Analysis of Remote Sensed Data Using Neuro- Fuzzy Algorithm: A Case Study of Hyderabad Region

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Abstract: In this paper we are presenting the Estimation of space in Hyderabad using Neuro Fuzzy approach in Digital image processing. Digital image processing is the science of manipulation of an image by means of a processor. The advantage of combining neural networks with fuzzy logic is that, it is better in noisy environment as picture not to do and it has fault tolerance capability better than individual approach, so we are working for a better result using this approach in image processing.

Every intelligent technique has particular computational properties (e.g. ability to learn, explanation of decisions) that make them suited for particular problems and not for others. For example, while neural networks are good at recognizing patterns, they are not good at explaining how they reach their decisions. Fuzzy logic systems, which can reason with imprecise information, are good at explaining their decisions but they cannot automatically acquire the rules they use to make those decisions. Hybrid systems are also important when considering the varied nature of application domains. Many complex domains have many different component problems, each of which may require different types of processing. Fuzzy logic provides an inference mechanism under cognitive uncertainty,computational neural networks offer exciting advantages, such as learning, adaptation, fault-tolerance, parallelism and generalization.

Keywords: Fuzzy logic, Remote sensing, Artificial Neural Network, Hybrid systems, Multi spectral image, Fault tolerance system, Neuro-fuzzy system

I.INTRODUCTION

In the present scenario of the world, the information technology plays a major role in the world economics; if we get the information about the resources of a region well in time then we can plan and manage the resources of that region in a better way, for the economically and environmentally sustainable development land cover.

Satellites play a major role to provide the timely and cost-effective information about the resources of any area. With the increased availability and improved quality of multi-spatial and multi-temporal remote sensing data as well as new analytical techniques, it is now possible to monitor land cover/ land-use changes and urban sprawl in a timely and cost-effective way.The techniques we have used here are well known for the classification of the multispectral images worldwide,they are:Fuzzy C-Mean clustering and ANN. Then we have used the technique of NEURO-FUZZY. As it is the combination of ANN and FCM, it gives better results than that of ANN and FCM taken individually. It is found that these techniques are fast and efficient algorithms for image analysis.

Satellite Data Image that we have received from the National Remote Sensing Agency (Space Department, Government of India); Integrating Spectral, Temporal and Spatial Features of the Objects in the area of satellite image processing. Here the multi-spectral remote sensing data is used to find the spectral signature of different objects of Hyderabad region which we have already mentioned for the land cover classification, how the use of land changes according to time.During the study following objectives were achieved:

- General analysis of the different bands data of the multi spectral images.

- Determination of fuzzy mean and fuzzy covariance of FCM for classified objects from the ground survey data.
- Creation of the False Color Composite image for the classified objects such as (vegetation, structures,roads, free land and water) using intelligence methods and FCM.
- Calculation of transformed image using ANN.
- Calculation of comparative chart for different algorithms of ANN & NEURO FUZZY.

II. REMOTE SENSING

Remote sensing is a science used for finding details about a data captured from the target at a distance. It consists three parts, the targets - objects or phenomena in a region; the data acquisition explicit some tools; and the data analysis - again by some devices. This definition is so wide that the vision system of human eyes, sonar sounding of the sea floor, ultrasound and x-rays used in medical technology, laser probing of environmental element, and all are added. The target can be as big as the mars, the moon and other planets, or as small as biological cells that can only be seen through microscopic devices.

A diagrammatic explanation of the remote sensing process is as given below.

