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ANALYSIS OF DEPTH USING CLUSTERING TECHNIQUES WITH BIT PLANE FILTER FOR SATELLITE IMAGERY

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ABSTRACT

Calculation of measurements has noteworthy inspiration in different applications now a day. The count of sizes from the profundity of satellite pictures is fundamental for better representation, for recognizable proof of ranges, climate gauging, and so on. Fitting grouping strategies will give better yield for profundity calculation of satellite pictures with least time many-sided quality. The utilization of bit plane channel technique produces improved pictures with least epsilon esteem which helps in showing signs of improvement grouping of pictures. In this paper we apply the strategies for bit plane channel strategy with fuzzy c-means (BPFCM) and bit plane unpleasant c means strategy (BPRCM) on satellite pictures and it is watched that both of these systems give upgraded groups for satellite pictures contrasted with traditional techniques. Likewise, we set up that BPRCM gives a superior upgraded grouped picture in contrast with BPFCM. Furthermore we perform the profundity calculation of satellite pictures, which demonstrates that our methodology (BPRCM) needs least time unpredictability and edge esteem as for the customary techniques and in addition BPFCM for the bended satellite pictures.

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KEY WORDS

Bit Plane Filter; Otsu Thresholding; Mathematical Methods; Clustering; Depth Computation; Satellite Images

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INTRODUCTION

The satellite pictures acquired by remote detecting frameworks are not frequently adequate for high exactness applications because of different mutilations. The twists can be ordered as geometric, radiometric and atmospheric corrections. The satellite pictures manage three errors/mutilations, and the objective of this paper is to correct satellite pictures from such mistakes by suitable grouping of layers. The wellsprings of geometric mutilation incorporate sensor impacts, stage impacts, object impacts, and atmospheric impacts. We will quickly say a few wellsprings of mutilations. In a raw picture the pixel size on the ground is not steady since it varies with the scanning angle. On the off chance that the speed of the satellite in respect to the ground is not steady, the separation between two neighboring sweep lines is not consistent. Further contortions are brought on by the way that the elevation of the satellite changes with time.

What's more, atmospheric refraction might bring about geometrical distortions. A portion of the mistakes are deliberate, while a percentage of the blunders happen pretty much arbitrarily. By geometric correction, a picture is gotten from the raw picture such that it has the same geometry as a source of perspective picture or a very much characterized map projection.

For every pixel in the amended picture, we need to decide a mapping to the raw picture. Satellite pictures are helpful for checking changes in land use and land cover. Yet, significant issue with these pictures is that locales underneath mists are not secured by sensor. The picture distortion because of overcast spread is an established issue of unmistakable band of remote detecting symbolism. Particularly, for non-stationary satellite, it is normally found in the earth asset perception application. Expelling overcast spread from satellite symbolism is exceptionally helpful for helping picture understanding. Consequently cloud identification and evacuation is extremely essential in the preparing of satellite symbolism.

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Further it is more hard to measure and decipher changes on multi-fleeting pictures under various brightening, climatic or sensor conditions without radiometric adjustment. The relative way to deal with radiometric remedy, known as relative radiometric standardization is favored.

Then again, atmospheric particles diffuse the daylight into the sensor's field of perspective specifically, bringing about a radiation that does not contain any surface data by any means. The consolidated climatic impacts because of disseminating and retention are wavelength subordinate, shift in time and space, and rely on upon the surface reflectance and its spatial variety [1].

With a specific end goal to uproot mutilations, the bit plane filter calculation is utilized for pictures which improves the picture by isolating a picture into an arrangement of bits relating to a given piece position in each of the 0's and 1's speaking to a satellite picture. Furthermore satellite pictures can be isolated into cuts to locate an upgraded suitable piece planes to decide the trifling data of the satellite picture.

The edge location strategy is utilized for portioning a satellite picture into edges. There are four distinctive ordinary strategies i.e., Canny, Sobel, Prewitt, Zero-Cross and Robert-Cross Methods. The issue of false edge location gives dainty or thick lines which was vexed because of commotion and so on., has been utilized by diminishing the aggregate of information and channels out futile data, by safeguarding the critical auxiliary properties in a satellite picture. This kind of satellite picture is useful for applications inside and out (three dimensional spaces) calculation, picture recreation, and so on.

What's more, the calculation of depth was prepared by finding the third measurement of a clustered satellite picture utilizing traditional strategies. The clustered satellite picture is important for further preparing of picture reproduction which is fundamental for climate gauging or recognizable proof of locales, and so on of societal purposes. In [Swarnalatha et al, 2009], the misshaped pictures which are upgraded by utilizing a specific force appraisal, that exists underneath the past quality utilizing edge has been found to not to give precise results

As the routine strategies don't give legitimate division, fuzzy c-means and rough c-means clustering algorithms have been utilized as a part of this paper. To be more exact, in this paper, we utilize three grouping procedures (conventional, fuzzy c-means and rough c-means) utilizing with and without bit plane methodology for a satellite picture. One of the proposed strategies in this paper is the bit plane rough c-means (BPRCM) which yields better grouped pictures contrasted with traditional and bit plane channel technique with fuzzy c-means (BPFCM). As the depth calculation is crucial to locate the mutilated segment of a satellite picture or the control of various regions, it turns into a period expending process which is essential for further remaking of a satellite picture. We have processed the time complexity of changing a satellite picture utilizing the proposed BPRCM technique.

The skeleton of the paper is as per the following. Segment 2 manages writing overview identified with the bit plane strategy, conventional methods and clustering techniques of a satellite picture. This dialog additionally incorporates fuzzy c-means, rough c-means and time complexity for depth of a satellite picture. In segment 3 we portray our proposed strategy with bit plane channel for conventional, fuzzy c-means and rough c-means. In segment 4, we give a similar investigation of the diverse procedures such as the traditional strategies, fuzzy c-means, rough c-means, where for every situation we consider two adaptations of utilizing bit plane strategy and without utilizing it for better grouping of satellite pictures. Additionally an examination has been made on their execution basing upon test results. Segment 5 manages depth calculation and time complexity nature. Likewise, in this area we compress our commitment in this paper under conclusions. We propose some future work in this bearing under area 6. We introduce the source materials referred amid the readiness of this work in the references segment.

LITERATURE SURVEY

In the review, it has been found that distinctive picture upgrade methods have been actualized and have effectively removed the components of the affected/distortion areas/regions which is not precise.

Nowadays, satellite imaging sensors use multispectral or even hyper spectral devices, which results in acquiring multiple images require advanced techniques and experimental methods for processing [2].

