SPATIAL CLUSTERING METHOD FOR SATELLITE IMAGE SEGMENTATION

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Abstract - *As one of the best image clustering methods, fuzzy local information C-means (FLICM) is often used for image segmentation technique. When compared to the fuzzy c-means algorithm FELICM method can directly applied to the satellite image to obtain the valuable information without any filter preprocessing, and the Experimental results over remote sensing images show that FELICM is not only solves the problem of isolated and random distribution of pixel inside the region but it also obtain high edge accuracies when compared to the fuzzy local information c-means method. The proposed algorithm to compensate the problem for getting most valuable information from the satellite image with the help of neuro fuzzy logic c-means (NFLC) to estimate the number of object or samples from the satellite image with respect to texture, color, shape, size and also to calculate region of roads, buildings and vegetation area which are present in the urban land area of the satellite image using clustering techniques. In this method neighborhood weighting is implemented using self organizing map (SOM) to calculate the number of cluster in the image. Using the spectral and spatial information from the weighted local neighbors is clustered iteratively until the final clustering result can obtained in an efficient manner.*

Key Words: FELICM, neuro fuzzy logic c-means (NFLC), self organizing map (SOM), Image clustering.

1. INTRODUCTION

To extract some useful information from image we are using Image processing method to perform some operations in order to get an enhanced image. Image processing involves changing the nature of an image in order to either, are improving its pictorial information for human interpretation and Render it more suitable for autonomous machine perception. We shall be concerned with digital image processing, which involves using a computer to change the nature of a digital image. It is necessary to realize that these two aspects represent two separate but equally important. Enhancing the edges of an image make it appears sharper. Note how the second image appears "cleaner'; it is a more pleasant image.

1.1 Image Sharpening and Removing Noise form an image

Sharpening edges is a vital component of printing: in order for an image to appear "at its best' on the printed some sharpening is usually performed. Removing "noise" from an image is noise being random errors in the image. An example is given in figure1.1 and figure 1.2.

(a) The original image (b) Result after sharpening

Fig-1.1: Image Sharpening

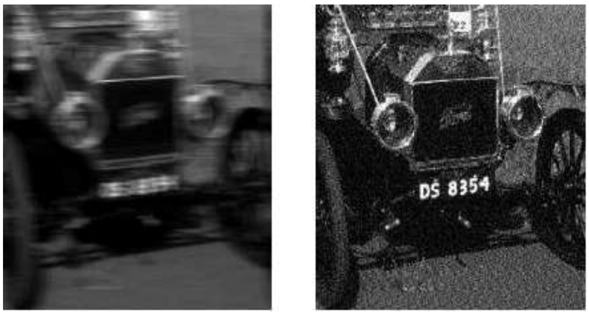
Noise is a very common problem in data transmission: all sorts of electronic components may affect data passing through them, and the results may be undesirable.

(a) The original image (b) after removing noise

Fig-1.2: Removing Noise from an Image

1.2 Image Deblurring

Removing motion blur from an image. An example is given in figure 1.3. Note that in the deblurred image. (a) Motion blur may occur when the shutter speed of the camera is too long for the speed of the object. (b) It is easier to read the number plates and to see the spikes on the fence behind the car, as well as other details not at all the clear in the original image.



(a) The original image (b) after removing the blur

Fig-1.3: Image Deblurring

2. IMAGE SEGMENTATION: CLUSTERING METHOD

The frame work for the image clustering procedure was implemented with the help of FELICM algorithm. First the grayscale image is obtained from the original image through the first component, such as principle component analysis. Canny edge detection algorithm can be used to detect the lot of edges from the grayscale image by adjusting two thresholds; if the threshold is achieved by multi-Otsu threshold algorithm.

2.1 Image Clustering

In this paper a clustering based method for image segmentation will be considered. Many clustering strategies have been used to such as hard clustering scheme and fuzzy clustering scheme, each of which its own special characteristics. The goal of the image segmentation is to partition of image into set of disjoint region with uniform and homogeneous attributes such as intensity, color tone or texture. The segmentation approaches can be divided into four; categories thresholding, clustering, edge detection, and region extraction.

2.2 Principal Component Analysis

Principal component analysis (PCA) is a mathematical procedure that uses orthogonal transformation to convert a set of observations of possibly correlated variables into a set of values of linearly uncorrelated variables called principal components. The number of principal components is less than or equal to the number of original variables. This transformation is defined in such a way that the first principal component has the largest possible variance (that is, accounts for as much of the variability in the data as possible), and each succeeding component in turn has the highest variance possible under the constraint that it be orthogonal to (i.e., uncorrelated with) the preceding components. Principal components are guaranteed to be independent if the data set is jointly normally distributed. PCA is sensitive to the relative scaling of the original variables.

