Improved SAR Images Segmentation Approach based on KFCM Technique

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Abstract **The segmentation of SAR pictures is measured great challenge due to noise shown. The median filter use for noise elimination. Clustering & thresholding method are conventional segmentation techniques but they do not give meticulous results. As in paper we suggest segmentation algorithm for noisy Synthetic Aperture Radar (SAR) pictures. So as a proposed, an improved kernel fuzzy c-means clustering techniques is used, along with K-mean clustering method and OTSU thresholding, morphological closing for efficient segmentation and correct outputs. Experimental results are evaluated on numerous considerations like PSNR, MSE, SSIM shows that projected algorithm gives effective and satisfactorily result.**

Keywords—**image segmentation; SAR images; Fuzzy C Means; kernel fuzzy c-means (KFCM); median filter; Otsu method.**

I. INTRODUCTION

Image Segmentation (IS) is undertaking of isolating a digital image (DI) slightly in one part according to districts of intrigue. IS is significant part in image processing (IP) and it is broadly used in various areas like medical imaging, agriculture, forensic and research, Traffic control system, so on. With appearance of well-developed SAR technologies [1] SAR IP method attracted further & additional concentration in current era. Particularly, SAR picture division is vital problem in SAR picture understanding. SAR is a functioning microwave instrument, which delivers high-goals pictures of planet surface in all climates, long separation conditions, which has obtained extensive applications in environmental monitoring, military system, earth-resonance mapping, and so on. The aim of SAR IS to partitions a picture into no overlapped, regular, and homogeneous areas.[2] The issues current in SAR photograph segmentation are noticeably overlapped pixels and big quantity of unpredictable speckle noise on this sort of photograph. Continuation of noise deteriorates the first-rate of SAR pictures significantly and can cover crucial information leading to the lack of thrilling objectives. Numerous segmentation methods like thresholding methods, clustering methods, morphologic method, and statistic model-based methods. As in paper it is used to recover segmented quality of noisy SAR pictures via utilizing KFCM clustering & thresholding methods to gain satisfactorily image segmentation.[3]

Remaining paper prepared as follow: part 2 offers the literature survey. In section 3 using techniques and section 4 propose work & section 5 experimental outcome are presented and section 6 gives the concluding remarks.[4]

II. LITERATURE SURVEY

Laxmi Gupta, et al. (2018) propose and investigate a blemish autonomous segmentation framework, which extends the application of an existing segmentation routine developed for a specific stain to arbitrary stains. The scheme to bring consecutive slides with different stains into spatial alignment to be able to transfer the location information obtained by segmenting images with a particular stain onto the successively registered images dyed with other stains. In the case studies with renal whole slide images, we perform experiments and evaluate the output of the presented techniques with straight-forward segmentation (i.e. segmenting the stain, the method had been developed for) and also evaluated the impact of the remaining alignment error.[5]

E.Niharika, et al. (2017) presented a segmentation algorithm for noisy SAR pictures. The technique is based on k-means (KM) clustering & thresholding techniques. SAR pictures have huge employment in topography, remote sensing, and subsurface imaging. Segmentation of SAR pictures is always demanding because of noise shows in it. Speckle noise is common noise visible in SAR images.[6]

Haigang Sui, et al. (2017) proposed a new stable shape feature-based image registration techniques that has been proposed by matching the stable region with a set of rotations, scale invariant features and multi-scale image segmentation are utilized to obtain the matching areas. This algorithm initially translated images into image object by multi-scale segmentation and convexity model limitation. Then these reliable and stable image regions are utilized as matching unit rather than points or lines. Experiments show the algorithms offers in this research paper are not susceptible to revolution and resolution distortion that can complete image registration automatically.[7]

Roopa.E, et al. (2018) Extraction of maximum solution satellite picture buildings is difficult task for researchers in secluded sensing area. In projected effort Region Growing Segmentation, morphological operations and perceptual grouping techniques are developed and to detect the buildings in high spatial resolution images. The necessary algorithm for execution of location rising segmentation is developed by use MATLAB software & its performance is tested by inputting several images. It is founded projected algorithm successfully detects the rectangular building footprints. The efficacy of the designed algorithm is tested by repeating the experiment multiple times successfully.[8]

Fang Liu, et al. (2016) As in paper, intention at addressing this issue and endorse a brand new SAR photo segmentation technique through a hierarchical visual semantic (HVS) & adaptive community multinomial latent version. In this

method, HVS of SAR picture is projected, that separates SAR picture into aggregated, structural & homogeneous location. Consider department, specific segmentation strategies are selected for these regions with exceptional traits. For the aggregated place, locality-confined linear coding-based hierarchical clustering utilize in segmentation.[9]

