International Journal of Scientific Research in Computer Science, Engineering and Information Technology
© 2018 IJSRCSEIT | Volume 3 | Issue1 | ISSN : 2456-3307

A Review on Different Categories of CBIR Methods

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ABSTRACT

Content based image retrieval (CBIR) has become a main research area in multimedia applications. In the literature, there is lot of papers focusing on the content-based image retrieval in order to extract the semantic information within the query concept. The CBIR methods used in image searching areas differ by the user interaction and processing style in query image input. If we classify the CBIR methods into different categories, they are useful for deciding the suitable method for suitable environment and application. This paper classifies the different category of CBIR methods based on the user interaction with query image and the query processing style. In this paper, a review on nine categories of CBIR methods are given and for each categories a significant count of latest papers are described to enhance the better understanding of the users. This paper highlights the best CBIR methods for every user specific requirements.

Keywords: Query, Database, Image Retrieval and Texture.

I. INTRODUCTION

The ever-growing amount of digital images on the web makes golden shining on the content-based image retrieval, because of its capacity in searching and indexing multimedia images [34]. Content based image retrieval techniques are intrinsic requirement in the multimedia applications through the usage in internet [15]. Most probably, CBIR systems use color, texture, shape or any other information, which are automatically extracted from query and database images. The retrieved images are refined by ranking based on the similarity between original and database images [32].

The inefficiency of CBIR systems is due to the gap between the low level features and the semantic features [33]. Many papers are introduced to demonstrate the variety of user interaction with the query image and the variety of feature processing schemes with query and database images. The CBIR schemes can be divided into few meaningful categories. One who has knowledge about these categories can choose his convenient CBIR system to adopt with the network, device and image types. This paper makes a review of the different categories of CBIR systems.

II. DIFFERENT CATEGORIES OF CBIR SYSTEMS

The CBIR systems can be worked with variety of user interactions and with variety of implementation types. In this paper, the major CBIR categories are differentiated based on the user interaction with query image and the principles of handling the query image processes.

The majority of CBIR systems can be divided into nine categories such as single query based CBIR, visual and textual based CBIR, sketch based CBIR, shape based CBIR, region based CBIR, bar code annotation, visual based CBIR, visual phrases based CBIR, multi query based CBIR and relevance

feedback based CBIR. The figure 1 demonstrates the architecture of the categories of CBIR systems.

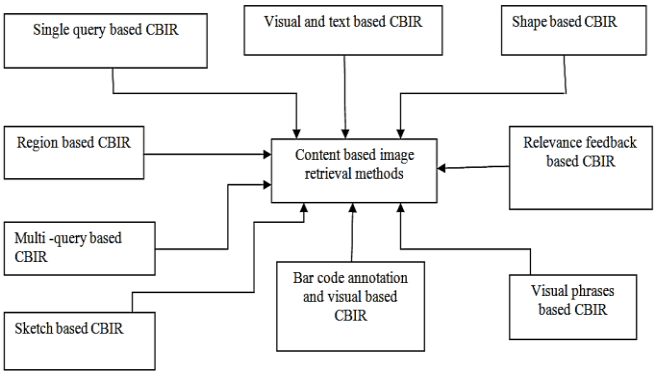

Fig. 1 Architecture of different categories of CBIR system

A. Single query based CBIR

In the beginning history of image retrieval, the annotation technique was used to get relevant images. The user quotes the query in the form of text query text is matched against the database annotations and produce image retrieval results [2] [6]. To improve the text based image retrieval, multi-label image retrieval is also proposed and the recent development on this type is presented in the paper [3].

The demerits in the annotation creation induced the development of content-based image retrieval schemes [35]. The CBIR methods retrieve images based on visual and semantic features [36]. The user provides a query image to make search on database and the query image feature is matched with the database image features, and finally the relevant images are given as result to user.

