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Rotation Invariant Content Based Image Retrieval System for Medical Images

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***Abstract*—**Content Based Image Retrieval (CBIR) is the practice of computer vision to the image retrieval problem, i.e. the problem of searching for digital images in the large database. As the medical image database is growing day by day due to prolonging use of medical imaging. Content Based Image Retrieval (CBIR) is in great demand now a days in the medical field. On the basis of literature review, we conclude that a lot of work being done by engineering and research community on CBIR. In this paper our main focus is on Rotation Invariant Content Based Image Retrieval (CBIR) system for medical image database using dual tree complex wavelet transform. Very good rotation invariant results have been obtained after implementing dual tree complex wavelet transform in CBIR used for medical image database.

Keywords*-Content Based Image Retrieval (CBIR), wavelets, dual-tree complex wavelets, Fourier transform, Polar coordinates.*

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I. INTRODUCTION

Content Based Image Retrieval (CBIR) is the application of computer vision to search images in large database based on their contents. Content based means that the search will analyze the actual contents of the image. The term content might refer to colors, shape, texture or any other information. Lamard et. al [1] proposed a Content Based Image Retrieval (CBIR) method in which they computed signature distances between the query & database images. The signature distances may be of several types, but they used wavelet co-efficient distribution. Bouguila et. al [2] stated that the performance of a statistical signal processing system depends in large part on the accuracy of the probabilistic model used. They presented a robust probabilistic mixture model based on the multinomial and the Dirichlet distributions. Banerjee et. al [3] proposed a region based approach for image retrieval. They develop an algorithm to segment an image into fuzzy regions based on coefficients of multi-scale wavelet packet transform. There is another region –based image retrieval method proposed by Suematsu et. al [4] which performs image segmentation and indexing using texture features computed from wavelet coefficients. This method has advantages in texture feature extraction and hierarchical image segmentation over the previous region based techniques using wavelet transform. Pabboju et. al [5] identified that digital content has become a significant and inevitable asset for any enterprise and the need for visual content management is on the rise as well. There has been an increase in attention towards the automated management and retrieval of digital images owing to the drastic development in the number and size of image databases. Smeulders et. al [6] presented a review of 200 references in content-based image retrieval. They have discussed the working conditions of content-based retrieval: patterns of use, types of pictures, the role of semantics, and the sensory gap. Similarity of pictures and objects in pictures is reviewed for each of the feature types, in close connection to the types and means of feedback the user of the systems is capable of giving by interaction. The authors stated that Wavelet transform has proved to be very popular & effective in Content Based Image Retrieval (CBIR). Kingsbury [7] has introduced a new kind of wavelet transform, called dual tree complex wavelet transform, which has approximate shift invariance property and improved angular resolution. A support vector machine (SVM) with the auto-correlation of a compactly supported wavelet as a kernel is proposed in this paper. Kingsbury [8] proved that this kernel is an admissible support vector kernel. The main advantage of the auto-correlation of a compactly supported wavelet is that it satisfies the translation invariance property. Romberg et. al [9] have extended the modeling framework to the complex wavelet transform, which features near shift-invariance and improved angular resolution compared to the standard wavelet transform. The accuracy [10] of the CBIR system is a very crucial part of CBIR. The accuracy of CBIR system is affected by the rotation invariance of CBIR. Invariant descriptor is very essential part in rotation invariant CBIR. The dual tree complex wavelets can be successfully used in rotation invariant feature extraction for Content Based Image Retrieval (CBIR). Chen and Bui [12] invented an invariant descriptor by using a combination of Fourier transform and wavelet transform. They have used 1-D Fourier transform in angular direction and 1-D wavelet transform in radial direction. J.M. Guo et al [12] presented a technique for content-based image retrieval (CBIR) by exploiting the advantage of low complexity ordered-dither block truncation coding (ODBTC) for the generation of image content descriptor. A. C. Gonzalez-Garcia et. al [13] considered the problem of retrieving images from a database. During training, a wavelet-based description of each image is first calculated using Daubechies 4-wavelet transformation. The resulting coefficients are used to train a neural network (NN). During classification, test images are treated by the already trained NN. Three different ways to obtain the coefficients of the Daubechies transform were proposed and tested: from the entire image color channels, from the histogram of the biggest circular window inside the image color channels, and from the histograms of the square sub-images in the image color channels of the original image. A. Oberoi et al [14] is proposed a system in which query image is divided into equal size sub-blocks. The feature extraction of each sub-block is carried out using Haar wavelet and Fourier descriptor. A matching scheme based on Most Similar Highest Priority (MSHP) principle and the adjacency matrix of bipartite graph partitioning

