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Multispectral Image Classification

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Abstract : we proposed a spectral-spatial information based classification method for classification of diseased trees in high-resolution multispectral satellite imagery. The proposed method consist Guided filter which is used to extract spatial information, with Support Vector Machine. Using the proposed method we are able to map diseased trees from the study area with better classification accuracy compared with existing methods. In this study, the Japanese Wilt in forested areas of Japan was classified into two class as 'diseased trees' and 'all other land cover area' according to the 6 attributes in the spectral data set of the forest. The Wilt Data Set which was obtained from UCI machine learning repository database was used for classification.

Keywords: Multispectral Image ,SVM, Guided filter.

I. INTRODUCTION

The target of image classification alluded to the naming of pictures into one of the various categories established in advance. The greatest challenge which is looked amid Multispectral image classification [2] is revile of dimensionality which is Hughes phenomenon. With regard to supervised classification, one of the fundamental troubles is identified with the little proportion between the quantity of accessible training sample and the number of features. This makes it difficult to get sensible appraisals of the class-contingent multidimensional probability density functions utilized in a standard statistical classifier. As an outcome, on expanding the number of features given as a contribution to the classifier over a given threshold which relies upon the number of training samples and the sort of classifier received, the classification precision diminishes this conduct is known as the Hughes phenomenon.

II. WHAT IS MULTISPECTRAL IMAGING?

Multispectral cameras can see more than just colors. They capture image data over a specific wavelength range of the electromagnetic spectrum. They measure light in a small number of spectral bands, somewhere in the range of 3 and 15. There are also cameras that can capture hundreds of spectral bands- this is called hyperspectral imaging [3]. The human eye can see electromagnetic waves with wavelengths between 380 and 780 nanometers. Electromagnetic waves with wavelengths outside of this range, such as infrared, are invisible to humans. Multispectral imaging allows us to obtain additional information the human eye cannot see. There are three possible ways to gain spectral image information: a camera with optical elements, or a continuous filter, like the filter wheel or a CMOS sensor with a filter.

III. DATASET

On August 27, 2012, high-resolution Quickbird images of 165 different regions were obtained. The image contains 4 multi-spectral bands and 1 PAN band. There are very few training samples for the "Diseased Tree" category (74) and the "Other Land Cover" category (4265). The Dataset [15] consists of image fragments. Fragments contain spectral and texture information. Dataset consist of two classes one is class 'w' (diseased tree) and other is 'n' (all other land cover). The data set consists of 4889 instances, each with 6 attributes. These attributes are

- GLCM mean texture of PAN,
- Mean of Green value,
- Mean of Red value,
- Mean of Blue value,
- Mean of NIR (near infrared) value,
- Standard deviation of PAN

IV. PROPOSED METHOD

Guided filter is used for Pre-processing of dataset to remove noise contain by wilt dataset. Guided filter provides edge-smoothening property also known as Edge-preserving filtering. Guided filter used to obtain spatial information and de-noise the classification result. Support vector Machine is used for classification refers to categorize the pixels into one of several classes based on their spectral characteristics. Using SVM combined with a Guided filter, five different spectral information values of 'diseased trees' and 'all other land cover' in the data set are used to classify into non-diseased trees or diseased trees.