The paper [4] describes a method for image retrieval using pattern co-occurrence matrix based on Block truncation coding (BTC) and vector quantization (VQ). The color query image is used as input for this system and the relevant images are extracted from the image database.

The paper [14] progresses a CBIR system with single query image by object based image retrieval. The 3D active model is constructed in the 2D query image and based on that the *speeded up Robust feature* (SURF) is adopted to do the image retrieval.

The paper [15] proposes a method to develop a CBIR application using object based processing. The main object is segmented and only for that object, the color and texture features are generated. The paper [45] is also developed based on content based image retrieval method and it provides high performance.

B. Visual and textual based CBIR

The CBIR methods are slower than the annotation based methods in majority of the cases. So the annotation based method is joined with the CBIR method to improve the speed of execution. The paper [5] provides a method for image retrieval using both visual features and textual features. Images are segmented into clusters based on visual features and each cluster is associated with a set of terms derived from textual descriptions. Text information retrieval methods are used to choose the relevant terms to utilize as tags. Here the query can be both image and text.

The paper [8] also supports this type of CBIR scheme and both image and text are taken as input queries. The *Maximum combinations* (Comb MAX) *sum combinations* (comb SUM), *Product of the maximum* and a *non-zero number* (comb MNZ) features are jointly used in this method. The paper [9] also supports the visual and textual based image retrieval. In this paper wavelet features and textual features are used for images retrieval in the web

C. Sketch based CBIR

The sketch based image retrieval (SBIR) applications retrieve the relevant images from image databases using outline sketch type query image which is drawn by the user at the time of querying. Outline sketches are normally easier and faster when compared with usual CBIR techniques. Sometimes query image may or may not be at hand while seeking an image from database, so that the outline sketch based CBIR methods are much helpful in sch cases.

The current world is switched from desktop to hand held devices, so outline drawing is easier than ever. This sketch based CBIR applications are much relevant on querying large image databases.

The paper [19] says about the SBIR application which takes outline-sketches as query image. In this paper the outline sketches (real user's input) can be drawn using computer or any hand held devices and the image retrieval is performed using the Bag-of-Features descriptor. The paper [20] describes a sketch based CBIR method to retrieve the natural images with relevancy from image database. The *Histogram ofline relationship* (HCR) and *noise impact reduction algorithm* are used to achieve the higher precision and recall rates. The paper [21] behaves as sketch based image retrieval application and this paper targets the achievement by saliency detection technique. The paper [37] and [38] are also support sketch based image retrieval.

D. Shape based CBIR

The image retrieval in binary images can be achieved through the shape based query image. The user provides his query in the form of shape image and that shape is used to extract features to compare with the database features to construct a CBIR system. The paper [16] proposes a CBIR method depending on shape based query using contour based edge points on binary image environment. This paper works with rotation invariant features.

The author Nafaa *et al* [17] has designed a mechanism to shape based CBIR system using Radon transform and Wavelet transform. The author Shan Li [18] has developed a method for shape based image retrieval using *complex Zernike moments* based feature which is robust and effective shape feature. The shape images are retrieved from MPEG-7 binary image database.

The papers [39] supports the shape based CBIR and its work is based on Ridgelet-Fourier Concept. The paper [40] also supports shape based image retrieval and its working is based on signature histogram which is constructed from the border of the objects.

E. Region based CBIR

The region based CBIR applications are forwarded to another form of image retrieval by choosing region of interest (ROI) in the query image by the user and the image retrieval is performed depend on the visual features of the query ROI. This type of image retrieval is known as RBIR. These types of CBIR applications improve the efficiency of image retrieval. The paper [23] presented a RBIR method to image retrieval which allows the user to specify a particular region of a query image. The similar image retrieval is handled using color and texture features. The *HSV color conversion and gray level co-occurrence matrix* are used to extract features.

The paper [22] describes a RBIR method to get better image retrieval of natural images. In this method, region of interest selection is done through the automatic segmentation i.e., there is no need of user interaction in query image. The *adaptive region segmentation, visual RI construction and semantic RI construction* are the main parts of this paper.