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There are many edge detection methods, which are used to visualize different layers existing in satellite images obtained through satellites. Edge detection techniques (Sobel detector, Robert Cross detector, Canny edge detector, Zero-based detection) are used to extract boundaries[13]. As a result of an abrupt change in brightness levels in the satellite images, we cannot obtain the correct smooth edges. That is why satellite images can be segmented using some methods handling imprecision. Some of these methods are the fuzzy c-means method introduced in [3] and the rough c-means [4]. In this paper, we shall be using these two methods for segmentation of satellite images.

Edge detection significantly reduces the amount of data and filters out useless information when storing the significant structural properties in an image. A comparative analysis of various Image Edge Detection techniques can be found in [5].

From a different prospective a vague spatial phenomenon has been dealt in [6] for the improvement of characterisation and quantification of vegetative drought. Vegetative drought is characterised using a membership function to model the gradual transition between drought and non-drought classes. A Crisp approach, using the median of the transition range as the threshold value, does not quantify the vagueness of vegetative drought. A membership function is used to represent the quantification of vegetative drought in order to form the steady transition between drought and non-drought classes The procedure has been implemented using fuzzy set to quantify the areas those have vagueness of vegetative drought.

The auto-searching and matching algorithm is introduced and miss-matching elimination is used in dealing with ortho-rectification of images aided by GCP (Ground Control Point) image databases method [7].

A hybrid lossless algorithm based on simple selective scan order with bit plane slicing method [8] is used for lossless Image compression of limited bits/pixel images, such as medical images, satellite images and other still images common in the world.

In [9] discussions have been made about the updating the map in GIS, environmental inspection, transportation and urban planning, etc for the purpose of speedy retrieval of road network that is useful in. And using fuzzy theory, for urban area from multi-spectral IKONOS imagery, an automatic road extraction algorithm was developed.

The paper [16] deals with the calculation of depth of the defect, which is very vital as the measure to which the image has been depreciated, can be estimated from this. The angle of incidence of X-rays and the thickness of the image are taken as an input from the user and thereby the dimensions of the affected areas such as the length, breadth and depth have been found which is not accurate in results for further reconstruction [11][13].

In [14] a three step method is presented, which is a simple, robust and efficient one to detect defects in the underground concrete pipes. It identifies and extracts defect-like structures from pipe images whose contrast has been enhanced. The objective of the paper is to reduce the effort and the labour of a person in detecting the defects in underground pipes.

The above issues have been solved individually so far. But in this paper we deal with a method to detect edges of distortions using conventional methods, fuzzy c-means and rough c-means techniques which cluster an enhanced image using bit plane filter method with minimum thresholding. Clustering can be used to segment an enhanced image using bit plane method into several clusters with Otsu thresholding and statistical techniques we are able to remove unwanted clusters. Finally, image is edge detected, where a clear boundary is obtained. As a result, the bit plane rough c-means performs better than existing edge detection methods which are useful for the assessment of time complexity of depth computation with minimum value compared to the existing tools [11][13] and bit plane fuzzy c-means algorithm.

Depth computation is essential for better visualization of images for satellite applications. The disorder portion of satellite images may lead to many natural disasters of rocket launching due to inaccurate classification and clustering of satellite images.

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To have proper analysis of the above applications, using statistical moments, the third dimension calculation was implemented using centroid model gives less accurate results. Hence in the paper [11][13], we aimed at developing an approach for better classification and clustering of the affected portion which may be helpful for depth computation and further process.

METHODOLOGY

The architecture of the paper provided in fig.1 provides a clear idea about the methodology. In this section we discuss on some of the key steps involved in the process.

Bit Plane Slice Method

This is a preprocessing technique which removes distortions from an image, yielding a better image which can be used for further processing.

Input Image: Ordinary Satellite image

Step 1: Declare an array of variables for matrix and to read pixel values and an integer of variables of n, m.
Step 2: Exercise loop for increment to the 'j' variable and count the occurrence of 1's in the first 3 most significant bit slices.
Step 3: Then use the method which will compute mean(standard deviation, variance) value for the declared array by applying binary
Addition operator. And to the calculated mean value, we have to replace the center pixel by iterating for the whole satellite image in the variable of an img.
step 4: By preserving edges of a satellite images, we can remove noise thereby.
for every row and column, till < than n and m Method
for (row to n){ for (col to m) {} }
Step 4.1: And to arrive the bit slices, declare the bit 1 to bit 8 array variables,
Step 4.2: And do instantiation as set pixels values ,
pixels[i] ∈ {1,2,…8}
initially, updated by bit planes loop number ,
i ∈ {1,2,….n*m},
initially 0, will be instantiated to a integer value.
Step 5: End
Step 6: Assign cbp=zeros(size(img));
Step 7: Compare the planes to display the correct bit
plane using iteration
cbp=bs(cbp,1,pixels[15])||(cbp,2,pixels[16]) ……
Step 8: Display the cbp
Step 9: End
Output Image: Bit Plane Satellite image

The bit plane algorithm is used to partition an image to 0-7 slices. As for illustration the 8 bit value 10011011 will become 155 in decimal. Pre-processing the satellite image should be carried out for the detection and extraction of the significant features [17].

Thereby reducing the first bit slice/plane of a satellite image, plane by plane till gives the final slice as a value of $2^{(m-n)}$ with better approximation having trivial information [18]. The cropped bit plane (cbp) can be applied for a particular portion of a satellite image for further interpretation.

Conventional Edge Detection Techniques

The problem of false edge detection [12] gives thin or thick lines which was troubled due to noise etc., was used by reducing the total of data and filters out useless information, by preserving the significant structural properties

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in a satellite image. We can have four conventional edge detection techniques (Sobel, Canny, Robert Cross and Zero-Cross). The “Sobel operator” edge detection method is simple enough to detect the edges and their orientation negatives which are sensitive to noise.

The Zero Cross edge detection method aims in detection of edges and their orientations having fixed characteristics in all directions that can respond to some of the existing edges, sensitivity to noise. Canny edge detection method can use probability for finding error rate, localization and response which improves signal to noise ratio with better detection specially in noise conditions. But it involves complex computations, false zero crossing and also it is time consuming.