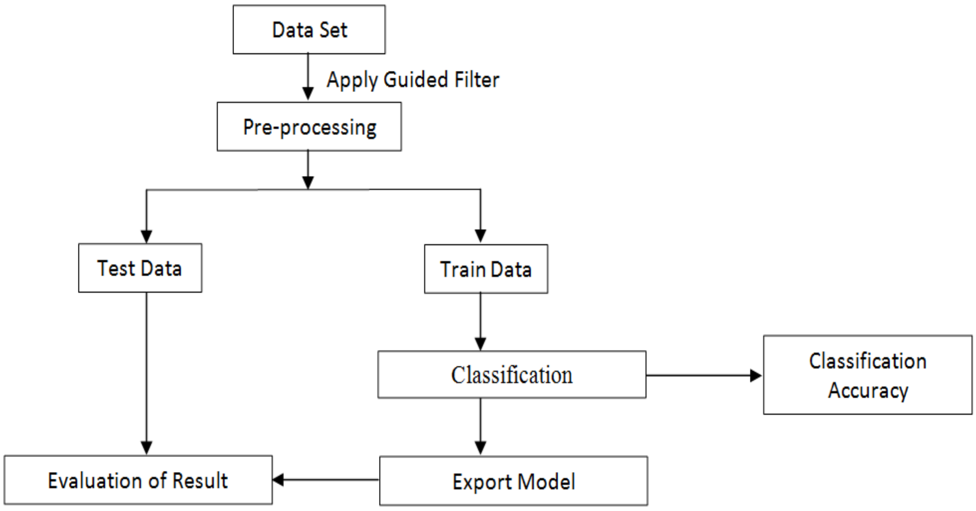

Figure 1*Spectral-Spatial Classification Model*

V. GUIDED FILTER

Guided filter [6] is an explicit image filter. It is derived from local linear Model. Filtering output produces by considering the substance of guidance image, which can be simply the input image or another distinctive image [8]. Guided filter has the edge-preserving smoothing property like bilateral filter [9]. It may have an issue of gradient reversal artifacts in detail decomposition and HDR compression. The purpose of this issue is when a pixel (regularly on an edge) has a couple of comparative pixels around it the Gaussian weighted average is precarious. Guided filter [8], defeats with gradient reversal artifacts issue. The guided filter has an O (N) time (in the number of pixels N) correct calculation for both color and gray-scale images. Guided filter connected in an extraordinary assortment of utilization, for example, HDR compression, noise reduction, detail smoothing, haze expulsion [11], image matting [12] and it provides compelling and quality outcomes.

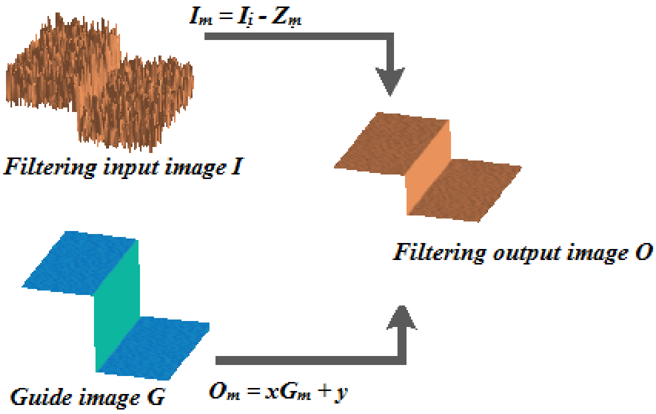

Figure 2*Overview of Guided Filter*

VI. SUPPORT VECTOR MACHINE

Support vector machines [5] are supervised learning model with related learning algorithms that examine information utilized for classification and regression investigation. . SVM has a place with a group of generalized linear classification. Notwithstanding perform linear classification, SVM can productively perform non-linear classification using kernel trick, which implies changing information into another measurement that has an unmistakable partitioning between classes of information. Choice of legitimate kernel gives the appropriate outcome. SVM called Maximum Margin classifier since it all limit the empirical classification error and amplify the geometric edge. SVM training algorithm expects to discover a hyperplane that isolates the dataset into a discrete predefined number of classes which can be utilized for classification, regression and outlier detection.

A SVM Scatter Plot

The Scatter diagram graph pairs the numerical data with a variable on each axis to find the relationship between them. If the variable is related, the points will fall along the line or curve. The stronger the correlation, the point will hug the line. When we have paired numerical data, the dependent variable has multiple value argument for each value. We try to determine if the two variables are related. The matrix scatter plot is used to test the relationship between two or more variables. It allows visualization of the relationship between multiple pairs of variables in a single chart. In fig.3 scatter plot is plotted between two attributes Mean_Green and GLCM_pan. Scatter plot can be plotted between any pair of attributes among GLCM_pan, Mean_Green, Mean_Red, Mean_NIR and SD_pan. In the fig.3, blue color shows 'n' class (all other land cover class) and red color shows 'w' class (diseased trees).Circle is used to visualize the correct prediction of class labels, whereas 'x' is used for incorrect prediction of class labels. Quadratic kernel is used for the SVM classifier, which is used to transform low- dimensional input space to high-dimensional input space.