2.3 Canny Edge Detector

The Canny edge detector is an edge detection operator that uses a multi-stage algorithm to detect a wide range of edges in images.

2.4 Stages of Canny Edge Detection

1. Noise Reduction

2. Finding the intensity gradient of the image

3. Non-maximum suppression

4. Tracing edges through the image and hysteresis thresholding

5. Differential geometric formulation of the canny edge detector

6. Variation formulation of the Haralick–Canny edge detector

2.5 System Architecture

A system architecture or systems architecture is the conceptual design that defines the structure and/or behavior of a system. An architecture description is a formal description of a system organized in a way that supports reasoning about the structural properties of the system. It defines the system components or building blocks and provides a plan from which products can be procured and systems developed, that will work together to implement the overall system. This may enable one to manage investment in a way that meets business needs; see figure2.1.

The composite of the design architectures for products and their life cycle processes.

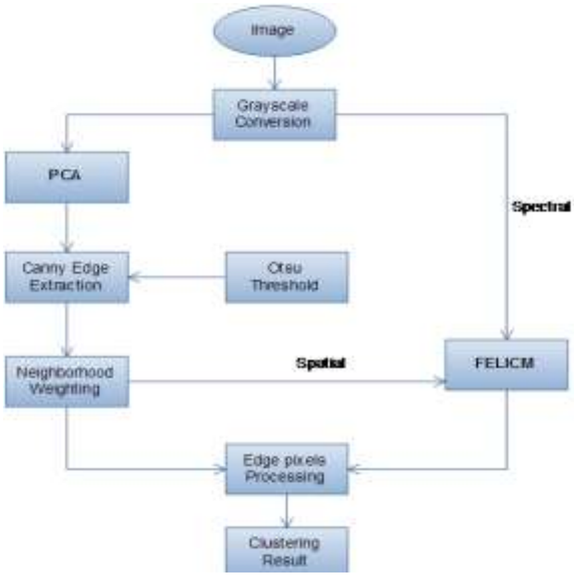


Fig-2.1: System Architecture

2.6 Module Architecture

2.6.1 Bias-corrected fuzzy c-means algorithm

Bias-corrected fuzzy c-means (BCFCM) algorithm with spatial information is especially effective in image segmentation. Since it is computationally time taking and lacks enough robustness to noise and outliers. Clustering is a process for classifying objects or patterns in such a way that samples of the same cluster are more similar to one another than samples belonging to different clusters. Fuzzy set theory has introduced the idea of partial membership, described by a membership function. Fuzzy clustering, as a soft segmentation method, has been widely studied and successfully applied in image clustering and segmentation; see figure 2.2.

2.6.2 Adaptive fuzzy c-means algorithm

Our approach is based on an adaptive distance which is calculated according to the spatial position of the pixel in the image. The obtained results have shown a significant improvement of our approach performance compared to the standard version of the FCM, especially regarding the robustness face to noise and the accuracy of the edges between regions; see figure 2.3.

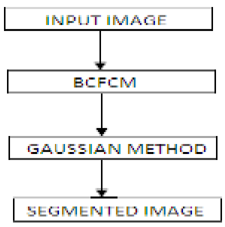


Fig-2.2: Bias Corrected Fuzzy C-Means Algorithm

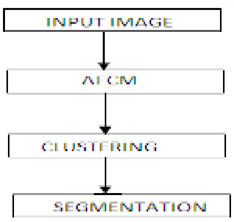


Fig-2.3: Adaptive Fuzzy C-Means Algorithm

2.7 Use Case Diagram

A use case diagram in the Unified Modeling Language (UML) is a type of behavioral diagram defined by and created from a Use-case analysis. Its purpose is to present a graphical overview of the functionality provided by a system in terms of actors, their goals (represented as use cases), and any dependencies between those use cases. The main purpose of a use case diagram(figure 2.4) is to show what system functions are performed for which actor. Roles of the actors in the system can be depicted.

