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A review of methods for the automatic annotation and retrieval of medical images

Seyed Masood Khademi *
Department of Computer, Islamic Azad University, Yazd Branch, Yazd, Iran

Seyed Reza Pakize
Department of Computer, Islamic Azad University, Yazd Branch, Yazd, Iran

Mandana Abdolahzade Tanoorje
Department of Computer, Islamic Azad University, Torbat-e-Heydarieh Branch, Mashhad, Iran

Abstract— Nowadays, There are a lot of medical images And Their numbers are increasing every days. Thus, find and retrieve images is the main challenge in this field. One of the methods for image retrieval, is automatic annotation concentrated on the image content. Image annotation means that we produce the words to describe the image content. There are variety of techniques for annotation and retrieval. In this paper, first, we describe the main parameters of annotation and retrieval, Then we introduce and describe some of techniques which to automatic annotation and retrieval of medical images such as Multilevel, IRMA code ii, Visual BOW, Improved MLP Neural Network, Combine Method, Surf detector, Hausdorff distance. Finally, we highlighting the advantage and dis-advantage of each Techniques.

Keywords— automatic annotation, classification, medical image, retrieval image, color, texture.

I. INTRODUCTION

In medical, images, especially digital images are used for diagnosis, treatment of diseases and management of patients [2],[14]. Nowadays, with the development of digital technologies, medical images being produced and stored[4]. Medical images are include: X-ray, MRI, MRS, CT, MSI, PET, SPECT, they are stored in very large databases or file systems with information including radiology reports, findings and visual Property which most of them are expressed in natural language [5]. With the increasing of medical images, Management and effective evaluation and ease of access to them are the important issues in this field.

Two methods are used for retrieving images, first is content-based image retrieval (CBIR) and second is semantic-based image retrieval (SBIR). In this systems, Response is based on applying text and we can do it retrieved based on the words If images with one or set of words described or other words have been annotated [5]. Image annotations means describe an image with one or more words that express the content and meaning of the image [7],[8]. Annotation can be done by traditional method and machine. The traditional or manual method of annotation is done by humans, but the second method annotation and retrieval is done by machine, which is divided into two ways: automatic and semi-automatic method.

Rest of the paper is organized as follows. Section 2 presents the important parameters of annotation. Section 3 will describe the various techniques of automatic annotation and retrieval. comparison and discussion are reported in section 4. Finally, the overall conclusions of this study are presented in section 5.

II. ANNOTATION AND RETRIEVAL OF IMAGES

image Annotation means that the production process refers to the words that describe the image content. The purpose of image Annotation is produce of words that are suitable descriptor for images. In fact, in the annotation is set of word or words that represent the actual meaning of the image is accompanied with images. The actual meaning is concepts which closer to human understanding of the image. Annotations can be done by traditional methods and machine. The traditional or manual method of annotation is done by humans. Considering that the images which Has been annotation are too high, so annotations by humans is unwise because time and cost should be spent, and the need to expert [3],[5]. The only advantage of this method is its high accuracy. the second method, annotation and retrieval is done by machines which is divided into two methods: automatic and semi-automatic. In The automatic method, annotation and retrieval are done completely by machine, but in the semi-automatic, human is involved in the retrieval and annotation. Automatic annotation and retrieval process including: feature extraction, classification/annotation and retrieval of images.

A. Feature Extraction Methods

Image features are divided into two categories: low level and high level. Low-level features including color, texture, and shape are which extracted by image processing, while the high-level features that represent concepts or words from image. Color features can be seen Less in the medical images. Texture features image is contain important information about the levels structural arrangement of the image [2]. Usually we used of tow techniques For texture feature extraction: gray-level co-occurrence matrix (GLCM) and local binary pattern (LBP). The shape feature is known sign important for humans to detect and recognize objects in the real world. The shape features are used in the most applications for retrieval of images[3].

for classify and retrieve images, their show with low-level features. because an image is Unstructured array of pixels, the first step to understanding the meaning of image is effective features extraction of this pixels. extractable Features from each image are divided into two categories: local and global. with use of these features we can improve the performance of semantic learning techniques [3]. Feature extraction methods can be classified into two groups: the first group, showing low level that consists gray-level co-occurrence matrix (GLCM), Operator edge canny, Local Binary Pattern (LBP) and the pixel value. the second is bag of words (BOW) [2].