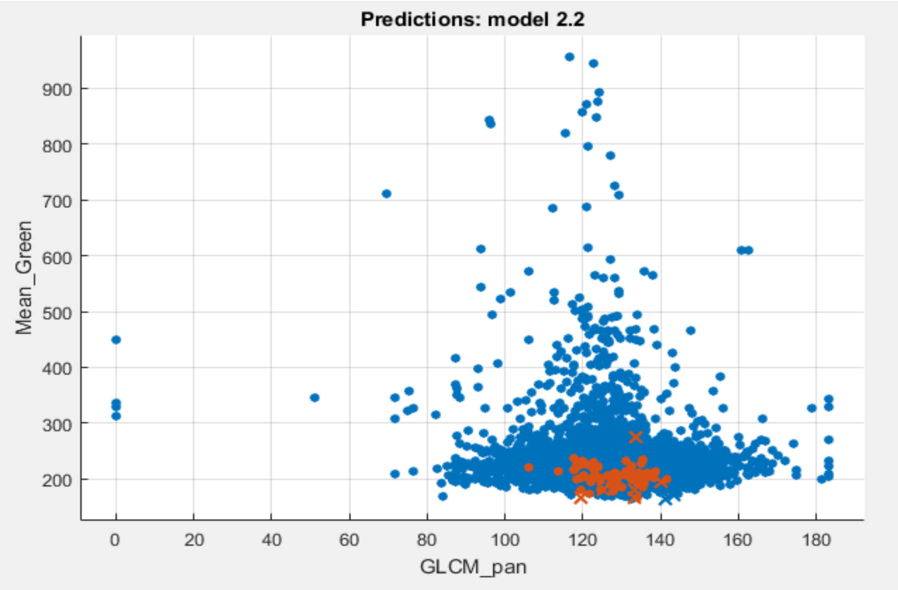

Figure 3*SVM Scatter Plot*

B Confusion Matrix

Confusion matrix is used to calculate classification accuracy of our classification model. The size of confusion matrix is determined by the number of things we want to predict. The columns in a confusion matrix correspond to what the machine learning algorithm predicted and the rows correspond to the known truth value. Since there are only two categories to choose from 'w'(diseased tree) which is negative class and 'n' (all other land cover) which is positive class, then the top-left corner true positive (TP) these are the image segments which is non-diseased tree (positive class) that were correctly identified by the algorithm. The true negatives (TN) are in the bottom right hand corner these are the diseased tree (negative class) image segments that are correctly identified by the algorithm. Bottom left-hand corner contains false positive (FP), false positive are when a image segment belongs to 'w' diseased tree class but the algorithm identified it as 'n' non-diseased class (all other land cover class).the top right-hand corner contains false negative (FN), false negative are when true class is 'n' but the algorithm says they belongs to diseased tree class 'w'.

In fig.4, there are 4255 true positive these are belongs to 'n' class and correctly identified and 62 are true negative, segments that belongs to diseased tree class 'w' that were correctly identified. However the algorithm misclassified 12 segments that did not belongs to diseased tree 'w' class, these are false positive. The algorithm misclassified 10 segments that did not have diseased tree class by saying they did, these are false negative. In summary, a confusion matrix tells you what your machine learning algorithm did right and what it did wrong.

$$Classification\ accuracy = \frac{(TN+TP)}{(TN+TP+FN+FP)} \times 100 \quad (1)$$

$$Error\ rate = \frac{(FN+FP)}{(TN+TP+FP+FN)} \times 100 \quad (2)$$

$$True\ positive\ rate = \frac{TP}{TP+FN} \quad (3)$$

$$True\ negative\ rate\ (TPR) = \frac{TN}{TN+FP} \quad (4)$$

$$False\ positive\ rate\ (FPR) = \frac{FP}{TN+FP} \quad (5)$$

Using (1), we can calculate classification accuracy (CA) of our model and (2) is used to calculate error rate or misclassification rate.

$$CA = \frac{(62+4255)}{(64+4256+10+12)} \times 100 = \mathbf{99.5}\ \% \quad \text{Use (1)}$$

$$Error\ Rate = \frac{(10+12)}{(64+4255+10+12)} \times 100 = \mathbf{0.5}\ \% \quad \text{Use (2)}$$

$$True\ Positive\ Rate = \frac{(4255)}{(4255+10)} = \sim \mathbf{1} \quad \text{Use (3)}$$

$$True\ Negative\ Rate = \frac{(62)}{(62+12)} = \mathbf{0.8} \quad \text{Use (4)}$$

$$False\ Positive\ Rate = \frac{(12)}{(12+62)} = \mathbf{0.16} \quad \text{Use (5)}$$