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(BGP) formed using sub-blocks of query and target image, is provided for matching the image.

II. FEATURE EXTRACTION METHOD

Several invariant descriptors use the Fourier Transform and the Wavelet Transform to extract features. In invariant features extraction, the Fourier Transform [14] has been an effective tool due to which a shift in the time domain causes no change in the magnitude spectrum. The translation invariance can be optional by taking magnitude spectrum of the 2-D Fourier Transform. But the concept of interest is rotation invariance that is obtained by taking 1-D Fourier Transform in the direction of polar co-ordinates.

Chan and Kegl [15] proposed a rotation invariant descriptor by using a combination of Fourier Transform and dual tree complex Wavelet Transform as shown in Fig.1 for rotation invariant retrieval of images in CBIR. Firstly, the centroid is moved to centre of image and the image is polarized by taking polar transform of the image. Then 1-D Fourier Transform is obtained on polarized image *g(r, θ)* along axis of polar angle *'θ'* and its spectrum magnitude is obtained.

$$G(r,\phi) = |FT(g(r,\theta))| \quad (1)$$

Then 1-D dual tree complex Wavelet Transform is applied on $G(r,\phi)$ along the radial axis *'r'*. The feature extracted by this method is rotation invariant descriptor.

$$WF(r,\phi) = DTWT(G(r,\phi)) \quad (2)$$

This method is 100% rotation invariant, since it retrieves an image rotated by an angle between 0^{o} to 360^{o}.

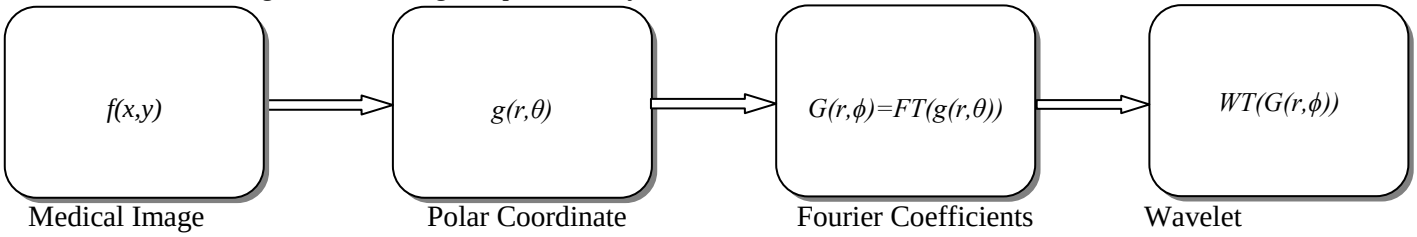

Fig. 1. Block diagram of Feature Extraction

III. ROTATION INVARIANT CONTENT BASED IMAGE RETRIEVAL SYSTEM (CBIR)

The problem of searching image from large database becomes more complex when images are rotated by some angle. The rotation invariant [16] Content Based Image Retrieval (CBIR) system used to retrieve the desired image from huge medical image database [14] when the query and desired image are rotated by an angle 'θ' from each other. The various blocks of rotation invariant Content Based Image Retrieval (CBIR) system are:

- *Medical Image Database*

Due to rapid growth in the field of medical imaging, the size of medical image database [14] is increasing day by day. In certain situations, there is a need of finding a particular image from the database. In this paper, the medical images are RGB images in jpeg format.

