A Study on Medical Image Content Based Image Retrieval

R. Senthilkumar1, Dr.M.Senthilmurugan2
Research Scholar, Research and Development Centre, Bharathiar University, Coimbatore-46, India
Research Supervisor, Research and Development Centre, Bharathiar University, Coimbatore-641046, India.
rskcs2k12@gmail.com
smsenthil@hotmail.com

Abstract— Content-based Image Retrieval (CBIR) supports the radiobiology to order related medical images by recovering the previous belongings during examination. The objective of content based image recovery is to recover set of features to characterize the content of each image in the training database for the purpose of recovering images by giving the query. There are various algorithms have been introduced to mine the content of the medical images, but recovery is still a disputing work due to the nature of its feature where most of them are extracted in low level form. In this paper, the topical works in CBIR certain efforts to minimize the semantic gap in mining the features from medical images are reviewed. Then, a study of algorithms and methods related to major methods are discussed, which contain feature demonstration, searching, etc. The report of current work, the impost protocols and many applications of large-scale medical image recovery are introduced, through a variety of tentative and analytic scenarios.

***Keywords*— Medical Image, Content-based Image Retrieval, Features extraction, Semantic Gap, Retrieved images.**

1. Introduction

The image data management techniques are increased to develop the image retrieval systems due to increasing number of image databases. A computer system might be used to browse, search and retrieve the images as a result of image retrieval system from the huge databases of digital images [1]. According to the visual content image, CBIR techniques are used to recover the query image and the image features are extracted as index or basis of search. Due to the development of image mining techniques, CBIR achieved high interest from various research community, which is also noted by Content-Based Visual Information Retrieval (CBVIR) and Query By Image Content (QBIC). The images are mined by the actual content of the image which discusses to shape, color, texture or some additional data of the image [2]. It varies starting the fields mainly over its importance on the recovery of images with covet characteristics from a group of substantial size. The functioning of CBIR classification take in the method of recovering images by comparing a set of images containing similar features as the features described in the query beginning a vast image collection [3]. Recovery of a query image from a large database of images is an essential assignment in the part of computer vision and image processing. The advent of large multimedia collections and digital libraries has led to an important requirement for development of search tools for indexing and retrieving information from them [4].

In a commonplace CBIR framework in medical area, referred to as Content Based Medical Image Retrieval (CBMIR) frameworks which can also have some limitations are discussed in this review [5, 6]. The existing CBMIR faced the challenges that in maximum cases, doctors require to browse over a large number of images for classifying related images, which requires lot of time. Most of the present tools searching medical images by text based retrieval techniques. The text based image recovery undergoes from several limitations [7] such as the need for manual explanation. Thus, the present medical image search and recover methods are not very effective with respect to time and accuracy. Next important issue in medical CBIR is to finding images by related structural regions and diseases. For example, in that instant of brain tumor images, the tumor can be at each of the different stages and an image of the cancer in a formal could be in any orientation [8].

In CBIR, low-level graphic features such as intensity, texture, shape, and the spatial arrangement of objects are used to define which images are similar to a given query. But, a key challenge for CBIR is the semantic gap, which is the variation between machine-computed similarity and a human's interpretation of similarity [9]. Many different CBIR algorithms have been investigated for this purpose; a summary can be found in the recent review by Kumar et al. [10]. Well-established CBIR techniques are therefore designed to communicate low-level image geographies to higher-level semantic concepts. This research work hypothesise that the problem of automatic semantic image annotation could be addressed by adapting the ability of CBIR techniques to leverage low-level image features in the search for images with similar high-level semantic concepts.In this research work, a survey of several techniques which are related to Medical image CBIR with its limitations are discussed. First the fundamental Mechanism of CBIR is discussed below.

