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Canny Edge Detection Method for Medical Image Retrieval

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Abstract

Image retrieval (IR) is one of the most exciting and fastest growing research area in the field of medical imaging. Medical image retrieval can play an important role for diagnostic and teaching purposes in medicine. Image modality is an important visual characteristic that can be used to improve retrieval performance. Edge of the image is one of the most significant features which are mainly used for image analyzing process. An efficient method for extracting the shape features of images using Canny edge detection operator is proposed in this paper. The experimental results demonstrate the efficiency and the good performance of the method.

Keywords: *Medical Image, Image retrieval (IR), Edge detection, Canny edge detection, Content-Based Image Retrieval (CBIR).*

1. Introduction

With the development of digital imaging technology in medical domain, hospitals and Medical research institutions produce a large amount of digital images every day. The modes of these images are various: X-ray, Computer Tomography (CT), magnetic resonance imaging (MRI), ultrasonography (US), etc. Medical image retrieval is an important tool for physicians in clinical diagnosis and medical research [1]. Medical images play a pivotal role in surgical planning, medical training, and patient diagnoses. In large hospitals thousands of images to be managed every year ,these images needs to be indexed, classified, and searched for easy retrieval[2]. In the medical field, images, and especially digital images, are produced in ever increasing quantities and used for diagnostics and therapy. Content based access to medical images for supporting clinical decision making has been proposed that would ease the management of clinical data and scenarios for the integration of content-based access methods into Picture Archiving and Communication Systems (PACS) have been created[3]. The success of a content-based image retrieval (CBIR) system is with difficulty related to the quality of the extracted features. If the system is not able to build a good representation of the image content, visual similar images can be considered quite different, so the retrieved images will hardly meet the expectations of the user. The feature extraction has three levels, the levels are: pixel, local and global. The simplest visual image features are directly based on the pixel values of the image [4].Edges in images are areas with strong intensity contrasts – a jump in intensity from one pixel to the next. Edge detecting an image significantly reduces the amount of data and filters out useless information, while preserving the important structural properties in an image [5].This paper emphasizes on the extraction of the image's edges of a specific image using Canny algorithm for medical image retrieval system. The organization of the rest of this paper is as follows. Section 2 highlights the related works. section 3 introduces image retrieval system. Section 4 present Canny edge detection, Section 5 describes the proposed method. Section 6 present the experimental results and section 7 concludes the paper.

2. Related Work

Content based image retrieval (CBIR) has become one of the most active research areas in the past few years. Many techniques based on different features are proposed. **Jie-xian Zeng, Yong-gang Zhao**[6] introduced a new shape representation and retrieval method called distance. autocorrelogram. Firstly, distance autocorrelogram is obtained under the premise of getting the contour' centroidal distances. Then,they applied this shape descriptor to content-based image retrieval (CBIR) . **B.Jyothi1, Y.Madhavee Latha,**[7] proposed an efficient retrieval system using region-based image retrieval system, finding region in the pictures using a new image segmentation method by improved mountain clustering (IMC) technique and features are extracted using a set of orthogonal set of moment functions for describing images. **Ashish Oberoi and Manpreet Singh** [8] designed a Content Based Image Retrieval System for Medical Databases (CBIR-MD) based on various techniques like

Fourier descriptor, Euclidean distance, Haar Wavelet transformation, Canberra distance and analyzed its performance on Endoscopy. **A.Kumari Sankari Mala, S.Allwin** [9] proposed a new method based on texture

based image retrieval system. It is particularly valuable in Histology image analysis for interpreting varying tissue composition and architecture into histological concepts. The proposed method consists of three steps.Texture features are retrieved using integer Wavelet. **Madhusudhana Rao, S.Pallam Setty**[10]presented a paper by considering brain medical images from a medical dataset. Feature vectors are to be extracted efficiently so as to retrieve the images of interest. In this paper a two-way approach is adopted to retrieve the images of relevance from the dataset. In the first step the Probability Density Functions (PDF) are extracted and in the second step the relevant images are extracted using correlation coefficient. Major headings are to be column centered in a bold font without underline. They need be numbered. "2. Headings and Footnotes" at the top of this paragraph is a major heading.

