A Content based CT Lung Image Retrieval by DCT Matrix and Feature Vector Technique

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Abstract

Most of the image retrieval systems are still incapable of providing retrieval result with high retrieval accuracy and less computational complexity. Image Retrieval technique to retrieve similar and relevant Computed Tomography (CT) images of lung from a large database of images. During the process of retrieval, a query image which contains the affected area / abnormal region is given as an input to retrieve similar images which contain affected area/abnormal region from the database. DCT Matrix (DCTM) is a kind of commonly used color feature representation in image retrieval. This paper describes a content based image retrieval (CBIR) that represent each image in database by a vector of feature values called DCT vector matrix(8x8). Using this DCTM row and column feature vector values considered as a query image which is compared with existing database to cull out more similar and relevant images. The experimental result shows that 97% of images can be retrieved correctly using this technique.

Keywords: *query image, Affected Region, Average Feature Vector GLCM*

1. Introduction

Content-based image retrieval (CBIR) is a technique to search for images relevant to the user's query from an image collection [1]. In the last decade, the conventional CBIR schemes employing relevance feedback have achieved certain success [2]. The idea of relevance feedback is to involve the user in the retrieval process so as to improve the final retrieval results. Normally, the user labels some returned images as relevant or irrelevant and the system adjusts the retrieval parameters based on the user's feedback. Relevance feedback can go through one or more iterations until the user is satisfied with the results. Content Based Image Retrieval (CBIR) is any technology that in principle helps to organize digital image archives by their visual content. By this definition, anything ranging from an image similarity function to a robust image annotation engine falls under the purview of CBIR [1]. The most common form of CBIR is an image search based on visual example. The user inputs an image (query image), and, based on certain global features, the system brings up similar images. This sort of feature is used for describing the content of the image and that is why they must be appropriately selected on occasion. The visual content of the images is mapped into a new space called the feature space.

The features that are chosen have to be discriminative and sufficient for the description of the objects. Texture based mage Retrieval is the traditional image retrieval system. The Main intention of CBIR is efficient some automatically extracted features. A typical CBIR system for retrieving images from database based on their similarity to the input image consists of four main steps. First, extract the features of the query image to convert the image from spatial data to feature vector. The feature extraction is the basic process of a CBIR system. Later on, compare the feature vectors of a query image with the feature vector of images in database by computing a similarity measure to search for the most relevant images in the database. Here Euclidian distance is used as similarity measure. The direct Euclidian distance between an image P and query image Q can be given as below

$$ED = \sqrt{\sum(Vpi-Vqi)^2} \qquad (1)$$

Where, Vpi and Vqi are the feature vectors of image P and query image Q respectively with size 'n'.

2. Feature Extraction

Generally, the input module and the query module, the feature vectors are extracted first. A training process is performed to organize those features. When a query image enters the query module, it extracts the feature vector of the query image. Then in the retrieval module, the extracted feature vector is compared to the feature vectors stored in the database. The target images are the similar images, which retrieved according to their matching scores (average feature vector values). Fig.1 shows the general diagram of CBIR system The amount of digital content available to users in form of image data is growing exponentially due to the tremendous increase in computing power, electronic storage capacity and communication networks. This growth forms the bases of much educational, entertainment and commercial applications. Due to the rapid growth of the number of digital media elements like image, video, audio, graphics on Internet, there is an increasing demand for effective search and retrieval techniques.

Development of efficient image retrieval techniques has become more challenging.

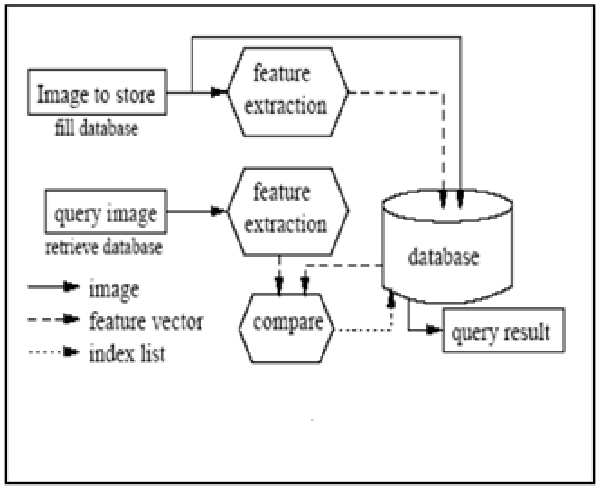
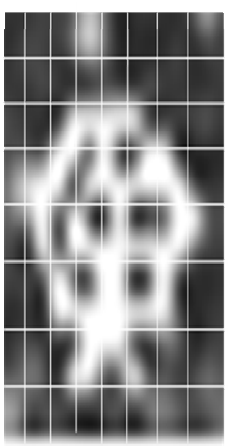


