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A review on various approaches of remote sensing based satellite image classification

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ABSTRACT

Image Classification is the process that has been done for the extraction of valuable regions from the image. In this paper various approaches have been discussed that has been used for process of image classification. Supervised image classification and unsupervised image classification has been widely used for classification process. The classification has the major advantage that provides information about the various regions that are scattered over the satellite image. This has been used for prediction of percentage of various regions under different maps. Supervised classification approaches are based on machine learning algorithms that have been used for different types of prediction and decision making processes. On the basis of various approaches that have been discussed in this paper one can predict best approach for image classification process.

Keywords— *Image classification, SVM, Near Neighbor Based, PSO, BAT, MDC, Membrane Computing*

1. INTRODUCTION

1.1 Image Classification in Remote Sensing

Image classification is the process of extraction of valuable information from the remotely sensed images so that various regions from the images can extracted. In this processing of image classification various types of images have been used for generation of thematic maps over the different regions. An image has been divided into different pixel group for extraction of various land cover representation over remote sensing images through satellite. Land cover images divide images into different image representation regions that are urban area, forested area, rocky area, and water region and agriculture area.

1.2 Image Classification Techniques in Remote Sensing

- Unsupervised image classification
- Supervised image classification
- Object-based image analysis

Pixel is the smallest unit of the image that has been used for the representation of the image. Image classification process uses this pixel information and group of different pixels for generation of various groups from dataset. First two classification approaches are mainly used in the process of remote sensing image classification. Another approach that is object-based classification has been used for evaluation of the image regions based on different objects available in the images so that better classification can be done based on training input.

1.3 Unsupervised Classification

Pixel available in the images is used for classification process so that these different pixels can be used for combination and represented as cluster. On the basis of cluster representation various groups of pixels have been divided into different classes. Various numbers of clusters have been used for formation of various brands of the image so that various regions can be extracted.

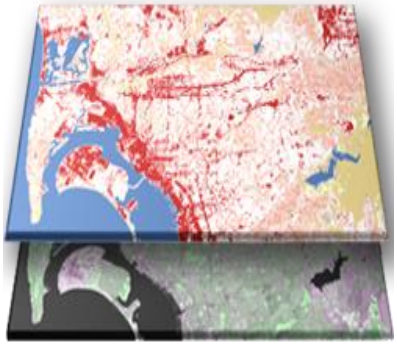

Fig. 1: Unsupervised Classification Example

The image classification software generates cluster. There are so many images clustering algorithm like K-Mean and ISO DATA.

The use identified each cluster with land cover classes. The unsupervised classification image classification approach is used when no sample site exists. Unsupervised classification is that in which classification has been performed on the basis of different classification approaches that based on machine learning that does not utilize any training class for extraction of classes from the remote sensing images.

1.4 Steps for Unsupervised Classification

- Division of image into clusters
- Assign classes

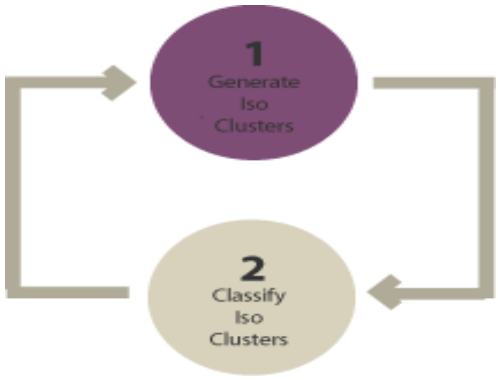

Fig. 2: Architecture of Unsupervised Classification

1.5 Supervised Classification

In remote sensing, Image classification is the procedure of assigning pixel. Various approaches of image segmentation exist and many fields apart from remote sensing. In the process of classification, all raw information has been used for classifying dataset so that effective information can be achieved from dataset. In the processing of image classification various tools have been used for preprocessing of the images so that better classification can be done easily. Remote sensing image classification extracts information about various land covers available in the dataset so that better regions can be extracted and used for various decision development processes. Maximum and minimum like hood classifier has been used for satellite image classification process.