3. Image Retrieval

Image retrieval system provides an effective and sophisticated tool for maintaining and managing image databases. There is a significant amount of increase in the use of medical images in clinical medicine and disease research[11]. Image retrieval is deal with searching and retrieving digital images from a huge database. An effective image retrieval system is able to operate on the collection of images to retrieve the relevant images based on the query image which conforms as closely as possible to human perception. According to database management and computer vision communities, there are two different perspectives***, text-based*** and ***content or visual based***. Text based image retrieval techniques use text to describe the content of the image and content based image retrieval used image visual features to describe the content of images[12]. Content Based Image Retrieval (CBIR) is a process to retrieve a stored image from database by supplying an image as query instead of text as shown in Fig. 1. This can be done by proper feature extraction and querying process. The features like histogram, color values and edge detection plays very vital role in proper image retrieval [13][14].

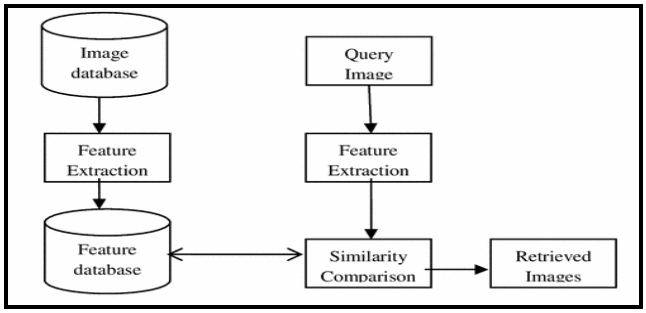

Fig.1 General CBIR System Architecture.

4. Canny Edge Detection

Edge detection is the name for a set of mathematical methods which aim at identifying points in a digital image at which the image brightness changes sharply or more formally, has discontinuities. The point at which image brightness changes sharply are typically organized into a set of curved line segments termed as edges. The purpose of edge detection in general is to significantly reduce the amount of data in an image, while preserving the structural properties to be used for further image processing. Canny's edge detection one of the edge detection method which was developed by John F Canny (JFC) in 1986 [15] [16]. In this algorithm optimal defining edge is detected based on some criteria which include finding edges by minimizing error rate, making edges closely to the actual edges to maximize location and marking edges only once when a single edge exists for minimal response. The optimal filter that meets all three criteria above can be approximated using the first derivative of a Gaussian function [17]:

$$G(x,y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}} \quad (1)$$

$$\frac{\partial G(x,y)}{\partial x} \propto x e^{-\frac{x^2+y^2}{2\sigma^2}} \quad (2)$$

$$\frac{\partial G(x,y)}{\partial y} \propto y e^{-\frac{x^2+y^2}{2\sigma^2}} \quad (3)$$

In the first stage the image is convoluted with a Gaussian filter. Then the gradient of the image is measured by feeding the convoluted image. The 2-D convolution operation is described in the following equation:

$$I'(x,y) = g(k,1) * I(x,y) \quad (4)$$

Where:
$g(k,1)$ = *convolution kernel*
$I(x,y)$ = *original image*

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$I'(x,y) =$ *filtered image*
$2N+1 =$ *size of convolution kernel*

Canny improves edge detection by following list of criteria, good detection, good localization, only one response to a single edge[18]:

1-The first one is low error rate. It means that the edge occurring in images should not be missed and there should be no response for the none edges. The probability of missing the real edges and incorrect detection of none real edges should be least.
2- The second principle is that the edge pints should be good localized, i.e. the distance between the edge pixel detect by detector should me minimum if compared with the original image edges i.e. the distance between the detected location and the actual location of the edge should be minimum.
3-There should be only response for a single edge. This principle is implemented because first two pints are not sufficient for good edge detection and there can be possibility for multiple responses for single edge. Multiple respond to a single edge and the none real edges detected because of noise should be removed.

It first smooth the image to remove noise and unwanted data and then it calculate image gradient to select region with high spatial derivatives .Then the algorithm suppress any pixel that is not the maximal suppression along that selected region and then it tracks remaining pixels that have not been suppressed yet. Canny edge detector uses two thresholds and if the intensity of that pixel is below that lower threshold than it is assigned "0" value that can be none edge and if the intensity of any pixel is above that the higher threshold than it is assigned "1" value and can be edge. Now the problem arises that if any pixels intensity falls between those two thresholds than what to do? So, if such situation arises than that pixel is set to be "1" value if it falls on the edge or there is a path from this pixel to the other pixel with threshold greater that higher threshold, Canny edge detector reduces noise and then locates edges it reduces noise by smoothing the image then detects edges[18].