Fig1: General Diagram of CBIR

3. Discrete Cosine Transform

A discrete cosine transform (DCT) expresses a sequence of finitely many data points in terms of a sum of cosine functions oscillating at different frequencies. DCTs are important to numerous applications in science and engineering, from lossy compression of audio (e.g. MP3) and images (e.g. JPEG) (where small high-frequency components can be discarded), to spectral methods for the numerical solution of partial differential equations.The texture filter functions provide a statistical view of texture based on the image histogram. These functions can provide useful information about the texture of an image but cannot provide information about shape, i.e., the spatial relationships of pixels in an image. Shown in fig.2



713	651	641	601	651	641	690	640
3	2	12	11	10	4	2	5
12	21	29	11	8	15	12	7
3	2	5	7	14	17	15	22
4	4	6	5	10	12	11	15
17	1	2	5	10	14	13	19
7	8	8	7	9	9	7	9
2	1	1	5	10	2	2	7

Fig 2: Image Extraction

4. DCT- Method

The discrete cosine transform (DCT) [5],[15] is closely related to the discrete Fourier transform. It is a separable linear transformation; that is, the two-dimensional transform is equivalent to a one-dimensional DCT performed along a single dimension followed by a one-dimensional DCT in the other dimension. The definition of the two-dimensional DCT for an input image A and output image B is Where M and N are the row and column size .If you apply the DCT to real data, the result is also real

$$B_{pq} = \alpha_p \alpha_q \sum \sum A_{mn} \cos\frac{\pi(2m+1)p}{2M} \cos\frac{\pi(2n+1)q}{2N}, \quad \begin{matrix} 0 \le p \le M-1 \\ 0 \le q \le N-1 \end{matrix} \quad (2)$$

$$\alpha_p = \begin{cases} 1/\sqrt{M} & , p = 0 \\ \sqrt{2/M} & , 1 \le p \le M-1 \end{cases} \quad (3)$$

$$\alpha_q = \begin{cases} 1/\sqrt{N} & , q = 0 \\ \sqrt{2/N} & , 1 \le q \le N-1 \end{cases} \quad (4)$$

Fig.2 shows the query image converted into feature vector and it is stored in a vector table by Appling DCT. The DCT tends to concentrate information, making it useful for image compression applications and also helping in minimizing feature vector size in CBIR. For full 2-Dimensional DCT for an NxN image the numbers of multiplications required are N2(2 N) and number of additions required are N2(2N-2).

5. Medical CBIR Architecture

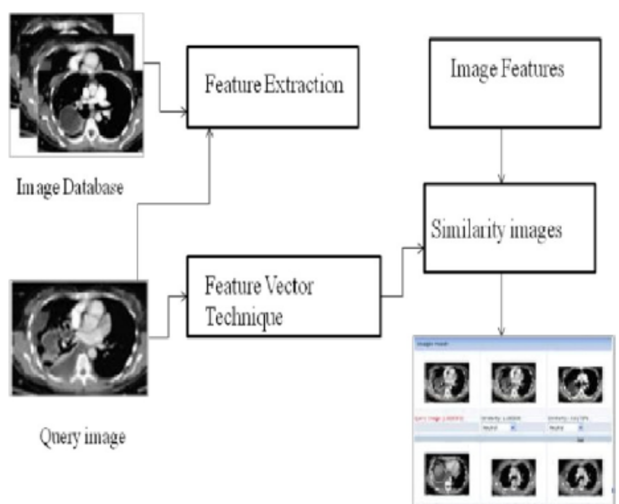


Fig 3: General Diagram of CBIR

Fig.3 shows the block diagram of common content-based image retrieval systems. Three modules constitute the system: the input module, the query module, and the retrieval module [1]. In the input module and the query module, the feature vectors are extracted first.

