nearer to the viewer, the darker ones match to more distant areas. A white pixel in a depth map deals with the the pixel of the original image that has the smallest distance to the viewer (foreground),**Figure 7(a), 8(a**) and a black pixel with the pixel of the original that has the biggest distance to the viewer (background),**Figure 9(b) 10(b**)

a. riginal Image and Depth Map Image of Satellite Imagery of Ahmadabad without geometric correction

b. Original Image and Depth Map Image of Satellite Imagery of Ahmadabad with geometric correction

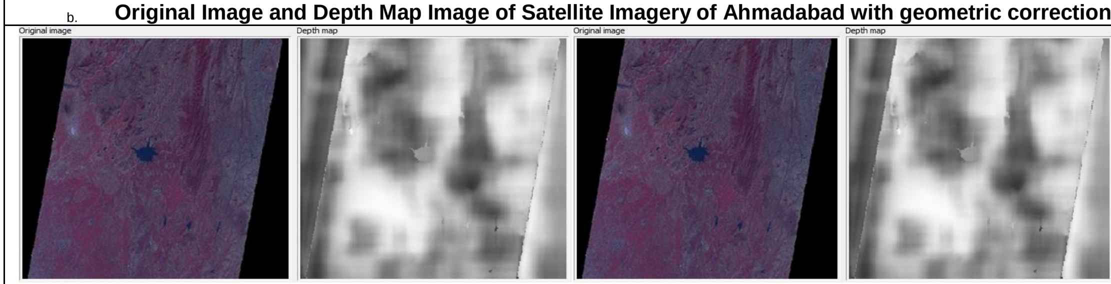


Fig:7 (a):Original Image and Depth Map of Satellite Imagery without geometric correction (WOGC-C-D) b. with geometric correction (WGC-C-D)

……………………………………………………………………………

And frames of images will be generated from the third dimension map, **Figure 9(c) & 10c** resulting anaglyph 3D image, from a set of generated frames. The Anaglyph 3D images can be viewed through the "color-coded" "anaglyph glasses", each of the two images reaches one eye, revealing an integrated stereoscopic image. The visual cortex of the brain fuses this into perception of a three dimensional scene or composition as given in **Figure 9(d)** (WOGC-C-D) and **Figure 10(d)** (WGC-C-D).

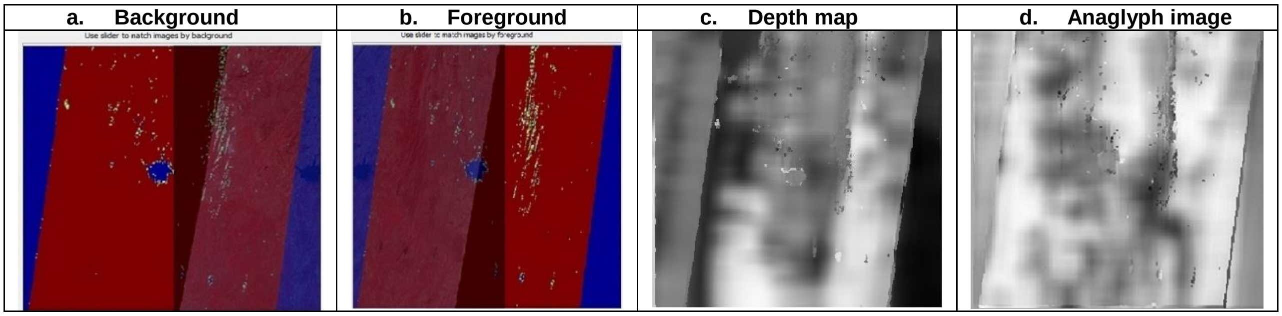


Fig: 8. Depth images of a .background b. foreground c. depth map d. anaglyph images of without geometric correction (WOGC-C-D)

……..