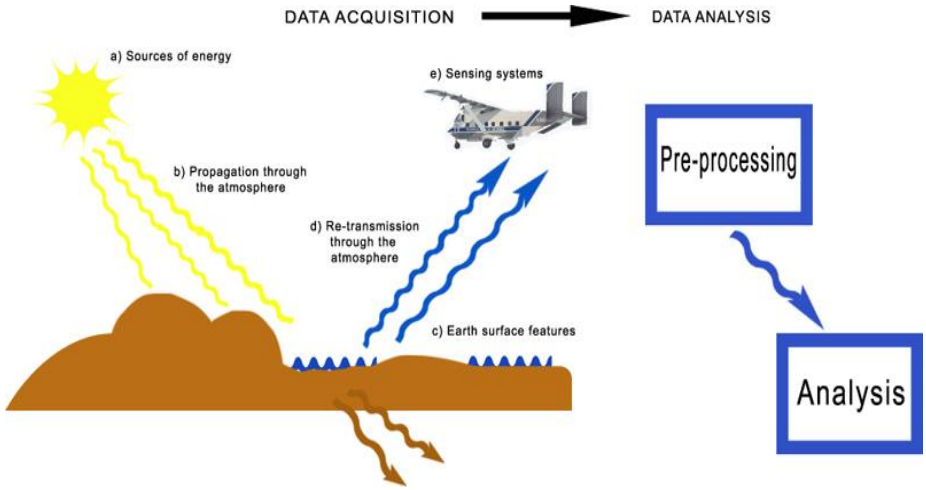

Fig1. Flows of Energy and Information in Remote Sensing

Remote Sensing includes of the following elements: electro-magnetic energy, target (s), spectral response, sensors, platforms, and data/image. It involves the following:
(a) Data Acquisition
(b) Data Processing/Analysis
(c) Data Fusion
(d) Data Interpretation
(e) Data Utilization
Remote sensing data acquisition can be performed on such bases as aircraft, satellites, balloons, rockets, space shuttles, etc. Inside or on-board these bases, we use sensors to bring data together from several place. Sensors involve aerial photographic cameras and nonphotographic devices, such as radiometers, electro-optical scanners, radar systems, etc. Electro-magnetic energy is reflected, transmitted or radiated by the object and captured by the sensor. Because energy travels through the medium of the earth's surrounding, it is adjusted such that the signal between the object and the sensor will differ. When image data are obtained, we need tools and methods for interpreting and analyzing images. By knowing “what” information we expect to obtain from remote sensing, we will analyze methods that can be used to obtain the necessary information.

III.ARTIFICIAL NEURAL NETWORK

Artificial Neural Network commonly referred as 'Neural Networks' is a new branch of Artificial Intelligence. It enables crude simulation of the structure of human brain either through electronics or through software. The inherent properties of human brain enable it to analyze complex patterns which consist of number of elements. These patterns individually reveal little of the total pattern, yet collectively they easily represent recognizable objects.