The Robert Cross edge detection method deals with the properties of the produced edges which should be well-defined, the background should contribute as little noise as possible and the intensity of edges should match as close as likely to what a human would recognize [17]. The Canny Edge Detection technique is used for the detection of high range of edges in satellite images that may lead to detection and localization as good. Filters as horizontal, vertical and diagonal edges can be detected using canny edge detection algorithm to determine the intensity gradient of the satellite image by way of as given below:

$$\Theta = \arctan\left(\frac{G_y}{G_x}\right)$$

(3.2.1)

$$G = \sqrt{G_x^2 + G_y^2}$$

(3.2.2)

Otsu Thresholding, Statistical Methods and Histogram Analysis

Thresholding is computationally inexpensive and fast. It is one of the oldest segmentation methods and is still widely used in simple applications. Using range values or threshold values, pixels are classified and clustered using either of the thresholding techniques like global and local thresholding. Global thresholding method selects only one threshold value for the entire satellite image. Local thresholding selects different threshold values for different regions. Structuring elements are applied to the pixels of the satellite image. That is, using the structuring elements the pixels in the satellite image can be clustered and classified into different classes and then by performing the set difference operation the features of the affected area can be extracted from the satellite image for which the horizontal structuring element must be varied. A particular intensity value is considered and all the pixels whose intensity values lie below that value are obtained.

Statistical Methods

The different mathematical methods can be applied on the bit-plane to get the enhanced satellite image [11-13] In the paper, root mean square error and peak signal noise ratio has to be computed for better interpretation of a satellite image.

RMSE and PSNR Value

Peak Signal-to-Noise Ratio can be characterized as **PSNR,** which is the relation with the majority, likely power of a signal and the power of corrupting distortions that influence the fidelity of its demonstration to validate the performance of the clustering techniques.

The PSNR value can be computed through mean squared error(MSE). For an example distortion-free mxn monochrome satellite image ‘I’ with its noisy approximation ‘K’, MSE can be represented as given below:

$$MSE = \frac{1}{mn}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[I(i,j) - K(i,j)]^2$$

(3.3.2.1)

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Hence, the PSNR is defined as:

$$PSNR = 10.\log_{10}\left(\frac{MAX_I^2}{MSE}\right) \qquad (3.3.2.2)$$

$$= 20.\log_{10}\left(\frac{MAX_I}{\sqrt{MSE}}\right) \qquad (3.3.2.3)$$

$$= 20.\log_{10}(MAX_I) - 10.\log_{10}(MSE) \qquad (3.3.2.3)$$

where MAX_I is the most possible 0's and 1's values of a satellite image. And it will be replaced with 255, as and when the 0's and 1's are given using 8 bits per model. And MSE will become '0', when the distortion is null indicating that the two input satellite images are same.

Here, MAX_I is the maximum possible pixel value of the satellite image. When the pixels are represented using 8 bits per sample, this is 255. In the absence of noise, the two satellite images I and K are identical, and thus the MSE is zero. In this case the PSNR is undefined**.**

Histogram Analysis

Histogram can be applied to review graphically the satellite images have resulted in terms of allocation and deviation. Let the variable 'u' represent the gray levels of the satellite image to be enhanced. We assume that 'u' has been normalized to the interval [0, 1], with u = 0 representing black and u = 1 representing white.

Later, we consider a discrete formulation and allow pixel values to be in the interval [0, G-1] where G is the highest gray level value.

For any 'u' satisfying the aforementioned conditions, we focus attention on transformations of the form

$$s = T(u) \quad 0 \le u \le 1 \qquad (3.3.4.1)$$

that produces a level s for every pixel value r in the original satellite image. We assume that the transformation function T(u) satisfies the following conditions:

(a) T(u) is single - valued and monotonically increasing in the interval $0 \le u \le 1$; and

(b) $0 \le T(u) \le 1$ for $0 \le u \le 1$. (3.3.4.2)

Let $p_u(u)$ and $p_v(v)$ denote the probability density functions of random variables u and v, respectively, where the subscripts on p are used to denote that p_u and p_v are different functions.

For discrete values we deal with probabilities and summations instead of probability density functions and integrals. The probability of occurrence of gray level u_k in a satellite image is approximated by $P_u(u_k) = n_k/n$ k = 0,1,2,…, G – 1 (3.3.4.3)

Where, n is the total number of pixels in the satellite image, n_k is the number of pixels that have gray level u_k, and G is the total number of possible gray levels in the satellite image. The discrete version of the transformation function given in Eq. (3.3.4.2) is

$v_k = T(u_k) = \sum p_u(u_j) = \sum n_j/n \quad k = 0,1,2,...G-1$(3.3.4.4)

Thus, a processed (output) satellite image is obtained by mapping each pixel with level u_k in the input satellite image into a corresponding pixel with level v_k in the output satellite image via Eq. (3.3.4.4).

Fuzzy C Means (FCM)

Here, we are presenting the FCM which is used for data clustering. For this, first we need to define the concept of a Fuzzy Set.

Definition

A fuzzy set A is determined by its membership function μ_A, where $\mu_A : X \to [0.1]$ such that every x ∈ X is associated with its grade of membership in A, $\mu_A(x)$. If an element does not belong to A then $\mu_A(x)$ =0. The closer the membership value $\mu_A(x)$ to 1, the more x belongs to A. The grade 1 represents full membership, [19].

Fuzzy C-Means Algorithm

Let X={ x_1,…., x_j,,…….., x_n } be the set of n objects and V={ v_1....,. v_i ,….., v_c } be the set of c centroids (means), where $x_j \in$ to $\Re^m$, $v_i \in \Re^m$ and $v_i \in$ X. The FCM provides a fuzzification of the HCM by [3]. It partitions X into c clusters by minimizing the objective function.

$$J = \sum_{j=1}^{n}\sum_{i=1}^{c}(u_{ij})^{m_1} \| x_j - v_i \|^2$$

(3.3.5.1.1)

Where 1<= $m_1 < \infty$ is the fuzzifier, v_i is the ith centroid corresponding to cluster β_i, $\mu_{ij} \in [0,1]$ is the probabilistic membership of the pattern x_j to cluster β_i , and ||.|| is the distance norm, such that

$$v_i = \frac{1}{n_i}\sum_{j=1}^{n}(\mu_{ij})^{m_1} x_{j,} where \qquad n_i = \sum_{j=1}^{n}(\mu_{ij})^{m_1} x_{j,}$$

(3.3.5.1.2)

$$\mu_{ij} = (\sum_{k=1}^{c}(\frac{d_{ij}}{d_{kj}})^{\frac{2}{m_1-1}})^{-1}, where \qquad d_{ij} = \| x_j - v_{j|} \|^2$$

(3.3.5.1.3)

Subject to $\sum_{i=1}^{c}\mu_{ij} = 1, \forall_j, and\ 0 < \sum_{j=1}^{n}\mu_{ij} < n, \forall_{i.}$ The process begins by randomly choosing c objects as the centroids of the c clusters. The memberships are calculated based on the relative distance of the object x_j to the centroids { v_i } by (3.3.5.1.3). After computing the memberships of all the objects, the new centroids of the clusters are calculated as per (3.3.5.1.2).

The process stops when the centroids stabilize. That is, the centroids from the previous iteration are identical to those generated in the current iteration.

