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AUTOMATED FEATURE EXTRACTION FROM HIGH RESOLUTION SATELLITE IMAGERY USING ANN

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ABSTRACT

Automatic extraction of feature from high resolution remotely sensed imagery is not only scientifically challenging but also of major practical importance for data acquisition and update of geographic information system (GIS) databases. Recent advances in the quality of satellite imagery and the desire to analyze this data has spurred the development of new image processing techniques for object extraction. Road detection from satellite images can be considered as a classification process in which pixels are divided into road and background classes and can be used as a criterion in road extraction process. Apart from the spectral information, textural parameters and contextual information are usually used by human being in road recognition from images. Contributing texture information in the neural network input parameters seems to be an improving idea for road detection from satellite images. Different texture parameters show different aspects of textural behaviour in a defined neighbourhood of a given pixel. Artificial neural networks are found to be superior to several previous techniques due in part to their ability to incorporate both spectral and contextual information. Neural Networks will be applied on high resolution satellite images for road detection. At first, road detection will be performed using only spectral information. Then different texture parameters including contrast, energy, entropy and homogeneity will be computed for each pixel using Gray Level Co-occurrence Matrix (GLCM) from source image and a reclassified road raster map will be produced. To optimize neural networks functionality and to evaluate the impact of contributing texture parameters in road detection, extracted texture parameters will be integrated with the spectral information.

1. INTRODUCTION

Today satellite and airborne remote sensing systems can provide large volumes of data for monitoring the Earth resources and the effects of human activities on the Earth. Few people are involved in the research of cultural feature extraction, i.e. the detection, identification, classification, and delineation of man-made features for GIS update from aerial and satellite imagery. Automatic feature extraction from images has a history of more than two decades **De cadestro (2010)**. The problem of automated feature extraction in general is a challenging task as it involves the recognition, delineation, and attribution of image features. At present information regarding features like road, building location and their characteristics is stored digitally within geography databases. These data enable Geographic Information System (GIS) applications to facilitate a variety of services which include satellite navigation, route planning, transportation system modelling, health care accessibility planning, urban planning, land cover classification and even infrastructure management.

Two methods are typically used to obtain feature data sets, namely ground surveying and delineated from remotely sensed imagery. Ground survey can be conducted by using devices such as receivers for the total station or Global Positioning System (GPS). Delineating features from remotely sensed imagery is feature extraction and can be categorised as being a manual, semi-automated and fully automated process. Manual extraction needs a human operator to delineate features from remotely sensed images; while semi automated extraction requires some human input to guide a set of automated processes. Finally, the automated process requires no human interventions. In this study, an automated system for extraction of Road from high resolution satellite images is proposed that utilizes structural and spectral information. Using Artificial Neural Networks algorithms, the detection

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percentage and quality of the feature extraction have been greatly improved **Zahra lari**.

Neural Networks are inspired from biological neural systems. There are two main stages in artificial neural networks

• Learning (training) - the process of modifying weights between neurons to fulfil a specific task
• Recalling- generalization ability of the trained network

Artificial neural networks are found to be superior due to their ability to incorporate both spectral and contextual information. An important factor in road detection using ANNs is to decide what type of information should be extracted from input image to be fed through the network as its input parameters. The discrimination ability of the network is highly affected by chosen input parameters. Operation of Artificial neural network is explained in Figure.1.