The paper [24] also performed a RBIR application using color and texture features on irregular regions of interest. The ROI region is automatically obtained using K-means method and harralic features are used for texture feature extraction. The paper [41] and [42] also retrieve images based on RBIR method.

F. Bar code annotation and visual features based CBIR

Annotation based methods make faster the image retrieval results. The annotation combined content based image retrieval methods work faster and better in efficiency. But the annotation marking is a complex problem and in major cases the annotation may be spelled in file names. This may create practical problems, so that the bar code can be used, instead of text based annotations.

The paper [1] explores the method for barcode based annotations and here small bar codes are generated to embed in the medical DICOM files. The content based feature named LBP is also combined with this method. The 1D Radon transform based barcodes are used to get fast retrieval instead of 2D bar codes.

G. Visual phrase based CBIR

Some images may be photographed with the textual data inside of it. For example, a CAFE shop sign board contains the word 'CAFÉ' and if that sign board is acquired by camera, then that image

contains the word 'CAFÉ' as scene text. An image retrieval technique is developed to make image retrieval using this type of scene texts. The user provides the query image (which contains the scene text) to the CBIR system and the CBIR system extracts the text from the query image. The extracted text is used to retrieve the relevant images from the database. The paper [7] describes the method to extract the scene text from the query image and presents a procedure to index the relevance images. The text detection is performed using robust feature descriptor like SURF and the string matching is performed by the N-grams method.

H. Multiple Query based CBIR

The Single Query based CBIR methods can be improved by intaking multiple query images instead of single query image. In this system, each query image is related with same image semantic concept but there exists a possibility of variation in background and angle. Here this type of multiple query methods, fused the low level features from the query images to produce a mid range query. The multi-query CBIR systems significantly improve the precision and recall rates compared with single query systems.

The paper [11] concentrates about multi query type of CBIR method and two query images are accessed as query corresponding to different image semantics. The Pareto front method with manifold ranking is employed to achieve the multi query based CBIR. The paper [10] can also applied for the multi query CBIR system and the binary component vector is used to obtain the improved image retrieval results on the flower images. Here two different roses are fed as multi query input and relevant images are ranked.

The paper [12] presents a multi query based CBIR method using query replacement algorithm which uses the statistical features of the query image set. The paper [13] also released a CBIR method with multi queries, but here the user should provides positive images as query 1 and negative images as query 2. The image retrieval considers both the two sets to formulate the relevant images.

I. Relevance feedback based CBIR

The content based image retrieval systems are suffered by two issues namely accuracy and response time. These drawbacks are occurred due to the great gap between the semantic concepts and low level image features. The relevance feedback can be used to improve the efficiency of information retrieval and it is a supervised learning way which can elevate the effectiveness of information retrieval schemes [44].

The positive and negative feedbacks of user is considered here as key concept for the improvement of image retrieval. The system first retrieves the relevant images in accordance with query image and then the user chooses positive or negative examples from the first level image retrieval results. After that the system updates its query list and retrieves the image depending on the new query images [43]. The success of the relevance feedback method exists in the way of new query updation and similarity measure according to the feedback.

The paper [25] concentrated about the relevance feedback based image retrieval system using Bayesian frame work feature subspace and progressive learning. The positive examples are used to estimate a Gaussian distribution to get relevant images and the negative examples are utilized to alter the ranking of the retrieved images. The paper [26] presents the CBIR system with the assistance of relevance feedback technology. This paper retrieves the remote sensing images using active learning and relevance feedback. This method gains better precision criteria with minimum RF rounds.

The paper [27] also supports for relevance feedback technology. This method pushes the log of feedback data in to the traditional relevance feedback data in to the traditional relevance feedback schemes, so that the joining of low level image features and high level concepts elevates the image retrieval performance. The soft label support vector machine theory is

incorporated with this nice method for similarity based image retrieval.