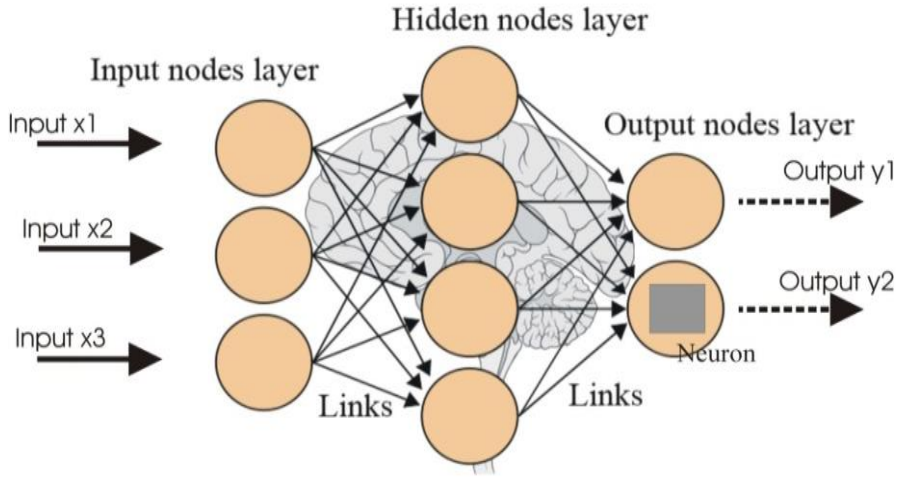

Fig2.A Neural Network Model

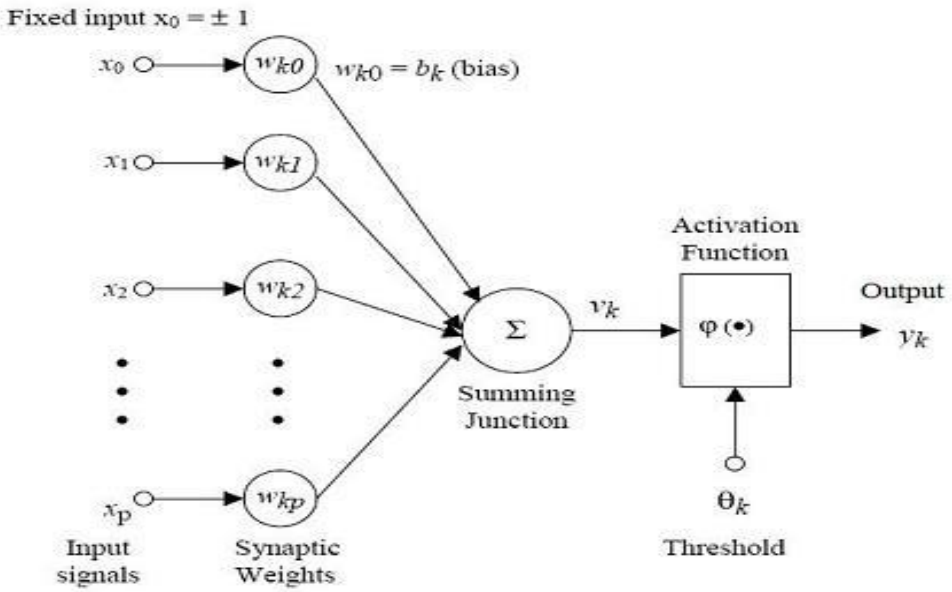

Fig3. A mathematical model of ANN

ANN is a mathematical model or computational model that tries to simulate the structure or functional aspects of biological neural networks. It consists of an interconnected group of artificial neurons and executes information using a connection-oriented approach to *computation.* In most cases an ANN is an adaptive system that changes its structure based on external or internal

information that flows through the network during the learning phase. In more practical terms neural networks are non-linear statistical data modelling tools.

This network perceives the nodes as ‘artificial neurons. These are called artificial neural networks (ANNs). An artificial neuron is a computational model inspired in the natural neurons. Natural neurons receive signals through synapses located on the dendrites or membrane of the neuron. When the signals received are strong enough (surpass a certain threshold), the neuron is activated and emits a signal though the axon. This signal might be sent to another synapse, and might activate other neurons.

Artificial Neural Networks are relatively crude electronic models based on the neural structure of the brain. The brain basically learns from experience. It is natural proof that some problems that are beyond the scope of current computers are indeed solvable by small energy efficient packages. This brain modeling also promises a less technical way to develop machine solutions. This new approach to computing also provides a more graceful degradation during system overload than its more traditional counterparts.

These biologically inspired methods of computing are thought to be the next major advancement in the computing industry. Even simple animal brains are capable of functions that are currently impossible for computers.

IV.FUZZY LOGIC

The concept of Fuzzy Logic (FL) was conceived by LotfiZadeh, a professor at the University of California at Berkley. He presented it as a way of processing data by allowing partial set membership rather than crisp set membership or non-membership. This approach to set theory was not implemented infield of control systems until the 70's due to insufficient computer conditions. Professor Zadeh reasoned that people do not require precise, numerical information input. If feedback controllers could be programmed to accept noisy, imprecise input, they would be much more useful and easier to implement.

Meaning of fuzzy logic

Fuzzy Logic is a problem-solving control system methodology that lends itself to implementation in systems ranging from small, simple, embedded micro-controllers to large, networked, workstation-based data acquisition and control systems. It can be implemented in software, hardware, or a combination of both software and hardware. Fuzzy Logic was better method for handling and sorting data but had proved an excellent choice for many control system applications. Fuzzy Logic follows simple steps to arrive at a definite conclusion based upon imprecise, vague, ambiguous, noisy, or missing input information. FL's approach to control problems mimics how a person would make decisions, only much faster.

Fuzzy logic is an application of computing based on "degrees of truth" rather than the usual "true or false" (1 or 0) Boolean logic on which the modern computer is based. The idea was first approached by Dr. Lotfi Zadeh of the University of California at Berkeley in the 1960s. He was working on the problem of computer understanding of natural language. This language is not simply converted into the absolute terms of 0 and 1.

NEURO-FUZZY LOGIC

In the field of artificial intelligence, Neuro-fuzzy is referred as combinations of artificial neural networks and fuzzy logic. Neuro-fuzzy these two techniques through combining the reasoning style of fuzzy systems with the learning of neural networks that results in a hybrid intelligent system Neuro-fuzzy system incorporates the reasoning style of fuzzy systems through the use of a

set of IF-THEN fuzzy rules.

The main strength of neuro-fuzzy systems is two contradictory requirements in fuzzy modeling: interpretability versus accuracy. Generally assumed to be the realization of a fuzzy system through connectionist networks, this term is also used to describe some other configurations including fuzzy logic-based tuning of neural network training networks.