In the FCM, the memberships of an object are inversely related to the relative distance of the object to the cluster centroids. In effects, it is very sensitive to noise and outliers. In addition, from the standpoint of "compatibility

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with the centroid," the membership of an object x_j in a cluster β_i should be determined solely by how close it is to the mean(centroid) v_i of the class and should not be coupled with its similarity with respect to other classes.

Rough C-Means (RCM) Algorithm

The notion of rough sets was introduced in [18] as an extension of the concept of crisp sets. We provide below the definition of a rough set.

Let U (≠∅) be a finite set of objects, called the universe and R be an equivalence relation over U. By U/R we denote the family of all equivalence classes of R (or classification of U) referred to as categories or concepts of R and $[x]_R$ denotes the class of x in R containing elements of U related to x by the relation R. By a Knowledge base, we understand a relational system K = (U, *R*), where U is as above and *R* is a family of equivalence relations over U.

For any subset P (≠∅) ⊆ *R*, the intersection of all equivalence relations in P is denoted by IND (P) and is called the indiscernibility relation over P. The equivalence classes of IND (P) are called P- basic knowledge about U in K. For any Q∈*R*, Q is called a Q-elementary knowledge about U in K and equivalence classes of Q are called Q-elementary concepts of knowledge *R*. The family of P-basic categories for all ∅ ≠ P ⊆*R* will be called the family of basic categories in knowledge base K. By IND (K), we denote the family of all equivalence relations defined in k. Symbolically, IND (K) = {IND (P): ∅ ≠ P ⊆ *R*}.
For any X⊆U and an equivalence relation R∈ IND(K), we associate two subsets, $\underline{R}X = \cup\{Y \in U/R : Y \subseteq X\}$ and $\overline{R}X = \cup\{Y \in U/R : Y \cap X \neq \emptyset\}$, called the R-lower and R-upper approximations of X respectively. The R-boundary of X is denoted by $BN_R(X)$ and is given by $BN_R(X) = \overline{R}X - \underline{R}X$. The elements of $\underline{R}X$ are those elements of U which can be certainly classified as elements of X employing knowledge of R. The borderline region is the undecidable area of the universe. We say X is rough with respect to R if and only if $\underline{R}X \neq \overline{R}X$, equivalently $BN_R(X) \neq \emptyset$. X is said to be R- definable if and only if $\underline{R}X = \overline{R}X$, or $BN_R(X) = \emptyset$. So, a set is rough with respect to R if and only if it is not R-definable.

$$\mathbf{v}_i = \begin{cases} w_{\text{low}} \dfrac{\sum_{\mathbf{x}_k \in \underline{B}U_i} \mathbf{x}_k}{|\underline{B}U_i|} + w_{\text{up}} \dfrac{\sum_{\mathbf{x}_k \in (\overline{B}U_i - \underline{B}U_i)} \mathbf{x}_k}{|\overline{B}U_i - \underline{B}U_i|}, & \text{if } \underline{B}U_i \neq \emptyset \wedge \overline{B}U_i - \underline{B}U_i \neq \emptyset \\ \dfrac{\sum_{\mathbf{x}_k \in (\overline{B}U_i - \underline{B}U_i)} \mathbf{x}_k}{|\overline{B}U_i - \underline{B}U_i|}, & \text{if } \underline{B}U_i = \emptyset \wedge \overline{B}U_i - \underline{B}U_i \neq \emptyset \\ \dfrac{\sum_{\mathbf{x}_k \in \underline{B}U_i} \mathbf{x}_k}{|\underline{B}U_i|}, & \text{otherwise} \end{cases} \quad (3.3.7.1)$$

RCM Algorithm

Rough c-means algorithm was introduced by [4], which describes a cluster by its centroid and its lower and upper approximation. In rough c-means an object can belong completely in one cluster or in between two clusters. The lower and upper approximations are weighted differently. Since the objects in the lower approximation completely belong to the cluster, therefore they are assigned a greater weight denoted by w_{low}. The objects in the upper approximation as assigned a relatively lower weight denoted by w_{up}. The algorithm is given as follows:

1. Assign initial means V_i for c clusters.
2. Let $d_{i,k}$ be the minimum and $d_{j,k}$ be the next to minimum distance of x_k from clusters U_i and U_j. Assign each data object to the lower or upper approximation by computing $d_{j,k} - d_{i,k}$.
3. If $d_{j,k} - d_{i,k}$ is less than threshold (ε) then
   $x_k \in \overline{B}U_i$ and $x_k \in \overline{B}U_j$ and is not the member of any lower approximation.
   else $x_k \in \underline{B}U_i$

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4. Calculate new centroids for each cluster using equation 3.3.7.1
5. Repeat from step 2 until there are no more assignment.

Our approach is based on fuzzy c-means (FCM) and rough c-means (RCM) with bit plane filter method. In fact we shall be using the Bit Plane Conventional Methods (BPCM), Bit Plane Fuzzy C- Means (BPFCM) and Bit Plane Rough C-Means (BPRCM), which are obtained as follows:

1. Bit Plane Filter Algorithm where the satellite images are divided into slices
2. Otsu Thresholding and statistical Methods with conventional edge detection techniques.
3. Otsu Thresholding and statistical methods with Fuzzy C-Means
4. Otsu Thresholding and statistical methods with Rough C-Means for better clustering and classification for depth computation and future analysis.

As the first method, Otsu thresholding (OT) is applied for a original satellite image that can be used for the bit plane filter, which divides the satellite images into slices to have better visuality and methodology as follows: a satellite image is divided into a set of bits corresponding to a given bit position in each of the 0's and 1's which represents a satellite images. And that satellite image can be divided into slices to determine the trivial information with updated Otsu thresholding of the Bit Plane (BOT).

