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ANN based GUI to Classify Satellite Images for Remote Sensing

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***Abstract*: Automatic classification of satellite images to detect the presence of urban/forested/deserted features of the areas on earth plays a most crucial part in the field of remote sensing. This paper presents an image classification technique to classify the urban/forested/deserted areas on input satellite images by utilizing mean-shift clustering with artificial neural network. The input satellite images are first enhanced through fuzzy histogram equalization and the Haralick's texture features are utilized to ascertain the arbitrariness in the image. Testing and training is done through the ANN and the resultant image is finally utilized to quantify its accuracy and error rate. The proposed algorithm is implemented on MATLAB GUI and obtains a classification accuracy of 90.9% and is immune to noise.**

Keywords: Artificial Neural Network, Image Classification, MATLAB, Mean Shift Clustering, Remote Sensing

INTRODUCTION

A digital image is the representation of a two dimensional image as a finite set of digital value called picture elements or pixels. On the basis of number of pixels, it may be classified as High Resolution, Medium Resolution or Low Resolution Image [1]. Today, Digital Image Processing is being used for research & development purpose in almost all the important areas. One of such area is Remote Sensing. Use of image classification is important in remote sensing to produce land cover maps and to suggest the information about the usage of land in terms of Forests/Urban Land/Desert/Ocean etc [2]. As this information is to be classified from the images that are to be acquired from satellites, hence, it is mandatory to develop an algorithm which accurately classifies such information from high-resolution satellite image. A sample high-resolution satellite image is shown in figure 1 below:

Figure 1: High Resolution Satellite Image [3]

It is also pertinent to note that Artificial Neural Network (ANN) is widely used for feature classification in digital images. The prime advantage of using ANN is its capability to handle high resolution images with less computational complexity and best error tolerance.

Literature Review

Shohel Ali Ahmed et al. [4] presented an ANN based texture classification or segmentation which is an advanced technique to provide rich information of an image. It works suitably on remotely sensed images and can extract objects from images that are without complex backgrounds i.e. don't have major colour or textural variations.

D. Chaudhuri et al. [5] presented an approach to extract roads from high resolution panchromatic remotely sensed imagery. Morphological segmentation & template matching is used to detect only the presence of roads in satellite images. This algorithm requires at least 13 stages including road enhancement, road segmentation, hole filling, small region filtering, length based region filtering, small branch removal method and road segment linking [5.

B. Ankayarkanni et al. [6] suggested a way to deal with the extraction of road and structures from a high resolution satellite image and compared the performance of k-means clustering algorithm to the KFCM strategy. It is finally suggested by the author that KFCM have better performance over K-means clustering method.

Capt. Dr.S Santosh Baboo et al. [7] presented an approach for effectively detecting the features on the surface of Earth i.e. the places that are recognized from the scalable imagery using FCM (Fuzzy C-means). This method generates the segmented results of selected regions in image but the use of FCM is rare & ineffective for practical usage due to complex spatial correlation properties of image pixels.

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S K Katiyar et al. [8] proposed a neural network based approach to extract and identify various objects like road network, water body & lake from satellite images. A model of back propagation neural network BPNN combined with Haralick's texture feature is used to classify these objects.

Rongjun Qin [9], proposed a mean shift vector based shape feature (MSVFS), a noval spatial feature which enhances the classification accuracy of very high resolution remote sensing imagery Support vector machine (SVM) in used to group spectral and spatial elements.

It is observed from the literature review that existing ANN based segmentation system is incapable of extracting objects from complex backgrounds when the colour and textural variations are observed [10]. It is further observed that although FCM is widely used technique for satellite image segmentation but its effective practical use is rare due to spatial correlation properties of image pixels [11]. In addition to this, spatial segmentation techniques (such as watershed algorithm) based segmentation undesirably produces a large number of small quasi-homogenous regions and finally, edge information is not preserved in case of clustering based segmentation approach. This paper presents an approach to develop an algorithm by combining the advantages of MST based clustering with ANN to overcome these drawbacks.

Research Methodology

Figure 2 below shows the flowchart of the proposed algorithm. The algorithm is tested over 44 high resolution satellite images that are principally acquired from online database and Google Earth. The images used for testing are the blend of rural, urban and deserted territories.