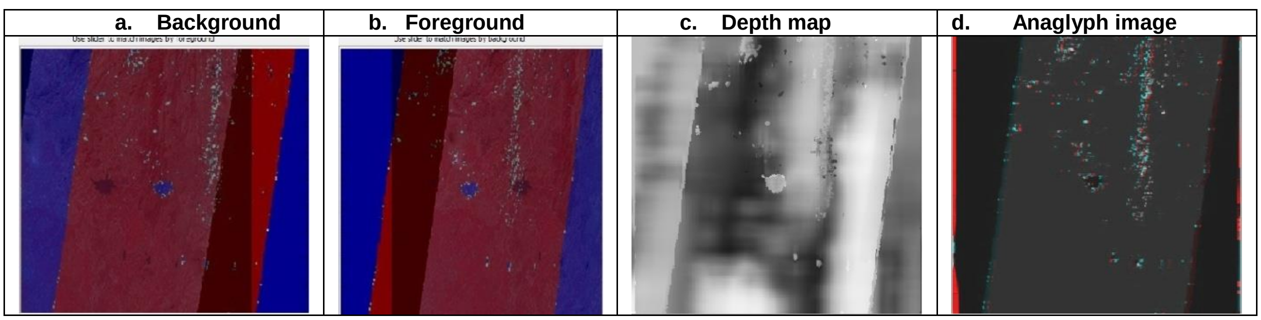


Fig: 9. Depth images of a. background b. foreground c. depth map and d. anaglyph images of with geometric correction (WGC-C-D)

……..

RESULTS AND DISCUSSION

Performance The proposed paper resulted overall method of WOGC-C –D and WGC-C-D resulting depth map with geometric correction (WGC)and without geometric correction(WOGC) which involves three steps as first phase deals without using geometric correction (WOGC) and with using geometric correction (WGC) has been dealt in **Figure- 2(a)(b)(c)** and tabular representation**[Table-1]** of performance analysis of metric PSNR and RMSE as per **Table- 2 and Figure- 10** has been carried on which yields improvised value (8.3992 for WOGC to 7.5597dB for WGC).

THE IIOAB JOURNAL ISSN: 0976-3104

The clustering of WGC and WOGC has resulted in proper cluster of satellite imagery which yielded again better results as per **Table- 2** and **Figure- 10** (8.3992-11.0707dB for WOGC) and (7.5597-10.8370dB for WGC) and clustered images also been tested which gives minimum PSNR and RMSE using WOGC.

The clustered imagery has been considered for depth map generation as reconstruction with the help of stereo pair images resulting in anaglyph 3d image for better visualization of satellite imagery with an efficient unsupervised true colour composite results as per **Figure-10**.The metric PSNR and RMSE also applied to check the performance of satellite imagery (8.3992-6.9112dB for WOGC) and (7.5597-6.5697dB for WGC) as per **Figure - 11** with related **Table- 2**.

TABLE: 2. PERFORMANCE OF PSNR AND RMSE VALUES

Input Images	PSNR Value-WOGC	RMSE Value-WGC	PSNR Value-clustered	RMSE Value-clustered	PSNR Value-depth map	RMSE Value-depth map
WOGC	8.3992	13.7734	11.0707	13.7734	6.9112	10.3854
WGC	7.5597	12.9627	10.8370	12.9627	6.5697	8.9570