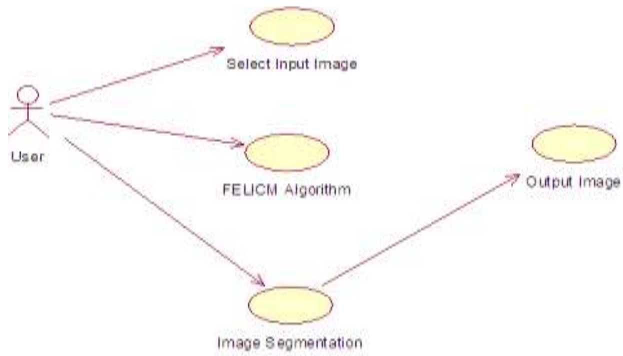


Fig-2.4: Use Case Diagram

2.8 Simulation Image

Fig-2.5: Satellite Image

Fig-2.6: Grayscale Image

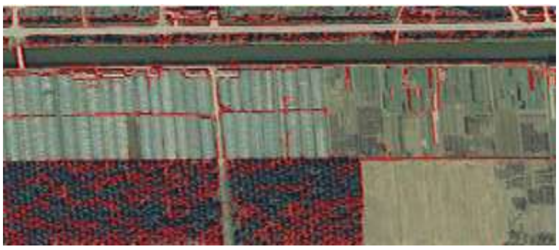


Fig-2.7: Canny Edge Detection

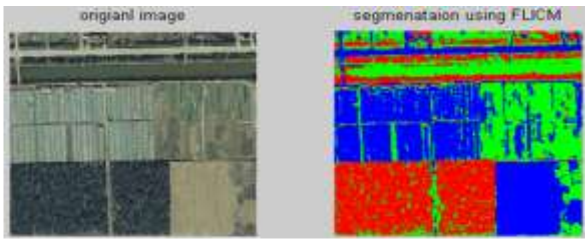


Fig-2.8: Simulation Result for FLICM

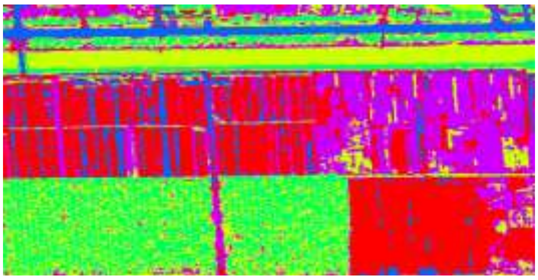


Fig-2.9: Simulation Results for FELICM

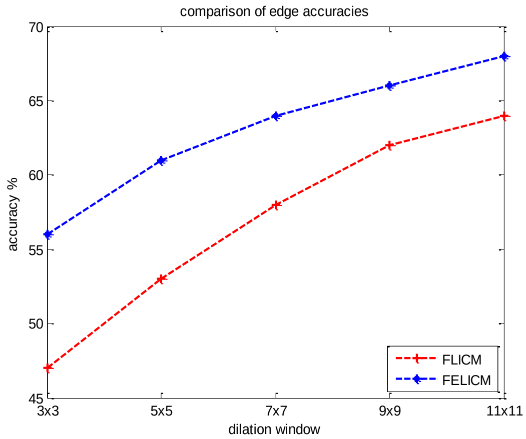


Fig-2.10: Edge Accuracies Result between FLICM vs. FELICM

Finally,(figure 2.10) fuzzy clustering method is the powerful unsupervised segmentation technique for the analysis of image, and data construction of models. The proposed approach of FELICM algorithm starts for find the cluster to segment the images in a fuzzy region. Corresponding results is shown and its segmentation is accurately discussed.

3. IMAGE SEGMENTATION USING ARTIFICIAL NEURAL NETWORKS (ANN) WITH FUZZY C-MEANS ALGORITHM

3.1 Artificial Neural Network (ANN)

Neural Network the way of biological nervous system such as human brain process information; see figure 3.1. An artificial neural network (ANN) is an information processing system which contains large number of highly interconnected neurons. This neurons work together in a distributed manner to learn from the input information to coordinate internal processing and to optimize its final output and as the numerous algorithms have been reported in the literature applying neural networks to the satellite image analysis. Artificial neural network neural networks providing various application for medical system such as image registration, segmentation, edge detection and diagnosis with specific coverage on mammograms analysis toward breast cancer screening and other application providing a global view on the variety of neural network application.

Neural network applications in computer aided diagnosis represent the main aim of computational images in satellite imaging. Their penetration and involvement are almost comprehensive for all extraction of information from the satellite image analysis. In that neural networks have the capability of effective relationship between the inputs and outputs via distributed computing, training, and processing leading to the reliable solutions desired by the specifications and medical diagnosis often relies on visual inspection , and the satellite imagining provides the most important tool for faciliting such inspection and visualization.