A training process is performed to organize those features. When a query image enters the query module, it extracts the feature vector of the query image. During the process of retrieval, a query image which contains the affected area / abnormal region (shown in fig.4) is given as an input to retrieve similar images which contain affected area/abnormal region from the database.

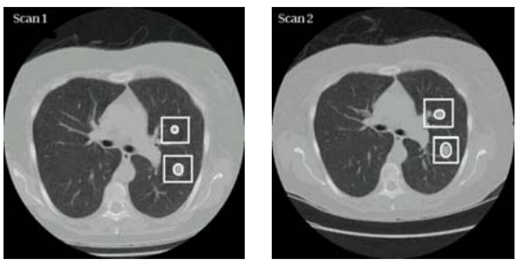


Fig 4: Affected or Abnormal Region

Then in the retrieval module, the extracted feature vector is compared to the feature vectors stored in the database. The target images are the similar images, which are retrieved according to their matching scores. Unlike other general content-based image retrieval system where the shape, size, color and location of an object are usually considered as the feature of the input object in a query image, our content based CT image retrieval system uses only the texture of images alone for getting the feature vector. After the interview with several radiologists, we found that the most important features of lung cancer are the Density (texture or the type of distribution of the brighter pixels). According to this, we define that feature vector is based on the texture information.

6. Proposed Methodology

The following fig .5shows the step by step process for retrieve the most similarity images. In this system there are five steps to be following while retrieving CT lung images.

- Query Image
- Feature Extraction & Feature Vector Calculation (Using DCT)
- From the Matrix(8X8) : Calculating Row Average Value
- Calculating Column Feature Vector Values (8 X 8)
- Comparing the Existing Medical Image Database

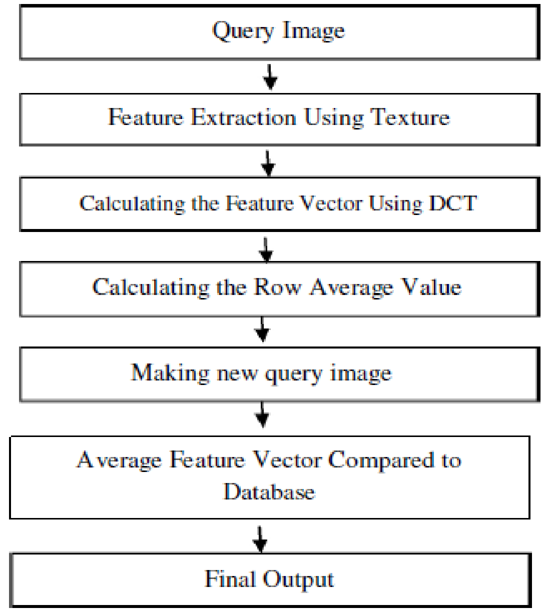


Fig 5: Process Flow

Initially to find the feature vector of query image, DCT approach is used to convert the numerical value into a vector value. This query image feature vector is stored in a matrix table. Likewise, the feature vectors of previous patient images relating to lung disease of different category will be stored in a database. During the process of retrieval, the matrix table value (feature vector of query image) is compared with the existing database. Our system contains the above five modules. During the first module an affected CT lung image is given as query image to retrieve similar images from the database.

In the second module, feature extraction takes place and this feature is converted into feature vector using Discrete Cosine Transform (DCT). Once the feature vector of query is obtained, the system moves onto the third module to calculate the row average feature vectors and the fourth module to calculate the column average feature vector values from input query image. Then find the row and column feature vector is store in a matrix table This row and column average feature vector is used as a query image to cull out the most similar and relevant images from the database which is the final output.

The result obtained using the new row and column feature vector is thus the most similar images that could be obtained.
Image retrieval mainly has following steps to calculate

- 8 x8 matrix: Row Feature Vector
- 8 x8 matrix: Column Average Feature Vector
- Database Comparison with query image

6.1 DCT- Row Matrixes

Here first the row average and column aver found and then discrete cosine transform i to get feature vectors of image for respe image retrieval.

