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Research paper

A Study on Image Retrieval Based on Tetrolet Transform

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Abstract

Retrieving images from the large databases has always been one challenging problem in the area of image retrieval while maintaining the higher accuracy and lower computational time. Texture defines the roughness of a surface. For the last two decades due to the large extent of multimedia database, image retrieval has been a hot issue in image processing. Texture images are retrieved in a variety of ways. This paper presents a survey on various texture image retrieval methods. It provides a brief comparison of various texture image retrieval methods on the basis of retrieval accuracy and computation time. Image retrieval techniques vary with feature extraction methods and various distance measures. In this paper, we present a survey on various texture feature extraction methods by applying tertrolet transform. This survey paper facilitates the researchers with background of progress of image retrieval methods that will help researchers in the area to select the best method for texture image retrieval appropriate to their requirements.

Keywords: *Image retrieval, tetrolettransform,Texture image retrieval,Content based retreival*

1. Introduction

Image retrieval has been an emerging issue due to the big volume of multimedia data. There are two basic approaches for image retrieval: text based image retrieval and content based image retrieval. Text based search has been proved ineffective in various image search applications because it creates a huge semantic gap between human perception and system understanding. Since the digital image databases are continuously growing in size because of this, traditional text based searching methods are inadequate to retrieve the image from the large databases. Image annotation cannot be performed on large databases to increase the retrieval performance. Similarly it is also difficult to express features of an image like color, texture, shape and object within the image perfectly. Another problem with text based search is that it increases linguistic problem to share images worldwide. To overcome these problems associated with text based search, Content based image retrieval (CBIR) is used. Content based image retrieval (CBIR) plays a vital role in digital image processing. Themain techniques of CBIR represent the visual features like color, texture and shape. Indexing ofimages is performed only on the basis of these visual features. Main benefit of using CBIR is thatit has the ability to deal with visual queries. Indeveloping a CBIR system main issue is to achieve higher accuracy. Wavelet transform provides multi resolution analysis of an image with color and texture features [27]. This approach provides higher retrieval accuracy despite not possessing very high dimension of feature vector.

However, method proposed survey focuseson image retrieval using a CBIR technique based on terolite transform. Basically texture represents the roughness of the image surface. It is a low level visualfeature which deals with the surface properties of an image. Texture characteristics are present in many real world images like clouds, trees, fabrics, bricks, hairs, etc. Texture images are extensively used in medical images analysis. This method employs the concept of tetrolet which is a special case of 'Haar' wavelet. Images areanalyzed with all possible rotations and reflections. There are total of 117 possible combinations, and this approach selects one best tile among 117 possibilities. A strategy is designed using tetrolet transform which makes image retrieval process rotation invariant. Image retrieval performance is measured in terms of average retrieval precession and average retrieval recall rate:

$$\text{Precision :PIc} = \frac{\text{Number of relevant images retrieved}}{\text{Total number of images retrieved}}$$

$$\text{Recall :RIc} = \frac{\text{Number of relevant images retrieved}}{\text{Total number of relevant imagesin the database}}$$

The computational time depends on feature extraction time and searching time and also partially depends on the distance measure method. An effective image retrieval system must have high precession and recall values for getting better performance.

2. Related Works

Raghuwanshi and Tyagi,[6] in their paper, they propose a method for texture image retrieval based on adaptive tetrolettransforms. At each decoposition level, tetromines are applied and the best combination of tetromines is selected. High pass component of the decomposed image at each level is used as input values for feature extraction and also by taking the standard deviation in combination with energy at each subband. Experimental evaluation is done based on the texture image taken from database. The accuracy of propose system is 84.4%.The terolet transform has the advantage of adapting itself to image geometry, hence it eliminate the need of taking specific direction for feature extraction. This method is also tested on rotated image set and the performance is found to be good.

Deok Chun et al.,[15], propose a content base image retrievel based on a combination of texture feature and multiresolution.