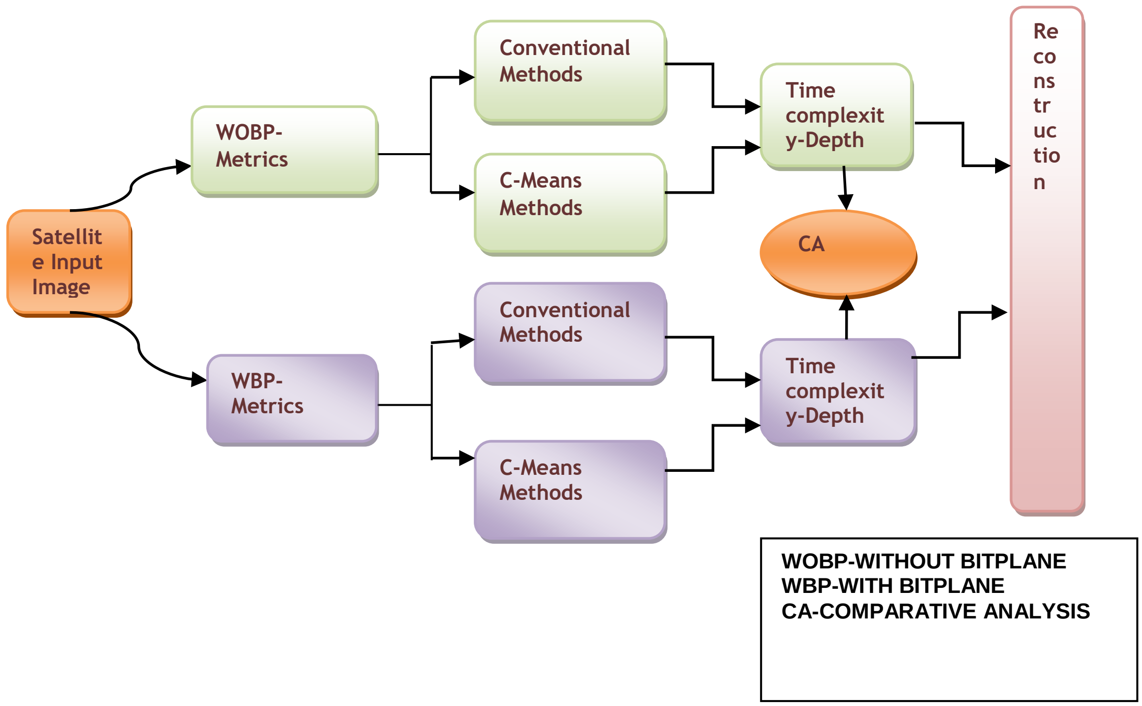

Fig: 1. Block Diagram of Depth Computation of Time Complexity using Without Bit Plane Fuzzy C-Means, Rough C-Means, Conventional Methods

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And as the second method, for the bit plane sliced satellite image can be used for conventional edge detection techniques (Sobel, canny, zero-based, Robert cross etc,) with Conventional Otsu thresholding (COT) and Statistical Methods.

In the third method, for the bit plane satellite image, we have to apply fuzzy c-means with Fuzzy Otsu Thresholding (FOT). In the fourth method, for the bit plane satellite image, we have to apply rough c-means with Rough Otsu Thresholding (ROT).

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Hence, obviously there is a necessity to generate results using the conventional edge detection techniques, fuzzy c-means and rough c-means with bit plane and without bit plane for better clustering of a satellite image. And comparison of three clustering techniques (conventional, fuzzy c-means, rough c-means) has been applied to a satellite image to extract control points for depth computation and further reconstruction of an image.

Figure– 1 deals with four levels as 1) with gray scale satellite image as an input with Original Otsu Thresholding (OOT) for two categories in level 2) of Without using Otsu Thresholding (WOOT) /Bit Plane and using With using Otsu Thresholding/Bit Plane (WOT). In comparison, WOT/BOT gives an efficient performance to OOT and WOOT. In level 3) the three methods of conventional, fuzzy c-means and rough c-means should be applied for without using and with using bit plane, thereby getting Conventional Otsu Thresholding (COT), Fuzzy Otsu Thresholding (FOT) and Rough Otsu Thresholding (ROT).

Table: 1. Bit Planes with Statistical Values and Thresholds

Bit Slices with statistical values and thresholds				
Bit Slice	**Mean**	**Standard Deviation**	**Variance**	**Threshold**
Original satellite image	138.1219	122.9636	125.0	62
0	103.6880	121.5076	129.0	42
1	103.1821	121.4028	129.5	46
2	107.6164	122.2095	129.5	46
3	115.1320	123.1899	126.5	40
4	99.6205	120.6428	126.5	42
5	90.5032	118.1787	127.0	46
6	104.6774	121.8552	128.0	41
7	60.1268	104.7469	126.5	40

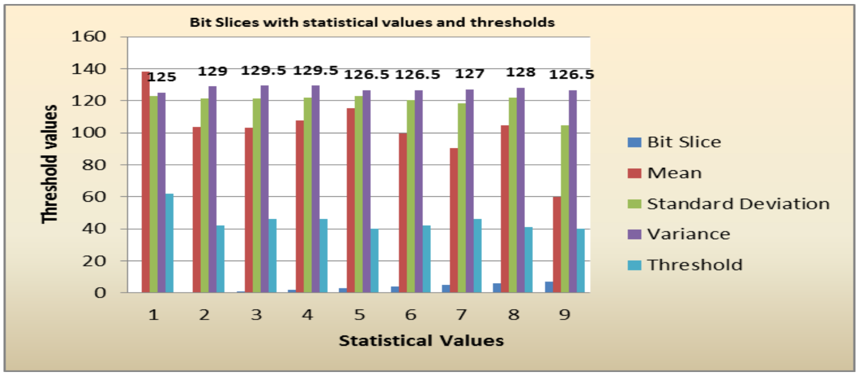

Fig: 2. Performance of Bit Planes with Statistical Values and Thresholds

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Figure– 2, discuss about the bit planes that have been justified based on the statistical values of mean, standard deviation , variance with their thresholds.

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The **Table –1** states that satellite image **(Figure 4.a)** has been sliced into 8 planes(i.e., 0 to 7 and 8 as original satellite image for comparison) for better visualization been used as one of the filter algorithm. Thereby, the mathematical values for the 7th bit slice like mean (60.1268),standard deviation(104.7469),variance(126.5) with Otsu threshold (40) shows improved result compared to the 0th bit slice of original satellite image of mean(103.6880),standard deviation(121.5076), variance(129.0) with Otsu threshold (42).

