Satellite Image Classification By Neural Networks And Fuzzy Inference Systems

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Abstract:-This paper studies the performance and efficiency of the classification approaches on the satellite images. In this work, two methods will be used for image classification: the neural network and fuzzy inference methods. Also, this study displays the comparison between the previous approaches for explaining the amount of the efficiency and accuracy of these approaches in the image classification. The performance of two satellite image classification approaches has been examined.The experimental results prove that the neural network approach (NN) has the high efficiency and efficacy in the satellite image classification than the other classification approaches.

Keywords: -Satellite image, neural network approach, fuzzy inference technique.

I. Introduction

Classification methods explained by identifying the unknown sections according to a particular area which is depending on the extracted information by comparing unknown region information with the known region.Also, it is defined as the pattern classifications utilized to connect the position of the pixels extracted from the image in the object characteristic terms at similar points on the earth cover [1].The image classification has been determined a very primary role in the remote sensing imagery. The universal classification algorithms implemented by labeling the samples of the training period to evaluate the classification performance depending on the training samples. The previous procedure needs an increasing the sampling numbers that result the time-consuming.

The performance is calculating for each learning methods by comparing the image classification taken from West Iraq with the conventional schemes. The principal benefit of the fuzzy logic method is not needed the large memory storage; the approach inference speed has been very high and can accurately measure for each fuzzy rule [2]. This paper prepared from six sections, the first section is the introduction. The second one is the satellite image classification. The third one is the neural network method. The Fuzzy inference method is displayed in the fourth section. In the fifth section, the result and discussions are explained. The last section is the conclusion.

II. Satellite Image Classification

Actually, satellite images became available to everyone for utilizing because it has distinguished properties such as the costs decreasing and the image resolutions increasing. The satellite images technology entered into various life fields because it is lead to the hyperspectral enhancement and multi-spectral sensors around the world.Also, satellite image technology utilized for mapping the special materials by discovering special chemical materials by the satellite sensors. The satellite senses make the mentioned ideas possible to gather data on severe or complicated positions [3].

The satellite imaging technology helped the researcher for capturing images in unlike fields to study the properties of these areas and making decision associated with the similar area. Computers support for creating colorful images by applying false coloring approach.

The various satellite image classification approaches have been compared using the satellite images located on western Iraq. The land use classification of the realization location has been made by different supervised image classification methods and the result has been compared with another procedure. The Supervised image classification has been one of the numerous generally utilized approaches of the digital remotely sensed data analysis. The set of supervised classifier is possible to assign known status of the image classes to pre-defined classes on their spectral properties. The thematic map notion supposes that each spot on the ground can be labeled as relevance for one and a unique category. The accuracy of the classified images has been depended on the various features having the training data elements [4].

This study compare between the neural network and the Fuzzy systems by using the satellite image classification getting from western of Iraq. The performances and the efficiency of both the previously mentioned approaches will be evaluated to explain the reliable approach than the other on the satellite image classification. The performance of each previously mentioned approaches will be calculated by using the satellite image getting from western Iraq. The results obtained from the previous approaches are compared with the traditional approaches to analyze the satellite images as pixel-by-pixel. In this study also the comparison between previously utilized neural networks and the Fuzzy systems will be studied. In addition, the two neural networks models will be used. The first one uses the mean histogram, minimum histogram, and maximum histogram values. The second one utilizes the peak and standard deviation values. The results that are got from the previously mentioned approaches will be compared to explain the accuracy, the efficiency, and performance of them [5].

III. Neural Network Method

The Neural Network approach utilized for very wide differently tasks such as problems of simple speech recognition and computer vision. The (NN) idea is used on the application of the interconnected element processing (node) systems which are distinguished by various properties similar to the biological neurons functions. These nodes connected with the weights that will create randomly as numerical values. The result of this connection makes the system to be able to approximate the desired function [6].

The (NN) hierarchical structure is prepared by the different hidden layers. The dataset will be entered on the input layer, and then the result will be taken from the output layer to produce the network output. All layers between the input and output layers are called the hidden layers [7].