Fuzzy Histogram Equalization

The input images are further enhanced for their contrast using Fuzzy Histogram Equalization (FHE) [12]. The FHE comprises of two phases. To start with, fuzzy histogram is figured taking into account fuzzy set hypothesis to handle the estimation of grey level qualities better contrasted with established crisp histograms. Secondly, the fuzzy histogram is isolated into two sub-histograms in light of the median estimation of the first image and after that evens out them freely to protect image brightness. The subjective and quantitative investigations of proposed FHE calculation are assessed utilizing two parameters, average information content (AIC) and natural image quality evaluator (NIQE) file for different pictures. Experimental result demonstrates that the proposed technique can successfully and fundamentally dispense with washed-out appearance and antagonistic curios instigated by a few existing strategies. Mathematically, it is represented as given in equation 1.

$$F = \cup_{m=1}^{M} \cup_{n=1}^{n} \frac{\mu_{mn}}{g_{mn}} \; with \; \mu_{mn} \subseteq [0,1] \qquad \text{Eq. (1)}$$

Where, g_{mn} is the intensity value of (m,n)th pixel and μ_{mn} is its membership function.

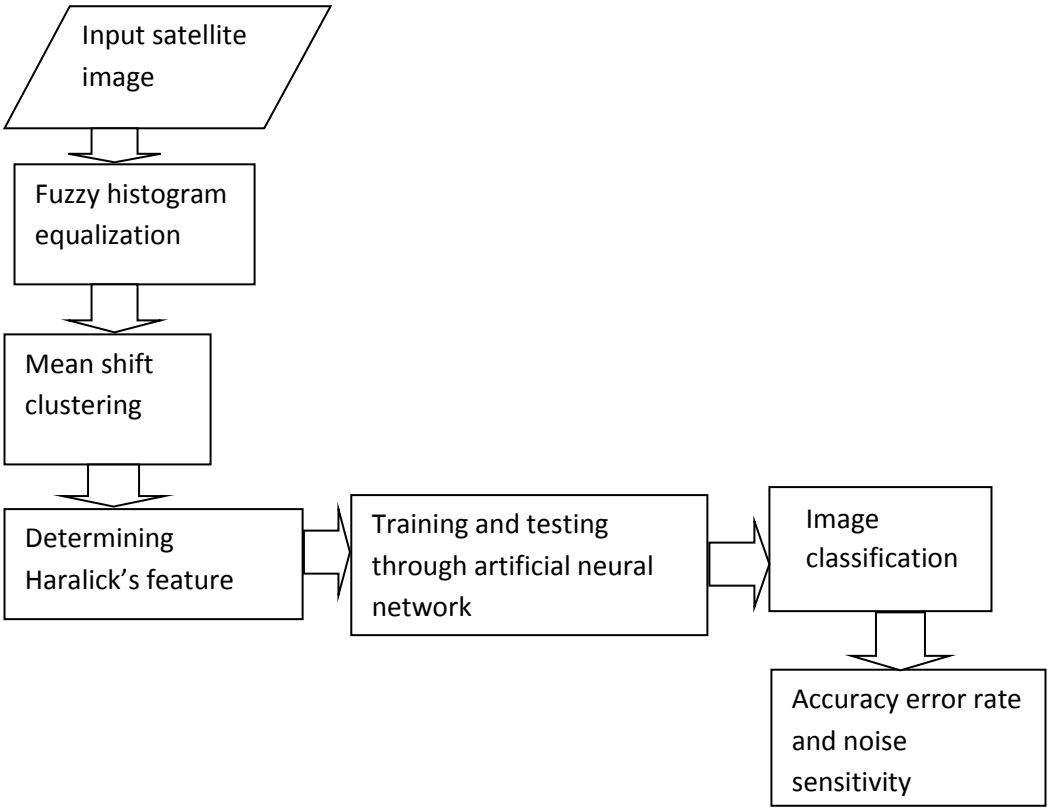

Figure 2: Flowchart of proposed algorithm

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Mean Shift Clustering

Mean Shift clustering acts as a mode finding algorithm [13]. Every one of the focuses in the same bowl of interest is connected with the same group. The quantity of cluster is obtained by the quantity of modes. It is capable to hold the notable elements of the general images because of its edge saving sifting property.

Here, the parameter q is the likelihood that the distinction between two neighbouring pixel is equivalent to (m,n) and is the logarithmic capacity.

Artificial Neural Network

The Artificial Neural Networks are generally unrefined electronic models in view of the neural structure of the mind [15]. In this paper, a back propagation neural network (BPNN) is employed with nine information layers and ten hidden layers to classify the picture by grouping them as pixels belonging to rural or urban or some deserted image.