Table: 2 Overall performance of Original satellite image using conventional methods with epsilon values of without and with bit planes

Conventional Otsu	Without bitplane	With bitplane
Original	60	51
Canny	49	102
Robert	36	102
Sobel	124	71
Zero-cross	88	123

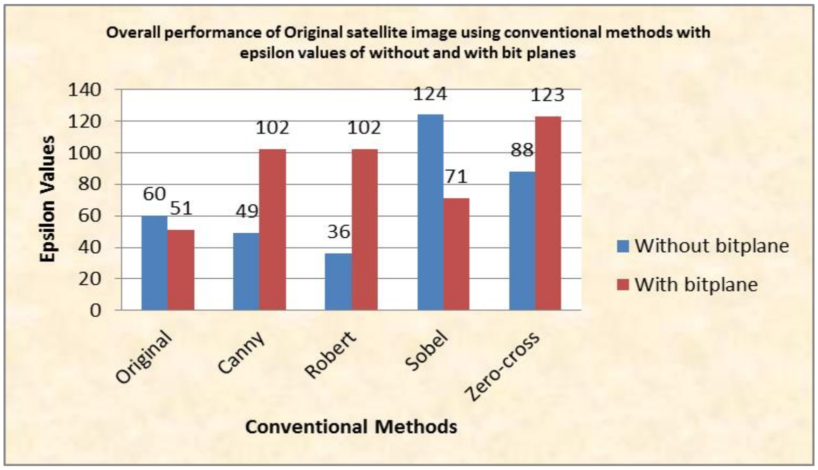

Fig: 3. Overall performance of Original satellite image using conventional methods with epsilon values of without and with bit planes

Table– 2 and **Figure– 3** deal with overall performance in figures and graphical form respectively of the original satellite image using conventional methods with epsilon values, by using bit plane technique and without using it. The epsilon values for traditional methods without bit plane give segmented satellite image with different performance values that is for one image, canny method has minimum value whereas for another Robert method does so. But the epsilon value is unique with minimum value for one method for all images Thus establishing that using bit plane, a stable reduction is possible in one method for all images in a field (satellite, medical, etc.,). The original satellite image with conventional methods without bit plane and with bit plane is given in **Figure 4.a.b.c.d. & 5.a.b.c.d.** after references of the paper.

Original Satellite image	Conventional Methods			
	Canny(a)	Sobel(b)	Zero-Based(c)	Robert-Based(d)

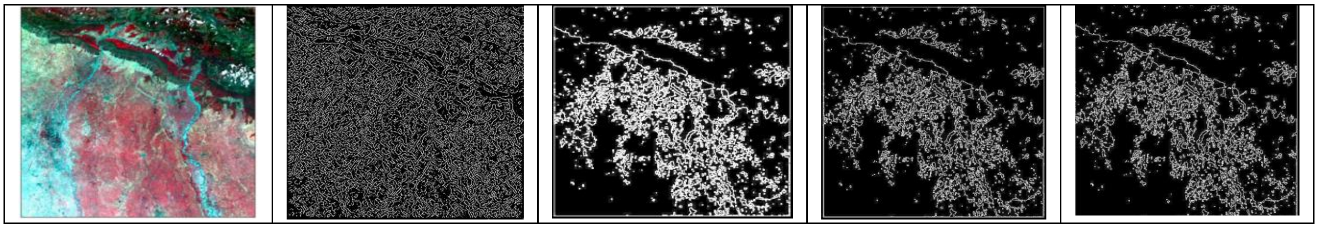

Fig: 4.a.b.c.d. Original satellite image with conventional Methods

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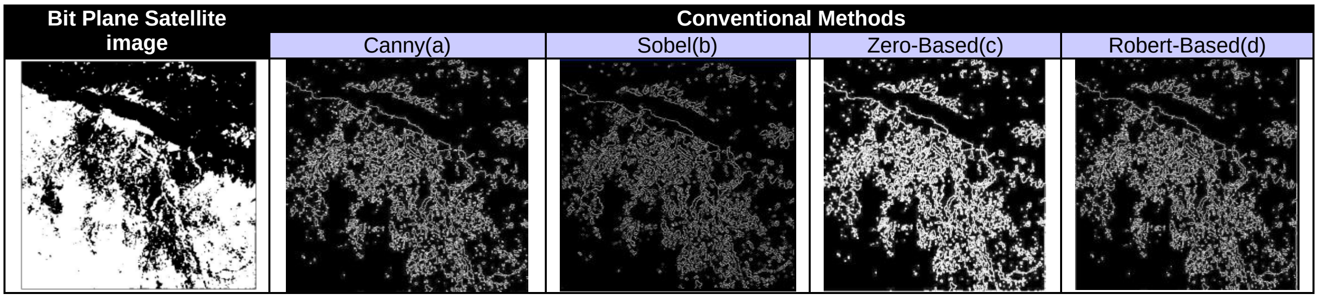

Fig: 5.a.b.c.d. Bit Plane satellite image with conventional Methods

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Table: 4. Original , fuzzy c-means and rough c-means satellite images with epsilon values of without and with bit planes

	Without bitplane	With bitplane
Input Satellite image	130	122
Fuzzy c-means	126	120
Rough C-means	109	102

As a result, we can get a blurred satellite image from the given input satellite image by removing the noise present on raw unprocessed data **.** The **table– 3(a)(b)** discuss about satellite images using without bit plane(WOBP) and with bit plane(WBP) for traditional/conventional, fuzzy c-means and rough c-means. With histogram analysis, a graphical representation of satellite images that results in terms of allocation and deviation have been processed giving better visualization of three methods.

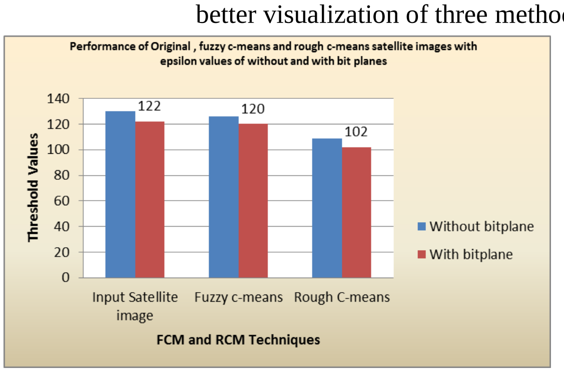

Fig: 6. Performance of Original , fuzzy c-means and rough c-means satellite images with epsilon values of without and with bit planes

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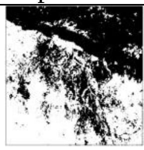
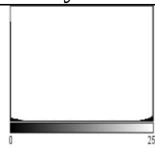
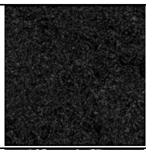
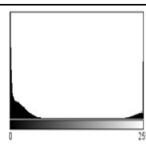
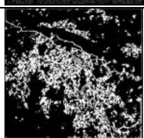
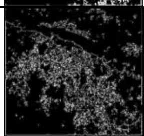
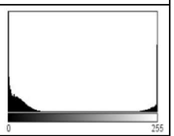
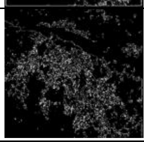
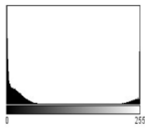
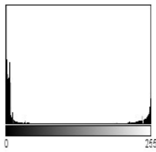
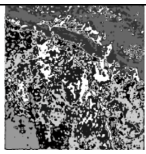
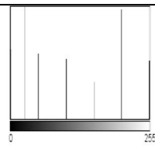
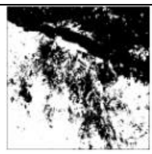
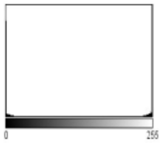
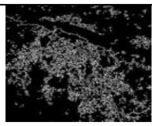
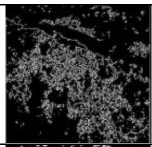
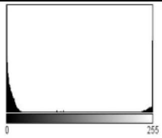
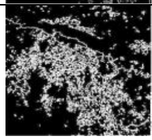
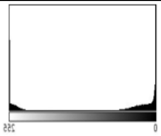
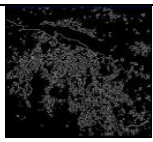
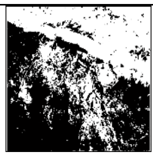
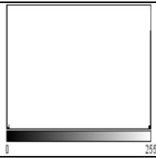
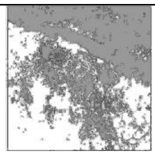
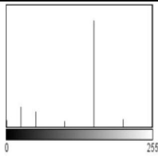
Table : 3(a_b Satellite images using without bitplane and with bitplane for traditional, fuzzy c-means and rough c-means with Histogram Analysis

