International Journal of Engineering & Technology, 7 (3.24) (2018) 476-478

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET

Research paper

A Robust Approach for Multi Spectral Image Classification

[*1]K.Radhika, [2]Y.Muralimohanbabu, and [3]SK.M.Shahina

*.[*1]Associate Professor, GIST, Nellore, A.P, India.*
[2]Professor, SITAMS, Chittoor, A.P, India
[3]Assistant Professor, GIST, Nellore, A.P, India.
**Corresponding author E-mail:[*]krkvarma15@gmail.com*

Abstract:

Remote sensing images reveal valuable and sensitive information. The applications of satellite image processing are uncountable. Without classification of any satellite image, it is not possible to interpret into useful information. Different classification methods exist in optical remote sensing, microwave remote sensing, hyper-spectral, lidar, etc. Classification models like support vector machine method, k-means method, k-nearest neighbor method, maximum likely hood method, neural network method, fuzzy logic method, random forest method, etc. are used models in the satellite image classification. The number of classes in the optical image processing or multispectral image processing depends on the usage of the data, software used to simulate the data, processor used to classify the data, etc. The validation process is mandatory to crosscheck the classified result with ground points. More number of ground points gives a better result of a classification. Validation of classified image with ground truth says about the relevance of the points that leads to form a confusion matrix.
This paper presents an adaptive methodology for image classification.

Keyword: Classification, Confusion matrix, Parameters, Image.

1. Introduction

The objective of this work is to investigate the cluster and classification methods to improve the accuracies, to observe the changes that can be viewed in the satellite images. To obtain better results supervised classification is preferred. The proposed approach aims to improve the classification accuracy using ensemble classification by observing the different parameters to decide the classification quality. The major concentration of this research work is carried out by considering images from the LANDSAT-8 and SENTINEL-2 satellites [1]. The ultimate goal of classification is to utilize the classified satellite images for the identification of the changes on earth for different applications. It is also desirable to observe the changes in temporal satellite images, which is the prime focus of the work. The most important question surrounding the selection of satellite image classification method is towards improving the accuracy, precision, and other quality parameters of classification algorithms that correctly produce information in satellite images. Based on the survey and review of articles on satellite image classification, it is imperative to develop a novel classification technique that would detect the underlying information regarding earth surfaces providing sense to this investigation [2].
Many different image classification algorithms have been developed in the past, but image classification still remains a complex and challenging task. A given classification method performs well on one problem domain but performs poorly on a different domain. Thus, it is tough to recommend a generic classification method that is universally applicable for a broad range of problem domains. The purpose of this survey is to identify set of methods that have been used for satellite image classification over the decade and provide an opportunity to view the transitions that have occurred as this research has developed.
Combining several classifiers to build a better classifier is being reviewed in multispectral satellite image classification using ensemble method [3-5]. The ensemble classifier methods are attractive and popularly used in several image classification applications. This research work takes the benefit from, unsupervised segmentation K-means algorithm, support vector machine (SVM) regularization and supervised neuronal technique linear vector quantization (LVQ) by making use of majority vote. LANDSAT 7 remote sensing images are used to validate the developed ensemble classifier. The K-means segmentation provided understanding of the different components in the image, which are improved using SVM classification method. The supervised linear vector quantization technique is employed to improve the opinion of base classifier in ensemble classification. The authors opine that in the ensemble classification process, SVM classifier yielded best results using simple majority vote. The classification of multispectral satellite image for solving the unsupervised landcover with cluster ensemble and self-learning is proposed in [6-7]. The proposed method introduces a label for each cluster ensembles. The maximum likelihood classification scheme is trained with the parameter obtained in the expectation maximization step and used to classify the remaining pixels of the image portion. This classifier learns by itself downsizes the data overlapping from remaining clusters. The performance of clustering worked extremely well on medium and high spatial resolution images than the individual clustering of the ensemble.
A novel neighborhood texture characterization in multispectral imagery is put forth in [8-9]. The technique brings-in point-wise method that is set into a graph model, that explore the radiometric, spectral and spatial details of characteristic pixels to illustrate the textural features in multispectral image. The point-wise method

uses texture descriptors for local extrema key points in the image. The texture features with similar point descriptors are utilized to construct a weighted graph, which is evaluated through spectral graph clustering and the spectral graph wavelet transform based classification algorithm. The researchers have demonstrated that their approach is lesser complex and yielded precise classification accuracy.

