Integrated Deep Learning Model with Hybrid Texture based Medical Image Retrieval System

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ABSTRACT

Electronic restorative imaging and examination techniques utilizing different modalities have encouraged early determination. The development of the computer-aided retrivel systems in recent years turned them into a nondestructive and popular method for diagnosis the disease in medical images. In this work, adaptive Gabor wavelet filter bank and Texton based a feature descriptor is developed for medical image retrieval. The design of the proposed descriptor basis provides flexibility in order to extract the dominant directional features from medical images.. Also, we present a novel end-to-end integrated deep learning model using Convolutional Neural Network (CNN) and the Long Short-Term Memory cell (LSTM). The proposed integrate deep learning descriptor is compared to other descriptor such as CCM, CHD, MTH and MSD using the datasets such as New Caltech , Corel-1000,Oliva and Corel-10,000.

Keywords : CBIR, Deep fusion , Feature extraction, Texture, Feature Selection.

1. INTRODUCTION

Ongoing advances in PC innovation have empowered the advancement of various sorts of fully automatic computer based diagnosis Presently, restorative picture investigation is an exploration zone that pulls in a ton of worry from the two researchers and doctors. Electronic restorative imaging and examination techniques utilizing different modalities have encouraged early determination [1][2]. The presence of hemorrhages is commonly used to analyze DR or hypertensive retinopathy by utilizing the arrangement plan of Scheie. Notwithstanding distinguishing microaneurysms, it is troublesome for ophthalmologists to discover them in noncontrast fundus pictures. The unpredictability found in a microaneurysm picture is extraordinarily low; thus, ophthalmologists for the most part recognize microaneurysms by utilizing fluorescein angiograms. In any case, it is hard to utilize fluorescein as a difference mode for diagnosing all the medicinal examinees exposed to mass screening..

A typical medical image retrieval system consists of feature extraction and similarity measurement. This paper focuses on the feature extraction step which is the key for a successful image retrieval system. Several methods have been proposed for the extraction of features from the medical images. Local binary pattern (LBP) [3] performs well in texture classification of medical images and has a low computational com- plexity. In addition to that several LBP variants are also proposed such as center symmetric LBP [4], data driven LBP [5], local ternary patten (LTP) [6] and center symmetric LTP,MTH and MSD [7-9] where a relationship is established between the center pixel and it's neighbourhood pixels for medical image retrivel images.

Contours usually contain key visual information of an image. In computer vision, contours have been widely used in many practical tasks. Although quite a few contour detection methods have been developed over the past several decades, contour detection is still a challenging problem in the image field. Among the non-learning approaches, many early methods, such as the famous Canny detector, find contours by extracting edges where the brightness or color changes sharply. However, such methods usually employ regular kernels, e.g., Gaussian filter and Gabor filter , to measure the extents of local changes, and thus can hardly deal with textures . To address this problem, many texture suppression methods have been proposed. Examples are the method based on nonclassical receptive field inhibition, the method based on sparseness measures, the method based on surround-modulation, etc. It has been validated that texture suppression can help improve contour detection performance. Nonetheless, these methods still mainly use low-level local features. Moreover, some of them are computationally heavy, which leads to difficulties in practical applications[10].

Medical image is a popular non-invasive modality for the visualization of different abnormalities in the brain due to its good soft-tissue contrast and accessibility of multispectral images. Using information from MR images, CAD systems have been developed to benefit doctors in rapid diagnosis. CAD systems can provide the diagnosis depending upon the specific attributes present in the medical images. Typically, these systems usually employ the steps of preprocessing, attribute extraction, selection, and classification for categorizing normal/ abnormal brain MR images. Numerous methods have been proposed in the literature that employs classical machine learning algorithms for the detection of abnormal brain images. These studies have proposed solutions based on k-NN, SVM, KHNN, and Artificial neural networks (ANN), etc[11].

2. Hybrid Texture and Colour Descriptor

This section provides some techniques to enhancement of medical images, which can perform image enhancement and noise removal techniques that enhance quality of the images for better retrivel accuracy. This primary stage plays a significant role to detect, trace and extract the region from hemisphere. Because in this step images are changes to finer, sharper and enhanced. The enhanced image is finer than the original one for the specific application and gives the more accurate segmentation. The main objectives of this step is improve image and quality[12].