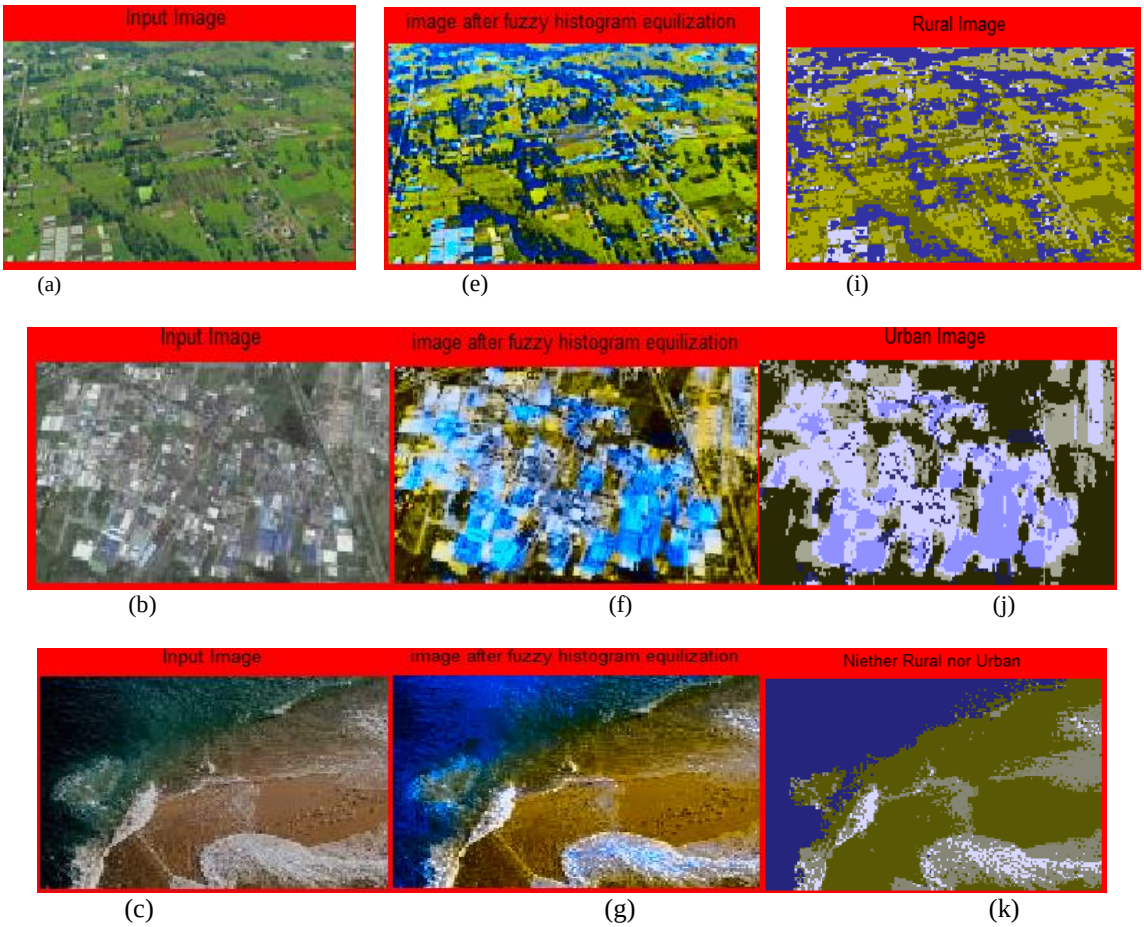
Haralick's Features

It is a statistical measure that defines the correlation between pixels that are presented in neighbourhood in a given space [14]. Out of the fourteen features that determine the textural or surface properties of an image, entropy is the one. The more the entropy, the more likely it is to be a complex image. It measures the randomness in the image and is defined as,

$$Entropy = -\sum_{m,n} q(m,n)\log(q(m,n)) \quad \text{Eq. (2)}$$

RESULTS & DISCUSSION

The proposed algorithm has been designed & tested over MATLAB. A GUI is designed for effective representation of results. The testing has been done over 22 satellite images under two scenarios: *Noiseless and Noisy*. Overall the results have been presented in this paper for 44 images. Figure 3 below shows four different types of sample images taken for testing, and their corresponding results obtained after *image enhancement* and *classification using ANN* are also presented.