2. Proposed Method

Classification accuracy is an important parameter to estimate the quality of classification while extracting information underlying in satellite imagery. This information gives a solution to many problems related to earth sciences. Accuracy, employing a single classifier is not enough in meeting the requirements. Ensemble methods provide accurate results than using a single classifier. The major proposal behind the ensemble methodology is to consider several efficient classifiers and merge all those to get a better classifier that outperforms individual classifiers. For two class or more than two class classification using an ensemble, several classifiers can be combined in intelligent way. In the proposed method, the classifiers that can be selected are 'subspace' or 'Random subspace' and 'Discriminant classifier.

To validate the obtained results, first it needs to have ground truth values with which confusion matrix is generated based on actual and predicted pixels. Based on this confusion matrix all quality parameters are calculated including accuracy. At most care should be taken while collecting samples points or ground truth points and its locations. Generally these locations are in degrees, minutes and seconds. These location points have to be converted into corresponding pixel values of the image, while working with MATLAB software. From the confusion matrix all the required parameters can be calculated using following equations. The confusion matrix gives the way to calculate various quality parameters sensitivity, precision, specificity, kappa, F1 score or F score, Balanced Classification Rate (BCR), Geometric Mean (G-MEAN), etc for all the four classes (A, B, C & D). Remote sensing images are playing a vital role in providing useful information of land use land cover. In remote sensing optical satellite images are very much useful to the society. Satellite remote sensing images provide necessary information that minimizes the difficulty of human fieldwork and required analysis time. Satellite technologies collect images of a particular scene at regular intervals. Due to the latest technology used to get the data and the requirement of equipment for analysis is also latest. Classification of these images place an important role in satellite image processing and it is used to reveal the information of the scene. Validation of the classified image is having equal importance as the image is classified.

3. Results And Discussion

The proposed classifier has been used for classification of the image. The input satellite image, the clustered image and classified image are shown in Figure 1. The classified image has four colors represent water, agriculture, barren land and green land. The classified image is validated with 200 ground truth points. The ground truth points of all classes are collected as class name and location of a point. The ground truth points are denoted with latitude and longitude of the point. The validation process with taken ground truth points gives confusion matrix of multi class (4) as given in Table 1. The matrix contains correct classified points and wrongly classified points.

All the basic confusion matrix values are calculated. These values affect the quality parameters of the classifier. All the required accuracy values are calculated and tabulated in Table 2 The quality parameters of the classification model are calculated from the basic confusion matrix values and tabulated in Table 3. The quality parameters of the proposed ensemble method have been compared with other existing classification models as shown in Table 4. It is clearly identified that the proposed classification model has a better values. The proposed method is producing the accuracy of 83.5%. The proposed method is getting kappa coefficient of 78.15%. This value is calculated with confusion matrix values. The average kappa coefficient is more than the given value.

Table 1: Confusion matrix of Sentinel image

	PREDICTED					
ACTUAL	**CLASS**	**A**	**B**	**C**	**D**	**Total**
	A	30	25	0	0	55
	B	2	39	0	1	42
	C	0	0	51	4	55
	D	0	1	0	47	48
	Total	32	65	51	52	200