5. Proposed Method

In this paper the edge detection for medical images based on applying Canny edge detection method is proposed. At first the color image is read from a database that contains a collection of medical images, then these images are converted to grayscale images.Global thresholding is applied in order to obtain binary images, then a median filter is used to remove noise, finally Canny edge detection algorithm is applied to produce the final images after edge detection. The proposed method is depicted in the block diagram shown in Fig.2:

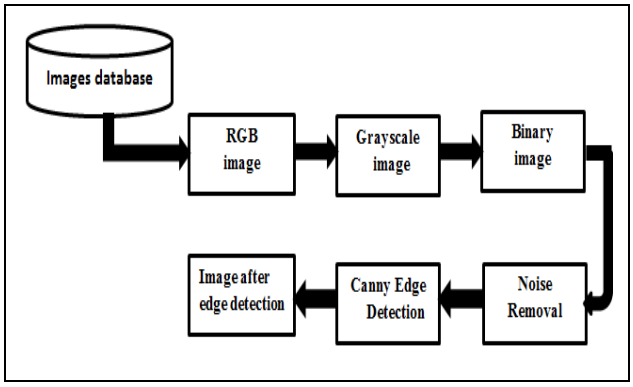

Fig.2 Block diagram of proposed method.

5.1 Image Database

The proposed method is applied on a database that containing six medical images (brain and lung) images, modalities having different sizes that is collect from the web. as shown in Fig.3:

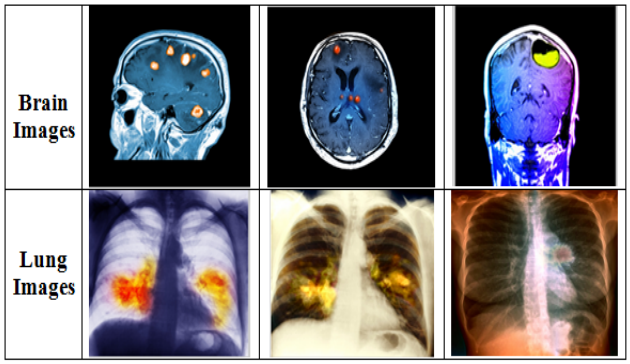

Fig. 3 Images Database

5.2 RGB Image Conversion

The input image is colored medical image is converted to gray scale image by converts RGB values to grayscale values by forming a weighted sum of the R, G, and B components using Eq.(5):

$$y = 0.2989 * R + 0.5870 * G + 0.1140 * B \quad (5)$$

5.3 Global Thresholding

The global thresholding is used to convert gray scale image into binary form. Otsu's method [19] is used to automatically perform histogram shape-based image thresholding or to convert gray level image to a binary

image. The algorithm assumes that the image to be threshold contains two classes of pixels or bi-modal histogram (e.g. foreground and background) then calculates the optimum threshold separating those two classes so that their combined spread (intra-class variance) is minimal[19].

5.4 Noise Removal

The binary image may have some noise these noise create problems in the image edge detection .In order to remove these errors, median filter with (3x3) size is used. The median is calculated by first sorting all the pixel values from the surrounding neighborhood into numerical order and then replacing the pixel being considered with the middle pixel value. (If the neighborhood under consideration contains an even number of pixels, the average of the two middle pixel values is used).

5.5 Canny Edge Detector

In Canny edge detector algorithm, initially the raw image is convolved with a Gaussian filter in order to reduce its susceptibility to noise. Then, utilizing two filters for each of the directions as in horizontal and vertical it computes the gradient .Finally, it calculates the magnitude and the orientation of the gradient and with the usage of a simple threshold technique it suppresses edges with low values [20].

6. Experimental Results

The experiments of the proposed method are implemented on Intel Core i7-5500U, CPU 2.40 GHz with 6 GB RAM under Matlab environment and a Windows 8 platform. The color medical image is reading from the database then it converted to grayscale as shown in Fig.4:

Fig. 4 Colored Image conversion.

Then the global thresholding algorithm is applied on grayscale image to obtain the binary image as show in Fig.5:

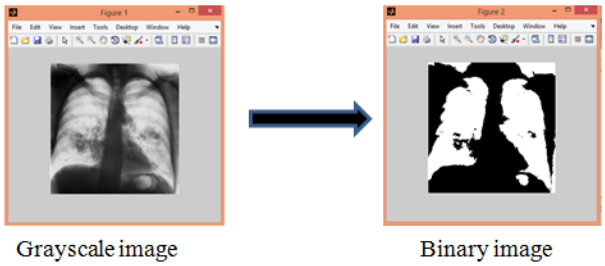

Fig. 5 Grayscale to binary conversion

Fig.6 show the binary image after applying the (3x3) mask median filter to remove noise from it.

