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Road Detection from High-Resolution Satellite Image Using Lvq

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ABSTRACT. This paper shows the idea of using Learning vector quantization (LVQ) a type of artificial neural network for detection of the road using high- resolution satellite images of a region in Goa provided by google earth. Road detection is one of the concepts of satellite image processing for smart city de- velopment. The proposed methods detect the road with the help of high-resolution satellite images. This paper concluded by comparing the accuracy and kappa coefficient using LVQ which is a type of supervised machine learn- ing model. Here, the accuracy of 85.85% with a Kappa coefficient of 0.8293 is achieved.

Keywords: Learning Vector Quantization, Road Detection, Artificial Neural Network, Classification, Supervised Learning.

I. INTRODUCTION

The road is the fundamental need for many developing and underdeveloped countries for modernization and communication in terms of a better future and facilities. The ultimate source of transportation is carried by using roadway only. The importance of land and the geographical area is very important for any country maybe they are very tiny or very huge in terms of a land surface. Since the old age period, the world has practiced transportation by using animals from horses to oxen, and after bit develop- ment, we shifted towards bikes or automobiles, trucks, and many more. Even though Road is the basic need for any country is also parallel important in words of infra-structure. Nowadays the technology such as remote sensing is becoming used to and noisy for the science background student. Using this data government can plan many ideas and plan for local peoples of the region of the city, town, and state. Road detec- tion is also important for application for remote sensing and but a bit more difficult for detection to find the appropriate features based on different classes from each other. The primary category of machine learning is supervised detection techniques which help us to classify the previous data and may also train set on basis of classifier capability to classify the known and unknown data from the different classes. Here we have used the detection method known as LVQ which is much known and quite a favorite for researchers. While detecting the road using satellite images consists of errors because of the presence of the big tree, people, and various vehicles.

II. LITERATURE REVIEW AND MOTIVATION

Idris Kahraman et.al in their research paper, have performed the detection of roads based on multilayer perceptron with RGB feature value for the detection of the road using satellite image [1]. J.S.J. Wijesingha et.al had used two types of neural network family member's i.e artificial neural network pattern net and LVQ neural for detection of the rural and urban road using World View-II satellite panchromatic images [3]. Jiang Xin et.al involved few parameters and only two datasets of high-resolution images then comparison with three classical semantic segmentation methods from road extraction [4]. Yoni Nachmany et.al they proposed the idea of the comparison of two models' prediction on-road using local training data [5]. In this paper, they have used Artificial Neural Network for a semiarid river basin. Here the modeling is covered based on Multi-layer Perceptron (MLP)-Artificial Neural Network ANN. all the games of prediction are based on the number of items. Accuracy is coming around 89.69% after 10,000 iterations, kappa=0.61 and AUC=0.67 [6]. Jake Stolee et.al in this project, have built and experimented with a road detection pipeline that aggregates the pixels in each photograph, computes relevant features and performs classification at the "superpixel" level, and then translates the

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classification results back to the pixel level and performs additional enhancements to the classification using structured prediction [7]. Aparajit Narayan et.al in this paper has used convolutional neural networks to predict the position and width of roads from camera input images [8]. Rudranarayan Hota et.al this research paper aims to detect line or curve-like segments from a video image taken from a moving vehicle and merge them to detect road lane marks using Clustering and Weighted Regression [9].

III. LEARNING VECTOR QUANTIZATION

The artificial neural network is part of machine learning where there are various types of artificial neural networks are available for supervised and unsupervised classification purposes. Learning vector quantization is one of the types of artificial neural networks which uses supervised learning for the classification of data. The learning vector quantization neural network consists of three layers which are the input layer, hidden layer, and output layer. All the neurons of three different layers are connected with some random weights later on after training these weights are adjustedso that it can generate the line of discrimination to categories the data into various classes. The LVQ applied the clustering at hidden layers and classification at the output layer for classification purposes.

IV. PROPOSED METHOD

The core of any kind of research is the methodology adopted for the research to get the desired output to support or reject the hypothesis. Any kind of proposed method consists of a set of steps to achieve the desired output. The set of steps involved in the proposed methodology are as follows:

High-resolution satellite image acquisition

The high-resolution satellite image consists of much more information than normal satellite images. In high-resolution satellite images, it is very easy and convenient to recognize the various feature and characteristics of various resources for classificationor recognition purposes. Google earth provides high-resolution satellite images for study and research purposes. Therefore, in the proposed method the Google earth high-resolution satellite images of a region in Goa are used for classification purpos- es.