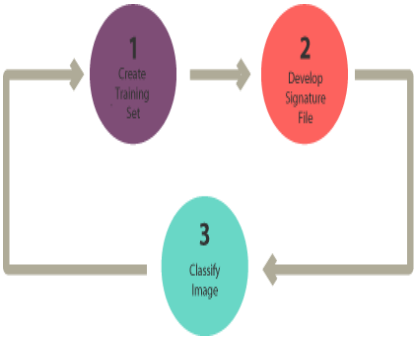

Fig. 3: Supervised Classification Diagram

In the past year, various steps have been carried out for development of efficient classifier so that better classification can be done. Supervised classification mainly depends upon different classification approaches that are liable to training information so that better classification can be achieved. In the processing supervised classification various steps that have to be cared out that have been explained below:

a) Training images has been taken as the input to the system so that various features from these images can be extracted that can be used for the classification process.
b) On the basis of training samples, various images have been used for feature extraction from the training images. Feature selection approach has been used so that various regions features can be evaluated from training images.
c) After extraction of the features from the dataset images various images have been used for the classification process on the basis of features extracted from the dataset images. Similar features have been extracted from the dataset so that classes can be easily evaluated from the testing remote sensed image.

In the processing of classification more number of classes has been selected that causes better classification of remote sensing images. After training of the images, various features have been extracted from the training sample and classes has been extracted from the dataset.

Fig. 4: Representation of Supervised Classification

This figure represents classification based on supervised learning that uses different training input for image classification process. In this process training sample has been input to the system, and features for all the regions available in the training sample has been extracted that can be used for classification process.

In the process of supervised image classification process various sample has been input to the system that contains land cover features. These samples have been represented as training samples for remote sensing image classification. Supervised learning approach uses different training sample for prediction of different contents available in the image that represents various types of information of the images so that best classification can be achieved on the basis of these different samples.

Supervised classification of remote sensing images has been based on this idea in which training features from the input samples can be used for classification process and these features have been used for different classification regions from the testing images. In the recent research combination of the supervised as well as an unsupervised classification has been done so that better classification performance can be achieved.

2. REVIEW OF LITERATURE

Singh et. al. (2015) compared Intelligence Based Techniques in the field of Remote Sensing Image Classification. They concluded that to proper classify remotely sensed images, there is the need for a high-level Computational Intelligence based classifier for the perfect use of land cover features. Computational Intelligence explodes its area based on Swarm Intelligence, Modelization of human mind, nature-inspired and some other intelligent techniques. From these major categories, the author's included Artificial Bee Colony Optimization, Cuckoo Search, Rough Set, Fuzzy Set, Membrane Computing, Minimum Distance Classifier and Maximum Likelihood Classifier for the comparison classification of Alwar region, India. Kappa coefficient was taken as acceptance estimation parameter. User's accuracy & Producer's accuracy are considered to check the accuracy of a solitary land feature.

Jayanth ET. al. (2015) studied and described that the attempts to classify remote sensed data with traditional statistical classification technique faced number of challenges as the traditional per-pixel classifier examine only the spectral

variance ignoring the spatial distribution of the pixels, corresponding to the land cover classes distribution of the pixels, corresponding to the land cover classes and correlation between bands causes problems in classifying the data and its result. The author's used artificial bee colony to improve the performance of classification of data, based upon swarm intelligence to characterize, spatial variations within imagery as a means of extracting information forms on the basis of object recognition and classification in several domains avoiding the issues related to band correlation. The belonging to the classes and other artificial intelligence results showed that ABC algorithm brings improvement of 5% achieved in overall classification accuracy at 6 classes on comparison with MLC.

Kundra and Rana (2015) implemented a new approach in order to find optimized path which is different from the conventional approaches. The newly developed approach acknowledged the problems like terrain mapping, obstacle detection and avoidance, and goal-seeking in cross-country using Swarm Intelligence. A combination of techniques PSO (Particle Swarm Optimization) for finding out the natural paths moreover keeping the obstacle detection from the satellite image, and BCO (Bee Colony Optimization) algorithm for obstacle avoidance and shortest path to the goal was used by the authors.