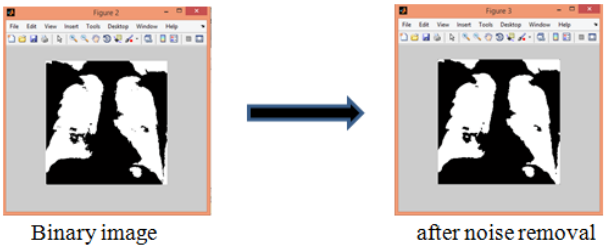

Fig. 6 Noise removal

After removing noise from the binary image, features extraction is perform. Features extraction is a process to find the edges of the medical image. Canny edge detection algorithm is used to find the edges of the image as shown in Fig.7:

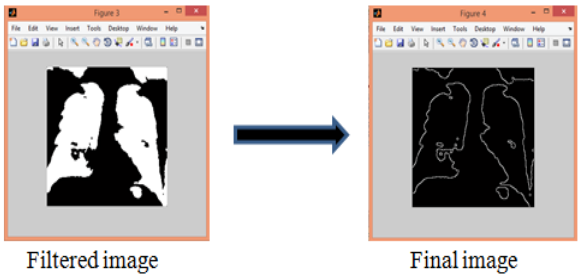

Fig. 7 Canny edge detection

The same steps applied for the rest images given the result as shown in Fig.8:

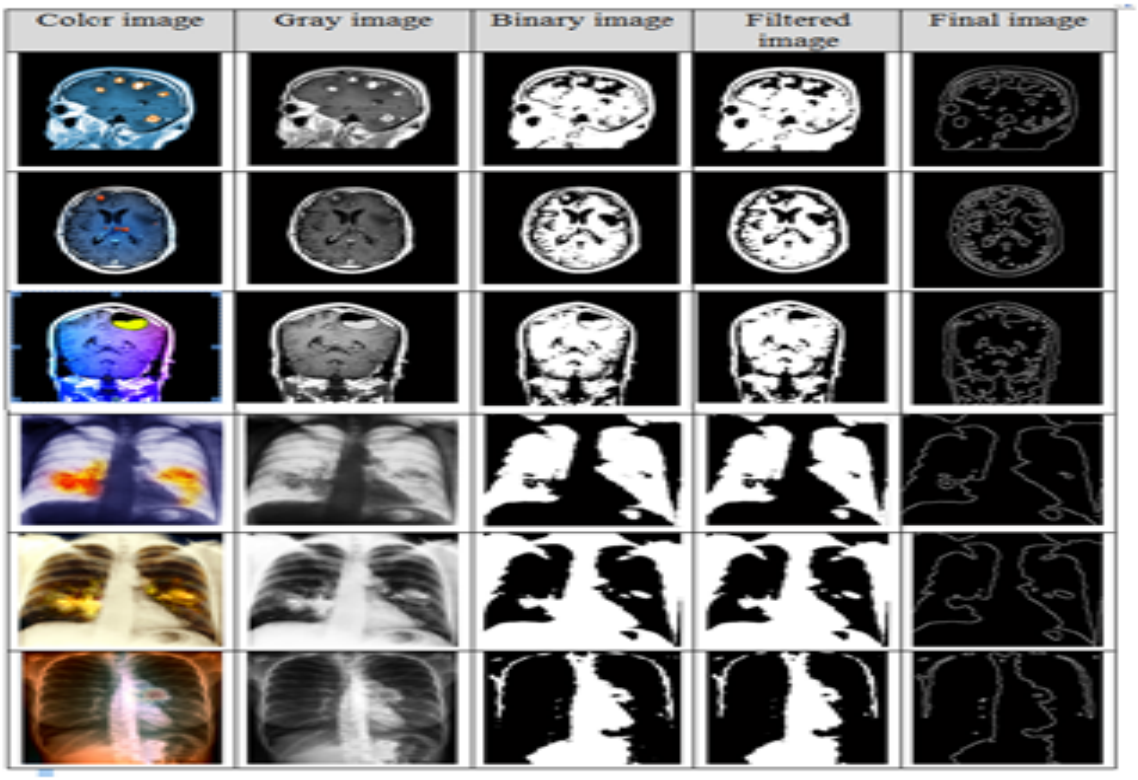

Fig.8 Results of Canny edge detection for medical images

7. Conclusion

An efficient medical image retrieval system requires higher class of robustness, accuracy, and efficiency. In this work, a method for extracting the medical image shape is proposed using Canny edge detection since it is the optimal and widely used as edge detection technique in research. This algorithm is considered to be a very good candidate for image retrieval, this is due to its high generalization performance, and it is a multi-step algorithm that can detect edges with noise suppressed at the same time. The experimental results reveal that the proposed method is better.

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