Table 2: Measurement of accuracy values of Sentinel image

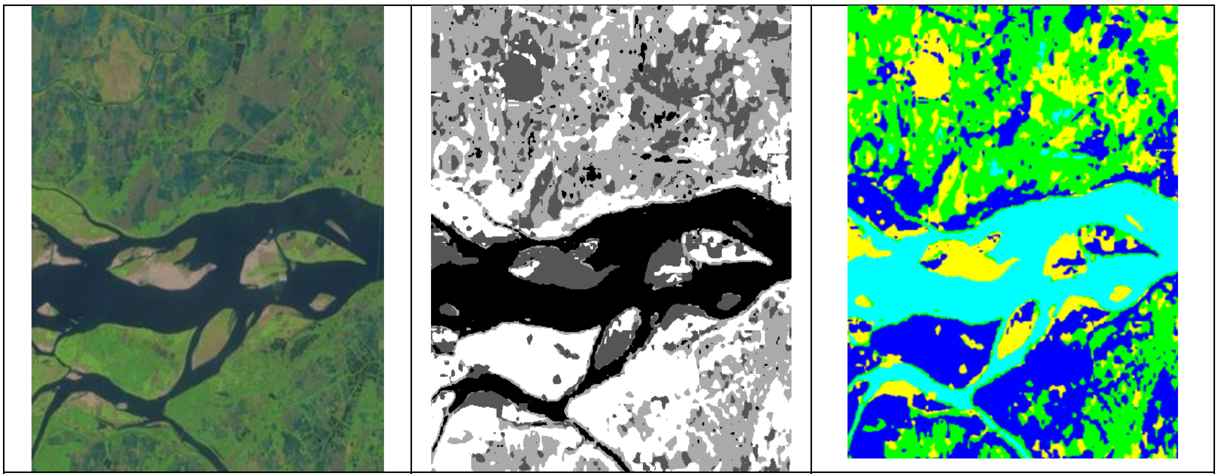
Class Type	Referenced Pixels	Classified Pixels	Matched Pixels	Type of accuracy	
				Producer	**User**
A	32	55	30	93.75%	54.55%
B	65	42	39	60.00%	92.86%
C	51	55	51	100.00%	92.73%
D	52	48	47	90.38%	97.92%
Total	200	200	167	83.5%	
Total Accuracy					

Table 3: Measurement of quality parameters of Sentinel image

Class Type	Accuracy	Precision	Recall	Specificity	F-score	Kappa	BCR	G-MEAN
A	0.8350	0.9375	0.5455	0.9862	0.6897	0.4589	0.7658	0.7284
B		0.6000	0.9286	0.8354	0.7290	0.8942	0.8820	0.8051
C		1.0000	0.9273	1.0000	0.9623	0.9024	0.9636	0.9630
D		0.9038	0.9792	0.9671	0.9400	0.9718	0.9731	0.9570
Over all		0.8603	0.8451	0.9472	0.8302	0.7815	0.8962	0.8635

Table 4: Comparison of different classification methods for Sentinel image

Method	Accuracy	Precision	Recall	Specificity	F-score	Kappa	BCR	G-MEAN
SVM	0.5500	0.5214	0.5778	0.8566	0.5116	0.4161	0.7172	0.6304
KNN	0.5850	0.5406	0.6164	0.8679	0.5374	0.4616	0.7422	0.6590
RF	0.6250	0.7481	0.6482	0.8794	0.6365	0.5093	0.7638	0.6917
ML	0.5800	0.4887	0.5958	0.8647	0.5257	0.4500	0.7302	0.6550
PRO	0.8350	0.8603	0.8451	0.9472	0.8302	0.7815	0.8962	0.8635



Satellite Image | Clustered Image | Classified Image

Figure 1: Input, clustered and classified images of Sentinel image

4. Conclusion

The ensemble subspace discriminant classifier has been tested for the classification of sentinel satellite images. The output of the neural network clustering process and ensemble classifier result are calculated. A total of 50, 100, 150 and 200 ground truth points have been considered for the validation process. From the validation of classified result of satellite image with selected ground truth points give the confusion matrix values. Commission errors and omission errors of all classes have been evaluated. Four types of classes; green lands, agriculture fields, water and barren lands were considered for classification of the scene. The above-mentioned fields have been designated with letters A class, B class, C class and D class and provided in the tables for simplicity. The classes that have been given in the figures as Water class with Cyan, Agriculture class with Green, Barren Land with Yellow and Green Land with Blue color. Producer, user and overall accuracy values are calculated for the proposed method. Quality parameters of classification of images; precision, kappa, recall, BCR, specificity, F score and G-MEAN values of all these classes are calculated for the proposed method. The same procedure has been followed for other state-of-art classification models and all the quality parameters are calculated and compared with the proposed method. It can be seen that the ensemble subspace discriminant classifier has a clear edge in the quality parameters evaluation.

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