The neural network model is similar to the neurons of the human brain. Each neuron has input, performed some operations and the output neuron that is given the network results. It has been taught the computer for recognizing images and classifies them into one of these categories. The supervised learning can be labeling the images, the computer will begin for recognizing patterns present in a set of images that are taken from other ones and will start building its own knowledge [8].

Neural Network (NN) is composed of a large number of samples, interconnected (neurons) working in the parallel within a network. The (NN)has been able to develop an internal representation of a signal pattern that is offered as the network input. This automatic learning performed with the dynamic modification of the network connectionsthat have been associated with each neuron. This approach, called back propagation, applies the wanted outcome pattern and the input in it called training set to the neural network. The network periods with the training weight sets are implemented the network perfectly generating the input to obtain the desired output. When new data is used, the internal weights are preventing the specific processing neurons will be increased [9].

IV. Fuzzy Inference Method

The fuzzy and the unsupervised clustering approachesutilized for classification of the satellite images. The supervised computational neural network is presented as normal network. The supervised and unsupervised classification algorithms implemented in general the similar results of image classification. The unsupervised fuzzy algorithms are spotted to explainthe better classification of the images when compared with the data of raw images resulted from samples of the volunteer studies. In the further complex segmentation problem with cancer and edema, the similar MR relaxation conducted as in the feed forward cascade correlation results. Different facets of the supervised and the unsupervised learning approaches must be obtained like the utility of the diagnostic process and the time complexity idea [10].

The input signalpattern neuronshave been utilizedtoevaluate the output classes.The most superficial advantages of the back propagation neuralnetwork are the learning method that is not prior. The learning procedure has been used the new input data to be completely specified.

The parallel processing of the neural network has been implemented in the real-time. (NNs) are not real-time techniques.Some studies employ an (NN) software simulation that is developed by the Cartographic Applications Group, Image Processing Laboratory has been provided recent procedures worked in Parallel Distributed Processing.This neural network is embedded within the image processing and information systems domain.

The input and output of the network layers are special in image processing algorithms. The inner functions of the networks are realizing because the network outputs may be viewed as images. The neural networksimulation software divided into some programs available for all people to use. These programs have been used to define and build the networks, training, and testing and analyzing the behavior of the neural network.Also, this software is utilized to check the performance of the internal parameters and the neural network [11].

V. Result And Discussion

In this work, the neural networks are used for image classification systems that are developed for classifying the remotely sensed images with the high spatial resolution. The classification accuracy has been explained by comparing the results obtained by the maximum likelihood and fuzzy inference approaches.In this study, there are some locations have been chosen as case study areas like the Anbar and it's closed environment that is lying on the west of Iraq as shown in the figure (1).

Figure 1 shows the case study area of this work.

The (FS) and (ML) techniques have been utilizing for classifying the digital images.The six spectral bands used as inputs of the neural network that is utilizing for training the network to predict all pixels within the images. whereas the (FS) and (ML) have the individual spectral bands on the network inputs, then the features of the network are extracting by calculating the histograms of the mean and standard deviation values for all pixels within the images.

The neural network has(input, hidden and output) layers. The hidden layers are tested by varying number of nodes such as (5, 7, 10, 14, 20, and 36). There are some parameters need calibration in this work such as (patch size of the input, learning rate, number of the iterations (epochs).The results of the neural network obtained by combining the (NN), (FS) and (ML) results together in the case study area. Figures (2 and 3) show the correct and incorrect results of different classifications.
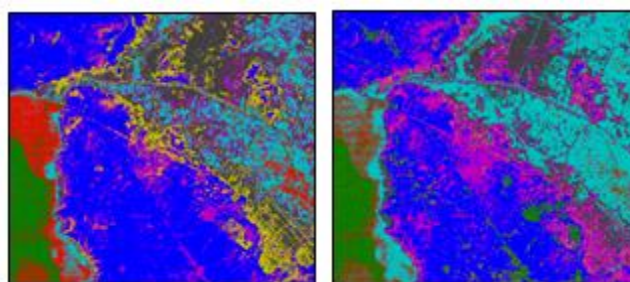