3.2 Neuro- Fuzzy C-Means Model

A neural network can be an appropriate function but it is impossible to interpret the results in terms of natural language. The consolidation of neural networks and fuzzy logic in neuro-fuzzy logic models(figure 3.2) provides learning as well as reliability. The main difference between fuzzy clustering and other clustering techniques is that it generates fuzzy partition of data instead of hard partitions. Clustering is the process for classifying objects or patterns in such a way that the samples of the same group are similar to one another than samples belonging to different groups. Many clustering strategies have been used such as the hard clustering scheme and the fuzzy clustering scheme each of its which has its own special characteristics. The conventional hard clustering method restricts each point of the data set exclusively just one cluster. As a sequence with this approach the segmentation results are often very crisp that is each pixel of the image belongs to exactly just one class. However in many real situations for the images issues such as limited spatial resolutions, poor contrast, overlapping intensities, and noise and intensity inhomogenities variation make this hard crisp segmentation a difficult task.

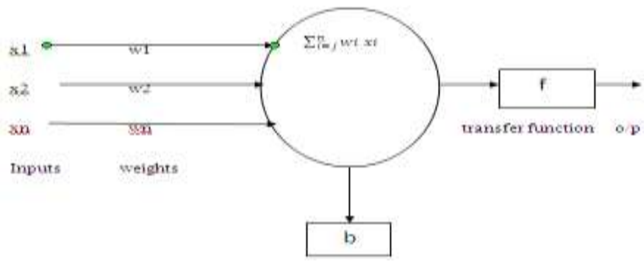


Fig-3.1: A Model of Neural Networks

Thanks to fuzzy set theory was proposed which introduce the idea of partial membership. Although the conventional FCM algorithm works well on most noise free images it has a serious limitation and its does not incorporate any information about the spatial context which cause it to be sensitive to noise and imaging aircrafts.

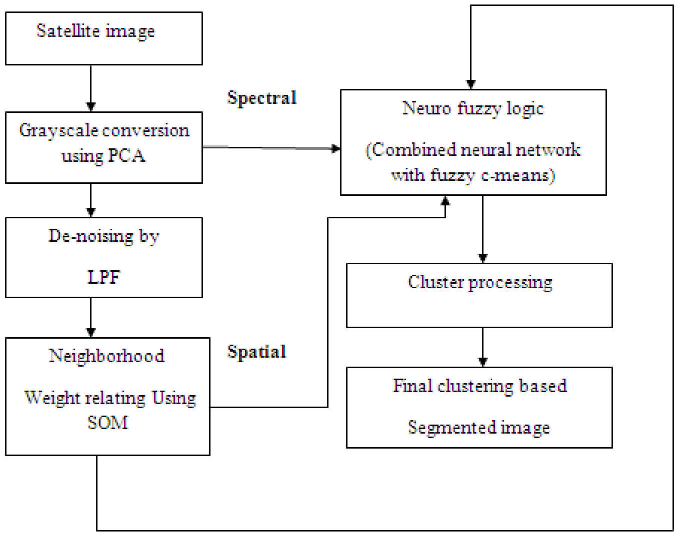


Fig-3.2: Architecture of Neuro-Fussy Logic System

It minimizes an objective function with respect to fuzzy membership 'U' and set of cluster centeriods V.

$$J(U,V) = \sum_{k=1}^{n} \sum_{i=1}^{c} (uik)m\ d2(xk,vj)$$

C is the number of cluster or data subsets

m- The weighting exponent 1for hard clustering and increasing for fuzzy clustering

d2 (Xk, Vi) – is the distance measure between object XK and cluster center Vi.

n is the total number of pixel in the image

Uik is the fuzzy membership values of pixel k in cluster i

Vi is the cluster center for subset 1 in feature space.

u is the fuzzy c- partition.

3.3 Image Segmentation Using Self-Organizing Map

Figure 3.3, Self organizing map is an unsupervised neural network method and it converts pattern of arbitrary dimensionality into responses of two dimensional arrays of neurons. One of the important characteristics of SOM is that the feature map preserves neighborhood relations of the input data patterns **(SOM).** It consists of two layers input layers and output layers. The number of input neurons is equal to dimensions of the input data. The output neuron are however, arranged in a two dimensional array.