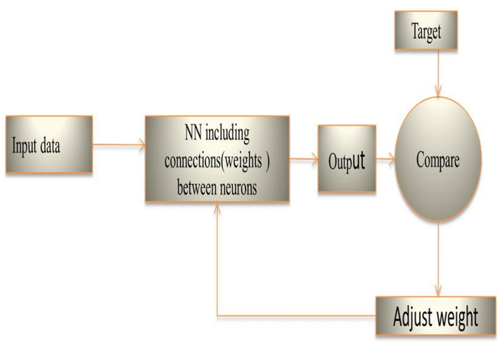

Figure. 1 Artificial Neural Networks

2. LITERATURE REVIEW

A method based on neural network strategy for detecting road network in the city of Laghouat (Algeria) **Benkouider et al. (2011)** developed a method based on spectral information. Mathematical Morphology is a powerful tool for the extraction of features from the remotely sensed imagery. Feature extraction is performed using a set of morphological operators like erosion, dilation, opening and closing etc.. **Jumlesha et al (2011)** developed this method and implemented it in Matlab environment. Back Propagation Neural Network (BPNN) is used for classification of remote sensing images**.** The back propagation neural network was trained on six classes of the IRS-1D image based on known features and the trained network was used to classify the entire image this method proposed by **Hosseini Aria et al**. A new method for road extraction from high resolution Quick Bird and IKONOS pan-sharpened satellite images is presented. **Mokhtarzadev (2008)** says that to optimize neural networks functionality, a variety of texture parameters are used. **Rizvi et al (2010)** proposed a method that focuses on the automated extraction of various objects like water bodies, roads, and buildings etc in high resolution remotely sensed images using the eCognition software. **Zahra Lari** suggested features are calculated for each region of satellite image and a three layer perceptron neural network is trained for detection of buildings in satellite images.

Rajani Mangala (2010). proposed classification system has four stages of processing, namely, image segmentation, morphological operation, dominant objects extraction and neural network-based classification. The system is implemented and its performance is evaluated using standard quality measures. A test image has been given to the system and the results have been evaluated As the roads of rural areas have no proper layout, considerable complexity is involved in the extraction process. **Ashwini Sapkal** has implemented two different algorithms namely K-means Algorithm and Back Propagation Algorithm of ANN for Segmentation and Classification of Satellite images. The comparison of results shows good accuracy in both the methods. K- Mean algorithm and back propagation are studied in detail and implemented on various database for the segmentation and classification purpose. It is found that K- means algorithm gives very high accuracy, but it is useful for single database at a time. Whereas neural network is useful for multiple databases, once it is trained for it. Neural network also provides good accuracy.

3. STUDY AREA

Study area is chosen as part of Chennai. A Part of study area spatial extent shown in table.1 and location map shown in Figure.2 used in this study.

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Table.1 Study area spatial extents

Location	Spatial Extent	
Kathipaara flyover, Guindy	13°00'18"N, 80°11'55"E	13°00'05"N, 80°12'42"E

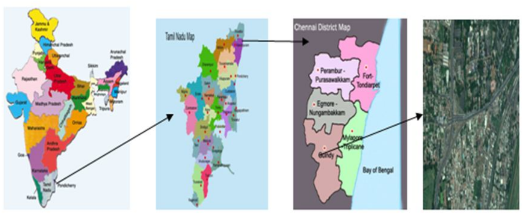

Figure.2 Study Area

4. PROPOSED METHODOLOGY

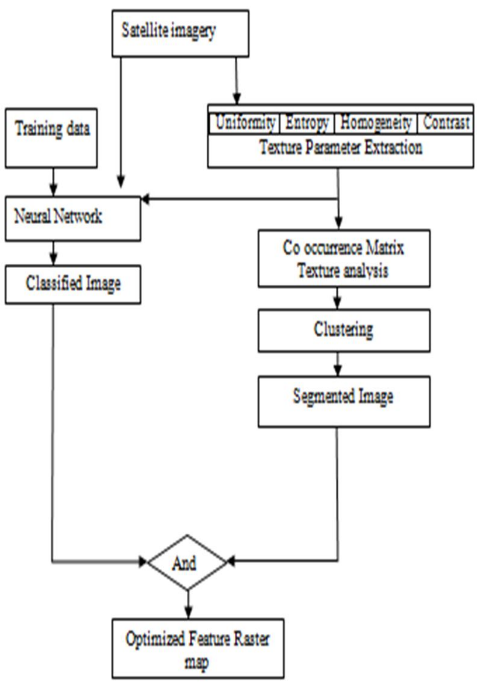

Figure. 3Image Classification Using Back propagation neural network

In order to classify the satellite images certain features are calculated for each pixel. Then, the network is trained by computing the input matrix and the target vector. The input matrix is obtained from the features and the target vector is manually calculated. Once training is completed, the network is simulated with an input image, for which classification should take place, to specify road and non road features.