Dingsheng Hu, et al. (2016) proposed, advanced PolSAR unsupervised statistical segmentation technique and utilize the dual flexible, two parameter, distribution model for the PolSAR statistics. However complexity of the probability density function leads to high time consumption. This research paper investigate the key dependent parameter in the $\mathcal{U}$-distribution model and find a new variable domain where the PDFs are smooth. Then a 1-D look-up table is set in this domain with nodes number determined by corresponding Fourier spectrum and is adopted to avoid re-evaluating the numerical integral in PDF to determine class posteriori probabilities for each sample. The proposed methodology is included in the ordinary segmentation algorithm. Prototype test has been completed to confirm the efficiency of the proposed method.[10]

Marek Wdowiak, et al. (2016) proposed a modified traditional watershed calculation for cell division in minuscule pictures of desmoglein-3 stained specimen. Proposed strategy combines color de-convolution for ihc indication division and GVF for watershed division. Regular watershed is sensitive to noise, which frequently happens in microscopy pictures. Recommended solution significantly decreases over division issue (80–90% cells divided effectively) and empowers additionally picture investigation.[11]

Maithili Lawankar, et al. (2016) worked showed that Watershed Transform segmentation Algorithm because it produces complete division of pictures in distinct region even if contrast is poor. Therefore, this method can be accomplished 92.1% accuracy.[12]

Yiping Duan, et al (2016) presented a convolutional neural network (CNN) is better on studying characteristics from unprocessed data without manual intervention, especially the structural characteristics. CWNN provide outcome of segmentation with 2 types of method, i.e., a super pixel approach and a MRF approach to produce the final segmentation map. The superpixel approach is used to implement the smooth nature on the local arena. Contrary, the MRF approach is used to protect the edges and gives full information about SAR pictures. By applying the super pixel and MRF strategy, two segmentation maps will be generated. The initial segmentation map is achieved by assembling the segmentation map of CWNN and the super pixel method, and the second segmentation map is achieved by applying the MRF approach on the authentic SAR image. CWNN is efficient for the segmentation mission, because the efficacy of CWNN is proved by several experiments on texture images. The speculation on the actual SAR images represents that the approach achieves the area along labeling consistency and protect the edges and details at similar time.[13]

Bo Zhang, et al. (2013) As paper suggests latest detector for concerned object searching in maximum solution SAR picture. To attain maximum presentation, 4 parameter are needed to illustrate characteristic of concerned object. Specifically, parameters of segmentation scale and common expected item length are used for SAR photograph segmentation to get patches that may be small photo parts to capture best scale data that have grey variance and shape. In this step, adjoining map is followed to recode the facts and the connection of overall the patches; the third parameter is false alarm rate that is use to recover the depth threshold for finding out all of the capability goals in SAR picture.[14]

Rachid Sammouda, et al. (2015) worked showed two image segmentation methods. K-means algorithm & FCM algorithms are discussed and evaluated. The K-mean is much precise approach than FCM in extricate the proper shape of tumors.[15]

Sneha M. Mahajan, et al. (2015) presented the fuzzy c-means (FCM) algorithm which is widely used in the field of image segmentation because of its simplicity and less sensitivity to noise. The FCM membership function can handle the overlapped clusters efficiently with predefined number of clusters, but this algorithm are unable to cluster non-linearly separable data as well as choosing of initial cluster centre is difficult task which results in poor image segmentation.To overcome this demerit, we proposed Kernalized Fuzzy C-means (KFCM) clustering method, in which kernel space clustering is used for clustering of nonlinear image, which have kernel functions which transform data in image plane into higher dimension feature space and these kernel functions are used to determine non-ED between feature point without defining transfer function, and then perform FCM in feature space.Here, we use two different kernel functions for IS and evaluate their outputs.[16]

Eman Abdel-Maksoud, et al. (2015) worked on an effective picture segmentation approach using K-means clustering method integrated with Fuzzy C-means algorithm. It is followed by thresholding and level set segmentation steps to provide an accurate brain tumor detection. The proposed method can get benefits of the K-means clustering for picture.[17]

P. Pedda Sadhu Naik, et al.(2015) presented a novel image segmentation using iterative partitioning mean shift clustering algorithm, which overcomes the demerits of traditional clustering techniques and provides a good segmented pictures. Simulation performance shows that the proposed scheme has performed superior to the existing clustering approaches.[18]

III. USING TECHNIQUES

Segmentation is done via clustering. In this work following clustering techniques are used.