2. Content based image retrieval Mechanism

The simple schematic diagram of the CBIR is shown in Fig.1. CBIR is a process for recovering images on the source of freely resultant features such as color, texture and shape. CBIR is also called query based visual information retrieval [11]. The CBIR structure consists of two stages, namely, offline and online. In offline stage, the system continuously extracts visual aspects of all images in the database and stores them in an altered database within the system known as a feature database. The attribute data for each of the visual attributes of each image is worse in size related to the image data. In online image recovery, the user can submit a query occurrence to the recovery method in search of preferred images. The method reforms this case into an attribute vector. The spaces among the attribute vectors of the query example and those in the feature database are then computed and categorized. Recovery is focused by applying an indexing system to afford an efficient technique of searching the image database. Finally, the method grades the search results and returns the images that are most parallel to the query example. If the user is not contented with the search results, they can afford significance feedback to the recovery method, which encloses a mechanism to learn the user's information needs. Difficulties with standard methods of image indexing have led to the increase of importance in methods for recovering images on the source of automatically consequent features such as color, texture and shape – a technology now generally mentioned to as CBIR. However, the technology quiet lacks maturity, and is not yet being used on an important scale. The steps of CBIR are explained in the following section.

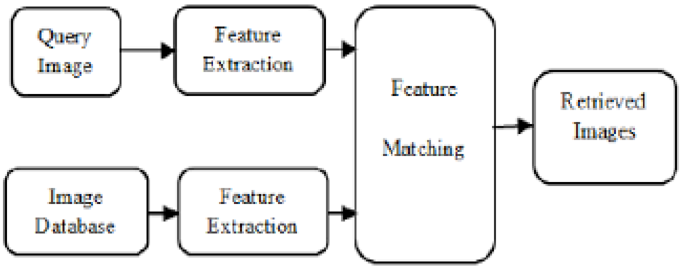

Fig.1.Block diagram of Basic CBIR system.

2.1. Datasets

With the increasing availability of digital imaging techniques, a large number of medical images are generated and well organized in many repositories. Some of the repositories are publicly available for users and researchers. The medical image repositories usually include thousands to millions of images. Images are collected for different purposes, such as cancer grading/staging and treatment planning. In below we mentioned some of the public data sets that are widely used as bio image recovery such as ImageCLEF, DDSM, MedPix, TCGA, TCIA, Retinopathy, DREAM, VISCERAL, LIDC-IDRI, ADNI, NBIA, CAMELYON 17, PubMed Center and NLST [12].

2.2. Pre-Processing

The images stored in standard database to provide collection of image. After the acquisition of input image, an important phase in the image processing is preprocessing of acquired image. Preprocessing methods helps to remove the unwanted noise from the image and also to progress the standard of images. The preprocessing block supports in improving the performance of the system by separating the noise from the actual image. There are several techniques used for pre-processing the query image such as, Histogram Equalization (HE), mean filter, median filter, Gaussian filter, normalization, etc.

2.3. Feature extraction

The CBIR method improves the accuracy of the image by exclude the low-level features such as shape, color, texture and intensity for classifying the given query and retrieves the similar images from huge database [13]. The image feature extractions are divided into three levels which is proposed by Eakins [14] is as follows:

Level 1: The primitive features of objects are used in this level to filter the images on a global scale. The primitive features include color, shape, spatial information and character of the image which is used to find the related images based on a given query by end user.

Level 2: The derived attributes or logical features are involved in this level to identify the degree of inference about the object which is depicted in query image. For instance, in medical analysis the typical query can be "Find the images of a liver".

Level 3: It contains the complex reasoning which described the import of the object. In this level, the sample query will be like "Find the images of an infected liver"

1. 2.3.1. COLOR FEATURES FOR IMAGE RETRIEVAL

One of the low level visual features includes color which is invariant to orientation and image size [15].

- ✓ Color Histogram: In HSV color space, color histogram is the major features of the images which is mostly used in MPEG-7 descriptor. In this level, 64-bit color histogram is generated by converting the HSV components into 16, 2 and 2 regions [16].
- ✓ Color moments: RGB color spaces is the best known color space used for visualization which is used to form the 9-dimensional feature vector. The cube can be formed by extracting the mean μ, standard deviation σ, and skew g. In cube, red denotes the horizontal x-axis which increased to left, blue describes the y-axis which increased to lower right and green represents the z-axis which is increased towards the top [17].

2.

2.3.2. TEXTURE FEATURE FOR IMAGE RETRIEVAL

The texture feature vector is removed from the first image in the database and the gray level co-occurrence matrix techniques is used to give the intensity value for the query image [18]. The texture properties are extracted by the following features includes variance, local stationary, skewness, inverse difference, uniform distribution, homogeneity, energy, entropy and Moment of inertia [19].