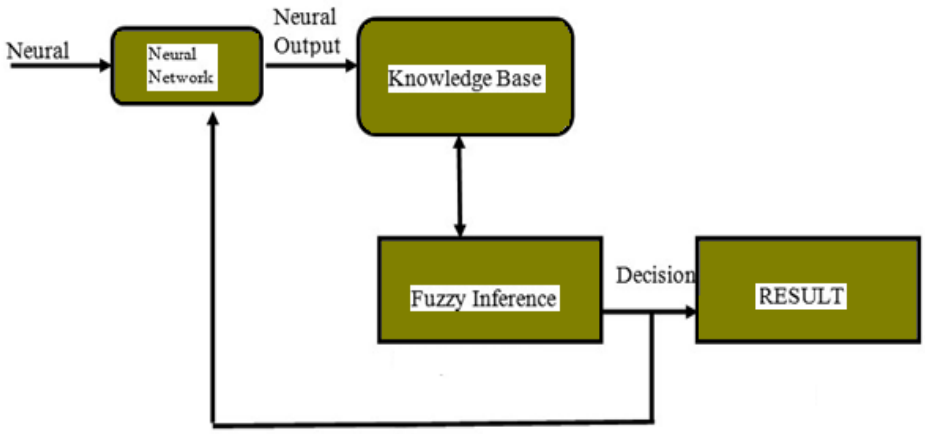

Fig4. A Model of Neuro-Fuzzy System

V. NEURO FUZZY SYSTEMS

Neural networks can grasp, but cannot interpret. They are just like black boxes to the user. Fuzzy Systems can inteprert, but they cannot grasp from data. The learning algorithms can learn both fuzzy sets, and rules, and can also use pre-knowledge.

We usually use the term neuro-fuzzy system for approaches which display the following properties:

- A neuro-fuzzy system is based on a fuzzy system which is trained by a learning algorithm derived from neural network theory.
- A neuro-fuzzy system can be viewed as a 3-layer feed-forward neural network. The first layer represents input variables, the middle layer represents fuzzy rules and the third layer represents output variables.
- Fuzzy sets are encoded as (fuzzy) connection weights. It is not necessary to represent a fuzzy system like this to apply a learning algorithm to it.
- A neuro-fuzzy system can be always interpreted as a system of fuzzy rules. It is also possible to create the system out of training data from scratch, as it is possible to initialize it by previous knowledge in form of fuzzy rules.
- The learning procedure of a neuro-fuzzy system takes the semantical properties of the underlying fuzzy system into account. This results in constraints on the possible modifications applicable to the system parameters.
- A neuro-fuzzy system approximates an N-dimensional function that is partially defined by the training data. The fuzzy rules coded within the system represent samples, and can be seen as prototypes of the training data.

The Neuro-Fuzzy system is able to deal with multiple parameter input and output problems.

VI.MATERIAL AND METHODS

ANALYSIS OF THE MULTI SPECTRAL IMAGE USING ANN

Step 1 Assembling the Training Data: We have received the image of the Hyderabad region and by using the Data Cursor tool in the MATLAB we have obtained the R-G-B components of the pixels which best represent the different features of the image like the River & Water Bodies, the

Concrete Structures, the Roads and the Vegetation and created the table:

Features	R	G	B
River and Water Bodies	120	059	056
	128	049	052
	131	051	060
	136	081	076
	142	052	058
Concrete Structures	151	104	096
	172	093	088
	181	059	074
	186	074	088
	197	098	104
Roads	154	049	064
	163	052	068
	169	096	087
	172	074	089
	178	062	073
Vegetations	224	086	101
	229	119	130
	230	096	105
	234	082	095
	240	104	114

Table 1 Few of Pixels representing different features

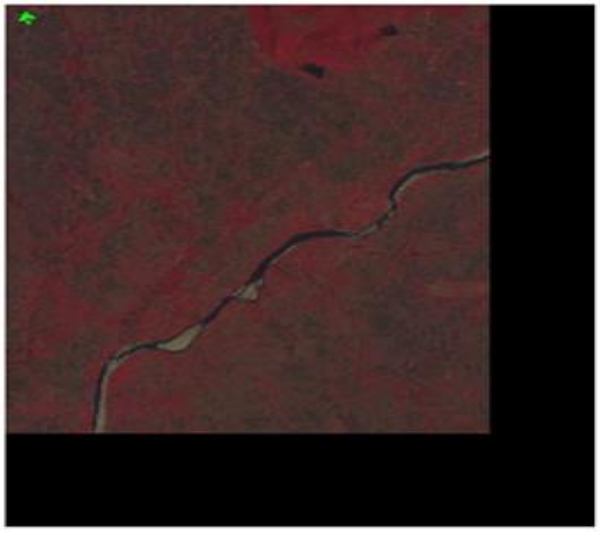

Fig5. Original image of Hyderabad (IRSA)
Thus we obtained R-G-B values of almost 100 pixels and these values may be written in 3X100 matrix as in figure.

