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Medical Image Retrieval Using Discrete Wavelet Transform

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Abstract: *This work deals with medical image retrieval using Discrete Wavelet Transform. In this the retrieval results from texture feature are analyzed. The color information of an image is represented by the hue, saturation and intensity values. The texture features are determined by calculating the energy, entropy, contrast and correlation values. Discrete Wavelet Transform is applied for analyzing the texture feature. In DWT, Haar wavelet is chosen because it is conceptually simple, fast and memory efficient. The final query ranking is based on the total normalized distance in texture feature. The texture feature of all the data base images are calculated and compared with the same features of the input image. The top 10 images with least difference are retrieved as the output.*
Keywords: *Discrete wavelet transform, Haar wavelet transform, Texture feature, Hue, Saturation, Intensity, Energy, Entropy, Contrast, Correlation, Local binary pattern*.

I. Introduction

The emerging development of multimedia and network Technology makes people to access a large number of multimedia information. For people who want to make full use of multimedia information resources, the primary question is how to query the multimedia information of our interest.

This work deals with the process of retrieving a required query image from a database. This is done with the help of analyzing the texture features of the image. These features are most important for analyzing any color image or gray scale image. The analysis of the images is done using content based image retrieval system. The color images are converted from RGB to Gray images and then analyzed.

The database is created and texture features are calculated for every image. The calculated values are stored separately. Whenever a query image is given as the input by user, the texture features of the image are calculated and these are compared with the calculated values of all the images in the database.

The image which gives minimum difference is taken as the similar image with respect to the query image and hence given as output. The texture features are extracted separately. The advantage of the wavelet transform over the Gabor transform is that the wavelet transform is computationally less demanding and covers the complete time frequency plane. Each level of the DWT has three subbands, for respectively the horizontal, vertical and diagonal directions.

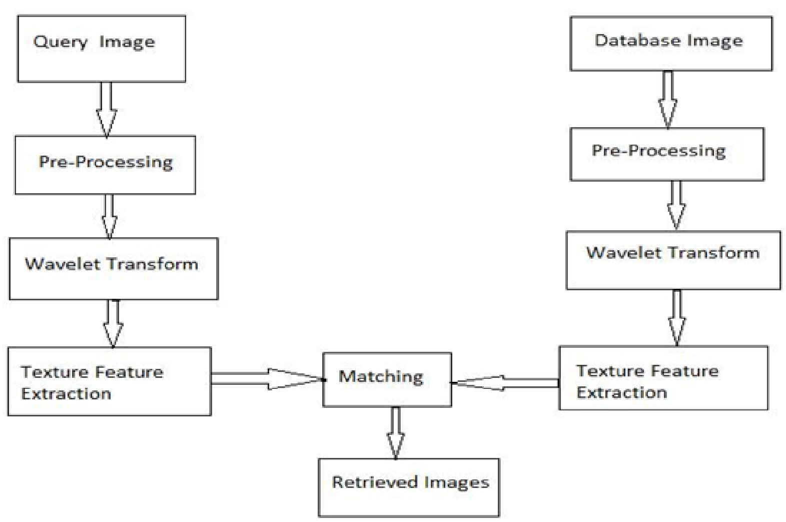


Fig. 1: block diagram

II. Image Feature Extraction

The image content is mainly embodied in texture shape etc. The texture feature and shape feature describe the image content from different angle.More features will provide more information on the image content. In our research, we are considering the texture feature.

A. Texture feature extraction

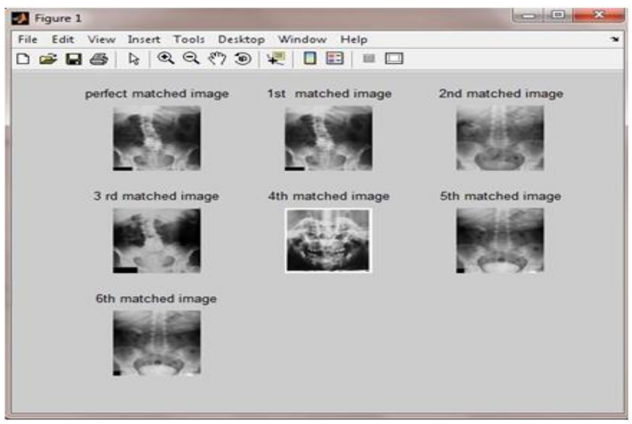
The statistical properties of image co-occurrence matrix are taken as texture features of an image. Firstly, color image is converted to grayscale image, and the image co-occurrence matrix is gained.