Preprocessing and feature extraction

Preprocessing and feature extraction is the primary step of the classification process therefore in the proposed methodology pixel-based features are used as the character- istics or attributes for classification purposes. Based on the pixel-based collected fea- tures the training and testing datasets are prepared for training and testing purposes.

LVQ model

The learning vector quantization model is prepared using the MATLAB simulation toolbox. The MATLAB simulation toolbox provides various methods to simulate the learning vector quantization neural network. Here, learning vector quantization is generated with input, hidden, and output layer neural networks.

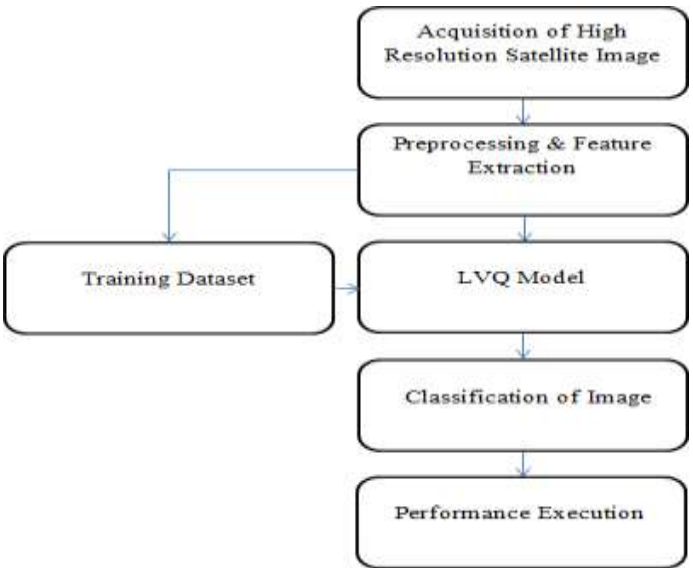

Fig. 1. Steps for satellite image classification

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Classification

After the creation of the LVQ model now the training dataset file is used for the train- ing process. The training dataset consists of attributes along with it's the labeling of whether attributes belong to the road or not. After the training process, the model is ready for classification. The image is now supplied to the classification model for classification purposes.

Performance evaluation

The performance evaluation is the part of the classification algorithm to understand the performance of classifiers for specific. There are various types of methods are available for performance evaluation which are included in the result section of the research paper.

V. EXPERIMENTAL RESULTS USING LVQ METHOD

The below figures show the experiment result using the LVQ algorithm.