Texture features and colours are extracted from the multiresolution wavelet domain and is combined. Feature vector dimension is determined at the point where the retrieval accuracy becomes saturated.Experimentalanalysisgives higher retrieval accuracy than the conventional existing methods, even though its feature vector dimension is not higher than those of the latter Moreover the proposed method showed high gain performance in both precision and recall .As further studies, the proposed retrieval method is to be evaluated for more various DBs and to be applied to video retrieval.

Jens Krommweh,[7],proposed a new method for image representation for sparse image called new adaptive haar wavelet transform called Tetrolite Transform, which make use of tetrominoes which are shapes made by connecting four equal-sized squares. This method make use of fast filter bank algorithm, which is more simple and effective. The basis functions have tetromino support and are able to adapt different directions in images.Ineach level of the filter bank algorithm we divide the low-pass image into 4X 4 blocks. Then in each block we determine a local tetrolet basis which is adapted to the image geometry in each block. The approximation qualityoftetrolet can be improved by using a suitable post-processing step. The numerical analysis shows the strong efficiency of the TT for image approximation.

Cuiping Shi et al.,[8] their paper focused on two problems 1) the remote sensing image contain lot of information, its difficult to obtain a good sparse performance. 2) Based onthedesignspecializationofdecomposition processes. Proposed method make use of two specialized processes of decomposition, for increasing the energy concentration and information preservation. For a remote sensing image,tensor product wavelet transform is used and the redundancy among adjacent wavelet coefficients is removed by making a polyphase decomposition to each subband with a p-foldfilter. Then the approximation of the low frequency image is obtained by reconstructing the preserved coefficients. For detailed image, the sparse decomposition is carried out by the tetrolet transform. Numerical analysis indicate the effectiveness of the proposed system for remote sensing sparse image.The limitation of the proposed method is that, the ratio of N1 an N2 is set empirically. Future researches will focus on the automatic calculation of the ratio to allocate the given number of coefficients properly.

Nitheesh et.al,[9] their paper proposed, Haar wavelets technique for defining tetrominoes to form a localized orthonormal basis.The procedure is applied on small 4×4 partitions of the low pass image and the sparsest covering from each partition is stored the non-redundancy in the wavelet basis result in sparse image representation. The compression ratio obtained as a result is very high which in turn shows the efficiency of the proposed system. The reduction infile size allows more images to be stored in the given memory space.Experimental results prove that Tetrolet Transform achieves similar reconstruction results as compared to tensor product wavelet transform using lesser number of coefficients. This compression technique can also be used for image denoising. Further study can also be well extended to otherimage processing areas such as face recognition, edge detection and video editing etc.

Yang Hui-xian,[10] in their paper, to overcome the limitation of traditional illumination invariant methods for single sample face recognition, a modified version of gradientface named adaptively weighted orthogonal gradient binary pattern (AWOGBP)is proposed, which is proved to be robust to illumination variation. Tetrolet decomposition is used to get different band information of face images. This method also combines the illumination preprocessing and illumination invariant feature extraction to achieve a good performance for face image recognition. The principle component analysis method is used finally for dimensionalityreuction and nearest neighbour classifier is used for face image classification and recognition. Experimental results on CMU PIE and Extended Yale B face databases indicate that the proposed method is significantly better as compared with related existing system.

Abdelouahad et al ,[11] proposed a new method to reduced reference image quality assessment (RRIQA) using a statistical features extracted in the tetroletdomain.Firstly, they decompose the reference and distorted images and tetrolet coefficients is applied for each image. Secondly, a marginal Generalized Gaussian Density (GGD) model is applied to each subbandcoefficients.Finally, the distortion measure is computed using the KullbackLeibler Divergence (KLD) between GGD Probability densityfunction (PDFs). Experimental results show the efficiency ofthe proposed method when comparing to other exiting system. Future study of RRIQA method may give importance to additional storage information and to reduce the adaptivity cost

Wang et al.[12],proposed a new image restoration method based on a compound regularization model associated with the weighted anisotropic total variation (WATV) and the tetrolets-based sparsity. The WATV helps to recovers sharp edgesby embedding two directional gradient operators into the original anisotropic totalvariation (ATV), and the tetrolet transform adapts its basis to the local image structures.This model has theadvantage of edge preservationsuch as textures and edges in the processing ofimage restoration by combining the WATV with the tetrolets-based sparsity moreover, they present an alternate iterative scheme which consists of the variable splitting methodand the operator splitting method to solve the proposed minimization problem.Experimental results proves that the proposed method leads to high PSNR and SSIM measures, and they preserves the structure details and the edges of images.