$$\begin{bmatrix} \mathbf{R:}\ 120\ 128\ 131\ 136\ 142\ 151\ 172\ 181\ 186\ 197\ 154\ 163\ 169\ 172.... \\ \mathbf{G:}\ 059\ 049\ 051\ 081\ 052\ 104\ 093\ 059\ 074\ 098\ 049\ 052\ 096\ 074.... \\ \mathbf{B:}\ 056\ 052\ 060\ 076\ 058\ 096\ 088\ 074\ 088\ 104\ 064\ 068\ 087\ 089.... \end{bmatrix}$$

Fig6.The Matrix of Input Pixels

Step 2 Create the Network Object: Now we define the network and specify its features like no. of neurons, range of the values of the input neurons, no. of layers etc. and specify the input and target matrices. In target matrix, there is a particular colour for the particular feature to generate the FCC

*Step 3Simulate the Network Response for Whole the Image:*Now, the function representing the relationbetween the input and the target, we are ready to generate a resulting matrix corresponding to the final FCC of the given image.

But, before we simulate the image with the help of given network of neurons, we are to convert the 3-dimensional matrix of dimensions '512 X 512 X 3' corresponding to the multi spectral image into a 3-dimensional matrix of dimensions '3 X 512X512' i.e. '3 X 262144'

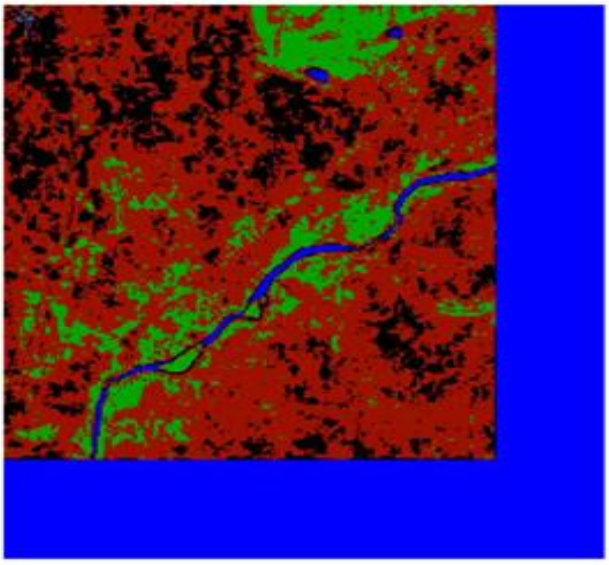

Fig7. FCC Image of the Multi Spectral image

ANALYSIS OF THE MULTI SPECTRAL IMAGE USING FCM

Step 1: In the very first step we receive the multispectral image and convert it into the double image to apply the FCM algorithm on the image.

Step 2: After we have got the double image, we apply the nir,red and green band images algorithm of the FCM on the multi spectral image and analyze the averaged component of this multispectral image.

Step 3: Now as we have obtained the arrange data in a matrix component of the multi spectral image, using "reshape" function.

Step 4: After getting the images of the different bands and reshape the image now our aim is to find out the cluster values of FCM of the given image

[ctr,class]=fcm (data,4);

By using the MATLAB we got the cluster values of each pixel and finally we got the image. The

values of cluster of FCM are in the range of 0 to +1. Now we calculate the reshape of class data using reshape function.

RESULTS FOR HYDERABAD IMAGES AFTER APPLYING DIFFERENT ALGORITHMS

Step 5: Next aim after getting the FCM image was to get the classified images of the region, in order to get these images, we performed the ground survey at various places of the city and taken the proper longitude and latitude values of the survey region from Google earth, and with the help of that we identified the survey locations into the multi spectral images.