3.1 Segmentation Using K-Means Clustering:

The K-mean clustering group of law is mostly common iterative algorithms which are largely used for its simplicity of execution & convergence speed. The clustering procedure of K-means is pursuing. First, k preliminary centroids are decided on, where k is particular by the person and indicate the preferred variety of clusters. Each point in information is allocated to closest centroid and every series of factors allocated to centroid appear a cluster. The centroid of every

cluster is updated based at points allocated to cluster. The technique is recurring since no factor modifications clusters.

3.2 Segmentation Using KFCM

KFCM is kernel edition of FCM, confines that the prototypes inside kernel gap are truly mapped from the original information area or the function area. That is, object operation described as.[19]

$$Q = \sum_{i=1}^{c} \sum_{j=1}^{n} u_{ij}^{m} \left\| \varphi \left(x_j \right) - \varphi(O_i) \right\|^2 \quad (1)$$

The objectoperationis reformulated as,

$$Q = \sum_{i=1}^{c} \sum_{j=1}^{n} u_{ij}^{m} \left(1 - k\left(x_j, O_i\right)\right) \quad (2)$$

Here,

$\left(1 - k\left(x_j, O_i\right)\right)$ can be reflect on robust distance dimension resultant in kernel space.

Where, || is Euclidean space. U_{ij} is membership data of x_j belong to cluster i, that is symbolized by prototypes O_i. The constraint u_{ij} is $\sum_{i=1}^{c} u_{ij} = 1$ and m is the fuzzfication coefficient.

3.3 Kernel based Fuzzy C means Algorithm

The picture for segmentation is presents as input. Mostly, the variety of successive facilities & result of fuzzy c-manner and different gentle clustering depends on initial centers of clusters. In widespread the clustering algorithms pick the preliminary hub in that arbitrary way, which affects result of clustering.

1.Providing the kernels for the enter picture.
2. Evaluation of memberships of pixels.
3. Evaluation of successive facilities.
4.Repeat the level iteratively till no new cluster hub are determined.[20]

3.4 OTSU algorithm

The N.Otsu in 1979, proposed an Otsu algorithm whose motive is to search threshold value. In Otsu method, picture divided in 2 classes, the foreground (target) & background via searching suitable threshold value in variety of image grey level. The interpretation is based between – class variance of two classes. If the variance is larger, the greater variation amid foreground & background, provides better segmentation results. If the variance is small, the smaller dissimilarity among foreground & background and provides poor segmentation results. OTSU system is simple, and consumes less time than other thresholding algorithm. The Otsu system is represented as follow;[21]

Let an image indicated via L gray level (GL) [0, 1,… L − 1]. Amount of pixels at step i is given by n_i & sum of amount of pixels is given by $n_1 + n_2 + \cdots n_L$. The probability of i is indicated by:

$P_i = n_i/N, \quad P_i \geq 0, \quad \sum_0^{L-1} p_i = 1 \quad (3)$

Assume pixels of picture is divided in 2 classes C_1 (background) via gray levels [0, 1,… t] & C_2 (foreground) via GL [t+ 1,t+2 … L − 1] with threshold t. The probability distributions of GL for 2 classes denoted as w_1 and w_2 are given as:[22]

$w_1 = P_r(C_1) = \sum_{i=0}^{t} p_i \quad (4)$

$w_2 = P_r(C_2) = \sum_{i=t+1}^{L-1} p_i \quad (5)$

Mean of C_1 and C_2 are:

$u_1 = \frac{\sum_{i=0}^{t} i p_i}{w_1} \quad (6)$

$u_2 = \frac{\sum_{i=t+1}^{L-1} i p_i}{w_2} \quad (7)$

The total mean is indicated by u_T

$u_T = w_1 u_1 + w_2 u_2 \quad (8)$

The class variances are

$\sigma_1^2 = \frac{\sum_{i=0}^{t} (i-u_1)^2 p_i}{w_1} \quad (9)$

$\sigma_2^2 = \frac{\sum_{i=t+1}^{L-1} (i-u_2)^2 p_i}{w_2} \quad (10)$

The within-class variance is

$\sigma_w^2 = \sum_{k=1}^{N} w_k \sigma_k^2 \quad (11)$

The amid-class variance is

$\sigma_B^2 = w_1(u_1-u_T)^2 + w_2(u_2-u_T)^2 \quad (12)$

The variance of grey levels is

$\sigma_T^2 = \sigma_w^2 + \sigma_B^2 \quad (13)$

Optimum threshold value t has selected automatically by OTSU by diminishing intra-class variance that handle equivalence to higher inter-class variance from total variance is stable for various separation.