Original Satellite image (a)-Without Bit plane		Histogram Analysis
Traditional Methods- Original Satellite image		
Canny Edge Detection		
Sobel Operator		
Zero-Cross Method		
Robert-Cross Method		
Fuzzy C-Means		
Rough C-Means		

Bit Plane Satellite image (b)- With Bit Plane		**Histogram Analysis**
Traditional Methods- Bit Plane Satellite image		
Canny Edge Detection		
Sobel Operator		
Zero-Cross Method		
Robert-Cross Method		
Fuzzy C-Means		
Rough C-Means		

The **Table– 4** and **Figure -6** gives the performance of threshold values for fuzzy c-means and rough c-means. The clustered techniques have been used without bitplane and with bitplane procedures. **Figure– 3** deals with using four (canny, sobel, zero-based, robert-based) conventional methods, any one of the method can be applied to one satellite image and differs for mages in one field. Thereby, Rough C-Means without bit plane and with bit plane (154, 71) gives better clustered satellite image compared to fuzzy c-means method (180,142) and conventional methods(96, 80) . Original Satellite image with fuzzy c-means and rough c-means and with that of bit plane satellite image is given in **Figure– 7, 8** for better visualization.

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Original Satellite image(a)	Fuzzy C-Means(b)	Rough C-Means(c)

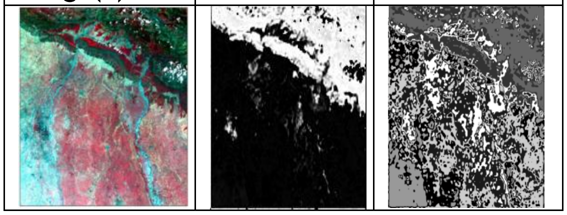

Fig: 7.a.b.c Original Satellite image with Fuzzy C-Means and Rough C-Means Methods

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Bit Plane Satellite image(a)	Fuzzy C-Means(b)	Rough C-Means(b)

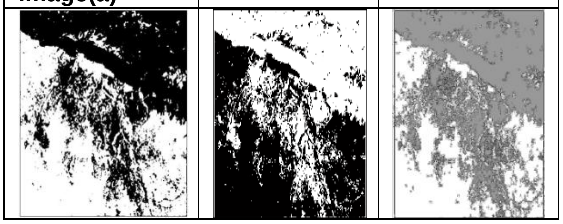

Fig: 8.a.b.c. Bit Plane Satellite image with Fuzzy C-Means and Rough C-Means Methods

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In the paper, we experimented with the above edge detection techniques which may miss true edges. With the application of clustering techniques i.e., conventional, fuzzy c-means and rough c-means methods, better segmented satellite image of rough c-means. Hence rough c-means method can be used for depth computation which carries minimum time consumption of a satellite image.

COMPARATIVE STUDY AND RESULTS

In this section we provide a comparative study of the experimental results obtained by applying the conventional methods as well as the fuzzy c-means and rough c-means with bit plane technique applied to a satellite image.

For comparison, sliced satellite image with Otsu thresholding has been used for conventional edge detection methods. And a comparative analysis of conventional, fuzzy c –means and rough c-means has been used with their root mean square error(RMSE) and peak signal noise ratio(PSNR) values for without bit plane /original satellite image (1347,38.7689,1352,38.7318) and with bit plane (477, 37.2323,473,37.1501) as given in table 5 and **Figure**– **9**. And a proposed Bit plane with conventional, fuzzy c means, rough c-means clustering methods (three) with Otsu thresholding is applied to a satellite image for better clustering as given in table 6. Performance of rough c-means yields better results compared to fuzzy c-means better than conventional methods [20].

As per **Figure**– **10**, comparison has been made by taking Otsu thresholding as the epsilon value resulted in an improved clustering of the rough c-means Otsu thresholding. And on comparison, rough c-means (RCM) yields good segmentation compared to that of old detection methods and fuzzy c-means (FCM) [20].

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Table: 5. PSNR and RMSE of three clustering methods for original and bit plane satellite images

Images with various clustering techniques	Original Satellite Image		Bit Plane Satellite Image	
	RMSE-Original	PSNR-Original	RMSE-Bit Plane	PSNR-Bit Plane
Input Satellite image	1347	38.7689	1352	38.7318
Canny	2180	33.9544	2163	34.0327
Robert	2060	34.5206	2280	33.5059
Sobel	1411	38.3047	2340	35.0733
Zero-cross	2357	33.1738	1482	37.8137
Fuzzy c-means	2489	32.644	520	48.286
Rough c-means	1311	37.3047	1238	39.612

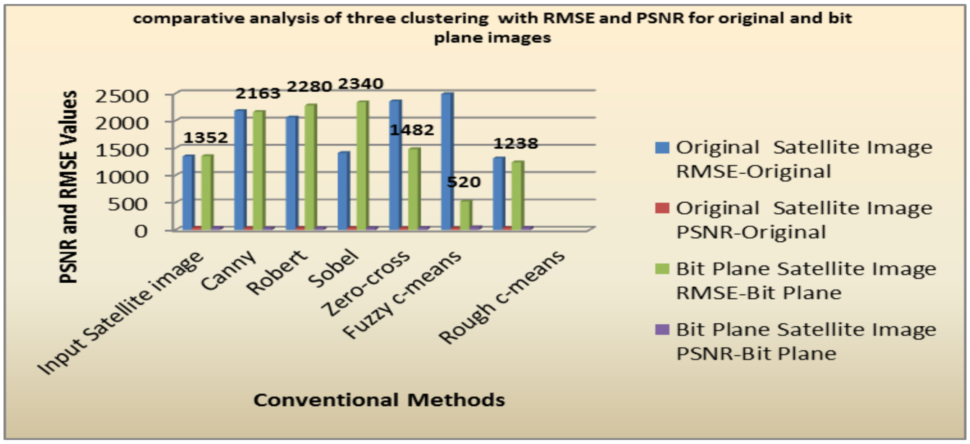

Fig: 9. Comparative Analysis of three methods with RMSE and PSNR values for original and bit plane satellite images

