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AN INGENIOUS TEXTURE AND SHAPE FEATURE EXTRACTION IN REMOTE SENSING IMAGES BY MEANS OF MULTI KERNEL PRINCIPAL COMPONENT ANALYSIS WITH PYRAMIDAL WAVELET TRANSFORM AND CANNY EDGE DETECTION METHOD

N. Balakumar and K. Ragul
Department of Computer Application, Pioneer College of Arts and Science, India

Abstract

In the rapid growth of the digital world, the dealing of remote sensing image is increased day to day in context with the extraction of information. The feature extractions had been an exigent part among the research to classify the remote sensing images for legitimate information reclamation. In such context this paper focus on the extraction of information from remote sensing images by means of classification of spectral classes. Texture and shape is one of the important features in computer vision for many applications. Most of the attention has been focused on texture features with window selection and noise models. This problem can be overcome through Multi Kernel Principal Component analysis with pyramidal wavelet transform and canny edge detection method for extracting feature in high resolute images based on texture and shape. In this paper, proposed Multi Kernel Principal Component analysis utilizes to extract common information and specify common sets of features for further process and reduces dimensionality. Pyramidal wavelet transform is used to extract texture perception for visual interpretation and it decomposes the images into number of descriptors. So texture can be extracted in an image with tree-structured wavelet. Finally, an edge detection technique identifies the boundary regions from the classified remote sensing image, which is taken as shape feature extraction. The performance of this proposed work is measured through peak signal to noise ratio, Execution time, Kappa analysis and structural similarity for a various remote sensing dataset images.

Keywords:

Feature Extraction, Texture, Edge Detection, Remote Sensing Images

1. INTRODUCTION

Remote sensing image feature extraction plays an imperative role in an extensive range of applications and hence has been in receipt of remarkable attention. During the past existence, noteworthy efforts have been made to develop various modus operandi or present a variety of approaches for feature extraction from remote sensing images. The hasty spreading out of the technology world and the wide use of digital image has been increased the call for both competent image database creation and retrieval course of action. The challenge in image retrieval is to develop methods that can capture the vital distinctiveness of an image, which makes it unique and allow its accurate classification [9].

The feature is defined as a function of one or more dimensions; each of which specifies some irrefutable property of an entity and is computed such that it quantifies some important uniqueness of the object [16]. Analysis of texture and shape is important in many applications of computer image analysis for classification, segmentation of images based on local spatial patterns of intensity or color [12]. Texture is a fundamental feature to describe image, but the majority of texture descriptors are based on regular images or regular regions and do not consider the color information. Shape is an important illustration characteristic and of the primordial feature for image content depiction [14]. Shape features are very significant features, which are very close to human perception. Many methods have proposed to extract texture features either directly from the image statistics or image classification.

Feature extraction is a special form of dimensionality reduction and contains more information about the original image [17]. The input data, which is to be processed, is transformed into a reduced representation set of features [24]. This proposed work, shows both texture and shape feature extraction in high resolute satellite images in efficient way. In the preprocessing process, Initially Gaussian noise added to remote sensing image and multi-level 2-D wavelet construction applied to get denoised image. Newly proposed Multi Kernel Principal Component analysis utilizes to extract common information and specify common sets of features for further process and reduces dimensionality [5]. Its shows that using multiple kernels is more useful when combining kernels in a nonlinear or data-dependent way seems more efficient than linear combination in fusing information provided by simple linear kernels. Next, Fuzzy C-Means clustering algorithm [1] finds the similar points without actually knowing the labels and attributes from other which can be distinguished through color conversion method to extract color features [15].

Wavelet transforms represents a function as a superposition of a family of basic functions called wavelets. Pyramidal wavelet transform decomposes the image into three levels of sub images in horizontal, vertical and diagonal directions with various resolutions corresponding to the different scales. Textures extraction can be found or artificially created in an image with tree structured wavelet. In this Canny, edge detection operator is used to find boundary regions in an image, which is taken as shape feature. The purpose of edge detection is to smoothen the images and to acquire the gradient of the image, which is to specify the presence of edges [3]. Finally, the performance of this proposed work is measured through peak signal to noise ratio, Execution time, Kappa analysis and structural similarity measure for a various remote sensing dataset like MODIS and Quick Bird.

2. LITREATURE REVIEW

Pfeifer [2] et al. proposed an unsupervised data integration method based on kernel principal component analysis. Therefore it present on the scoring function to determine the impact of each input matrix. The approach enables visualizing the integrated data and subsequent clustering for cancer s subtype identification. The direct extension of KPCA for several data sources does not allow for data integration is shown in the paper. The best combination of the input data is determined by the scoring function over five cancer data sets in the proposed work.