3.5 Morphological closing

In mathematical morphology, the closing of group (binary image) A by a structuring component B is erosion of dilation of that set, [23]

$$A \cdot B = (A \oplus B) \ominus B, \quad (14)$$

Where,

$\oplus$ denotes the dilation .

$\ominus$ denotes the erosion.

In IP, opening is, mutually via closing, is the fundamental workhorse of morphological noise reduction. Opening removes minute object, while closing eliminates small holes.

Closing is significant function from mathematical morphology. Like its dual operator opening, it can be resultant via basic function of erosion and dilation. Like those operators it is normally applied to binary pictures, although there are gray level versions. Closing is comparable in few ways to dilation in that it tends to expand boundaries of foreground (bright) location in picture (shrink surroundings color holes in location), but it is fewer destructive of original border outline. As in different morphological operations (MO), exact function is resolute by structuring components. The consequence of function is to protect surroundings areas which have alike shape to this structuring components or that can entirely have structuring components, as to remove all different areas of surrounding pixels.[24]

MO rely on relative arrangement of pixel values, not on arithmetical values &consequently are particularly suitable to processing of binary pictures. MO is applied to grey scale pictures, in such a way that their light transmit operation are unknown & hence their absolute pixel value are of no or lesser of interest.

3.6 Median filter (MF)

The MF is use for removing speckle noise via SAR snap shots. The MF is nonlinear filter, which replaces each pixels value via median of pixel value inside the local neighborhood. The pixels in each window are looked after into ascending order

and pixel value in center is selected as the new value for specific pixel.[25]

IV. PROPOSE WORK

Firstly take an image and then apply K-mean clustering algorithm on original picture. And then median filter (MF) is applied to the K-means segmented picture to eliminate noise. And then apply OTSU thresholding algorithm to MF result to have threshold value for an image. It executes morphological closing on OTSU segmented picture to strengthen the results. And lastly, apply KFCM algorithm for effective IS & to get accurate image results, to calculate result parameters like PSNR, MSE, SSIM.

PROPOSED ALGORITHM

- Input: SAR picture of variable size.
- Output: Segmented region.

To examine presentation of proposed method we've taken an SAR photo of size 256x256. Different steps of proposed method are illustrated as,

Step. 1. Start.
Step. 2. Taken a SAR images from dataset.

Fig.1 Original SAR image

Step. 3. Consider a 5X5 window.
Step. 4. Apply k- means clustering on original image. And resultant of k-means cluster image is presented beneath.

Fig.2 K-means segmented image

Step5. Apply MF on clustered image. And it effects of image filtering in fig.3 presented beneath.

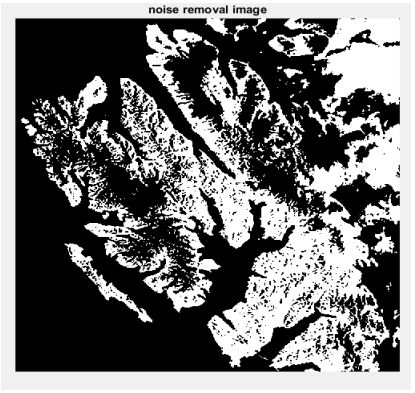

Fig.3 Noise removal image

Step 6. Apply Otsu based threshold on filtered image. And the output threshold image is shown below.

Fig.4 Threshold image

Step. 7. Use morphological closing on threshold image. And resultant picture to is presented beneath.

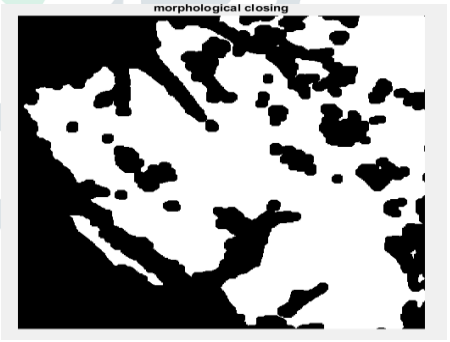

Fig.5 Morphological closing

Step. 8. Then use KFCM on Morphological closing image. To get final segmented image.