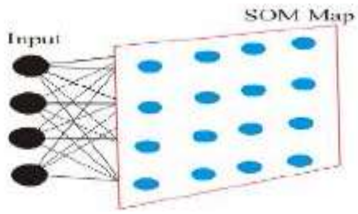


Fig-3.3: Self Organizing Map

Colors are the most important features considered in biological visual system, since it is used to separate object and patterns even in conditions of equi-luminance. SOM is used to map the patterns in three dimensional color space to a two dimensional color space. In SOM the input signals are n-tuples and there is a set of m-cluster units.

3.3.1. SOM and the Threshold Technique.

In order to eliminate small cluster (cluster with few pixels) and to reduce over segmentation problem the following (T-cluster) is implemented (figure 3.4).

These techniques consist of several steps as follows:

After obtaining the cluster center by SOM the process of clustering starts by calculating the distance between the values of the cluster centers representing the sum of three bands.

Two clusters are combined if the distance between their centers is less than a predefined threshold T (figure 3.5).

d(V(Pi),V(Pj))<-T

Where T is the predefined threshold and V (Pi) is the value of three bands of the cluster center pi. The value represents the sum of the resultant 3 weight obtained from running SOM each weight is multiplied by 255. V(pj) is the value of the three bands of another cluster center are combined together if the distance value is less than a predefined threshold T. The chromosomes which forms the population of the hybrid dynamic genetic algorithm (HDGA) consist of different solutions are available. In the previous method the successes of the segmentation processes depends on the correct selection of two criteria ,one is the minimum number of pixel in each group and another one is the degree of similarity of the grey level values of the cluster centers. SOM uses the satellite image features to organize the pixels in group. The highest peaks of the histogram are used as a cluster centers and are provided to T- cluster to deliver the final solution in image segmentation process. This methods starts by reading the satellite image than it is provided to SOM to organize pixels in group.

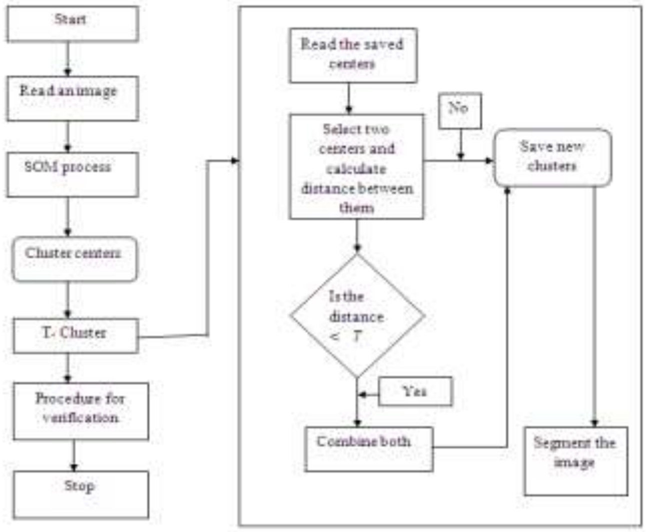


Fig-3.4: SOM and T cluster sequential process

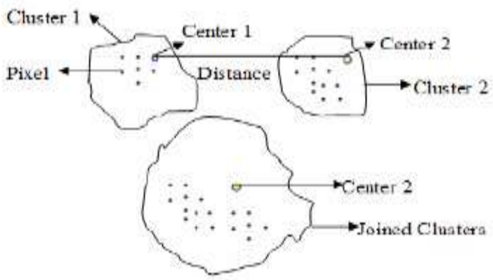


Fig-3.5: Merging process according to the distance between cluster centers

4. EXPERIMENTAL RESULT FOR NEURO FUZZY LOGIC SYSTEM

The experimental results of the segmentation of satellite image using the neuro fuzzy logic system demonstrate the proposed algorithm is effective and robust in nature. In order to make clustering is more robust, many spatial clustering methods which can deal with the original image without any filtering have been proposed. If the neighboring pixel is determined both the spectral features of the pixel and it is mean filtered neighbors and a parameter α controls the effect of neighbors.

In this artificial based neural network system, from the input original satellite image the gray image can b obtained from the original image by taking the first component such as principle component analysis (PCA). The gray image is convolved the noise is present in the image, and the noise is suppressed some important image details. Therefore the satellite image is de –noised by the filtering method using the low pass filter using the quarter tree decomposition method. After that processes from the synthesized image the neighborhood implementation process will be followed by the self organizing maps (SOM) with T-cluster technique can be used.