A back propagation neural network with ten hidden layers and adaptive learning rate and momentum was used for road detection. At first, only spectral information was fed through the network and thus three neurons were designed in the input layer in charge of receiving R, G, and B bands. The output layer consist of only one neuron that shows the network's response by a number 0 and 1 background and road pixel respectively. The network was trained using the training set.

5. TEXTURE PARAMETER ANALYSIS

Texture analysis is used in a variety of applications, including remote sensing, automated inspection, and Satellite image processing. Texture analysis can be used to find the texture boundaries, called texture segmentation. Texture analysis can be helpful when objects in an image are more characterized by their texture than by their intensity, and traditional thresholding techniques cannot be used effectively. Texture analysis is a common method of generating region descriptors in digital images. Gray Levels Co-occurance Matririx (GLCM) method is the most common statistical method of texture analysis that takes into account not only the distribution of gray levels but also the posotion of pixels with respect each other. This task will be Performed by considering the pixels in pair in a predefined neibourhood of the current pixel.

1) **Gray level co occurance matrix** It has the folowing form in equation.

$$A = |a_{i,j}| : a_{i,j} = P(d, \varphi, I_i, I_j) : i, j = 0,1,2 \ldots\ldots N_{g-1}$$

Where, N_g is the number of gray levels, P(d,φ,I_i,I_j)shows the number of times the pixel pairs with intensity values of (I_i,I_j) are located at the intensity contrast between a pixel and its neibourgh.

2) **Texture parameters**

Contrast is a measure of intensity contrast between a pixel and its neibour.

$$\text{Contrast} = \sum_{i=0}^{Ng-1} \sum_{j=0}^{Ng-1} (i-j)^2 a_{i,j}$$

Energy is a measure of Uniformity.

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$$\text{Energy} = \sum_{i=0}^{Ng-1} \sum_{j=0}^{Ng-1} a_{i,j}^{2}$$

Entrophy is measure of randomness.

$$\text{Entropy} = \sum_{i=0}^{Ng-1} \sum_{j=0}^{Ng-1} a_{i,j} \log (a_{i,j})$$

Homogenity is measure of spatial closeness of the distribution of elements to the diagonal.

$$\text{Homogeneity} = \sum_{i=0}^{Ng-1} \sum_{j=0}^{Ng-1} \frac{a_{i,j}}{1 + |i - j|}$$

Road Detection Using Texture Parameters

The source image will transform into a gray level image with four gray values {0, 1, 2, 3}. Four texture parameters including contrast, energy, entropy and homogeneity will be computed for each pixel in a 3x3 window using co-occurrence matrix. Each texture parameter will be computed in 4 directions (horizontal, diagonal, vertical and anti-diagonal) and the averaged gray level image will be produced representing the relevant texture criterion at each pixel. In this way, each texture parameter could be regarded as a new information channel. Therefore, each texture parameter can be put next to the spectral information in order to be sent to the neural network via input neurons. Different combinations of spectral and texture parameters will be designed to be used as network input parameters. All four texture images will be used together making a seven neuron input layer. The network is trained by the prepared training set and then, the trained network will be implemented on the whole image for road detection and accuracy assessment parameters will be evaluated. This procedure will be repeated several times to make sure the networks stability.