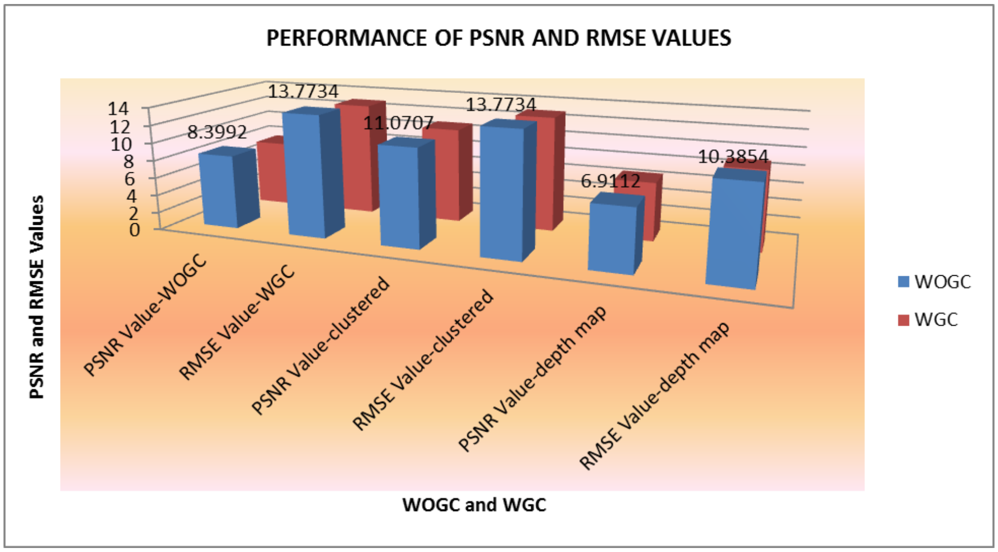
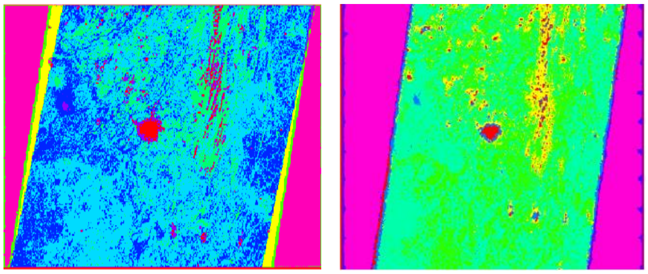


Fig: 10. Overall performance of PSNR and RMSE of WOGC,WGC for original, clustered images and Depth Maps

……



(a-WOGC-C) **(b-WGC-C)**

Fig: 11.(a)(b) Accuracy of True Color Composite of Clustered with Original Satellite Imagery

THE IIOAB JOURNAL ISSN: 0976-3104

CONCLUSION

The proposed work of the paper deals with the Depth Reconstruction using Geometric Correction with Anaglyph approach for Satellite imagery. It discuss about without geometric correction (WOGC) and with geometric correction (WGC) as two ways for clustering using Rough Intuitionistic Fuzzy C-Means algorithm as WOGC-C and WGC-C. The resampling techniques have been used at WOGC and WGC level with PSNR and RMSE [0.036559 rate] at WOGC-C and WGC-C level with PSNR and RMSE[7.5597-10.8370dB]and true color composite at WOGC-C and WGC-C level with PSNR and RMSE [7.5597-6.5697dB] for reconstruction of depth map generation. At all levels, the performance of satellite imagery yielded improvised results of WGC-C-D in comparison with WOGC-C-D. As a future work, author aim to propose a method that can be used which extracts the cloud from a satellite image. This will extract R, G, and B components of a true color satellite image and converted to a true color satellite image to a 256 gray image (from one image to four images). The R-components" is used to extract the cloud from a satellite image, instead of the converted gray image to reduce time complexity.

CONFLICT OF INTEREST

Authors declare no conflict of interest.

ACKNOWLEDGEMENT

The authors would like to thank the anonymous reviewers and the editor-in-chief of the journal for their valuable guidance which has improved the quality and presentation of the paper.

FINANCIAL DISCLOSURE

No financial support was received to carry out this project.

REFERENCES

[1] Lillesand TM and Ralph W Kiefer [2003] Remote sensing and image interpretation *Fourth Edition, John Wiley and sons inc, Singapore.*

[2] Swarnalatha P and P.[Venkata Krishna 2013] An efficient method of Bitplane filtering algorithm using convex hull of medical images *Anale.Seria Informatică*. 1(1): 9–16.

[3] Arif M. Akbar and A. M. Wu (2006) Most favorable automatic georeferencing based on GCPs selection using least square method *proceedings of 4th International Conference on Digital Earth*: 25–26.

[4] Ramakrishnan.R, Manthira Moorthi.S, Prabu.S and P Swarnalatha [2013] Comparative Analysis of Various Methods for Preprocessing of Satellite Imagery *International Journal of Engineering and Technology (IJET)*, 5(1):431–437.