Figure 2 shows the correct and incorrect image classifications.
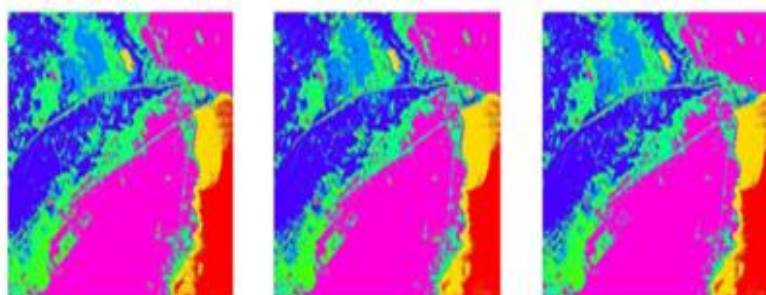

Figure 3 shows the correct and incorrect image classifications.

The testing dataset collected by the random sampling schemes and the references data that included (50) samples for each land-cover class.The confusion matrix shown in figure (4) generated by the previous testing dataset for each of the (90) land-cover maps.The classification accuracy is changed through the various number of the hidden layer nodes.In this study, different experiments are implemented for measuring the significant differences between the tests in terms of their classification accuracy. The classification accuracy can be changed by using the training algorithms as explained in the table (1). At each epoch, the different gradient values are evaluated as shown in the figure (5).

Table 1 shows the neural network with the hidden neurons.

|	Name	NN with number of hidden nodes						FS	ML
		5	7	10	14	20	36		
1	Deep Water	7.3742	7.2792	7.4406	7.7526	6.8211	7.0980	5.9574	5.9574
2	Shallow Water	7.5653	6.6666	5.8842	5.6198	6.5670	6.3595	3.4286	6.6509
3	Tree	7.4692	8.1688	8.4034	7.5729	6.9469	5.5058	23.3974	11.9579
4	Vegetable	14.009	14.583	14.1689	17.3180	14.035	15.8146	20.5708	15.2283
5	Urban	10.183	8.6727	8.4866	5.9093	7.7511	7.6756	2.8114	10.5350
6	Crop	16.260	17.007	18.3899	19.0918	20.9003	19.7803	12.3558	16.0618
7	Bare	37.138	37.622	37.2265	36.7355	36.9785	37.7663	28.8448	33.6086
	Over All Confusion matrix	89.6	90.2	90.7	89.2	90.0	90.5	83.5	88.3
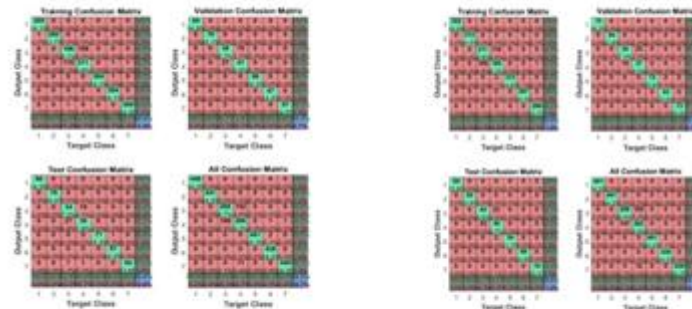
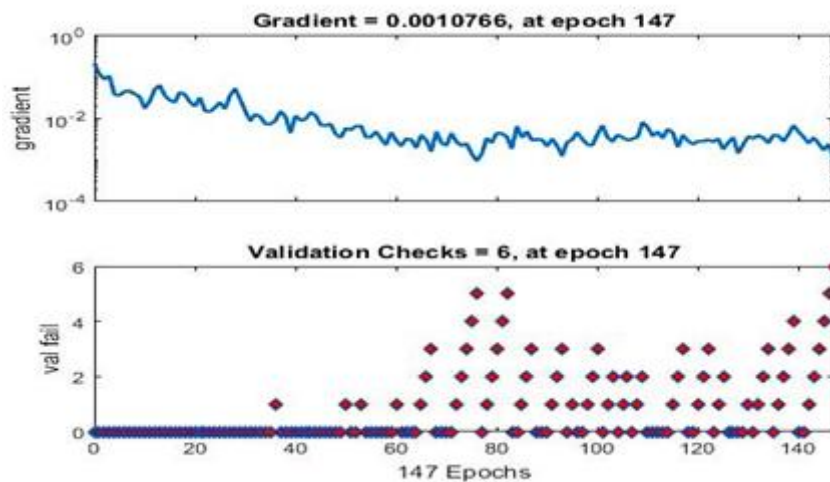**Figure 4** Sample of the confusion matrices.