Clustering

The K means algorithm is an iterative technique that is used to partition an image into K clusters. The basic algorithm is:

1. Pick K cluster centres, either randomly or based on some heuristic
2. Assign each pixel in the image to the cluster that minimizes the distance between the pixel and the cluster centre
3. Re-compute the cluster centres by averaging all of the pixels in the cluster
4. Repeat steps 2 and 3 until convergence is attained (i.e) no pixels change clusters

In this case, distance is the squared or absolute difference between a pixel and a cluster centre. The difference is typically based on pixel colour, intensity, texture, and location, or a weighted combination of these factors. K can be selected manually, randomly, or by a heuristic.

The quality of the solution depends on the initial set of clusters and the value of K. The texture images are put in a K means clustering process. K means training starts with a single cluster with its centre as the mean of the data. This cluster is split into two and the means of the new clusters will be iteratively trained. These two clusters will be again split and the process continues until the specified number of clusters will be obtained. The clusters will be iteratively trained to get the final clusters. Based on training set, road clusters will be determined and a segmented image will be produced.

6. ACCURACY EVALUATION

For accuracy assessment, binary images will be extracted from image truth, assigning 1 to road and 0 to background pixels, given as Total Road Pixels (TRP). The numbers of road pixels identified by the neural network will be given as Count. The parameter Root Mean Square Error (RMSE) will be the difference between network's responses and expected results (1 for road and 0 for background pixels) as error values. The overall accuracy calculated is the percentage of correctly classified pixels to all available pixels in entire image. Road Detection Correctness Coefficient (RCC)is given by,
RCC= (Count/ Total road pixel) x100
Root Mean Square error is given by

$$\text{RMSE} = \sqrt{\frac{1}{MN} \sum_{m=0}^{M-1} \sum_{n=0}^{N-1} (I(m,n) - \hat{I}(m,n))^2}$$

where M, N are the Image width and height.

Result and discussion Work completed in phase I

1. Frame work of objective was done. 2. Gone through various literatures related to extraction of road from satellite image. 3. Study area was selected. 4. Training sample for neural network is prepared from satellite image. 5. Classification of Satellite

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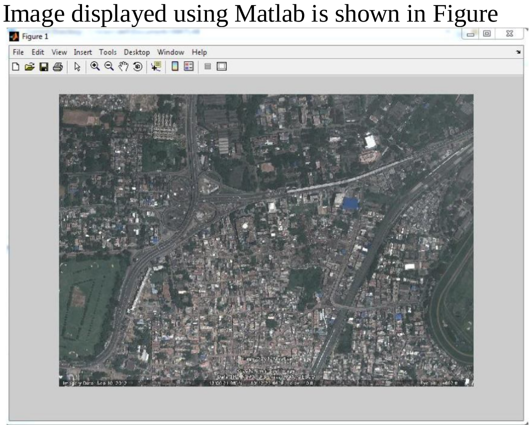
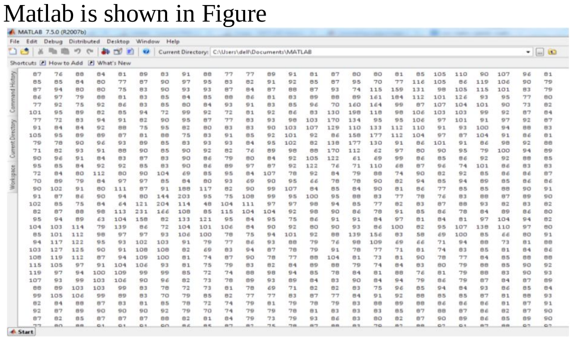
image using neural network tool in Envi software was performed.

