A Framework to Classify the Satellite Images

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Abstract— **Satellite image classification uses the reflectance statistics for individual pixels. Unsupervised and supervised image classification techniques are the two most common approaches. The user manually identifies each cluster with land cover classes. It's often the case that multiple clusters represent a single land cover class. The user merges clusters into a land cover type. In order to identify an object we must have its features in the form of a feature vector. This can be achieved by feature extraction. There are various ways of extracting features of an image. It can be based on color, texture or shape. Fuzzy inference system may also be developed for classifying the satellite image. The use of gabor wavelet transform and use of SVM on satellite images to classify the land into crop and non crop land are two better ways.**

Keywords— Gabor filter, SVM, Fuzzy Rules, supervised classification.

I. INTRODUCTION

The classification of satellite images has various issues including image quality. The classification of satellite images depends on various factors like texture, shape, color of an image. Texture is the inborn property of all surfaces that describe visual patterns and contains important information about its arrangement [3]. The Gray level Co-occurrence matrix (GLCM) and the Haar wavelet transform are the techniques for texture analysis.
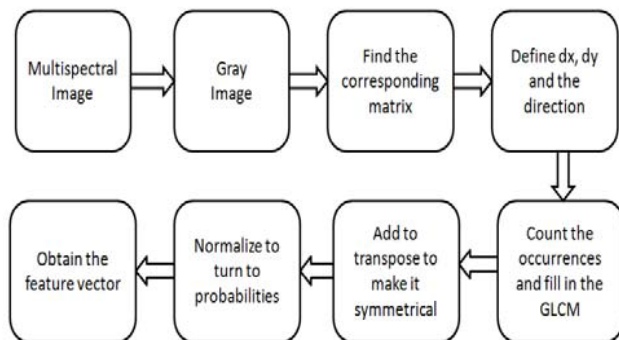

Figure-1: Block diagram of GLCM technique

The process of texture segmentation using gabor filter involves proper design of a filter with different spatial frequencies, orientation to cover the spatial frequency and decomposing the image into number of filtered images [2].

The Support Vector Machines (SVM) [1] is a statistical learning based classification system where the basic idea is to find a hyper plane which separates the n-dimensional data perfectly into its two classes. When data is not labeled, a supervised learning is not possible and an unsupervised learning is required that would find natural clustering of the data in to groups and map these new data. The clustering algorithm which provides improvement to the support vector machine is support vector clustering.

Figure-2: Satellite Image

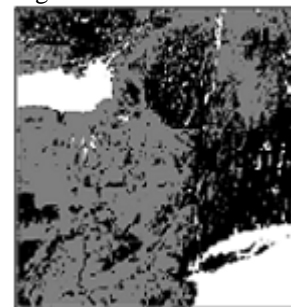Figure-3: GLCM Method

Figure-4: Gabor Filter Method

Figure-5: DFT Method

The figure-2 shows one of the satellite images. When we apply GLCM on the image, the figure-3 will be the conversion. Similarly on applying gabor filter, we get figure-4 and figure-5 on applying discrete fourier transform.

II. SATELLITE IMAGE CLASSIFICATION USING WAVELETS AND FUZZY INFERENCE SYSTEM

Fuzzy logic starts with the concept of a fuzzy set. A fuzzy set is a set without a crisp, clearly defined boundary. It can contain elements with only a partial degree of membership. Reasoning in fuzzy logic is just a matter of generalizing the familiar yes-no (Boolean) logic [9].

Saraswat et al [3] described that object recognition plays an important role in the area of image processing and target based applications. In order to identify an object we must have its features in the form of a feature vector. This can be achieved by feature extraction. There are various ways of extracting features of an image. It can be based on color, texture or shape. The aim of this paper is to study and compare the different texture based approaches for object recognition and feature extraction. The GLCM and Haar wavelet transform are the most primitive methods for texture analysis. In this paper two more techniques based

on their fusion have been considered. These techniques have been tested on sample images and their detailed experimental results along with the method of implementation have been discussed.

The results depend upon a lot of factors like template size, pixel moves, system configuration, spatial distribution of pixels and the complexity of input image. GLCM gives more specific results as compared to Haar Wavelet but takes more time. Hence, when both the techniques were combined, they gave the best results in least time.

It also increases the classification accuracy and reduces the computational burden. Texture analysis has been employed in a variety of applications such as remote sensing, medical image processing, document processing, and classification of land use categories.

Malik et al [9] explained that the base of the classification process is to categorize all pixels in a digital image into one of several land cover classes, or "themes". Fuzzy inference system is developed for classifying the satellite image of 472 x 546 x 7 pixel. The input satellite image was in form of 7 bands which were then reduced to 3 bands.

The analysis of pictures that employ an overhead perspective, including the radiation not visible to human eye are considered. These images were represented in digital form. An image may be defined as a two dimensional function, $f(x, y)$, where x and y are spatial co-ordinates, and the amplitude of f at any pair of co-ordinates (x, y) is called intensity or gray level of monochrome images at that point. Converting the continuous image to digital form requires that the coordinates, as well as the amplitude, be digitized. Digital image is composed of finite number of elements, each of which has a particular location and values.

The overall objective of image classification procedures is to automatically categorize all pixels in an image into land cover classes or themes. The author classified the satellite images using fuzzy logic. The mixed pixel is classified to a specific category.

III. SATELLITE IMAGE CLASSIFICATION USING SVM AS CLASSIFIER

Classification is carried out in two phases in SVM, namely testing phase and training phase. In the training phase the system is being taught using the features extracted and in testing phase, actual classification takes place. The feature extracted for the purpose is the average HSV value as the color feature of a region which is then converted to a semantic color name. In the testing phase, the input is classified by the trained SVM based on the features [1].