Fig.6 Segmented image

Step. 9. Calculate the average, median and weight of that SAR Images.
Step. 10. Returns the size of each dimension of array.
Step. 11. Then call the function pixwgt and KFCM.
Step. 12. Show the image.
Step. 13. Calculate parameter is PSNR, MSE and SSIM

PSNR (Peak signal to noise ratio): PSNR regularly shortened as PSNR is ratio among most feasible value (power) of signal & power of distorting noise that influence superiority of illustration. Usually, PSNR is expressed due to fact the term logarithmic decibel scale. The mathematical expression of PSNR is

$$PSNR = 20\log_{10}\left(\frac{MAX_f}{\sqrt{MSE}}\right) \quad (15)$$

Where,
MSE is Mean Square error.
MAX_f is highest signal value that exist in accurate picture.

MSE (Mean Square error): MSE indicates average square difference of the pixels during the photograph among the unique photo (speckled) g(x,y) and Despeckled photo f(x,y). A lower MSE method that there is a substantial filter overall performance. But small MSE values did now not constantly correspond to exact visible first-class.

$$MSE = \frac{1}{MN}\Sigma\Sigma[g(x,y) - f(x,y)]^2 \quad (16)$$

Where,
g denotes matrix data (MD) of an original image.
f denotes MD of degraded image.
M denotes amount of rows of pixels of images.
x represent index of row.
N denotes amount of columns of pixels of picture.
y denotes index of column.

SSIM: Structural Similarity (SSIM) index system for calculate comparison among 2 pictures. The SSIM index inspection as quality comparison of pictures being evaluated have different picture is consider as perfect quality.

Step. 14. Stop.

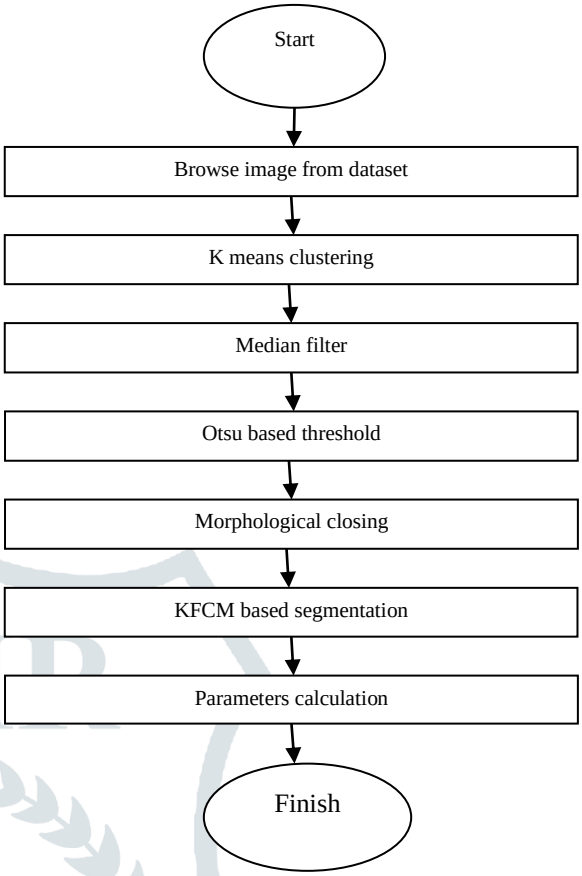

Fig.7. Flow chart of Propose Work

V. RESULT ANALYSIS

The study of PSNR value for K-means and proposed method are given below.
• PSNR value for K-means segmented picture is 75.9782dB.

• The PSNR value for proposed methodology is 87.6998dB.
Therefore, as PSNR value of proposed image is better than K-means segmented image, it can be terminated that projected approach provide superior results.

The MSE value for K-means and proposed method are given below.
• MSE value for K-means segmented picture is 0.1409.

• MSE value for proposed algorithm is 0.1087.
Therefore, as MSE value of proposed image is less than K-means segmented image, it can be concluded that projected technique provides superior results.

The SSIM value analysis for K-means and proposed method are given below.
• The SSIM value for K-means segmented picture is 0.1132.

• The SSIM value for projected approach is 0.7525.
Therefore, as SSIM value of proposed image is superior than K-means segmented image, we make a conclusion that proposed technique provide superior results.

TABLE 1 COMPARISION OF BASE RESULTS AND PROPOSE RESULTS

S.No.	Parameters	Base results	Proposed results
1.	PSNR (in dB)	75.9782	87.6998
2.	MSE	0.1409	0.1087
3.	SSIM	0.1132	0.7525

VI. CONCLUSION

In paper, it has developed robust algorithm for noisy SAR pictures by use of KFCM and traditional thresholding. By above consequences it is able to be concluded that projected algorithm is effective and offers higher performance.

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