Xin Zhou etal.,[13] this paper, tetrolet transform are applied to the images which are fused to obtain high-pass and low-pass subbandson different scales, followe by the application of local region gradient information to low-pass subbands to get the low-pass fusion coefficients. Finally, theinversetetrolet transform was utilized to obtain fused image. Variety ofimages are used to perform fusion experiment and the results shows that the fusedimage has more abundant features and more amount of information. The tetrolet transform can preserve the infrared and visible image's feature information, enhance the fused image's space detail representation ability, and improve the fused image's information. Compared with the traditional fusion algorithms, the fusion algorithmpresented in this paper provides better subjective visual effect, and the standarddeviation and entropy value has been increased.

Ceylan et al.,The main aim of the proposed system is comparing the image denoising abilities of existing sytems with wavelet transform. Image denoising is implemented by a three-stage methodology. Effectiveness of the multiresolution analysis methodologies has been investigated for standard test images beside magnetic resonants, mammography and fundus images. Performance measure of the transforms are compared by using peak signal to noise ratio, mean square error, mean structural similarity index and feature similarity index. The best results are obtained by tetrolet transform for random and rician noises with the database images. Future scope, different thresholding methods can be applied to improve the performances of the transforms. TT and FGCT have the longest-running processes, so a time-comparative study between these transforms could be realized.

Ramaswamy et al.,[18]In this author proposed a geometric adaptivetransform method for image denoising. The basic functions have tetromino support that can adapt to different directions in images. The Haar-typeTetrolets produce a fast filter bank algorithm which offers good approximation results even for natural images. A second reason ,a small support of the Tetrolets can leads to small filter mask of length four. For applying thetetrolet transform for imagedenoising, a combinationofTetrolet transform with a pre-processing scheme must be use. A combination of tetrolet with bilateral filter provide better smoothness and edge preservation at the time of

image denoising . The results show that the proposed algorithm provides a better performance in the image denoising than other traditional methods.

Vasimbabu,et al,[16**],** proposed a novel methodologyto classify a given MR brain image as normal or abnormal by using OTSU binarization segmentation in association with tetrolate transform. By replacing the wavelet transform with tetrolate transform the classification is made more effective for images with different geometric shapes. A good number of features are extracted by using OTSU binarization, more number of features makes the classification more effective and accurate. More over for better accuracy the image is finely segmented to pixel by pixel. Comparitive analysis of the proposed methods with four different kernels LIN (Linear), HPOL (Homogeneous Polynomial), and IPOL and GRB (Gaussian Radial Basis function) kernel is one to achieve the highest classification accuracy.

Durga Singh et al.,[17], proposed a method to overcome the drawback of losing high frequency component that suffer the resolution enhancement. The proposed method make use of wavelet domain based image resolution enhancement technique using terolet transform for satellite image enhancement using fourier transform. Proposed method make use of inverse Tetrolite Transform to generate a new resolution enhance image from the interpolation of high frequency subband image and low resolution image from an input.Signal to noise ratio (PSNR) calculated shows the efficiency of the proposed system over the other image enhancement system.

Jain et al., [19], paper presents a novel edge-preserving image denoising technique based on tetrolet transform to preserve edges. In the proposed method, a local structures of image are taken into account during decomposition with the help of adaptive haar wavelet transform (Terolet Transform). In this method the redundancy is exploited to achieve significant gain in denoising performance. It also helps in estimating noise varience. Thresholding is done in subband-dependent manner to suppress noise so as to preserve finer details and geometrical structures in the original image. This method denoises square natural gray-scale images with dimensions in the exponential order of two. Both the quantitative and qualitative analysis of the results indicates the efficiency of the proposed method in effectively suppressing the Gaussian noise without eliminating the image details.