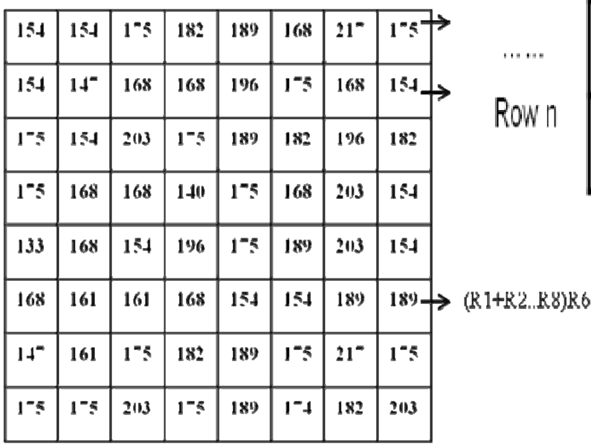


Fig 6: Row Average Feature Vectors

Fig.6 is representing the sample image with 8 rows and 8columns, the row average vectors for this image will be as given below.

Row-1: (R1 +R2+…..R8)/8

Row-2: (R1+R2+…..R8)/8

Row -n :(up to n times)

6.2 DCT Column Matrix

Here first the column mean of query image is obtained. Then the DCT column average feature vector of query image is obtained by applying DCT on each column. For image retrieval using DCT column average vector , these query image features are compared with DCT column average features of image database by finding Euclidian distances using the formula given as equation 1.

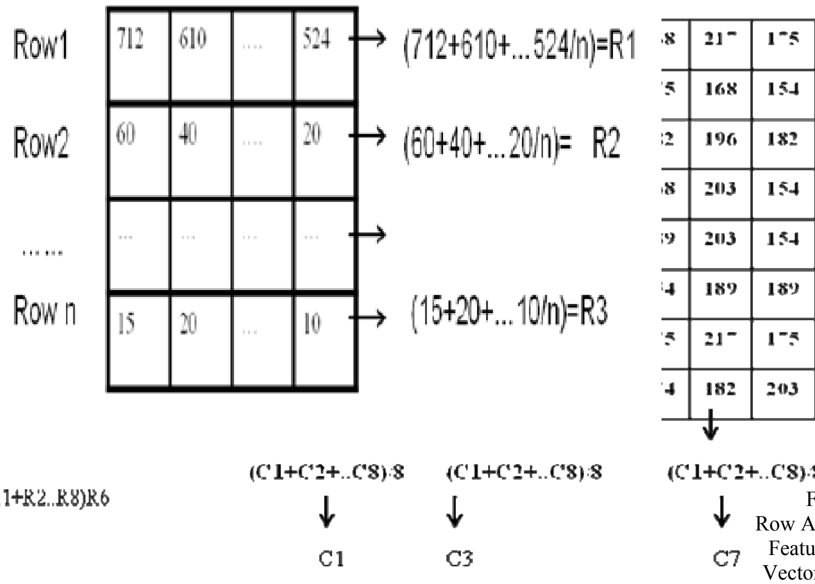


Fig 7: Row Average Feature Vectors

Fig.7 is representing the sample image with 4 rows and 4 columns, the Column average vectors for this image will be as given below.

Column-1: (C1 +C2+…..C8)/8

Column-2: (C1+C2+….C8)/8

Column-n :(up to n times)

6.3 Matrix Vector Table

The DCT can be applied to the row and column average vectors of image to get DCT row and DCT column average feature vectors respectively. The generated DCT coefficients will be playing the role of feature vectors of the image which can further be used for image retrieval. Thus features of all images in the database are obtained and stored in feature vector tables as shown in table 1.