Sheelarani [1] et al. in their paper have used the Reformed Fuzzy C-Means algorithm for land cover classification. The most basic attribute for clustering of an image is its luminance amplitude for a monochrome image and colour components for a colour image. There are many colours available where the classification becomes very so this algorithm is being to classify the images effectively using colours. The segmented images are compared using image quality metrics. The image quality metrics used are peak signal to noise ratio (PSNR), error image and compression ratio. The time taken for image segmentation is also used as a comparison parameter. The techniques have been applied to classify the land cover.

Can [7] et al. have made an attempt to present a different algorithm for MR image segmentation KFCM Kernelized Fuzzy c-means) using fuzzy c-means by altering the objective function of fuzzy c-means algorithm via implementing kernel distance and also altering spatial information of membership functions. The basic idea involved in their algorithm is to portray the centers of all the clusters as a sum of linear combination of an implicit non-linear map. Along with this, they have also introduced a spatial constraint for KFCM. They have introduced spatial information in the form of penalty which replicates its works as a regulator and helps to label the pixel that is associated with its neighborhood. Working as a regulator, the spatial constraint can alter the solution towards piecewise uniform labeling. This spatial constraint helps in image segmentation especially those that are corrupted by noise. Their approach implemented in a straight forward fashion to improvise the efficiency of conventional FCM methodologies.

Vignesh et al. in [4] implemented the canny edge detection algorithm in FPGA device, and it is applicable for image segmentation, image tracking, image coding etc. In his paper Canny edge algorithm reduces memory requirements, decreased latency, increased through output with no loss in edge detection performance and canny edge detection algorithm use probability for finding error rate localization and response in various images.

3. METHODOLOGY

The system architecture is represented as our proposed work is given in the Fig.1. It consists of noise removal, image enhancement, proposed Multi Kernel Principal Component Analysis, Pyramidal wavelet transform, edge detection methods.

3.1 PREPROCESSING

The main aim of image restoration is to remove noise from the original image. So Gaussian noise is added and it is removed through multi-level 2D wavelet decomposition which select pixels form image and decomposes features into blocks such as horizontal, vertical, diagonal bands.

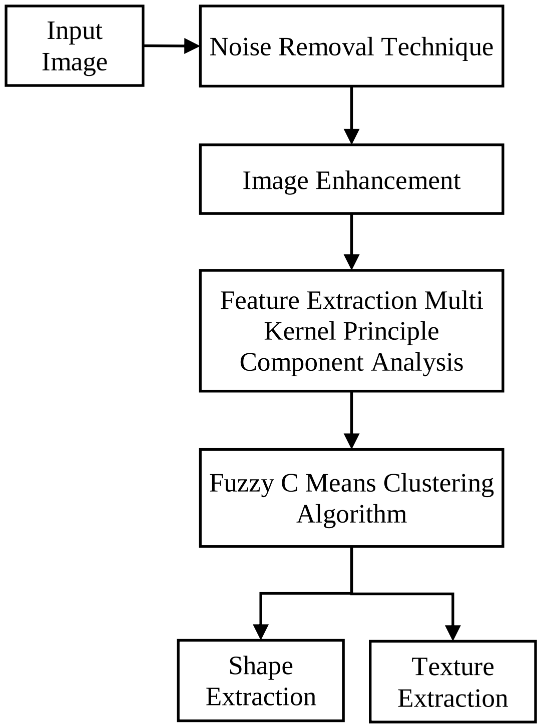


Fig.1. System Architecture

3.2 IMAGE ENHANCEMENT

Image enhancement is to improve the quality of the image [22]. It is quite easy, to make an image lighter or darker, or to increase or decrease contrast.

3.3 MULTI KERNEL PRINCIPAL COMPONENT ANALYSIS

Multiple Kernel Learning methods aim to construct a kernel model where the kernel is a linear combination of fixed base kernels [10]. Learning the weighting coefficients for each base kernel is more efficient [19].

3.3.1 Constructing the Kernel Matrix:

Nonlinear transformation $\varnothing(x)$ from the original D feature space to an M feature space, are usually denoted as $M > D$. Then each data point x_n is projected to a point $\varnothing(x_n)$. Traditional PCA can perform in the new feature space, but extremely costly. Thus, kernel methods are used to simplify the computation.