[5] Prabu Sevugan, Ramakrishnan.R, Manthira Moorthi.S and Swarnalatha.P (2013) Non Parametric Model Re-Sampling Techniques for Geometric Correction of Remote Sensing Satellite Images *International Journal of Applied Engineering Research (IJAER)*, 8(14):1611-1621.

[6] Manthira Moorthi S., Kayal Raja,.Ramakrishnan R and P.K.Srivastava [2008] RESOURCESAT-1 LISS-4 MX bands on ground co registration by in-flight calibration and attitude refinement *International Journal of Applied Earth Observation and Geoinformation*, 10 (2):140–146.

[7] Tripathy B.K.and P.Swarnalatha [2013] A Novel Fuzzy C-Means Approach with Bit Plane Algorithm for Classification of Medical Images *IEEE International Conference on Emerging Trends in Computing, Communication and Nanotechnology (ICE-CCN 2013)*, 360 – 365.

[8] Swarnalatha P. and B.K.Tripathy [2013] Depth Computation using bit plane with clustering techniques for satellite images: *accepted for publication in International journal of earth sciences and engineering,"in press",* ISSN: 0974—5904.

[9] Triaxes® StereoTracer [2013], *version 7.0, Triaxes Lab LLC. Russia, Tomsk.*

[10] Shorter Oxford English Dictionary [1968] *Mutual inclination of two lines meeting in an angle.*

[11] Jump upJump up "Parallax". Oxford English Dictionary (Second Edition ed.).[1989] stron. Apparent displacement, or difference in the apparent position, of an object, caused by actual change (or difference) of position of the point of observation; spec. the angular amount of such displacement or difference of position, being the angle contained between the two straight lines drawn to the object from the two different points of view, and constituting a measure of the distance of the object.

[12] Tripathy.B.K., Rohan Bhargava, Anurag Tripathy, Rajkamal Dhull, Ekta Verma and P.Swarnalatha [2013] Rough Intuitionistic Fuzzy C-Means Algorithm and a Comparative Analysis *in proceedings of ACM Compute-2013, ,International Conference, SITE, VIT University*.

[13] Kesikoğlu, M. H. Atasever, Ü. H., C Özkan. [2013] Unsupervised change detection in satellite images using fuzzy c-means clustering and principal component analysis *ISPRS - International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, 7(2) : 129–132.

[14] Li XL, Tian YC, Xing KZ, GQ Ma [2015] Cloud Extraction of Satellite Image Using Fuzzy C-Means Clustering Approach *Applied Mechanics and Materials*,743:289–292.

[15] Tripathy B.K., P.Swarnalatha [2013] A Comparative Study of RIFCM with Other Related Algorithms from Their Suitability in Analysis of Satellite Images using Other Supporting Techniques *Kybernetes*, 43(1): 53–79.
[16] Newcombe RA, Lovegrove SJ and AJ Davison Dtam. [2011] Dense tracking and mapping in real-time *in Proc. ICCV*.
[17] Stuhmer J, Gumhold S, D Cremers. [2010] Real-time dense geometry from a handheld camera *proceedings of the 32nd DAGM conference on Pattern recognition*:11—20.
[18] Seok Lee Hee, Kyoung Mu Lee. [2012] Dense 3D Reconstruction from Severely Blurred Images using a Single Moving Camera *CVPR*.
[19] *http://www.crisp.nus.edu.sg/~research/tutorial/opt_int.htm*
[20] Maji P, SK Pal. [2007] Rough Set Based Generalized Fuzzy C-Means Algorithm and Quantitative Indices *IEEE Transaction on System, Man and Cybernetics, Part B: Cybernetics*, 37(6):1529—1540.
[21] Swarnalatha P, Madhuri Kota, Nagarjuna Reddy Resu , G Srivasanth. [2009] Automated Assessment Tool for the Depth of Pipe Deterioration *SCOPUS-IEEE International Advance Computing Conference, IACC 2009*:721—724.
[22] Swarnalatha P and BK Tripathy [2012] Centroid Model for the Depth Assessment of Images using Rough Fuzzy Set Techniques *International Journal of Intelligent Systems and Applications*, 1(2), ISSN: 2249-9954: 20—26.
[23] *http://www.en.wikipedia.org/wiki/Parallax#cite_.*