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Table: 6. Original, fuzzy c-means and rough c-means satellite images with epsilon values of without and with bit planes

Old/fuzzy-otsu/rough otsu	Withoutbitplane	With bitplane
Original	130	122
Canny	99	102
Robert	130	102
Sobel	124	71
Zero-cross	88	123
Fuzzy c-means	126	120
Rough c-means	109	102

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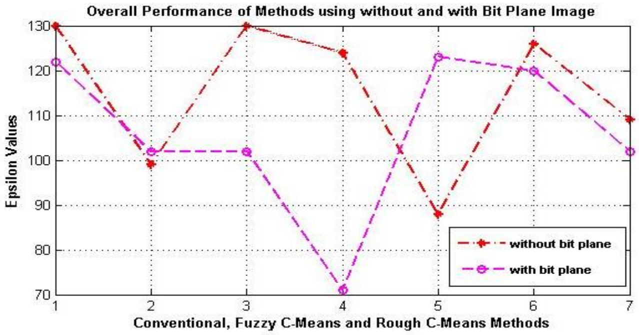

Fig: 10. Overall Performance of Original, fuzzy c-means and rough c-means satellite images with epsilon values of without and with bit planes

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The **Table –6** and the corresponding graph in **Figure– 10** deals with overall performance of Otsu thresholding with bit plane and without bit plane, performance for conventional methods using with bit plane and without using bit plane, performance of fuzzy methods using with bit plane and without bit plane and performance of rough c-means using with and without bit plane resulting PSNR of all performances for interpretation of control points.

DEPTH COMPUTATION

We computed results of time complexity in terms of seconds using conventional, fuzzy and rough c-means with bit plane of depth computation for further reconstruction of an image. The depth computation of various clustering techniques using bit plane and without using bit plane is shown in **Table– 7** and **Figure– 11**. First, we divided the satellite images into planes using bit plane and reducing the noise by applying on satellite images. The different mathematical statistical methods like mean, standard deviation, variance and their PSNR values were applied on the bit-plane to calculate the efficiency of the Bit Plane Method. The output of conventional and fuzzy c-means techniques gave clustering results of a satellite image. And still, rough c-means yields improved clustering of a satellite image compared to other methods. The depth image of a satellite image is shown in **Figure –11**.

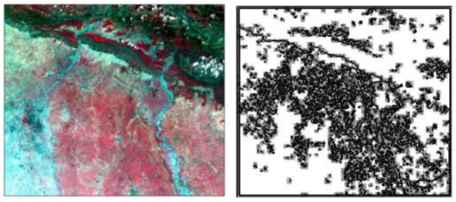

Fig. 11.a.b.Depth of a Original Satellite Image

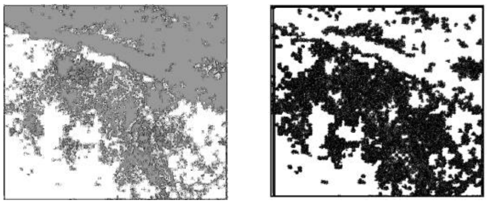

Fig. 12.a.b.Depth of a Rough C-Means Satellite Image

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Table: 7. Time complexity of Depth Computation of three methods using without and with bit planes

Old/fuzzy-otsu/rough otsu	Withoutbitplane-Time in Secs	With bitplane-Time in Secs
Input Satellite image	0.35	0.17
Canny	0.9	0.76
Robert	4.87	0.87
Sobel	10.63	5.99
Zero-cross	0.28	0.2
Fuzzy c-means	0.26	0.38
Rough c-means	0.24	0.20

Fig: 13. Time complexity of Depth Computation of three methods using without and with 4.bit planes

……..

Figure-10. discuss about the graph that deals with an overall performance of a satellite image using with bit planes and without bit planes for conventional, fuzzy and rough c-means methods. **Figure 11(a), (b).** deals with depth of a satellite image, **figure 12.a.b**.deals with depth of a fuzzy c-means satellite image and figure 13.a.b. deals with depth of a rough c-means satellite image. **Figure 13** deals with the proposed methodology (BPRCM-Bit Plane Rough C-Means), has proved to yield better performance with minimum time in computing the depth. The time complexity of original satellite image is 48.57%, conventional satellite image takes 56.34%fuzzy c-means takes 53.23% and rough c-means is 25.51%. And as a result, the performance of rough c-means with bit plane takes minimum time complexity compared to fuzzy c-means and conventional methods.

Thereby, a better cluster of satellite images has been processed after preprocessing using bit plane filter method. The enhanced satellite image has been used with proper edge detection techniques using conventional edge methods, fuzzy c-means method and rough c-means method. The distortions or errors or noise has been removed for further process of image reconstruction. And time complexity for the computation of depth has been carried out. The computation is needed for interpretation of degree of seriousness of any distorted portion or identification of any region for cultivation purpose or any weather forecast essential for the society. In this paper, satellite images for Himalayas have been considered which deals with geographical analysis. The proposed method may help the societies who are willing to proceed to Himalayas for the completion of task which involves efficient clustering.

CONCLUSION AND FUTURE WORK

In this paper, we proposed two new approaches; the FCMBP and the RCMBP, which segment the satellite image into planes. We justified the bit plane image using PSNR values to conclude that the satellite images are distortion free. These satellite images have been put under edge detection process involving better clustering algorithms. In all the phases, histogram analysis has been carried out to provide easy interpretation of satellite images. In conclusion, we can say that using rough c-means with bit plane technique results in better clustered satellite images compared to other techniques (conventional and fuzzy c-means) with increased efficiency and reduction in the epsilon (Otsu) and PSNR values. The depth computation for all possibilities using with and without bit plane techniques have been carried out. But compared to all three methods using without bit plane and with bit plane, the depth computation time is minimum for rough c-means method with bit plane than conventional methods and fuzzy c-means method. Thus clustering using rough c-means, using bit plane filter method at preprocessing technique yields better clustered image with minimum epsilon value and depth computation with minimum time complexity. In future, the authors aim is to apply other clustering techniques for further processing of satellite images.

CONFLICT OF INTEREST

Authors declare no conflict of interest.

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