2.3.3. FEATURES FOR IMAGE RETRIEVAL

A contour is the characteristics surface configuration of an object is known as shape, which can be separated by its outline from its surroundings [20]. The shape representation can be divided into two steps are as follows:

- ✓ Boundary-based contour representation defines the outer boundary of the objects such as pixels beside with the boundary. In this section, the certain areas of an image are described by using its outside characteristics.
- ✓ Region-based contour representation defines the total section by using its internal characteristics for example it works on the regions contained pixels [21]. This shape demonstration uses the total section of the query image given by the end user.

2.3.4 TILE BASED FEATURE EXTRACTION (TBFE)

The overall feature extraction and anthropogenic features are the two groups of TBFE. The general feature extraction is used for obtaining the spectral and texture features from the respective image.

Spectral histogram of the given tile is used by the group of spectral features. By analyzing each tile three different kind of spectral features obtained such as near infrared, histogram for panchromatic and grayscale RGB.

2.4. SIMILARITY MEASURES OR CLASSIFICATION

The similarity between two images reflects closeness of images by measuring the degree of it similarity by measuring the feature values In general, similarity/distance measures map the distance or similarity among the two images into a single numeric value and depend on two features such as the belongings of the two objects and the measure itself. The selection of similarity metrics has an impact on the enactment of CBIR systems. If the features mined from the images are accessible by multi-dimensional points, the separation between corresponding multi-dimensional points can be calculated. Euclidean space is the most common metric used to measure the separation between two points in multi-dimensional space. Thus, a good similarity measure would need to be employed in order to retrieve the most similar and relevant images.

2.5. CLASSIFICATION

Many classification algorithms have been introduced by researchers to improve the effectiveness and efficiency in CBIR. Now a day's more number of existing CBIR systems consist of supervised learning algorithm. This learning algorithms learns from the training data to predict relevant class images. Thus by making use of the different classification algorithms which is used to retrieve the similar images which belongs to input query given by user in lesser time. Four classification techniques are discussed in this paper – Support Vector Machine (SVM) [22-24], K-Nearest Neighbour (KNN) [25-26], Naïve-Bayes [27], Random Forest [28] and Convolutional Neural Network (CNN) [29] Classification.

Random forests or random decision forests are an cooperative learning method for classification, regression and other responsibilities that controls by constructing a multitude of decision trees at preparation time and outputting the class that is the mode of the classes (classification) or mean prediction (regression) of the individual trees. Generally, SVMs is a type of machine learning technique that has gained importance in environmental related applications. SVM is a learning algorithms employing high dimensional feature.

The correctness of an SVM model is to a great extent relies on determination of its model parameters.Convolutional Neural Networks (CNN) are developed using large scale inputs and elements. These inputs and elements identified as artificial neurons are much larger than inputs used in traditional architectures. These elements are positioned in an interrelated way in a group that utilizes a mathematical model for processing of information originated on a interconnection approach to calculation. In order to store them, those neurons are made receptive by the neural networks. ANN is a mathematical model that is based on the beneficial sorts of human biological neural networks.

3. CONCLUSION AND FUTURE SCOPE

Image collections are rapidly coming online and many researchers have developed user boundaries for browsing and searching such collections. Image search or image recovery systems are types of search engine that are specialized on finding pictures, images, animations and graphical elements from large databases. Like the text search, image search is data retrieval system aimed to help to find information on the Internet. The number of users mining images is increasing gradually along with the growth of huge number of large image databases. An image recovery system is a computer system that is used through searching, browsing and recovering images from large image dataset. The techniques, tools and algorithms that are used in CBIR, originate from many fields such as pattern recognition, statistics, computer vision and signal processing.

It is a field of research that is attracting professionals from different industries such us architecture, publishing, fashion and crime prevention. The main issues faced by the existing CBIR systems involve the techniques used for representing the image content (features) and how to improve accuracy of retrieval. This study presents an answer to these demands, designs and implements Content Based Image Recovery Systems which given a query image, automatically remove features that finest describe the image and perform a search in the template database to efficiently extract similar images in terms of accuracy and speed. The scope of this work focuses on the development of general-purpose CBIR system that is enhanced to improve the process of query image search and retrieval tasks. In order to design such a system, the CBIR is designed using four major steps, namely, pre-processing, feature extraction and reduction, model construction and query process. Each of these steps is treated as a separate phase and is interconnected to each other.