Table 1: Vector Table

R1	R2	….	RN
C1	C2	….	CN

6.4 Database comparison

The average of the row and column of the feature is calculated to find an average feature vector table which will be used as a new query image. The feature vector table of new query image will be used to obtain similar and relevant images from the images of the database. The resulting images will be a few in number and these images are final result and will be the most similar to the query image. The following fig.8 shows the feature vector

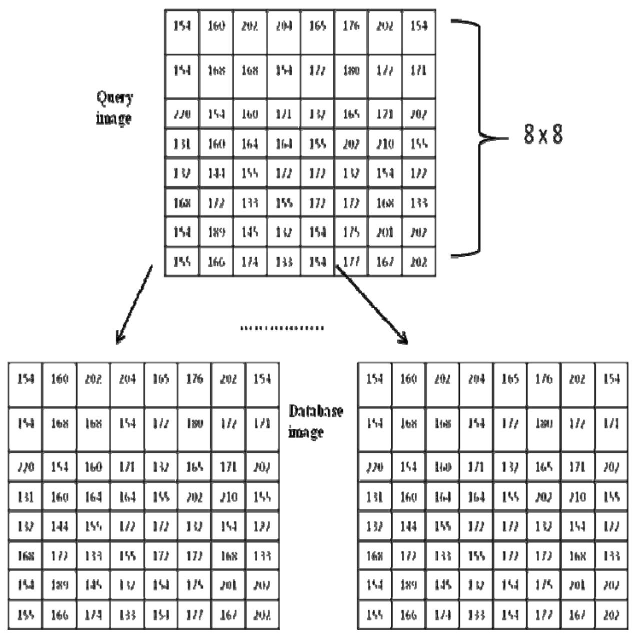


Fig 8: Database Comparison

7. Result and discussion

In the first module, the query image is divided into 64 sub divisions of 8 vertical and horizontal lines on the input image. From this N XN matrix, a corresponding feature vector to the value is calculated using DCT. What we obtain is the feature vector of the query / input image. Likewise, the images of different patients for various lung diseases have been collected and feature vector of the images has been found and stored in the database for ready reference the feature vector of query image is compared with the existing feature vectors in the database. Here Euclidian distance [6],[10]-[13] is used as similarity measure. The direct Euclidian distance between an image P and query image Q can be given as below

$$ED = \sqrt{\sum(Vpi-Vqi)^2} \qquad (1)$$

Where, Vpi and Vqi are the feature vectors of image P and Query image Q respectively with size 'n'. From the equation -1, the system will measure the most relevant image and the resulting images are Result image as shown in Fig.9.

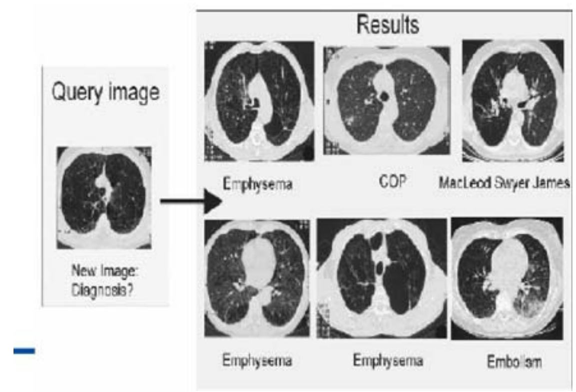


Fig 9: Database Comparison

The previous content based image retrieval systems is to find the feature vector is more complex but our system have proved that the images retrieved is simple. Instead, our system calculates average vector of the resulting images and then this average feature vector is considered as a fresh query image which will be compared with the existing feature vectors in the database. This time the resulting images are the final images which will be a very few in number and they will be the most similar images which leads to accuracy and efficiency. This avoids the chance of having an ambiguous opinion on an image.

8. Conclusion

Digital image processing is a subset of the electronic domain wherein the image is converted to an array of small integers, called pixels, representing a physical quantity such as scene radiance, stored in a digital memory, and processed by computer or other digital hardware. Most of the image retrieval systems are still incapable of providing retrieval result with high retrieval accuracy and less computational complexity Using DCT and GLCM method to extract texture values of query images has been easy and to calculate the feature vector has also been easy. The GLCM matrix gives the intensity variation of the given input image. Moreover, the DCT method always produces only real values and never produces imaginary part. This has been an additional advantage of using the DCT method for real time calculation. This system has a limited scope of using it only in Windows based applications. In future, the scope of the system can be extended to be used online from anywhere. This just requires the query mage to be sent online and this would suffice the database to retrieve the most similar images and sent it online. Our system helps the radiologist to ascertain the opinion that he had drawn by our unique method double iteration used to cull out the most similar images. Naturally, it helps the radiologist to take decision without having double minded opinion because the system used almost nullifies the chance of ambiguity.

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