By assuming that the projected new features have zero mean:

$$\sum_n \varnothing(x_n) = 0 \tag{1}$$

The covariance matrix of the projected features is $M\times M$, calculated by

$$C = \frac{1}{N}\sum_{n=1}^{N} \varnothing(x_n)\cdot\varnothing(x_n)^T \tag{2}$$

and its eigenvalues and eigenvectors are

$$Cv_i = \lambda_i v_i \tag{3}$$

where, i = 1.2…M. From (2) and (3), we have

$$\frac{1}{N}\sum_{n=1}^{N} \varnothing(x_n)\cdot\left\{\varnothing(x_n)^T v_i\right\} = \lambda_i v_i \tag{4}$$

which can be written as

$$v_i = \sum_{n=1}^{N} a_{in} - \varnothing(x_n) \tag{5}$$

Now by substituting v_{in} Eq.(4) with Eq.(5), we have

$$(x_n)\varnothing(x_n)^T \frac{1}{N}\sum_{m=1}^{N} a_{im}\varnothing(x_m) = \frac{\lambda_i}{N}\sum_{n=1}^{N} a_{in}\varnothing(x_n) \tag{6}$$

By defining the kernel function

$$k(x_n, x_m) = \varnothing(x_n)^T \varnothing(x_m) \tag{7}$$

and multiplying both sides of Eq.(6) by $Ø(x_i)T$, we have

$$\frac{1}{N}\sum_{n=1}^{N} k(x_i, x_n) \sum_{m=1}^{N} a_{im} k(x_i, x_n) = \frac{\lambda_i}{N}\sum_{m=1}^{N} k(x_i, x_n) \tag{8}$$

or the matrix notation

$$K^2 a_i = \lambda_i N K a_i \tag{9}$$

where,

$$K_{n,m} = k(x_n, x_m) \tag{10}$$

and a_i is the N-dimensional column vector of an_i. a_i can be solved by,

$$Ka_i = \lambda_i N a_i \tag{11}$$

and the resultant kernel principal components can be calculated using

$$y_i(x) = Ø(x_n)^T \underline{v_i} = \sum_{n=1}^{N} a_m\, k(x,x_n) \tag{12}$$

The power of kernel methods is that we do not have to compute $Ø(x_n)$ explicitly. Kernel matrix can be constructed directly from the training data set (x_n).

The Linear kernel is the simplest kernel function. It is given by the inner product $<x,y>$ plus an optional constant c. Kernel algorithms by means of a linear kernel are often equivalent to their non-kernel counterpart, i.e. KPCA with linear kernel is the same as standard PCA.

$$k(x,y) = x^T y + c \tag{13}$$

where $c > 0$ is a constant, and the Gaussian kernel

$$k(x,y) = \exp k(-\|x-y\|^2/2\sigma^2) \tag{14}$$

with parameter σ.

The standard steps of kernel PCA are:

1. Construct the kernel matrix K from the training data set $\{x_n\}$ using Eq.(10).
2. Use Eq.(11) to solve for the vectors a_i (substitute K with K_e).
3. Compute the kernel principal components $y_i(x)$ using Eq.(12).
4. The multi kernel function is computed by combining Eq.(13) and Eq.(14).

3.4 FUZZY C-MEANS CLUSTRING ALGORITHM

A cluster is a collection of data objects that are similar or dissimilar to one another within the same cluster or to the objects in other clusters [6] [15]. In clustering, dense and spare regions can be identified and find out overall distribution patterns and interesting correlations among data attributes [12]. Fuzzy C-Means (FCM) is a clustering algorithm which allows one portion of data to two or more clusters [25]. It is depend on minimization of the following objective function.

$$J_m = \sum_{i=1}^{N}\sum_{j=1}^{C} u_{ij}^m \left\|x_i - c_j\right\|^2, 1 \le m < \infty \tag{15}$$

In this m is any real number lesser than 1, u_{ij} is the degree of membership of x_i in the cluster j, x_i is the i^{th} of d-dimensional measured data, c_j is the d-dimension center of the cluster, and ||*|| is any norm expressing the similarity between any measured data and the center [21].

- Number of clusters to be selected.
- At each point coefficients are assigned arbitrarily for being in the clusters.
- Repeat until the algorithm has meet
- Assign the centroid for each cluster, using the formula above.
- Compute each points coefficients of being in the clusters.

The algorithm minimizes intra-cluster variance, local minimum, & the results depend on the initial choice of weights [8].