B. Image Classification

After image features extraction, they have to classified by classification methods. Each classification process consists of two phases: the learning phase and test phase. in the learning phase, features are extracted and selected from all the training images, And classification algorithms due to these features, the images are classified, and In the testing phase images are used of the space profile for classification. The most popular classification techniques are SVM, KNN, Decision tree, Bayesian belief networks, neural networks, fuzzy logic techniques and hybrid methods [6].

C. Images Retrieval

There are two main methods for images retrieval. These methods include: content-based image retrieval (CBIR) and concept-based image retrieval (SBIR). in the CBIR method, input of system can been sample image or features which explaining of the image content, while the output of the system is similar to the input image or images that contain these features [6],[17]. The weakness of this method is that it is difficult which is not what the user wants, search and describe features with the sample image. in the SBIR method, retrieval are done by keywords that describe the content of the image. This method is easier for the user. in this systems, Response is based on text application and If images have already described by one or a set of words or they are annotated then we can retrieved based on the words [5].

III. ANNOTATION AND RETRIEVAL TECHNIQUES OF MEDICAL IMAGES

In this section we briefly introduce some of the Automatic medical image annotation techniques.

A. Automatic Multi-level Annotation and Retrieval

Mueen et al. [10] for automatic annotation is used automatic multi-level code generation which multi-level annotation. In this method, used of combination of three levels of feature extraction methods include local, global, and pixels for features extraction. To do this case, in the first, make up a large feature vector And the image is divided into several sub-sections, then extracted the texture and shape features from each of these sectors. When the feature vector is created, First, 53 dimensions feature vector is obtained from the entire image by applying gray level co-occurrence matrix for texture extraction and edge histogram for shape feature extraction. Secondly, 53 dimensional (16 texture + 37 edges) features extracted from each of the parts and finally by resizing the image to 15×15, and pixel vector of size 225 was obtained. All of these features are combined to make up a feature vector of size 490. In this method, the concepts of hierarchy are used for interpretation of semantic image concepts. This hierarchical structure is major contribution of image semantic retrieval. in this method used of SVM for classification and low-level image features are mapped on to a larger feature space dimension. Considering that high dimensional feature vector, requires high memory and high computational power, in This method is used main component analysis to reduce the dimension of feature vector that reduce the memory and computational cost. In this system shown two types of annotations for a test of character for multi-level semantic image annotation specifies the corresponding. Each character is an interpretation of a text keyword.

B. IRMA Code ii

IRMA Code i used to unique labelling images which in this had been discovered several weak points: e.g., lack of individual parameters such as age and gender, pathologies are not included, not including different for the left and right sides of the body [11].

Tim-cristian et al. [12] proposed IRMA Code II to resolve the weaknesses of the IRMA code i. In IRMA Code II, eight axes of three levels in hierarchy for anatomy, biological system, configuration, direction, equipment, finding, generation, and human maneuver as well as additional flags for age class, body side, contrast agent, ethnicity, finding certainty, gender, quality, and scanned film, which are captured in form of another axis. Support classification coding from image retrieval must be unique, clearly ,arranged and could be expanded. Code should appear to reflect light from the image. In this method, due to ambiguities and uniqueness IRMA Code i and also to simplify and normalization hierarchical tree used Additional axis and flags.

results structure of IRMA Code ii method is includes eight axis That each is to three directions for refinement and a code eight place to keep the flags. general body position used to the ambiguity of code such as open or closed hands, sitting or standing patient. According class "Patient ID" this method use flag integral for age, sex and ethnic group for comparative studies. IRMA code ii allows annotation of the form A: XXX, B: XXX, C: XXX, D: XXX, E: XXX, F: XXX, G; XXX, H: XXX-IIIIIIIII. ImageCLEF2007 set used to test this method, that have followed good results. Generally, IRMA code II provide more robust with more options coding and particularly for abnormal image content.