Once the sequential process can be completed using the spectral and spatial properties of the information from the gray image and neighborhood pixel window added to that neuro fuzzy logic. This system can start the clustering process with respect to spectral and spatial relationship among the pixel in the neural network structure. Finally the effective image will be obtained using the segmentation technique based clustering process.

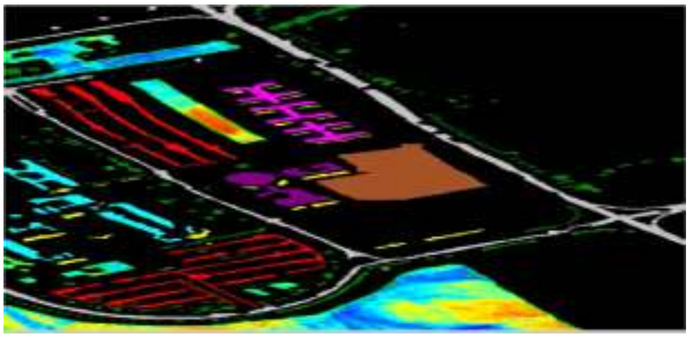
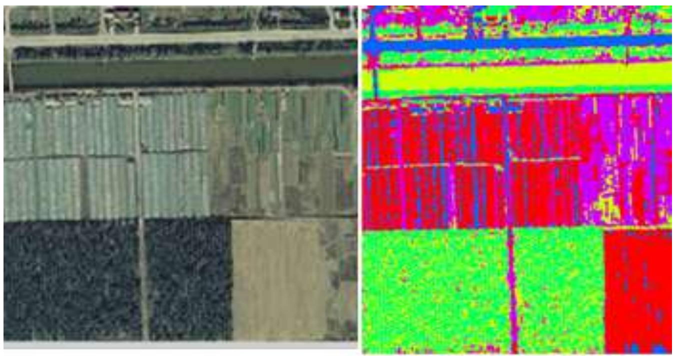


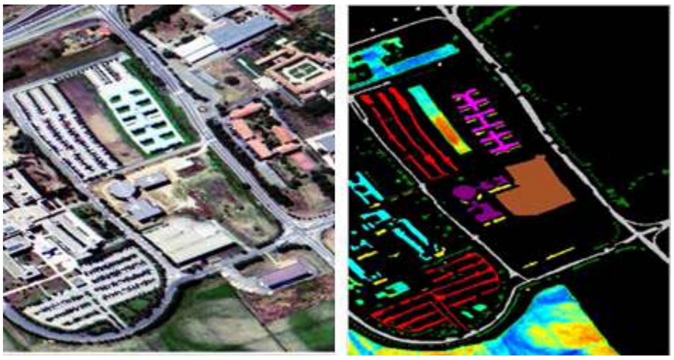
Fig-4.1: Image segmentation using neuro fuzzy logic

4.1 Comparative Result Performance between (FLICM, FELICM AND NFLCM)

The segmentation synthetic aperture radar satellite image demonstrates the proposed algorithm is effective in nature. To overcome the draw back or compensate the clustering edge accuracies of FLICM, fuzzy edge with local information c-means algorithm (FELICM) produce more accurate results . This algorithm is developed by modifying the objective function of the standard FLICM algorithm influences the neighboring pixel on the center pixel. This system can effectively solves the problem of isolated and random distribution of pixel inside the region but also obtain high edge accuracies. This simulation result will be shown that better image classification from the satellite land cover images and its performances will be evaluated in terms of sensitivity and clustering.



(a) Satellite image (b) Result of FELICM



(a) Satellite image (b) Result of Neuro Fuzzy Logic

Fig-4.2: Comparative Result Performance between FELICM vs. NFCL

5. CONCLUSION

The traditional image clustering methods usually regards image pixels as isolated samples, which usually result in isolated regions. FLICM uses local information to guarantee noise insensitiveness, but it often produces boundary zones due to the mix pixels near the edges of different regions. But the FELICM is proposed, and it improves FLICM by introducing the weights for pixels within local neighbor windows. The experiments show that FELICM method is insensitive to the isolated regions and obtains more accurate edges than FLICM. To compensate the drawback of fuzzy edge with local information c-means (FELICM), the neuro fuzzy logic (composed of neural network with fuzzy c-means) to improve the segmentation accuracy in each region by pixel wise method with respect to texture, color, shape, size of the object or samples which present in the satellite image and also to estimate the roads, buildings and vegetation region in the urban land area of the satellite image.

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