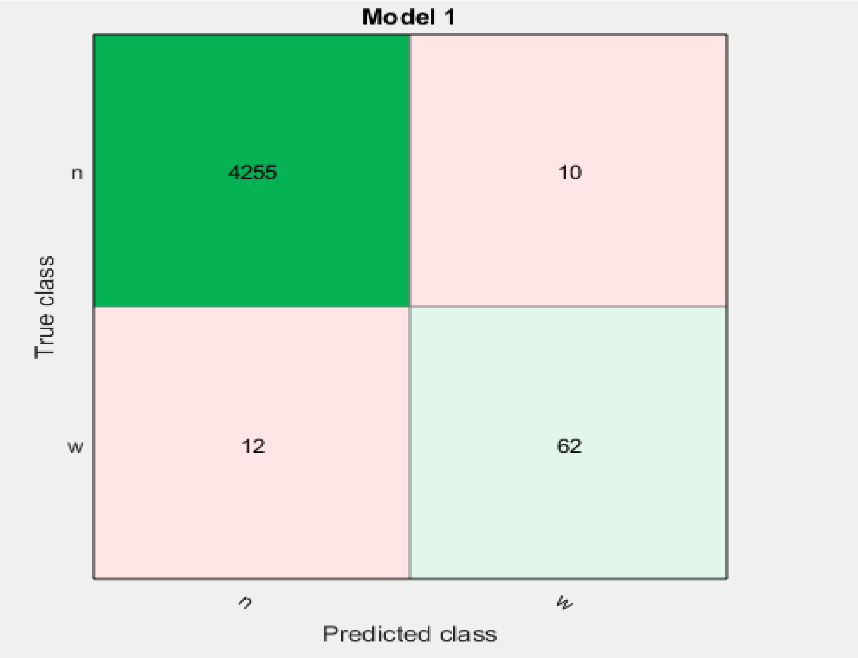

Figure 4*SVM Confusion Matrix*

C SVM Reverse Operating Characteristic Curve

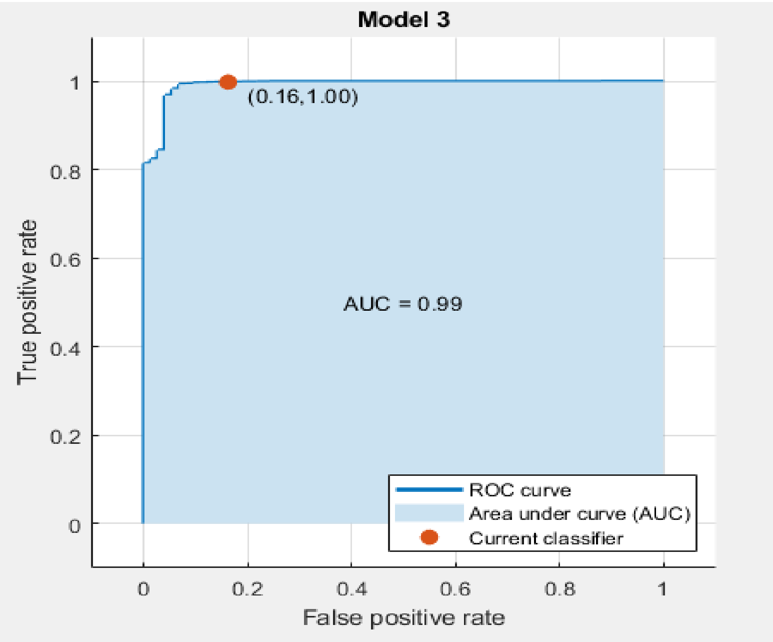

Figure 5*SVM ROC Curve*

Reverse Operating Characteristic (ROC) curve is normally utilized approach to envision the performance of “binary classifier” which means a classifier with two conceivable output classes. Roc curve is a plot between True Positive Rate (on the y-axis) versus the False Positive Rate (on the x-axis) for every conceivable classification threshold. Range for both the true positive rate and false positive rate go from 0 to 1.After ascertaining true positive rate from (10) and false positive rate from (12) ,along these lines we will plot a point at 1 (FPR) on the x-axis ,and 0.16 (TPR) on the y-axis, which is appeared in fig. 5.

VII. RESULTS

Table I Comparison between Different Classifier

S.No.	Classifier	Prediction Speed	Training Time	Kernel Function
1	Linear SVM	10,000 obs/sec	79.403 sec	Linear
2	Quadratic SVM	15,000 obs/sec	73.264 sec	Quadratic
3	Cubic SVM	18,000 obs/sec	115.44 sec	Cubic
4	KNN	40,000 obs/sec	32.021 sec	
5	Complex tree	24,000 obs/sec	16.948 sec	

Table II Comparison with existing methods

S. No.	Paper	Classification Method	CA	Software used
1	[13]	Multiscale object-based and pansharpening approach is used for multispectral image classification.	96.6 %	Weka 3.7.7
2	[14]	Multilayer perceptron and KNN fusion method is used for multispectral image classification.	86.4 %	Weka

VIII. CONCLUSION AND FUTURE SCOPE

Guided In the proposed method, by using SVM in combination with a Guided filter, the values of five different spectral information of the 'diseased tree' and 'all other land cover' in the dataset are used to classify them as normal trees or diseased trees. Classification accuracy is calculated for SVM and KNN. The classification accuracy of Quadratic SVM with guided filter is higher than KNN, which is 99.5 %.

Dataset is unbalanced, it needs improvement. The proposed method can be used for other Application areas including Healthcare, Military and Aerospace applications.

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