Mostly segmentation process depends on the sharp transition of image intensity level. A blur or noisy image is not appropriate for extract information. The average filter has been applied in this method for smoothing the images by reducing the image intensity values variation from one pixel to another. An average filter is a linear smoothing filter that was done by the value of each pixel in an image replaced with the average of the gray levels with a filter mask. In this proposed method, 5x5 filter mask was used for filtering approach that enhanced the image quality and reduced noise. This filter operation had done by the convolution sum of the filter mask with corresponding intensity values in an image[13-14].

On the acquired cross-area profiles a pinnacle discovery Step is performed. Our point is to choose whether a pinnacle is available at the focal point of the profile, i.e., at the area of the competitor point for a particular heading. A few properties of the pinnacle are determined, and the last list of capabilities comprises of a lot of factual estimates that show how these qualities shift as the introduction of the cross-segment is evolving. Along these lines, the variety of critical qualities, for example, symmetry and state of the structure, and its distinction from the foundation might be numerically communicated[15].

Gabor filters are generally used to obtain the local spatial and frequency information. This filter is applicable in many image pro- cessing applications such as texture analysis, edge extraction, object recognition etc. A 2-D Gabor function is a Gaussian modulated by a complex sinusoid and is given by in Eqn(1) and its Fourier transform is given in Eqn(2) :

$$g(x,y) = \frac{1}{2\pi\sigma_x\sigma_y}.e^{-\frac{1}{2}\left(\frac{x^2}{\sigma_x^2}+\frac{y^2}{\sigma_y^2}\right)}.e^{j2\pi fx} \quad (1)$$

$$G(u,v) = e^{-\frac{1}{2}\left(\frac{(u-W)^2}{\sigma_u^2}+\frac{v^2}{\sigma_v^2}\right)} \quad (2)$$

Orientation image construction is given in Figure 1 , then the Gabor transform images is divided into the block size is 2x2, 4x4 and 8X8, then, calculate the number of bock of each intensity values 1 to 255.

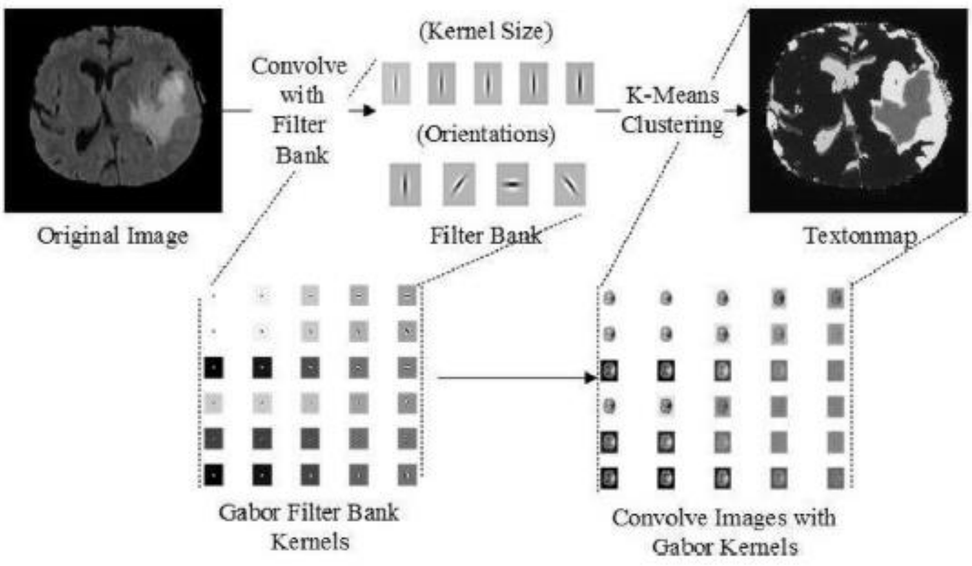


Fig. 1. Construction of the orientation image using Gabor filter bank.

The Feature extraction approach is one of the important methods to classification accuracy. It extracts the relevant information of image and it is formed in a feature vector. The obtained feature vector is applied to retrieval process or classification process. In this paper, from the query image three types of features are extracted on the basis of their shape, margin and their density. The shape features provide the boundaries of the image; margin features used to describe the margin characteristics of the image and finally the third feature of density feature represents the brightness variation of the image. Finally, the obtained three features are formed into a single feature vector[16]. MRI Brain image is represented in gray levels where density degree is denoted by their brightness variation of MRI image. MRI image is represented in gray levels where density degree is denoted by their brightness variation of MRI image. Density features are obtained through the following steps: First, separate or divide the MRI image into two regions are inner and outer regions. Inner region minor axis is equal to the half minor axis of the outer region. Calculate the density degree using the Eqn(3).

$$Density\ Degree = \frac{\Psi_{inner}}{\psi_{outer}} \quad (3)$$

Mostly,the effective classification is subjective to the image features which are associated with an edges and the depth of the network. Hence above mentioned pre-processing techniques are applied to the incoming image sequences to preserve the features edge and the connectivity of each edges for better classification. We boosted our network to the maximum in all possible ways and hence named as Maximum Boosted Convolutional Neural Network.