Prasad et al [4] investigated the classification of satellite images and multispectral remote sensing data .The paper focused on uncertainty analysis in the produced land-cover maps and proposed an efficient technique for classifying the multispectral satellite images using Support Vector Machine (SVM) into road area, building area and green area. The classification is done in three modules namely (a) Preprocessing using Gaussian filtering and conversion

from RGB to Lab color space image (b) object segmentation using proposed Cluster repulsion based kernel Fuzzy C- Means (FCM) and (c) classification using one-to-many SVM classifier. The goal of this research is to provide the efficiency in classification of satellite images using the object-based image analysis. The proposed work is evaluated using the satellite images and the accuracy of the proposed work is compared to FCM based classification. The results showed that the proposed technique has achieved better results reaching an accuracy of 79%, 84%, 81% and 97.9% for road, tree, building and vehicle classification respectively.

Sowmyashree et al [7] explained earth's surface consists of land features such as vegetation, soil and water, etc. Modeling of the earth's surface requires identification and understanding of the dynamics of land features. Analysis of land feature dynamics would reveal the changes that occur due to human induced activities or natural phenomenon. This plays a major role in providing up-to-date information of the natural resources. Data acquired remotely through space-borne sensors at regular intervals in visible and microwave bands aid in spatial mapping of the land features. Data acquired in visible and IR (Infrared) bands have been used for land use and land cover analysis. However, these data fails when there are cloud cover due to non-selective scattering. In this context, RADAR remote sensing would be useful as it provide information during all seasons due to long penetration properties. In present study, RADARSAT-2 single polarized HH (i.e., Horizontal to Horizontal with C- band) has been used to derive land features with spatial extent. Radar data interpretation and analysis is considered challenging and have both advantages and disadvantages in land use feature extraction.

Classification and accuracy assessment indicate that fused RADARSAT- HH and LANDSAT ETM+ provided best result. A comparison of four classification techniques for three temporal and two temporal co-registered RADARSAT-HH image indicated that contextual classification using SMAP estimation proved best with overall accuracy of 93.2% and kappa statistics of 0.89 (three temporal) and overall accuracy of 91.2% and kappa statistics of 0.85 for two temporal classified image

IV. SATELLITE IMAGE CLASSIFICATION USING GABOR FILTER

Gabor filter is a linear filter whose response is defined by a multiplied Gaussian function. A class of self similar functions known as gabor wavelet then self similar filtered dictionary can be obtained by proper dilations and orientation [5]. Gabor functions provide the optimal resolution in both the time and frequency domains [7].

Milmile et al [6] discriminated the crops using satellite images and textural information. It explained the use of gabor wavelet transform on satellite images to classify the land in to crop and non crop land and to classify different crops. First it enhances the image using color space transform then a filter bank consisting of gabor wavelets is

used to extract texture features from the satellite images. The purpose of using gabor filter as it has the property to isolate texture features according to particular frequency and orientations. In this paper, a texture image database of different crops is created. The texture

The features of input image are compared with the texture features obtained from image database of different crops and different types of crops are identified. Temporal resolution is a key advantage of wavelet transform over Fourier transform in which it captures both spatial and local information. The input image is intensity pattern or texture with in a rectangular window. Then the database consists of 12 different textures classes. A query pattern in the following is any one of the image in the database. This image is then processed to compute feature vector.

Rani et al [5] explained satellite image resolution and brightness enhancement technique based on the Gabor wavelet transform has been proposed. Satellite images are used in many applications such as geosciences studies, astronomy, and geographical information systems. The input image is enhanced first using Color Space Transform and then a filter consisting of Gabor wavelets is used to extract texture features from the satellite image. The feature formation process models the texture features from Gabor filter as a Gaussian distribution. The use of Gabor filters is driven by the potential they have to isolate texture according to particular frequencies and orientations. The parameters that define a Gabor filter are its frequency, standard deviation and orientation.

Marmol et al [8] proposed a texture approach for building and vegetation extraction from LIDAR and aerial images. The authors have used Gabor filter based method and its implementation is done for texture analysis. This approach is inspired by a multi-channel filtering theory for processing visual information in the human visual system. In the research visual system decomposes the image into a number of filtered images of a specified frequency, orientation and amplitude.

The objective of this work is to detect urban objects and tress. The first step is varying the gabor filter parameters, a filter bank is obtained that covers the frequency domain almost completely. These filters are used to aerial images and LIDAR data. The filtered images that possess significant information about analyzed objects are selected and the rest are discarded. Then an energy measure is defined on the filtered images in order to compute different texture features. The tests were performed using set of images containing very different landscapes: urban area and vegetation of varying configurations, sizes and shapes of objects. The obtained preliminary results are interesting. Texture analysis can be used in the process of object detection. In the case of aerial images, the trees have been detected correctly, but their size has been underestimated.

The researches have been done in this field and results found are studied in this paper. The satellite images may be of various types. The work belongs to these different types of images are studied through some research work. The authors have also used different classifier techniques such as gabor filter and SVM etc. It would be interesting to compare this method with other known methods of edge extraction. Only single pulses reach the ground surface but it was not enough for the textural analysis.

V. CONCLUSION

The different technologies may be used to classify the satellite images. The various classifiers may be neural networks and SVM etc. Textures are extracted using haar wavelet transform or GLCM. Various researches done in this field shows that satellite images may be detected efficiently through different algorithm. These methods have some limitations like unable to detect the trees in dense forest through available LIDAR data and determination of edges is not clear. A method is useful for satellite image classification towards river image, residential image, forest image, agricultural and mountain using Gabor filter with the feature extraction. These features are texture, color and shape. These features may then be trained with the help of SVM training module and then classify the satellite image into five categories with the use of support vector machine (SVM) classifier.

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