Researchers have proposed several approaches to provide a relationship in the use of low level features with high-level ones to association the semantic distance in the medical field. Past and current researches suggested to use research in CBIR, applying machine learning to classify images in retrieval task and employing Relevance Feedback (RF) to refine the retrieved images in the first iteration. Various algorithms have been conducted by the researchers to solve this matter. However, to build a working CBIR with high-level semantic requires many efforts such as extraction salient low-level features, selection of significant features, effectiveness of learning process, user friendly interface frequently in case of RF and effective similarity measure to index the images.

4. REFERENCES

[1] A.W.M. Smeulder, M. Worring, S. Santini, A. Gupta, R. Jain, Content based image retrieval at the end of the early years, IEEE Trans. Pattern Anal. Mach. Intell. 22 (12) (2000) 1349–1380.

[2] H. Pourghassem, H. Ghassemian, Content based medical image classification using a new hierarchical merging scheme, Comput. Med. Imaging Graph. 32 . (8) (2008) 651–661

[3] T.M. Lehmann, Mark O. Guld, Deselaers Thomas, Keysers Daniel, Schubert Henning, Spitzer Klaus, Ney Hermann, B.B. Wein, Automatic categorization of medical images for content based retrieval and data mining, Comput. Med. Imaging Graph., 9 (2) (2005) 143–155.

[4] H.D. Tagare, C. Jafe, J. Duncan, Medical image databases: a content based retrieval approach, J. Am. Med. Inf. Assoc. 4 (3) (1997) 184–198.

[5] W. Yang, Z. Lu, Yu. M, M. Huang, Q. Feng, W. Chen, Content-based retrieval of focal liver lesions using Bag-of-Visual-Words representations of single- and multiphase contrast enhanced CT images, J. Digit. Imaging 25 (2011) 708–719.

[6] Depeursinge Adrien, Foncubierta Rodriguez Antonio, Van de Ville Dimitri, Muller Henning, Multiscale lung texture signature learning using the Riesz. transform, Med. Image Comput. Comput.-Assist. Interv.-MICCAI (2004) 517–524

[7] G. Csurka, S. Clinchant, G. Jacquet, Medical image modality classification and retrieval, in: Proceedings of IEEE International Conference on CBMI, 2011, pp. 193–198.

[8] CeyhunBurakAkgul, et al., Content-based image retrieval in radiology: current status and future directions, J. Digit. Imaging 24 (2) (2011) 208–222.

[9] A. Smeulders, M. Worring, S. Santini, A. Gupta, R. Jain, Content-based image retrieval at the end of the early years, IEEE Transactions on Pattern Analysis and Machine Intelligence 22 (12) (2000) 1349 –1380.

[10] A. Kumar, J. Kim, W. Cai, D. Feng, Content-based medical image retrieval: a survey of applications to multidimensional and multimodality data, Journal of Digital Imaging 26 (6) (2013) 1025–1039.

[11]. Duan, G., Yang, J. and Yang, Y., 2011. Content-based image retrieval research. Physics Procedia, 22, pp.471-477.

[12]. Li, Z., Zhang, X., Müller, H. and Zhang, S., 2018. Large-scale retrieval for medical image analytics: A comprehensive review. Medical image analysis, 43, pp.66-84.

[13]. Ramamurthy, B., Chandran, K.R., Meenakshi, V.R. and Shilpa, V., 2012, August. CBMIR: content based medical image retrieval system using texture and intensity for dental images. In International Conference on Eco-friendly Computing and Communication Systems (pp. 125-134). Springer, Berlin, Heidelberg.

[14].Hwang, K.H., Lee, H. and Choi, D., 2012. Medical image retrieval: past and present. Healthcare informatics research, 18(1), pp.3-9.

[15]. Danish, M., Rawat, R., Sharma, R.: A survey: content-based image retrieval based on color, texture, shape &neuro fuzzy, Mohd. Danish et al. Int. J. Eng. Res. Appl. 3(5), 839–844 (2013).

[16]. Toldin, P.P., 2010. A survey on contentbased image retrieval/browsing systems exploiting semantic.

[17]. Lee, I., Muneesawang, P. and Guan, L., 1996. Automatic relevance feedback for distributed content based image retrieval. International Congress for Global Science.