3.5 TREE STRUCTURE WAVELET

In this tree structured wavelet the given textured image gets decomposes with 2D two-scale wavelet transform into four sub images [11]. Now calculate the energy of each decomposed image.

$$e = \frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N}\left|x(m,n)\right| \tag{16}$$

If the energy of a sub image is lesser than others, it stops the decomposition in this region. This step can be attained by comparing the energy with the largest energy value in the same scale. If the energy of a sub image is significantly larger, apply the above decomposition procedure to the sub image.

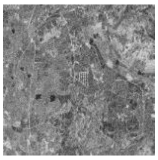
3.6 SHAPE EXTRACTION

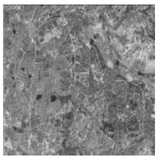
Edge detection is one of the most commonly used operations in image analysis [13]. The edges form the outline of an object. An edge is a boundary between an object and the background, and indicates the boundary between overlapping objects. The purpose of edge detection is to smoothen the images and to acquire the gradient of the image, which is to specify the presence of edges.

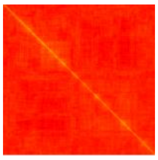
4. RESULT

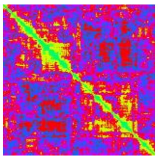
To test the system for accuracy of the feature extraction, two datasets are chosen that are multi resolute images in nature. The datasets which are considered in the experiment is MODIS and Quick Bird remote sensing images. The clarity of the images lies on the quality aspects as a part of image enhancement techniques after preprocessing. In such a case, the Gaussian noise is added to the remote sensing image and multi-level 2-D wavelet construction is applied to get denoised image. The proposed Multi Kernel Principal Component analysis [20] is implemented on the enhanced remote sensing image in a global dimensionality reduction approach, which uses the directions of maximum variance in the centered data. The propose technique extracts common information and specify common sets of features for further process and reduces dimensionality of features [18]. Then, the Fuzzy C-Means (FCM) [23] is a clustering algorithm which allows one portion of data to two or more clusters is applied in the dimensional image sets. The decomposed of the resultant image after the classification process is done by means of Pyramidal wavelet transform. In which the signal is passed through a low pass and high pass filter, and the filters output is decimated by two. Thus, wavelet transforms extract information from signal at different scales. The edge detection technique is used for feature extraction respectively for various remote sensing images. The efficiency of the proposed work is computed through peak signal to noise ratio, Structural similarity, Execution time and Kappa analysis and it shows best results for extracting texture and shape features for remote sensing images which is tabulated below. The experimental results of Modis (Fig.2) and QuickBird (Fig.3) Datasets are shown below,


(a) Original image


(b) Denoised Image


(c) Enhanced Image


(d) Multi-Kernel PCA


(e) Fuzzy C-Means

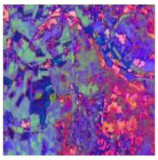
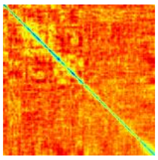

(f) Color Extraction

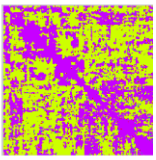
Fig.2. Experimental Results of Modis Dataset


(a) Original image


(b) Denoised Image


(c) Enhanced Image


(d) Multi-Kernel PCA


(e) Fuzzy C-Means

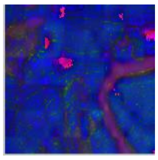

(f) Color Extraction

Fig.3. Experimental Results of Quickbird Dataset

Table.1. Performance metrics for MODIS and QUICKBIRDS Datasets

Performance metrics	Modis	Quick bird
PSNR	55.547	62.84
Execution Time	9.317	11.524
Structural Similarity Measure	6.014	1.402
Kappa Analysis	124.031	2.106

5. CONCLUSION

The significant development of remote sensing technology over the past decade has been providing us explosive remote sensing data for intelligent earth observation such as feature extraction using remote sensing images. However, the feature extraction, extracts ideal feature that can reflect the intrinsic content of the remote sensing images as complete image interpretation. The experiment shows that the implemented proposed Multi Kernel principal Component Analysis has been developed for the corresponding remote sensing image feature extraction and Fuzzy C-Means clustering algorithm for image segmentation scheme has been presented. The experimental result shows that the shape and feature extraction from the proposed technique and algorithm of the remote sensing data performed better by comparing with the other techniques. By using these two algorithms the PSNR, SSIM, Kappa and Execution time are deliberate for different remote sensing images to show the performance metrics of the experiment.

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