Classification of diseases is a crucial aspect in disease categorization through image processing techniques. The categorization of diseases according to pathogen groups is a significant research domain and potentially a challenging area of work.. Classification and detection are very similar, but in classification primary focus is on the categorization of various diseases and then the classification according to various pathogen groups. It consists of two stages such as training phase and testing phase. Mostly, the effective classification is subjective to the image features which are associated with an edges and the depth of the network. Hence above mentioned pre-processing techniques are applied to the incoming image sequences to preserve the features edge and the connectivity of each edges for better classification[17]. We boosted our network to the maximum in all possible ways and hence named as Maximum Boosted Convolutional Neural Network. CNN structure normally includes convolutional layer, max-pooling layer with an activation function and a fully connected layer. If the input of 2D convolutional layer is u(p, q) , and the corresponding feature map h(p, q) will be obtained by convolving the input data with a convolution kernel v(p, q) of size $m \times n$, it is defined in Eqn(4).

$$h(p, q) = u(p, q) * v(p, q) \qquad (4)$$

After each convolution, the input to the hidden layers are changed. Such input distributions limits the layer parameters performance and reduces the learning rate during training. Maxpooling layers are placed after each convolutional layer, which downsamples the input images. With the help of proposed architecture, the features are extracted and forwarded to fully connected layer. The information from fully connected layer are fused and integrated with LSTM layer for classification, Maxpooling and an activation function in each convolutional layer which boost the network to extract the deterministic features.

3. EXPERIMENTAL RESULTS

In our proposed system, the performance are evaluated using four benchmark Corel datasets (Corel-1000 and Corel-10000), Oliva dataset, and Caltech-256 dataset. The image size,dimension and resoluations are different for different classes. The performance of CBIR of medical image was evaluated on collected images from National Cancer Institute database (http://cancerimagingarchive.net.. Here, the dataset composed comprises of 20 different patients with 200 MRI images. Three orders of MR images has considered for each patient i.e., T1, T2 and FLAIR. However, each volume holds a dissimilar number of slices that is 100–150.

3.1 Retrieval metrics

In the field of information retrieval, two major metrics are accuracy and recollect. The two metrics are often combined as the subjective choral indicate, namely F — measure, and it is an overall performance measure. It can be defined as per Eqn(4)

$$F = \frac{(1+\beta^2) * R * P}{(\beta^2 * P) + R}$$

$$P = \frac{I_N}{N} \qquad (4)$$

$$R = \frac{I_N}{M}$$

3.3 Similarity measure

It is well known that the exactness not just depends on storing features illustration, but also superior parallel measure or detachment metric. Feature vector of query image Q is representedas $f_Q = f_{Q_1} + f_{Q_2} + ...f_{Q_{Lg}}$ obtained after the attribute removal.Similarity both image in the database is represented with feature vector $f_{DB_j} = (f_{DB_{j1}} + f_{DB_{j2}} + ...f_{DB_{jLg}}); j = 1, 2, ...|DB|$. In our work, four types of similarity distance metrics (Manhattan, Euclidean, Camberra detachment assess and Detachment assess) are used and these are per Eqn(5)

L1 - $$D(Q, DB) = \sum_{i=1}^{Lg} \left| f_{DB_{ji}} - f_{Q,i} \right|$$

L2- $$D(Q, DB) = \left(\sum_{i=1}^{Lg} \left(f_{DB_{ji}} - f_{Q,i} \right)^2 \right)^{1/2}$$

d1 -- $$D(Q, DB) = \sum_{i=1}^{Lg} \frac{\left| f_{DB_{ji}} - f_{Q,i} \right|}{\left| f_{DB_{ji}} \right| + \left| f_{Q,i} \right|} \qquad (6)$$

d2- $$D(Q, DB) = \sum_{i=1}^{Lg} \left| \frac{f_{DB_{ji}} - f_{Q,i}}{1 + f_{DB_{ji}} - f_{Q,i}} \right|$$

Where $f_{DB_{ji}}$ is the ith feature of jth image in the record

The experimental results of similarity measurements, such as L1-Manhatten distance, L2-Euclidian distance, Cambera distance and d1 distance measure of four different information set is given in Table 1. The corresponding evaluation graph is domenstrate in **Fig 4 and Fig 5.**