Then, the following statistical properties are calculated to describing image content. They are contrast, energy, entropy, mean and local stationary. All these statistical properties are calculated in 4 directions, so we can get 20 texture features. At last, we calculated the means and variances of these five kinds of statistical properties, and took the results as the ultimate texture features, denoted as

$$T = (\mu_1, \mu_2, \mu_3, \mu_4, \mu_5; \sigma_1, \sigma_2, \sigma_3, \sigma_4, \sigma_5,) \qquad (1)$$

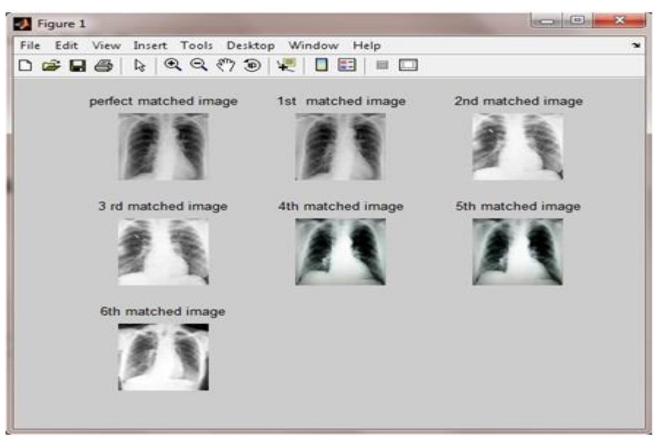
Some common uses of texture analysis are:

- Segment an image into regions with the same texture, i.e. as a complement to gray level or color.
- Recognize or classify objects based on their texture.
- Find edges in an image, i.e. where the texture changes.
- “Shape from texture”.
- Object detection, compression, synthesis.



Mean value is == 129.2920

Fig. 2: Output screen



Mean value is == 122.9504

Fig. 3: Output screen

III. Discrete Wavelet Transform

Wavelets are mathematical functions that cut up data into different frequency components, and then study each component with a resolution matched to its scale. They have advantages over traditional Fourier methods in analyzing physical situations where the signal contains discontinuities and sharp spikes. Wavelets were developed independently in the fields of mathematics, quantum physics, electrical engineering, and seismic geology. Interchanges between these fields during the last ten years have led to many new wavelet applications such as image compression, turbulence, human vision, radar, and earthquake prediction.

Wavelets are functions that satisfy certain mathematical requirements and are used in representing data or other functions. In wavelet analysis, the scale that we use to look at data plays a special role. Wavelet algorithms process data at different scales or resolutions. If we look at a signal with a large "window," we would notice gross features. Similarly, if we look at a signal with a small "window," we would notice small features. The result in wavelet analysis is to see both the forest and the trees, so to speak.

A. Wavelet Analysis

The advantage of wavelet analysis is the ability to perform local analysis. Wavelet analysis is able to reveal signal aspects that other analysis techniques miss, such as trends, breakdown points, discontinuities, etc. In comparison to the STFT, wavelet analysis makes it possible to perform a multi resolution analysis.

B. Multi resolution Analysis

The time-frequency resolution problem is caused by the Heisenberg uncertainty principle and exists regardless of the used analysis technique. For the STFT, a fixed time-frequency resolution is used. By using an approach called multi resolution analysis (MRA) it is possible to analyze a signal at different frequencies with different resolutions.

IV. HAAR Wavelet Transform

The Haar wavelet is also the simplest possible wavelet. The technical advantage of the Haar wavelet is that it is not continuous, and therefore not differentiable. This property can, however, be an advantage for the analysis of signals with sudden transitions, such as monitoring of tool failure in machines.

A Haar wavelet is the simplest type of wavelet. In discrete form, Haar wavelets are related to a mathematical operation called the Haar transform. The Haar transform serves as a prototype for all other wavelet transforms.

Wavelets are mathematical functions that were developed by scientists working in several different fields for the purpose of sorting data by frequency. Translated data can then be sorted at a resolution which matches its scale. Studying data at different levels allows for the development of a more complete picture. Both small features and large features are discernable because they are studied separately. Unlike the discrete cosine transform, the wavelet transform is not Fourier-based and therefore wavelets do a better job of handling discontinuities in data.The Haar wavelet operates on data by calculating the sums and differences of adjacent elements. The Haar wavelet operates first on adjacent horizontal elements and then on adjacent vertical elements. The Haar transform is computed using:

$$\frac{1}{\sqrt{2}}\begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}$$

A. Properties of Haar Wavelet

The Haar wavelet has several notable properties:

1. Any continuous real function can be approximated by linear combinations of

   $\phi(t), \phi(2t), \phi(4t), \dots, \phi(2^k t), \dots$ and their shifted functions. This extends to those function spaces where any function therein can be approximated by continuous functions.

2. Any continuous real function can be approximated by
linear combinations of the constant function, $\psi(t), \psi(2t), \psi(4t), \dots, \psi(2^k t) \dots$ and their shifted functions.