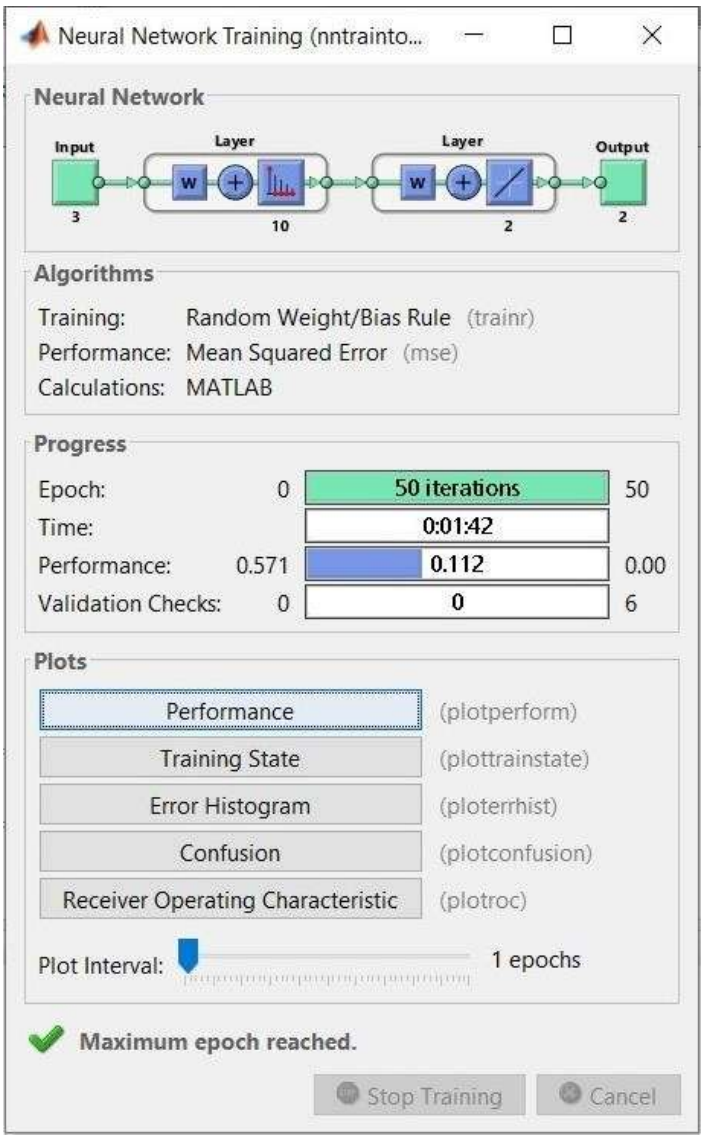

Fig. 2. Training neural network

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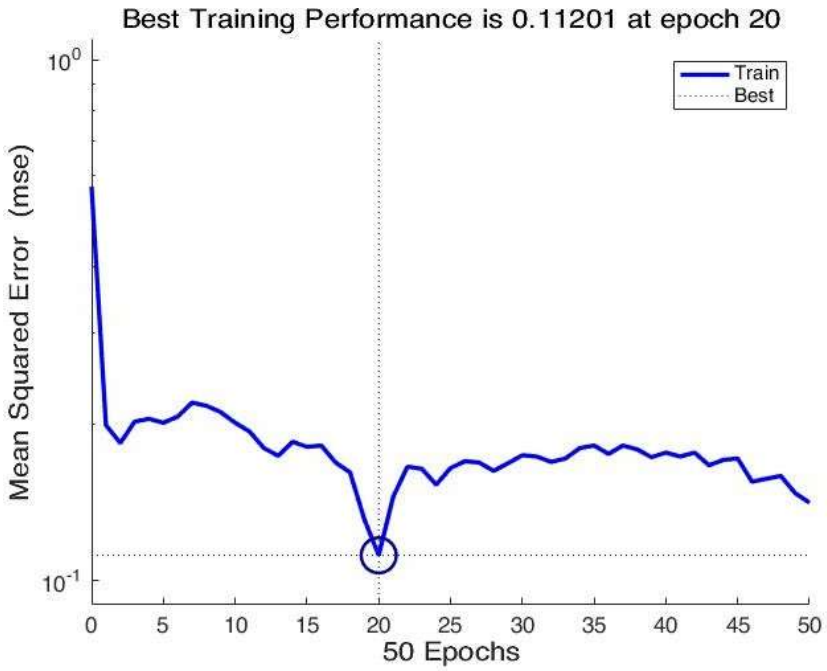

Fig. 3. The plot of MSE versus number of Epochs for the image

(a) (b)

Fig. 4. (a) False color image (b) Classified color image

VI. RESULT

The algorithm is developed in MATLAB R2016 It uses a Learning vector quantiza- tion artificial neural network with an LVQ algorithm. The method has been proposed for detecting the road network from high-resolution satellite images. The diagram represents the steps involved in satellite road image detection.

Table 1. Accuracy assessment LVQ classifier

Classes	Road	Non-Road	Total	Users Accuracy (%)
Road	809	37	846	95.98%
Non-Road	328	799	1127	78.26%
Total	1137	836	1973	
Producers Accuracy (%)	76.82%	96.29%		

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Accuracy= 85.85%

$$k = \frac{N\sum^{r} x_{ii} - \sum^{r} (x_{i+} x_{+i})}{N^2 - \sum^{r} (x_{i+} x_{+i})} \quad \begin{matrix} i=1 \\ i=1 \end{matrix}$$

k = 0.8293

The above table is the confusion matrix which is also called the error matrix. The confusion matrix is used to assess the accuracy of the classifiers therefore from the above table the accuracy of the classifier is 85.85%. The calculated accuracy is good for the classification of a high-resolution satellite image. The Kappa coefficient is another used for classifier accuracy assessment. The value of the Kappa coefficient is 0.8293. The value of the Kappa coefficient varies from 0 to 1 if the value is near to 1 it signifies that the classifier is good for the specified appropriate problem.

VII. CONCLUSION

Road detection is a crucial and tedious task because of many problems related to ve- hicles running across, people around the road. Many researchers are working on vari- ous issues related to road detection using numerous types of satellite images. In that follow in the proposed paper high-resolution satellite images are used for road detec-tion using LVQ. The proposed method shows good accuracy in terms of the classifi- cation of the high-resolution satellite image. In the future, more features can be con- sidered for classification purposes, even the multiple classifiers can be used for more accuracy for the classification of high-resolution satellite images.

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