- *Query Image*

The query image is the sample image which is initialized in the Content Based Image Retrieval system to extract the desired image from the huge database.

- *Rotation Invariant Feature Extraction*

The feature extraction is very important phase in the Content Based Image Retrieval (CBIR) system. The performance of a Content Based Image Retrieval (CBIR) system depends upon how efficiently image features are extracted. For a Content Based Image Retrieval (CBIR) system to be rotation invariant the extracted feature set [15] should attain the rotation invariance. The method for rotation invariant feature extraction has been discussed in section II.

- *Similarity Matching*

After feature extraction, next important step is to find the similarity between features sets of query image and medical database images. There are various methods to measure similarity like Euclidian distance [17], Canberra distance and Manhattan distance etc. In this Paper, Euclidian distance is used to measure the similarity between the images. The Euclidian distance 'd' is represented as:

$$\mathbf{d} = \| \mathbf{x} - \mathbf{y} \| \quad (3)$$

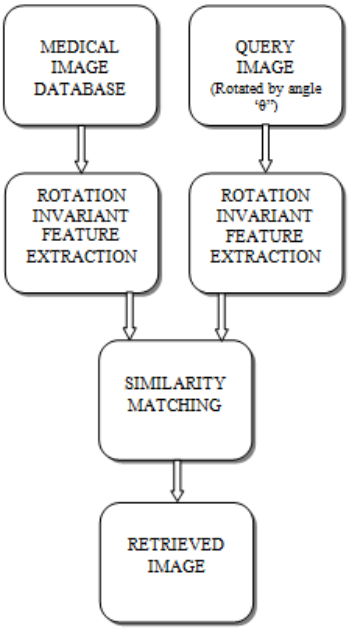

Fig. 2. Basic Block diagram of CBIR

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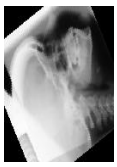
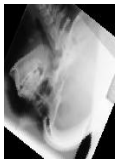
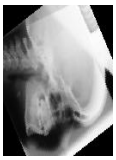
IV. EXPERIMENTAL RESULTS

This method is implemented by using MATLAB version 07. [20] The final feature set extracted using this method is 100% rotation invariant. The implementation results of the described method can be given in following way:-

Table 1: Rotation invariance for image rotated at different angles

Angle (θ) (in degrees)	Rotated Query Image by an Angle 'θ'	Retrieved Image
0°		
60°		
120°		
180°		
240°		
300°		
360°		

The similar images are retrieved using proposed content based image retrieval system. The query image and four most similar retrieved images are shown in Figure: 3 and Figure: 4 respectively.

Fig. 3. Query Image

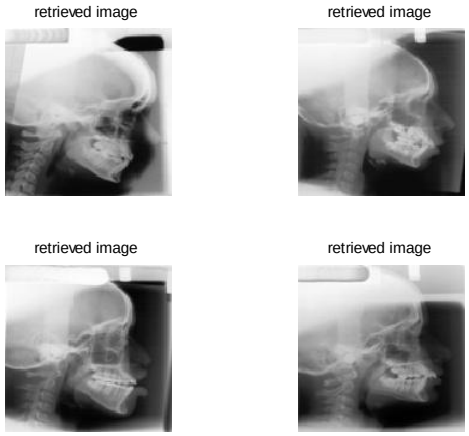


Fig. 4. Retrieved Images

V. CONCLUSION

The rapidly growing number and size of image databases in the area of medical image management, has increased the need of accurate system for content based image retrieval. Rotation invariance is very important for accurate Content Based Image Retrieval (CBIR). This paper implements a method which retrieves the medical

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image rotated between angles 0 ^{o} to 360 ^{o} that indicates there is an enhancement in the accuracy of CBIR with invariant feature set.

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