Table 1. The retrieval result with four methods on four datasets

Data set	Similarity	METHODS

name	measure(%)	L1	L2	Cambera	D1
Corel-1000	Precision	79.67	73.67	79.00	73.67
	Recall	9.56	8.84	9.48	8.84
Oliva	Precision	52.69	50.80	51.85	49.85
	Recall	1.94	1.87	1.91	1.84
New Caltech	Precision	45.93	44.24	45.06	44.27
	Recall	3.08	2.97	3.01	2.97
Corel-10,000	Precision	49.15	46.11	48.96	46.28
	Recall	5.90	5.53	5.88	5.55

We have compared our proposed image retrival method against various descriptor based image retrivel methods such as CED,CMS ,MTH and MSD. The performance analysis has been made by plotting the graphs of evaluation metrics such as precision and Recall .

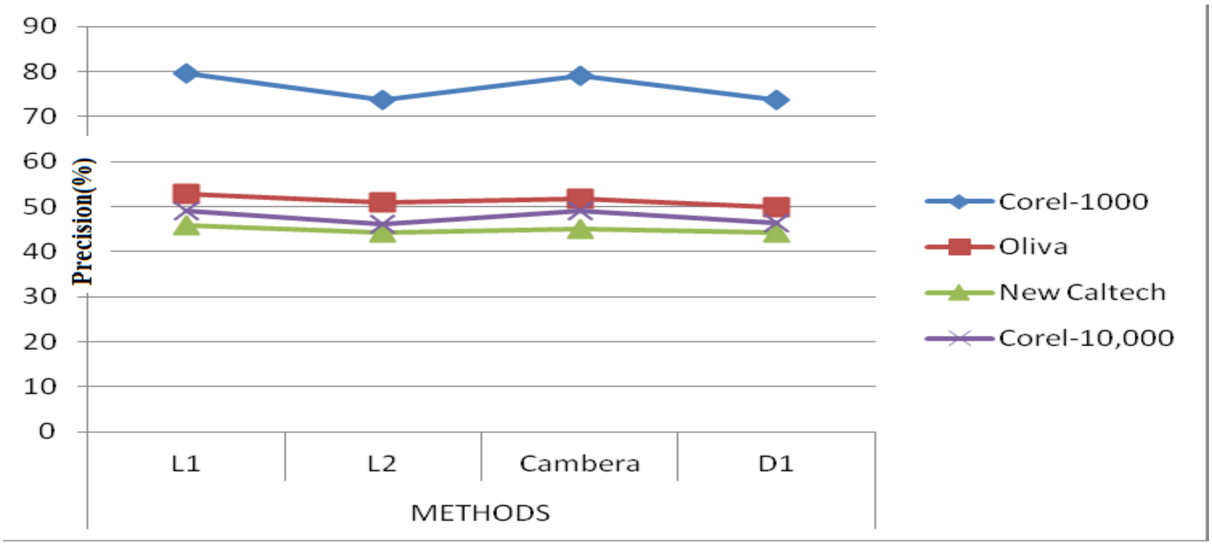


Fig 4. Similarity measures of Four data set using Precision

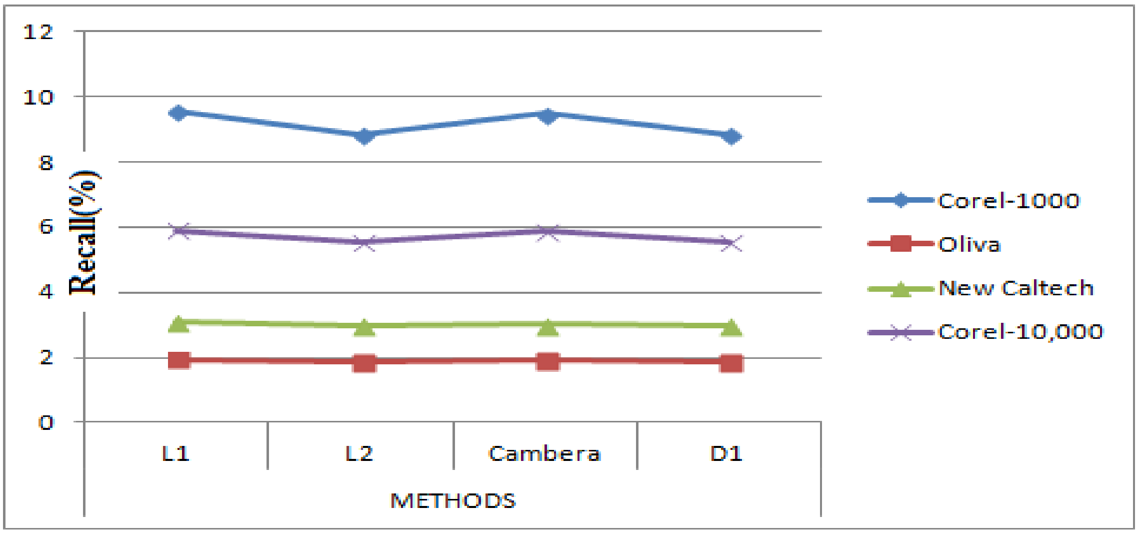


Fig 5. Similarity measures of Four data set using Recall

3.6 Experimental results using Medical Image Data set

National Electrical Manufacturers Association (NEMA) has formed medical images and communication (DICOM) in order to aid the viewing and distribution of medical images such MRI, CT and ultrasound for research and storage purpose. In this experiment, we have considered 10 set of computed tomography(CT) medical images created by NEMA and Open Access Series of Imaging Studies (OASIS). The detail of the database is available in [30,31 and 32], the query image from NEMA using proposed method is given in Fig 2 and OASIS is Fig 3.