[18]. Kong, F.H., 2009, July. Image retrieval using both color and texture features. In 2009 International Conference on Machine Learning and Cybernetics [19]. (Vol. 4, pp. 2228-2232). IEEE.Shah, N. and Broumi, S., 2016. Irregular neutrosophic graphs. Neutrosophic Sets and Systems, 13, pp.47-55.

[20]. Danish, M., Rawat, R. and Sharma, R., 2013. A survey: content based image retrieval based on color, texture, shape &neuro fuzzy. image, 2, p.3.

[21]. Sifuzzaman, M., Islam, M.R. and Ali, M.Z., 2009. Application of wavelet transform and its advantages compared to Fourier transform.

[22]. Habib Mahi , HadriaIsabaten, and ChahiraSerief, Zernike Moments and SVM for Shape Classification in Very High Resolution Satellite Images, The International Arab Journal of Information Technology, Vol. 11, No. 1, January 2014, pp:43-51

[23] Sonali Jain and Satyam Shrivastava, A novel approach for image classification in Content Based image retrieval using support vector machine" , International Journal of Computer Science & Engineering Technology (IJCSET), vol. 4, no. 3, pp. 223-227, March, 2013

[23] Jiawei Han et al, Data Mining Concepts and Techniques, third edition, ISBN 978-0-12-381479-1, 2012.

[25] T. Dharani, I. Laurence Aroquiaraj, Content Based Image Retrieval System using Feature Classification with Modified KNN Algorithm, International Journal of Computer Trends and Technology (IJCTT) –Volume 4 Issue 7–July 2013

[26] Pragati Ashok Deole and RushiLongadge, Content Based Image Retrieval using Color Feature Extraction with KNN Classification", IJCSMC, vol. 3, no. 5, pp. 1274-1280, May, 2014

[27]. Singh, B. and Dhillon, E.J.K., 2017. Retrieval and Classification of Images Using Hybrid of HMMD Color Space and Naïve Bayes Classifier.

[28]. Bhosle, N. and Kokare, M., 2016, October. Random forest based long-term learning for content based image retrieval. In 2016 International Conference on Signal and Information Processing (IConSIP) (pp. 1-4). IEEE.

[29]. Shah, A., Naseem, R., Iqbal, S. and Shah, M.A., 2017, December. Improving CBIR accuracy using convolutional neural network for feature extraction. In 2017 13th International Conference on Emerging Technologies (ICET) (pp. 1-5). IEEE.

[30] F. Zhang, Y. Song, W. Cai, A. G. Hauptmann, S. Liu, S. Pujol, and M. Chen, (2016). "Dictionary pruning with visual word significance for medical image retrieval". *Neurocomputing*, 177, 75-88.

[31] G. Wei, H. Cao, H. Ma, S. Qi, W. Qian, and Z. Ma, (2018). "Content-based image retrieval for lung nodule classification using texture features and learned distance metric". *Journal of medical systems*, 42(1), 13.

[32] E. Yildizer, A. M. Balci, M. Hassan, and R. Alhajj, (2012). "Efficient content-based image retrieval using multiple support vector machines ensemble". *Expert Systems with Applications*, 39(3), 2385-2396.

[33] L. Tsochatzidis, Zagoris, K., Arikidis, N., Karahaliou, A., Costaridou, L., &Pratikakis, I. (2017). Computer-aided diagnosis of mammographic masses based on a supervised content-based image retrieval approach. *Pattern Recognition*, 71, 106-117.

[34] A. Kumar, Dyer, S., Kim, J., Li, C., Leong, P. H., Fulham, M., & Feng, D. (2016). Adapting content-based image retrieval techniques for the semantic annotation of medical images. *Computerized Medical Imaging and Graphics*, 49, 37-45.

[35] R. Ashraf, Ahmed, M., Jabbar, S., Khalid, S., Ahmad, A., Din, S., &Jeon, G. (2018). Content based image retrieval by using color descriptor and discrete wavelet transform. *Journal of medical systems*, 42(3), 44.

[36] D. M. Hussain, and D. Surendran. "Content based image retrieval using bees algorithm and simulated annealing approach in medical big data applications." *Multimedia Tools and Applications* (2018): 1-16.