B. Why Haar Wavelet ?

There are a wide variety of popular wavelet algorithms, including Daubechies wavelets, Mexican Hat wavelets and Morlet wavelets. These wavelet algorithms have the advantage of better resolution for smoothly changing time series. But they have the disadvantage of being more expensive to calculate than the Haar wavelets. The higher resolution provided by these wavlets is not worth the cost for financial time series, which are characterized by jagged transitions.

V. Local Binary Pattern

Local binary patterns (LBP) is a type of feature used for classification in computer vision. It has since been found to be a powerful feature for texture classification; it has further been determined that when LBP is combined with the Histogram of oriented gradients (HOG) classifier, it improves the detection performance considerably on some datasets**.** Local Binary Pattern (LBP) is a simple yet very efficient texture operator which labels the pixels of an image by thresholding the neighborhood of each pixel and considers the result as a binary number. Due to its discriminative power and computational simplicity, LBP texture operator has become a popular approach in various applications. It can be seen as a unifying approach to the traditionally divergent statistical and structural models of texture analysis. Perhaps the most important property of the LBP operator in real-world applications is its robustness to monotonic gray-scale changes caused, for example, by illumination variations. Another important property is its computational simplicity, which makes it possible to analyze images in challenging real-time settings.

The local binary pattern (LBP) operator is defined as a gray-scale invariant texture measure, derived from a general definition of texture in a local neighborhood. Through its recent extensions, the LBP operator has been made into a really powerful measure of image texture, showing excellent results in many empirical studies. The LBP operator can be seen as a unifying approach to the traditionally divergent statistical and structural models of texture analysis. Perhaps the most important property of the LBP operator in real-world applications is its invariance against monotonic gray level changes. Another equally important is its computational simplicity, which makes it possible to analyze images in challenging real-time settings. The LBP method and its variants have already been used in a large number of applications all over the world.

A. Steps Involved In Creating A LBP

The LBP feature vector, in its simplest form, is created in the following manner:

- Divide the examined window to cells (e.g. 16x16 pixels for each cell).
- For each pixel in a cell, compare the pixel to each of its 8 neighbors (on its left-top, left-middle, left-bottom, right-top, etc.). Follow the pixels along a circle, i.e. clockwise or counter-clockwise.
- Where the center pixel's value is greater than the neighbor, write “1”. Otherwise, write “0”. This gives an 8-digit binary number (which is usually converted to decimal for convenience).
- Compute the histogram, over the cell, of the frequency of each “number” occurring (i.e., each combination of which pixels are smaller and which are greater than the center).
- Optionally normalize the histogram.
- Concatenate normalized histograms of all cells.

VI. Applications

The work can be used to retrieve X-ray and other scan images from large database, in many scan centers and hospitals. This work can be used for retrieving not only X-Ray images, but also retrieving

- CT Images
- MRI Images
- X-Ray Images
- Bio Medical Images

VII. Conclusion And Future Work

This work proposes an image retrieval method based on content based image retrieval method. For a given query image, the mean value of the texture feature is calculated and thus similar images are retrieved. The local binary pattern which is determined with the help of Gaussian low pass filter serves as an efficient method to compute the mean. The images are retrieved by comparing the minimum distance between the query image and all the database images. In future, this work can be extended by considering the other characteristic features of the image such as shape and location. Also, this work can be implemented for CT and MRI images with more number of images in the database.

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Author Profile

Pardhu Thottempudi became a Member (M) of IEEE in 2015. Pardhu was born in Luxettipet village in Adilabad district in Telangana state, India. He completed Batchelor's Degree B.tech in the stream of Electronics and Communication Engineering in 2011 from MLR Institute of Technology, Hyderabad, India. He has done his Master's Degree M.Tech in Embedded Systems from Vignan's University, Vadlamudi in 2013. His major fields of interests include Digital signal processing, RADAR communications, Embedded systems, implementation of signal processing on applicationsin FPGA.

He is working as Assistant Professor of Department of Electronics and Communication Engineering in Marri Laxman Reddy Institute of Technology & management, Hyderabad, India since 2014. Previously he worked as Assistant professor in Brilliant Group of Technical Institutions, Hyderabad, India. He also worked as project intern in Research Centre Imarat, Hyderabad. He published 15 research papers on VLSI, Image Processing, Antennas, Signal processing, RADAR Communications in Reputed International Journals and Various IEEE Conferences.

Pardhu Thottempudi is the Life member of ISTE, Associate Member of IETE from 2015. He filed a patent on "Design of Compressor using Full Adder Circuit". He is the member of IEEE signal Processing society, IEEE Industrial Electronics Society.