ABOUT AUTHORS

Dr Prabu Sevugan have completed Bachelor of Engineering in Computer Science and Engineering from Sona College of Technology (Autonomous) and Master of Technology in Remote Sensing from College of Engineering Guindy, Anna University Chennai and one more Master of Technology in Information Technology at School of Computer Science and Engineering, Bharathidasan University Trichy. Did his Doctoral studies on Integration of GIS and Artificial Neural Networks to Map the Landslide Susceptibility from College of Engineering Guindy, Anna University, Chennai. He was a Post-Doctoral Fellow at GISE Advanced research lab, Department of Computer Science and Engineering, Indian Institute of Technology Bombay. He has more than 45 publications in national and international journals and conferences. He organized 3 International Conferences which includes one IEEE Conference as chair and also participated in many workshops and seminars. He is a member of many professional bodies and senior member of IACSIT, UACEE and IEEE. He is having more than ten years of experience in teaching and research. Currently I am working as a Division Chair for Parallel and Distributed Computing, School of Computing Science and Engineering, VIT University Vellore.

B.K.Tripathy is a senior professor in the school of computing sciences and engineering, VIT University, Vellore, since 2007. He has produced 26 PhDs, 13 M.Phils and 03 M.S students so far. He has published more than 340 papers in different international journals, conference proceedings and edited research volumes. He has edited two research volumes for the IGI publications and has written 02 books on Soft Computing and Computer Graphics. He is in the editorial board or review panel of over 60 international journals including Springer, Science Direct, IEEE and World Scientific publications. He is a life member/ senior member/member of 21 international forums including ACM, IEEE, ACEEE and CSI.His current interest includes Fuzzy Sets and Systems, Rough sets and Knowledge Engineering, Multiset Theory, List Theory, Data clustering and Database Anonymization, Content Based Learning, Neighbourhood Systems, Soft Set Analysis, Image Processing, Cloud Computing, Social Internet of Things, Big Data Analytics, Multi Criteria Decision Making and Social Network Analysis.

Swarnalatha Purushotham is an Associate Professor, in the School of Computer Science and Engineering, VIT University, at Vellore, India. She pursued her Ph.D degree in Image Processing and Intelligent Systems. She has published more than 50 papers in International Journals/International Conference Proceedings/National Conferences. She is having 14+ years of teaching experiences. She is a member of IACSIT, CSI, ACM, IACSIT, IEEE (WIE), ACEEE. She is an Editorial board member/reviewer of International/ National Journals and Conferences. Her current research interest includes Image Processing, Remote Sensing, Artificial Intelligence and Software Engineering.

THE IIOAB JOURNAL
ISSN: 0976-3104

S. Manthira Moorthi received his M.sc in Applied Physics from Gandhigram University, Tamil Nadu, in 1989. He has been working in Signal and Image Processing Group, Space Applications Centre (ISRO), Ahmedabad as a scientist since 1991. He is involved in the development of methods, approaches, algorithms and software systems for earth and planetary remote sensing data pre and post processing. His areas of interests are geometric and radiometric processing, automatic image registration techniques, image analysis, geodetic procedures, information models, space science data management, and planetary data models.

He obtained his M.Sc. (Applied Mathematics) from University of Madras (Madras Institute of Technology) in 1977 and Ph.D in Mathematics form U.P.Technical University , Lucknow in 2004. Joined as scientist at Space Applications Centre in 1978 and leading Data Products Software Group. His contributions are in the area of development of software systems for Indian Remote Sensing data processing as well as Meteorological Data Processing such as INSAT for operational needs. His research area includes distributed computing, software architectures, Software Quality assurance and Image Processing of optical remote sensing data.