Prashar and Kundra (2015) implemented the image classification technique using SURF descriptor and SVM classifier. SURF method which is advanced version of SIFT was used to match feature points of training and test images. SVM classifier based on the outcome of feature points then classified images. Through the experiment and analysis of results, better results were achieved in terms of accuracy and matching time.

Woo et. Al. (2014) focused on the computational intelligence approach to classify and detect building, foliage, grass, bare-ground, and road of land cover. They proposed a method, which has high accuracy on classification and object detection by using multi-class Ada-Boost algorithm based on a combination of two extracted features, which are co-occurrence and Haar-like features. With all features, multi-class Ada-boost selects only critical features and performs as an extremely efficient classifier. Experimental results showed that the classification accuracy is over 91% with a high-resolution satellite image.

Chandrakala and Amsayeni (2013) classified the satellite images into 3 different regions as water, urban and green land. The process involves two steps, first training the class images and second classifying the testing image which consists of all the classes based on training image. Speed up Robust Features (SURF) was used to enhance the performance over low-level features like mean and standard deviation. Topic modeling concept was used to obtain Bag of Features (BoF) with Latent Dirichlet Allocation (LDA) algorithm. A threshold value for each class was obtained from BoF and compared with testing image feature values in order to classify it. Experiments were conducted on LANDSAT 7 images obtained from Google Earth.

Nguyen, Kim et al (2014) Terrain segmentation is still a challenging issue in pattern recognition, especially in the application of high-resolution satellite images. Among the various segmentation approaches are those based on graph partitioning, which presents some drawbacks such as high processing time, low accuracy on detection of targets on the large-scaled images such as high-resolution satellite images.[8][9]. Experimental results show that the classification accuracy is over 91% with a high-resolution satellite image.

Hosseini (2009) considers the problem of a natural river often finds the best paths among a number of possible paths in its ways from the source to destination [6] [7] This algorithm is implemented here with a mutation-based local search to find the optimum values for numerical functions. Flowing water drops are observed mostly in rivers or lakes where they form huge moving swarms. The paths that a natural river follows have been created by a swarm of water drops as they are carrying small amount soil with them. IWD algorithm is used here to find optimum solutions of the n-queen puzzle with a simple local heuristic. The Travelling Salesman Problem (TSP) and Multiple Knapsack Problems (MKP) are also solved with this adapted IWD algorithm.

3. APPROACHES USED

- **Artificial Bee Colony Optimization:** ABCO approach has been used based on the natural behavior of bees that have been used by them in daily routine. In this process bees have been divided into three different categories that are Scout Bees, Onlooker Bees, and Employed Bees. In this problem-solving approach employed bees have been survived in the search space region for extraction of food particles. After getting information about the food particles these bees come back to their hives such that best food particles can be extracted and information can be exchanged been other two different categories of bees. Information between different groups of bees has been exchanged on the principle of "Wangle dance". These bees use number of iteration form selection of optimum path to best food source on the basis of fitness function.
- **Cuckoo Search**: in this process, the natural behavior of the cuckoo bird has been used that swarm in the search space for selection of best nest to put his own eggs. Cuckoo bird finds best nest for survival of eggs under different condition based on best solution that has been optimized using different iterations.
- **Fuzzy Set Theory**: in this process, fuzzy membership rules have been used for extraction of valuable information from the source such that various tests of different problems pass and fails based on mathematical formulas. The solution of different problem mostly underlies between different conditions that are true and false.
- **Rough Set Theory:** this is machine learning approach that is based on set theory, on the basis of set theory capturing various approximations have been done that comprises a different number of sets under different simulation and assumption for selection of optimum solution of a problem that has been defined.
- **Membrane Computing:** This is a bio-inspired computing image. It uses membrane as an interface model. This is inspired by biological membrane. Components exist in membrane having placement of multiset object. The feature of membrane is explored. Skin membrane consists of main reason and outside space.
- **Minimum Distance Classifier:** This is supervised image classifier which included in the computational intelligence category. Because of this intelligence behavior, a computational image is classified. The data of unknown image can be classified into a different category with the help of MDC. In this each class is represented its mean vector.