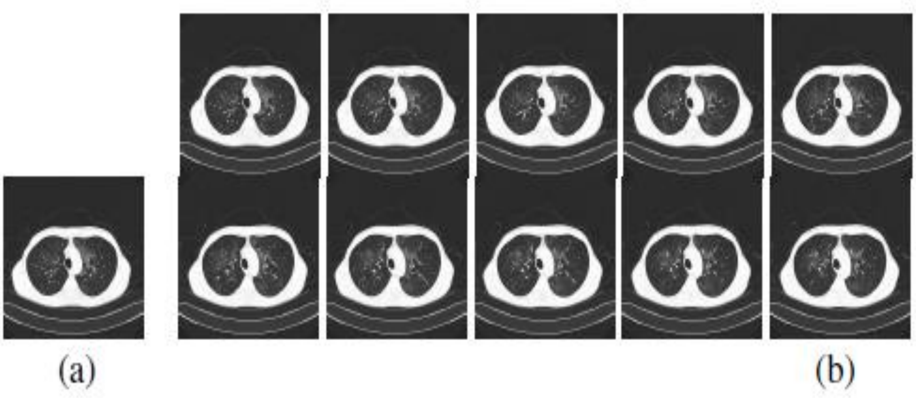
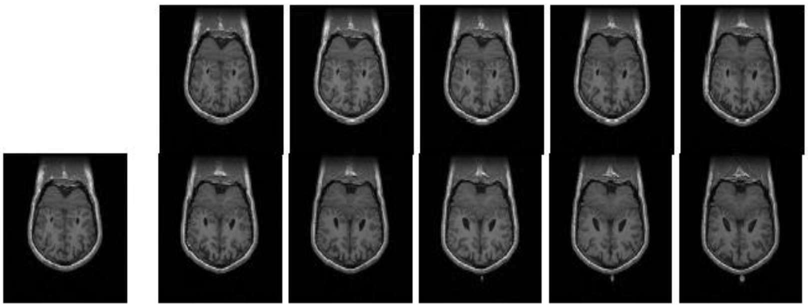


Fig. 2: Retrivel results of NEMA dataset. (a) Query image, (b) retrieved images.



(a) (b)

Fig. 3: : Retrivel results of OASIS dataset. (a) Query image, (b) retrieved images..

4.CONCLUSION

The development of the computer-aided detection systems in recent years turned them into a nondestructive and popular method for the cancer diagnosis in MRI images. The method includes different parts of image processing: in the first step, the original images have been pre-processed by a anisiotropic filter for the noise elimination. Afterward, an optimized image segmentation based on region growing algorithm is used for segmenting the cancer area from the background. Then, several features are extracted for improving the process of classification accuracy. To achieve an optimal feature extraction, an optimal method is used for selecting the useful features and for pruning the remained useless features. The experimental result is compared to other descriptors such as CCM, CHD, MTH and MSD, based on the experimental results, the proposed method is efficient for the retrivel of images from the different datasets such as Corel-1000,Oliva, New Caltech and Corel-10,000.

ETHICAL COMPLIANCE

Not applicable

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CONFLICT OF INTERESTS

The authors declare that they have no conflict of interest

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