Dacheng Tao [28] proposed a method to relevance feedback based image retrieval using the concepts such as *Asymmetric bagging* and*random subspace*. Three types of support vector machine mechanisms are adopted to achieve the image retrieval with the help of relevance feedback. Pushpa B. Patil [29] develops a method for image retrieval using relevance feedback by the utilization of Riemanniah manifolds. The positive and negative feedbacks of the user at each iterations is used by this method. The concepts such as *cost adjacency matrix* and its Eigen vectors are used to improve the efficiency of image retrieval.

The paper [30] supports relevance feedback based on CBIR by creating the link between high level concepts and low level features. The feature size reduction is achieved by user's feedback and it combines query and feature weights refinement to achieve the *feature adoptive relevance feedback* (FA-RF) which is able to adjust the feature space to the log of user selection.

The paper [31] expresses the image retrieval scheme which is packed with the relevance feedback facility to improve both the accuracy and time period. This paper is energized with the dynamic hierarchical semantic network which is constructed by the relevance feedback mechanism by allowing dynamic iteration levels. The image sets such as Rose, Building and seashore scenes are preferred for image retrieval.

III. DISCUSSION

This paper divides the categories of CBIR systems into nine separations and reviews the latest papers associated with them to understand each and every CBIR categories. The table 1 expresses some meaningful discussions on CBIR categorization. It shows the different types of categories in CBIR and the papers related with them. It also shows the best paper of among that category.

Table 1: Different types of categories in CBIR

S. No	CBIR type	Published latest papers	Best paper
1	Single query based CBIR	[4],[14], [15], [45]	[45]
2	Visual and Textual based CBIR	[5], [8], [9]	[5]
3	Sketch based CBIR	[19], [20], [21], [37], [38]	[20]
4	Shape based CBIR	[16], [17], [18], [39], [40]	[16]
5	Region based CBIR	[23],[22], [24], [41], [42]	[24]
6	Barcode annotation and Visual based CBIR	[1]	[1]
7	Visual phrases based CBIR	[7]	[7]
8	Multi query based CBIR	[11], [10], [12], [13]	[11]
9	Relevance feedback based CBIR	[25], [26], [27], [28], [29], [30], [31]	[26]

IV. CONCLUSION

Content based image retrieval has become an attractive field for regular human life, as a result of useful searches with variety of images. The image retrieval concept is first started with the text based image retrieval scheme and it meets the demerits in retrieval accuracy. The text based image retrieval is refined to content based image retrieval by processing the visual contents of images and this leads to the improvement of retrieval accuracy. The paper [45] provides the best results for the content based image retrieval. The annotation and visual feature combined form of image retrieval is focused to get better accuracy and this type of CBIR methods generates sufficient level of retrieval accuracy. The paper [5] yields better performance among the annotation and visual features based CBIR category. The sketch based CBIR methods provides an alternative way of query image input and the paper [20] gains the top performance in the sketch based

CBIR category. The shape based CBIR method retrieves images based on shapes of query image and the paper [16] wins the top rank in precision based performance in this category. The region based CBIR approaches the image retrieval by extracting the region of interest in query image and the paper [24] achieves the top position in performance. The bar code annotation and visual features based CBIR embeds the 1D barcode in database images and based on that image are retrieved. The paper [1] targets this achievement and made successful results. The visual phrases based CBIR can be useful for tourism development and the paper [7] achieves this target. The multiple query based image retrieval improves the accuracy of CBIR system by handling multiple query images and the paper [11] is the best method among the multi query CBIR systems. Finally relevance feedback based methods are focused and they generate best results based on precision and recall than all types of CBIR systems. The paper [26] is the highest gainful method in this category

The proposed review paper can be more useful for the researchers who precede their research on CBIR because this paper organizes different type of CBIR categories and the corresponding papers are associated with them.

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