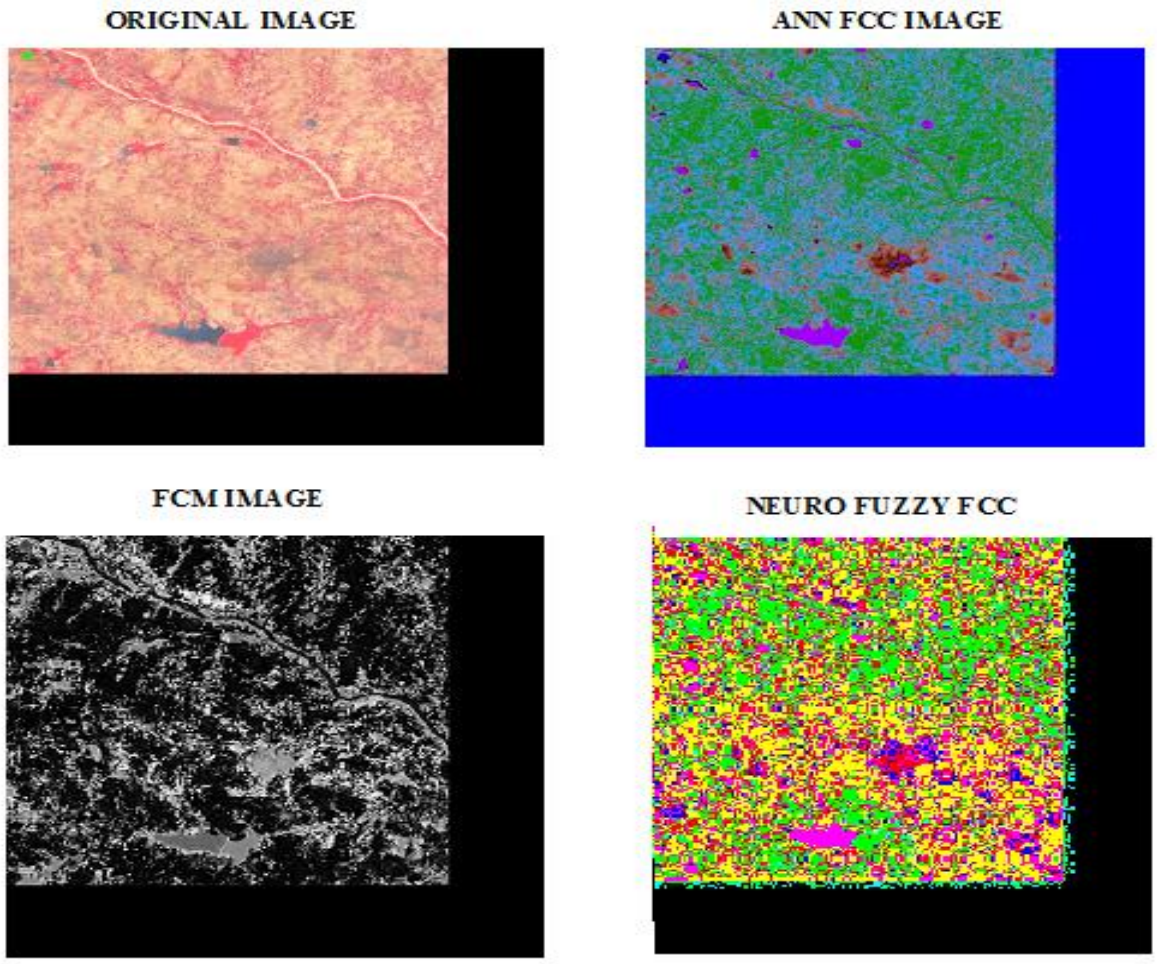

Fig8. Images of Hyderabad using different algorithms

Area Covered	FCM	Percent Result	Neuro Fuzzy	Percent Result
Total Area	388.08	100	388.0800	100
Vegetation	316.06	81.4444	230.3796	59.3639
River and Water Bodies	57.459	14.8010	98.2454	25.3158
Roads	88.772	22.8747	117.4712	30.2698
DenseStructures	154.71	39.8662	257.6046	66.3793
Weak Structures	36.403	9.3804	71.9884	18.5499
Free Land	18.161	4.6797	10.0826	2.5981

Table2 Comparison chart

VII. CONCLUSION

If we examine the results obtained from the three algorithms applied on the multispectral image, it is found that there are different pixels obtained by different algorithms. The FCM method has all the good results for all the six features presented here in the multispectral image and almost all the species are obtained. The ANN algorithm has better result in most of the cases than FCM. We have worked here on NEURO FUZZY method also and is giving as better result as we know it is obtained by combining the FCM and ANN. If we train the pixels in a very efficient way then it must be possible to get the more accurate results as expected. All these classification errors can be reduced by using the more higher resolution devices and hyper spectral images from the satellites, such satellites may be launched by the Indian government in coming years.

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