Thayammal et.al,[20], the proposed work develops a multi spectral band image compression technique using adaptive haar wavelet transform. This method make use of filter bank algorithm, the tetrolet transform coefficients of input image are obtained. Thresholding and encoding steps are used to achieve compression ratio of the image. The image reconstruction is done by using decoding and inverse tetrolet transform. This proposed method produces an improved performance than existing extended shearlet based compression technique and simulation results show that the proposed method produces better performance than extended shearlet based compression technique on the basis of peak signal to noise ratio (PSNR),[37] compression ratio(CR) and bits per pixel (bpp).The future work will focus on implementation of shearlettransfonn using filter bank decomposition algorithm and find out optimum number of directions to be used for preserving geometric features of multispectral band image.[38]

Table 1: Comparion Table for Findings based on Image Retrival Using Tetrolite Transform

Author & year	**Findings**	**Advantage**	**Disadvantage**
Raghuwanshi & Tyagi, 2015	Texture image retrieval using adaptive tetrolite transform	Better results with an accuracy of 84.4%	Complex architecture
Deok Chun 2008	Base image retrival using texture feature and multiresolution using tetrolite transform.	High accuracy, High gain performance	Low feature vector dimension
Jens Krommweh, 2010	sparse image representation using tetrolite transform	Simple , effective, improved efficiency for image approximation	costly
Cuiping shi,,zhang,Zhang2014	Tetrolet transform is used as a novel approach for remote sensing image approximation	Increased energy concentration and data preservation	Ratio's cannot be calculated automatically
Nitheesh v Ravi kumar, 2016	Image compression using tetrolet transform.	High compression ratio,High image storage capacity, low cost,used for edge detection.	Requires more execution time
Yang Hui –xian, 2015	Face recognition using adaptively weighted orthogonal gradient binary pattern and tetrolettransform .	Better performance, Robust	More costly
Abdelouahad, 2014	Reduced reference image quality assessment using tetrolet approach	Information storage with reduced cost, High efficiency	Decompostion of reference and distorted image is time consuming
Wang, 2008	Image restoration based on WATV and tetrolet based sparsity	Preserves edge details & textures efficiently, high PSNR and SSIM measures	Time consuming approach
Xin Zhou and Wei Wang, 2015	Infrared and visible image fusion assessment using tetrolet transform.	Better visual effect,improved standard deviation and entropy	Algorthim is complex
Murat Ceylan ,AyseElifCanbilen, 2017	Image denoising using wavelet transform and tetrolet transform.	Improved performance with tetrolet transform	Time consuming and costly
R.Ramaswamy, T. Vidhya, M. Siyamala, 2015	Performance comparision of natural images by image denoising using tertrolet transform	provides better performance,Better edge preservation	Effective coefficient calculation is difficult
Dr.vasimbabuM,D.Aparna, ,Hemahowdary .K,2018	Tetrolet transform based MR brain image classifier and kernel support vector machine based on OTSU binarization	User friendly,better accuracy	Complex architecture
R.Durga singh,2017	Satellite image enhancement using tetrolet transform	Improved efficiency	More complex
Paras Jain &VipinTyagi	Epsilon -median filtering for adaptive edge preservation in tetrolet domain	Improved gain,lownoise,improved efficiency	costly
S.Thayammal,Dr.D.Selvathi,2014	Multispectral band compression using Adaptive wavelet transform-tetrolet transform	Improved PSNR, increased CR and bit per pixel	Time consuming

3. Conclusion

In this paper, we have surveyed a new texture image retrieval approach, which is based on tetrolet transform. This work is based on the adaptability of tetrolet transforms according to image geometry. Since tetrominos adapts itself according to image geometry. So there is no need of taking specific directions, instead image geometry is taken into consideration. Since texture feature extraction is performed efficiently at eachdecomposed level, which produces better results. Standard deviation and mean are used as feature measures and Euclidean distance is used as distance measure. Performance of texture image retrieval is tested on the benchmark VisTex and Brodatz databases against previously reported texture image retrieval methods. Retrieval result shows a significant improvement over Gabor, DWT, RCWF methods in terms of retrieval accuracy.We hope that this survey will help researchers to select the best algorithm and feature extraction methods to meet their requirements.

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