(a) (e) (i)

(b) (f) (j)

(c) (g) (k)

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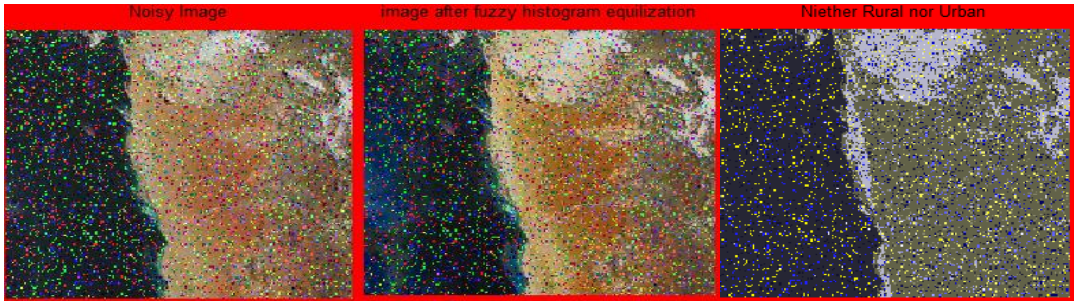

(d) (h) (l)

Figure 3: (a)-(d) shows the input satellite images, (e)-(h) shows the results of image enhancement using FHE and (i)-(j) shows the results of image classification on MATLAB GUI

Table 1 below presents the expected & obtained results of image classification using proposed algorithm in noise-less images and Table 2 summarises the similar results for same input images when corrupted by noise.

Table 1: Image Classification Results obtained on Noise-less Satellite Images

S. No	Input Image	Expected Result	Result Obtained through Proposed algorithm
1	Image 1	Urban	Urban
2	Image 2	Urban	Urban
3	Image 3	Urban	Urban
4	Image 4	Urban	Urban
5	Image 5	Urban	Urban
6	Image 6	Urban	Urban
7	Image 7	Urban	Urban
8	Image 8	Urban	Urban
9	Image 9	Rural	Rural
10	Image 10	Rural	Rural
11	Image 11	Rural	Rural
12	Image 12	Rural	Rural
13	Image 13	Rural	Rural
14	Image 14	Rural	Rural
15	Image 15	Rural	Rural
16	Image 16	Rural	Rural
17	Image 17	Neither urban nor rural	Neither urban nor rural
18	Image 18	Neither urban nor rural	Neither urban nor rural
19	Image 19	Neither urban nor rural	Neither urban nor rural
20	Image 20	Neither urban nor rural	Neither urban nor rural
21	Image 21	Neither urban nor rural	Urban
22	Image 22	Neither urban nor rural	Urban

Table 2: Image Classification Results obtained on Noisy Satellite Images

S. No	Input Image	Expected Result	Result Obtained through Proposed algorithm
1	Image 23	Urban	Urban
2	Image 24	Urban	Urban
3	Image 25	Urban	Urban
4	Image 26	Urban	Urban
5	Image 27	Urban	Urban
6	Image 28	Urban	Urban
7	Image 29	Urban	Urban
8	Image 30	Urban	Urban
9	Image 31	Rural	Rural
10	Image 32	Rural	Rural
11	Image 33	Rural	Rural
12	Image 34	Rural	Rural
13	Image 35	Rural	Rural
14	Image 36	Rural	Rural
15	Image 37	Rural	Rural
16	Image 38	Rural	Rural
17	Image 39	Neither urban nor rural	Neither urban nor rural
18	Image 40	Neither urban nor rural	Neither urban nor rural
19	Image 41	Neither urban nor rural	Neither urban nor rural
20	Image 42	Neither urban nor rural	Neither urban nor rural
21	Image 43	Neither urban nor rural	Urban
22	Image 44	Neither urban nor rural	Urban

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Table 3: Scenario Wise Quantitative Analysis of Results

S. No	Scenario	No. of images	Accuracy Rate	Error Rate
1	Noise-less	22	90.9%	9.09%
2	Noisy	22	90.9%	9.09%

Comparison of results

Table 4 below represents the accuracy result of the proposed algorithm with the existing algorithms and it is been found that the accuracy of the proposed algorithm is more as compare to the existing algorithm [16].

Table 4: Accuracy (in %) comparison representation

S. No	Proposed algorithm	Mean shift+ minimum spanning tree	Mean shift+ water shed	Mean sift +normalised cut based algorithm
1	90.9%	85.34%	73.68%	77.24%
2	90.9%	84.62%	81.11%	82.33%

CONCLUSION

The work gives an edge work of utilizing ANN for picture grouping and division. The framework as executed in mat lab programming is computationally simple and fast. Results of the algorithm are found to be more accurate than the methods like minimum spanning tree or watershed. The framework distinguishes the components accurately as it uses the Haralick's textures, state of the items withstanding pixel values, colour and texture feature for the classification of result. Which is classifying the information as a urban, rural or neither rural nor urban images. The future upgrades of the framework incorporate improvement of the framework by the utilization of setting data and general standards for image investigation.

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