Classification Methods for Land use and Land Cover Pattern Analysis

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Abstract—The importance of mapping of land use and land cover is highlighted in this paper. The paper discusses image classification as one way of mapping land use and land cover. Image classification is the process of sorting all the pixels into in an image into a finite number of individual classes .Image classification is further classified into supervised and unsupervised classification. This paper also highlights the numerous ways for image classification.

Index Terms— Image classification, Mapping, Supervised, Unsupervised.

I. INTRODUCTION

The land use and land cover are the two basic approach of describing land. The way humans are making use of the particular piece of land is called land use whereas land cover is the physical material on the surface of landscape. The information signifying the landscape condition and processes that are occurring at a particular place is given by the combination of land use and land cover. Today, research on regional landscape change is one of the most trending topics as it helps in management of land use. The landscape change is a natural process. Accordingly, to improve one's understanding related among landscape structure, natural environment, and human actions, the study of landscape changes is essential. This study helps in defining the magnitude and direction of landscape changes caused by human activities, and provides an essential methodical basis for the sustainable development of the region. Image classification is a method through which the landscape monitoring and assessment can be done. Image classification is one of the most important tasks in geo-computation that are being used to categorize for further analysis and management of land, potential mapping etc. This paper also highlights the numerous ways for image classification for land use and land cover.

II. IMAGE CLASSIFICATION

Image classification is the process of sorting all the pixels into in an image into a finite number of individual classes. Image classification is further classified into two basic classes that is supervised and unsupervised.

A. Supervised Classification

When there is preceding information about the classes present in the image the method used to classify the image is supervised classification.

Some common supervised classification techniques are: Maximum likelihood classifier, parallelepiped classifier.

B. Unsupervised Classification

When there is no preceding information about the classes present in the image the method used to classify the image is unsupervised classification. Some of the common unsupervised classification methods are: K Means, Simple one pass clustering, minimum distribution angle, Fuzzy logic.

III. IMAGE CLASSIFICATION TECHNIQUES

A. K-Means

The K-means clustering algorithm is one of the oldest and simplest algorithm known, which is widely used in the literature, and many authors successfully compare their new proposal with the results obtained by the k-Means. This technique follows a simple way to classify a given dataset through a definite number of clusters. The most important idea in K-Means algorithm is to define K centroids, one for each cluster. As different location causes different result these centroids should be placed in a cunning way. So, to get the better result the centroids should be placed as much as possible far away from each other. In the next step each point belonging to a given dataset is taken and associated it to the nearest centroid. The first step gets complete when there will be no remaining points, and then the recalculation of K new centroids is to be done by taking the clusters resulting from the previous step. After getting these K new centroids, a new binding has to be done between the same data set points and the nearest new centroid. A loop gets generated and as a result of these loop the K centroids change their location step by step until no change is observed. As per [11] their study they found that K-means algorithm gives high accuracy, but is useful for single database at a time. The disadvantage behind the algorithm is the cost of time calculation when the number of cluster is taken high [15]. As per [14] their analysis the algorithm works very well for small value of K but for large value of K the segmentation becomes coarse.

B. Fuzzy Technique

Fuzzy set was introduced by Zadeh in 1965. In fuzzy set theory the membership grade can be taken as a value intermediate between 0 and 1, although in the normal case of set theory membership the grade can be taken only as 0 or 1. The function of the membership grade is called its "membership function" in fuzzy theory. The membership function is to be defined by the user in consideration of the fuzziness.

[3] Fuzzy logic is comparatively a new theory and it has been used in broad range of problem domains, such as pattern recognition and classification, process control, management and decision making. The main advantage of using fuzzy logic in image classification is that it allows the natural description of the problem in terms of linguistic rather than in terms of relationship between precise numerical values. [1] Have suggested that fuzzy approach can be applied to both supervised and unsupervised method of classification. [2] Has suggested that Fuzzy classification methods are able to classify mixed pixels or land cover is not clearly visible. Fuzzy classification may be more appropriate than representing reality through sharp objects and crisp classes. [3] their study suggest that the only problem with the method of Fuzzy Logic is that the classification procedure is strongly influenced by the presence of cloud as these regions are lighter, so they cannot be properly classified.

C. Back Propagation Neural Network

The field of neural networks can be thought of as being related to artificial intelligence, machine learning, parallel processing, statistics, and other fields. The attraction of neural networks is that they are best suited to solve the problems that are difficult to solve by traditional computational methods. The back propagation algorithm was originally introduced in the 1970s, but its importance wasn't fully appreciated until a famous 1986 paper by David Rumelhart, Geoffrey Hinton, and Ronald Williams. Neural networks are built from simple units, sometimes called neurons or cells, by analogy with the real thing. Set of weighted connections are used to link these units. Learning is usually accomplished by modification of the connection weights. Each unit codes or corresponds to a feature or a characteristic of a pattern that we want to analyze or that we want to use as predictor. These networks usually organize their units into several layers. The first layer is called the input layer, the intermediate layer and lastly the output layer. The information to be analyzed is fed to the neurons of the first layer and then propagated to the next layer and so on until the last layer. Each unit receives some information from other units and processes this information, which will be converted into the output of the unit. The goal of the network is to learn or to discover some association between input and output patterns, or to analyze, or to find the structure of the input patterns. The learning process is achieved through the modification of the connection weights between units. Once a satellite image is given as an input, the first and the foremost step is feature extraction. In this step, for each pixel in an image, features like mean, Euclidean distance and RGB values are extracted. Then these extracted features are given to the neural network which is designed and trained by training data to classify each pixel as belonging to one of the output classes and a classified image is produced. If the training sites are not sufficient or they aren't selected from the whole image, unclassified regions are more. [16] Have suggested that the accuracy can be increased by increasing the number of features and sample data. [11] Found that neural network provides good accuracy and is useful for multiple databases to classify satellite image.

D. Maximum Likelihood Classifier

Maximum likelihood classifier is a supervised method of classification which is based on the Bayes theorem. To assign pixel to the class with highest likelihood discriminant function can be used. The key inputs to the function are class mean vector and covariance matrix and can be estimated from the training pixels of a particular class. This method makes an assumption that the training data statistics for each class in each band are normally distributed. Then each pixel is assigned to the class with the highest likelihood or labeled as unclassified if the probability values are all below a threshold set by the user. Maximum likelihood classifier is a good classification method, it is sometimes not able to classify mixed pixel accurately and it may leads to loss of information [6]. Maximum Likelihood classifies pixels based on known properties of each cover type, but the generated classes may not be statistically separable [18]. The maximum likelihood equation is extensive, and it takes long time for computation. As the number of input bands increases the computation time increases [19].

IV. CONCLUSION

The research on regional landscape change has been one of the hot topics as it helps in management of land use. Mapping of Land use and land cover should be done time to time to provides vital information on the state of the environment, development trends and wildlife habitat among others. Mapping of land use and land cover is done using image classification. Image classification is categorized into supervised and unsupervised classification. According to the information that has been retrieved from the image so provided we can choose the appropriate method of classification and apply to get more accurate result.

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