- **Maximum Likelihood Classifier:** This is a very intelligent supervised classifier, which is used for the classification of computational image. Pixels with its maximum belonging feature are classified into it is representative's class. In MDC the first assumption have all the vectors with same field. Computational Intelligence is very intelligent and it has a learning ability. These approaches can be applied for the remote sensing image classification into number of classes' i.e. Water, Vegetation, Urban, Rocky, and Barren, etc.
- **Particle Swarm Optimization:** Particle Swarm Optimization is a very simple algorithm dealing with swarms (groups). Over a number of iterations, a group of variables has assigned values closer to the member whose value is closest to the target location at any given moment. Let's imagine a flock of birds circling over an area where they can smell a hidden source of food. The one who is closest to the food chirps the loudest and the other birds swing around in his direction. If any of the other circling birds come closer to the target than the first, then it peeps louder and the other birds came towards them [5][9]. This tightening pattern continues until one of the birds happens upon the food. It's an algorithm that's simple and easy to implement. Swarm Intelligence is motivated by the behaviors of social Insects utilizing decentralized and self-organization. In particular, it focuses on the combined actions on basic relationships of the agents with each other as well as with their environment that comes from the such as getting best food source, guarding and setting up of best nest structure[7]. These show the brilliant actions at the swarm level and concepts which offer a new opportunity for classification of remotely sensed data. Various features of Nature-inspired algorithms Based on the features many characteristics motivated methods are formulated which depict behavior of insects.
- **Biogeography-based optimization:** Biogeography based optimization is an evolving algorithm that can work arbitrarily and recursively by enhancing individual alternatives with respect to a given evaluation of quality or a fitness function. BBO keeps inhabitants for individual methods to strengthen a problem and build new alternatives by mixing present ones [17].This is the way where objective is to manage as a black box that merely offers an applicant solution and the function's slope is not expected. BBO may usually use to make competent multidimensional real-valued functions, but it does not use the gradient of the function, that means it does not require the gradient of the function as required by classical optimization methods such as gradient descent and quasi-Newton methods. Therefore BBO can be used on discontinuous functions.[20]
- **Bat Algorithm:** Based on the above description and characteristics of bat echolocation bat algorithm with the following three idealized rules:

a) All bats use echolocation to sense distance, and they also 'know' the difference between food/prey and background barriers in some magical way;
b) Bats fly randomly with velocity v at position xi with a frequency fmin, varying wavelength λ and loudness A0 to search for prey. They can automatically adjust the wavelength (or frequency) of their emitted pulses and adjust the rate of pulse emission r ∈ [0, 1], depending on the proximity of their target;
c) Although the loudness can vary in many ways, we assume that the loudness varies from a large (positive) A0 to a minimum constant value A_{min}.

For simplicity, we do not use ray tracing in this algorithm, though it can form an interesting feature for further extension. In general, ray tracing can be computational extensive, but it can be a very useful feature for computational geometry and other applications. Furthermore, a given frequency is intrinsically linked to a wavelength. For example, a frequency range of [20 kHz, 500 kHz] corresponds to a range of wavelengths from 0.7mm to 17mm in the air. Therefore, we can describe the change either in terms of frequency for wavelength λ to suit different applications, depending on the ease of implementation and other factors. Each pixel is associated with a specific histogram bin only on the basis of its own color, and colo

4. CONCLUSION

The classification has been used in various fields so that dataset can be divided into different subsets. On the basis of classification an object class has been predicted so that decision can be made in which class an object have been liable. In this paper a study has been done about the various approaches that have been used in image classification process. Both supervised and unsupervised classification approaches have been discussed in this paper. On the basis of brief study of various approaches of image classification one can conclude that machine learning-based approaches outperform to other approaches in image classification process.

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