C. The Improved MLP Neural Network

Ravi et al. [14] using of mechanism the discrete sine transform (DST) for feature extraction that In which 50 of the top features select by the class feature with information gain. Information gain is selection of feature vectors which is necessary for the classification process. Information gain can be calculated based on the class attribute in The calculation of coefficients DST. Then These features are classified by MLP neural network classifier. MLP neural network consists a input layer and one or more intermediate hidden layer and a output layer. This method, improved classification accuracy traditional MLP with FS-MLP, by introducing the fuzzy softmax hidden layer.

D. Bag of Words (BoW)

Bouslimi et al. [5] offered a new method for automatic annotation of medical images using a bag of words (BoW) to display the visual meaning of medical image combined with text descriptors based tf.idf approach and reduced with connotation to extract between words and visual words. This method, first, classify local features with uses a unsupervised classification algorithm stylish of a dictionary of visual words. According to their descriptions each area of the image is associated with visual words. Vocabulary of visual words is used to display images. Each image can be displayed using vector weighted visual words. In this method, the annotation and retrieval are done in three phases. In the first phase, indexed text and extract all fit sentence, whit using of a term that contains a combination of Medical concepts. In the second phase, medical images are indexed until they are fixed for a specific area and retrieved to effects of light and scale changes. In the third phase use the bag of words to retrieve vector space for new image annotation. This approach Evaluated on a set of annotated images, which were provided by the Tunis military hospital. This collection is includes over 1000 medical report radiology images that consists 5 categories (chest, skull, pelvis, spine). The results showed that this approach works well on images of skull.

E. SURF Descriptor

wojnar and pinheiro [15] used descriptors SURF (speed up robust feature) based detector fast-hessein for extracting feature. In this method, performed feature matching with square root of SVM. Annotate images with this technique is performed in three stages: detection, descriptions, annotation. for discover points of interest , approximated hessian matrix using filters such as Box 9 * 9. Descriptor are described the intensity of the neighboring areas of interest. This Is performed in two steps: the first step using wavelet HaaR to points of interest, neighbours calculates a circle around the areas. Haar wavelet added one value on vertical and horizontal. The second step build a square region in around the center to extract describing. Finally, using SVM and K-NN classifier that confidence interval was 96%. Generally this approach for the automatic annotation of medical images has great potential.

F. Combine of Feature Extraction Methods

Zare et al. [2] in four experiments using both groups show a low level image feature extraction such as Gray Level Co-occurrence Matrix (GLCM), Canny edge detection operator, Local Binary Pattern (LBP), the pixel value and Bag of Words to extract features. These features take in Different classification algorithms into two phases: learning and testing to automatic classification of x-ray images. In learning phase isolated the selected features from all learning images and learn a classifier with extracted features to make a classification model. Then used this model to classify test images into preset categories in the testing phase. for each of the four experiments have used KNN and SVM classifier. In the first experiment used texture, shape and features of pixels to extract the features. In a second experiment used LBP feature extraction methods. In the third experiment, applied the method of pixel data, texture, shape and LBP (combined first and second tests) and finally the fourth test used BOW feature extraction methods. Result of Experiments show that the classification performance of using LBP and BoW image is better than the other algorithms.

G. Hausdorff Distance

Bouslimi and Akaichi [8] Have suggested an approach based on Hausdorff distance that can compute the similarity between a new image and the stored old images. User choose one of the similar images, then assigned descriptions to selected new pictures. annotation Images stored in an Oracle database and for annotation of new images using combination of the machine and the user (expert). After feature extraction of radiography image, expert has to choose then one of the similar images and annotations related to the selected one are assigned to the new one.