Figure 5shows the Gradient values at different epochs.

The figure (6) shows the (true and false) positive rate values for both the training and testing classes on the wide region of epochs.Also, the figure (7) shows the best validation performance of both the training and testing algorithms atthe epoch equal to 57 and 141.
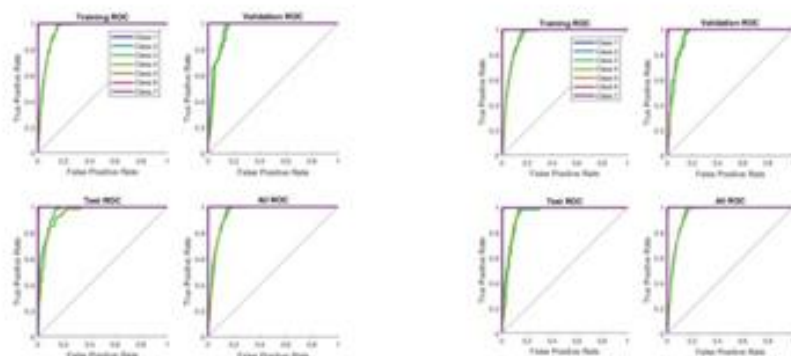
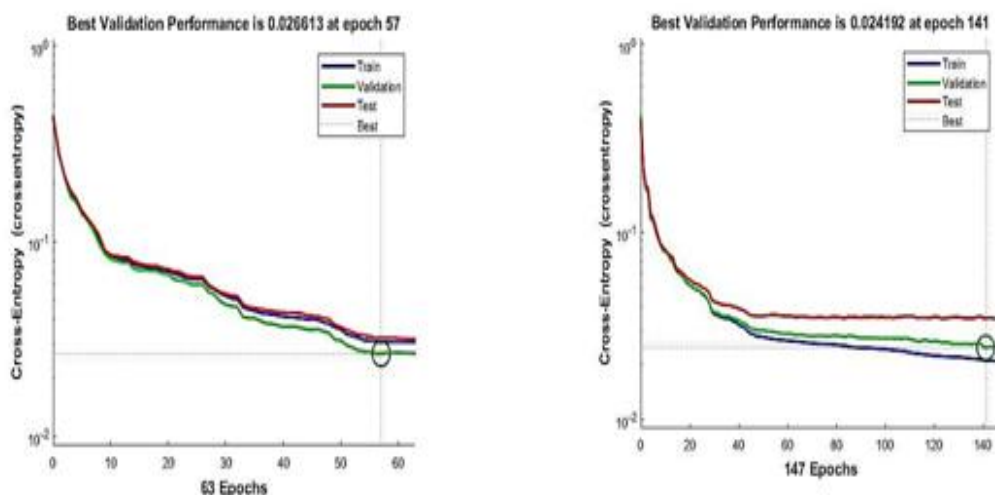**Figure 6** shows the positive rates of the training and testing methods.

Figure 7 shows the validation performance for different epochs.

VI. Conclusion

In this work, the neural networks and fuzzy inference approaches are utilized for classifying the satellite images. The neural network method is considered as a training algorithm for training the remotely sensed imagery. The performance of this approach will be compared with the (FS) and (ML) classification algorithms. The identical training samples have been utilized as the multiple times' neural network training algorithm, which is used for classifying the satellite images to multiple categories. In addition, the hybrid neuro-fuzzy method also studied for classifying the satellite images. In this study, the comparison between the neural network and fuzzy inference algorithms are explained and displayed. From the experimental results, the performance of the previous approach was very high for classifying the images. Also, the approaches have the high efficiency and accuracy properties through their implementation in the work.

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