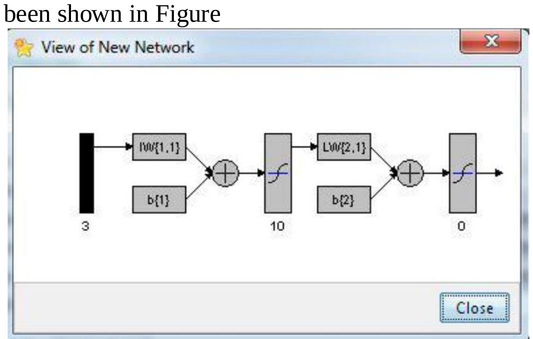
Image displayed using Matlab is shown in Figure



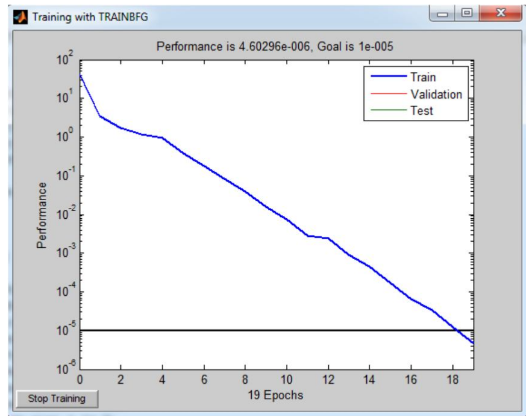
The RGB values of the image are displayed in Matlab is shown in Figure



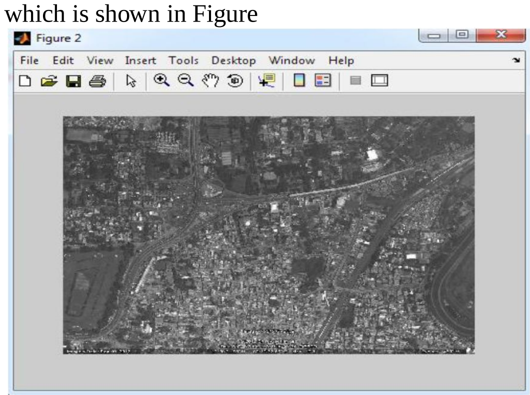
Matlab provides a neural network tool that helps to create the back propagation neural network this has been shown in Figure



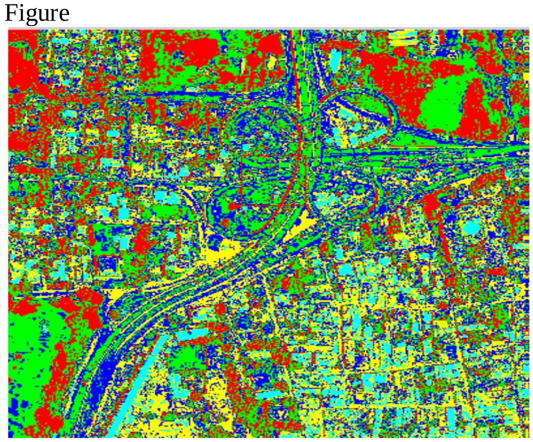
Training response curve obtained for the neural network is shown in Figure



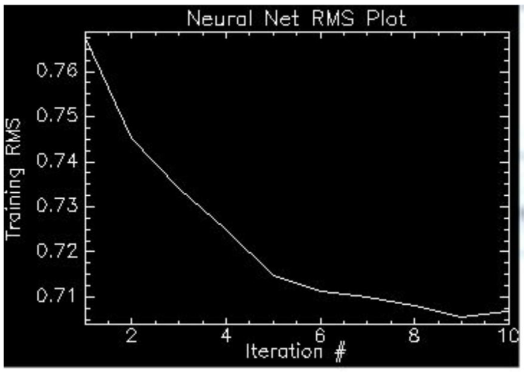
In order to calculate the gray level co occurrence matrix, the image is converted to gray scale image which is shown in Figure



For validation purpose, the image is classified using neural network in ENVI software which is shown in Figure



The response curve of the neural networks classifier is plotted as shown below in Figure



Work Plan For Phase II

1. To perform Neural Network classification of Satellite image by using trained Neural Network.
2. To perform texture parameter extraction from Satellite image.
3. To perform segmentation for road feature extraction.
4. Finally, road will be extracted and result will be validated.

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