IV. DISCUSSION AND COMPARISON

So far we have described techniques for medical image annotation and Retrieval. In this section, we evaluated and compared these techniques based on feature extraction method, classification method, dataset, type of image, type of annotation. Table 1 are showing all the techniques with each features of them.

TABLE I: FEATURES TECHNIQUES ANNOTATION AND RETRIEVAL OF MEDICAL IMAGES

Technique	Type of Annotation	Feature Extraction Method	Classification in Used	Images type	Data set	Annotation/ retrieval technique	Number of tested images
Multilevel	automatic	Local, Global, Pixel	SVM	Radiology	Image CLEF2005	Hierarchy	Trained: 9000 & tested: 1000
IRMA code ii	Automatic	Texture, Shape, Color	Unique	Radiology	Image CLEF2007	Unique	12000
Visual BOW	Automatic	Local	Unsupervised Classification Algorithm	Radiology	Military Tunisian Hospital	Distance Vector	1000
Improved MLP Neural Network	Automatic	DST	FS-MLP	MRI	MRI	MLP Neural Network	50
Combine Method	Automatic	Texture, Shape, Pixel, LBP, BoW	SVM,KNN	X-RAY	Image CLEF2007	BOW	1100
Surf detector	Automatic	Fast Hessian Detector	SVM-KNN	Radiology	Radiology Images From IRMA	Surf	4241
Hausdorff distance	Semi-automatic	Texture	Hausdorff distance	Radiology	Bank of Radiology of the Council of France	Hausdorff distance	13,715

TABLE III: STRENGTHS, WEAKNESSES AND ACCURACY RATE OF ANNOTATION AND RETRIEVAL TECHNIQUES

Technique	Advantage	Dis-advantage	Accuracy rate
Multilevel	1. Reduce size of Feature vector 2. Improved Image semantic Retrieval.	It's Slow	-
IRMA code ii	1. More Consistency with more option. 2. Covered disadvantages of IRMA i	Use of extra vectors and flags	-
Visual BOW	Production visual vocabulary	It's only good result for skull	MAP: 0.3359
Combine Method	High accuracy	1. High size of Feature vector. 2. it's only work on the X-rey images.	LBP: SVM = 90.7% KNN= 86% & BoW:SVM= 90% KNN=86%
Improved MLP Neural Network	Improvement accuracy	It's Slow	96.55%
Surf detector	High speed and high potential	-	96.6%
Hausdorff distance	High accuracy	1. Requires to expert. 2. it requires a large sample of learning to be effective.	Between 80-90 %

Table 2 shown Strengths and weaknesses and accuracy rate of each of the techniques listed. As is seen, two techniques multi level and Improved MLP Neural Network, despite having many benefits and high accuracy, in annotation and retrieval processes are slow. combine methods are more suitable than other methods when we want to work on X-ray images. Also, if you have to work on the skull images, Visual Bow technique is a good case.

due to the Hausdorff distance is a semi-automated method, in the annotation and retrieval need expert, which On the one hand, caused The result is high level of accuracy, but on the other hand, given that this force should be professionals, So which require more time and cost. Surf detector has a higher accuracy rate is compared to other techniques.

V. CONCLUSION

In this paper, we explained the main parameter of annotations and retrieval, then reviewed the medical image Automatic annotation and retrieval. Furthermore, compared these techniques based on feature extraction method, classification method, dataset, type of image, type of annotation. Then, we explained advantages and dis-advantages of each with accuracy rates. The most important part of these techniques are feature extraction and how they are classified. For the feature extraction, should be Consider to method of feature extraction and size of feature vector; because If the size of feature vector be high, increases the time complexity and memory space, But if that be low, classification results are not good. Thus, a balance must be set between them. In general, if in the annotation and retrieval, accuracy is important, the combination of methods is suitable, and if the speed is considered, Surf detector is the best cases.

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