Grenze International Journal of Engineering and Technology, January Issue

Review on Content based Image Retrieval Systems for High Dimensional Data

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***Abstract*—Increasing use of image capturing devices and rapidly growing internet, multimedia is creating challenge for image storage and retrieval. How to efficiently search the image information from a massive image database is challenging issue. For growing size of digital image collection development of efficient image retrieval tools are required. Content-based image retrieval (CBIR) is the system for searching images based on their visual features. CBIR extracts visual features from image and search in the visual feature space for similar images. There are various systems for image retrieval. Some uses low level features such as colour and texture. Some uses high level features such as SIFT and SURF and some other uses combination of different features. CBIR for high dimensional data can be developed by using clustering approach. But there are various difficulties for dealing with high dimensional data. This paper reviews various content based image retrieval systems which addresses above problem.**

***Index Terms*— Content-based Image Retrieval, CBIR, Image Retrieval, Clustering and High Dimensional Data.**

I. INTRODUCTION

Increasing use of image capturing devices and internet are important source of digital image content. Images are being generated by sources such as defence and civilian satellites, home entertainment systems biomedical imaging, military reconnaissance and surveillance flights, fingerprinting and scientific experiments with ever increasing rate. For growing size of digital image collection development of efficient image retrieval tools are required. Image retrieval systems enable users to browse retrieve images from large image database. Images retrieval can be done in two ways, text-based and content-based.

In text base image retrieval systems image annotation is done by text descriptors. In this approach, the images in the database are manually assigned certain descriptions related to their content. Database management system is used for image retrieval. The major drawback of this approach is necessity of human labour for manual annotation and annotation inaccuracy.

Another drawback of the text based search techniques is that they lack concern on the visual contents of an image, therefore suffering inconsistency between the text words and visual content. This approach is is labour intensive and also results in imprecise responses mainly due to the manual annotation inaccuracy. As images are noticed differently by different people the manual descriptions of images given in the database could differ from person to person. It leads to irrelevant image retrieval result.

Grenze ID: 01.GIJET.11.1.534

To overcome these difficulties with text based image retrieval Contents based image retrieval (CBIR) [1] emerged. Contents based image retrieval is the technique of searching images out of large database based on their visual content. In this approach images are indexed by their visual content like shape, texture and colour. It has wide spread applications including medical diagnosis[2], crime prevention, art collections, face finding etc. For CBIR low level features such as colour, texture, shape, special layout etc. can be used.
The aim of this paper is to review some of the important Content Based Image Retrieval method with their advantages and disadvantages. This paper is organized as follow: section I gives introduction about CBIR. In section II, Basic Architecture of CBIR system is explained. In section III, important CBIR systems are reviewed. In section IV literature studied is summarized, followed by conclusion and suggestions in section V.

II. Basic Architecture of CBIR System

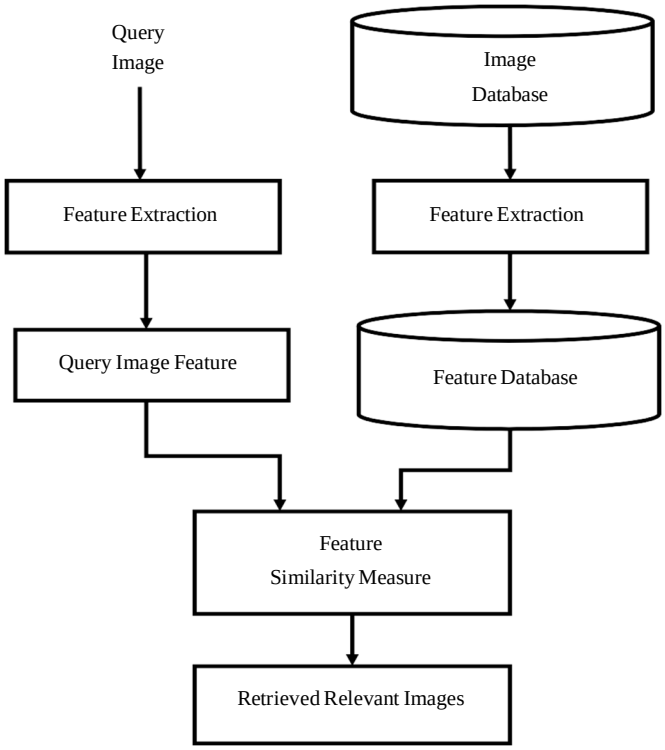

Figure 1. Typical structure CBIR systems

CBIR systems employs various techniques of image retrieval based on visual similitude. Usually, CBIR systems extracts a specific token value for each image based on its pixel values. It defines a specific rule for finding similarity of images. A typical CBIR system extracts token values like colours, texture, spatial and shape of each image in database. These extracted values are stored in a different database within the system called a feature database. The components of these token values are called features which act as an descriptive content for image representation. After extracting the features, the next step is to determine the similarity measure between images. A query image is given as input by the user. The features of the query image are extracted and compared with the features stored in feature database. Finally, based on the comparisons between similarity between features of query image and the feature database, the relevant images are retrieved.

III. Literature Review

Ballerini L, Li X, Fisher RB, Rees J.[3] proposed a CBIR system for skin lesion images as a diagnostic aid. Query-by-example (QB) uses low-level features such as textures, shapes, histograms and computes the relevance based on the visual similarity of the images. In another method Scale Invariant Feature Transform (SIFT) is used. Colour and texture features of image are extracted from lesions.
In this work, RGB, HSV (Hue, Saturation, Value) and CIE Lab, CIE Lch (Munsell colour coordinate system [4]) and Otha [5] colour spaces are used. Generalized co-occurrence matrices which is extension of the co-

occurrence matrix to multi-spectral images, is used for extracting texture features. Feature selection method is used for selecting a subset of texture features from all the extracted feature .

The retrieval system in QB is based on a similarity measure defined between the query image and a database image. Experiments are performed on 208 image database and results evaluated. The QB system is primarily based on colour and texture features, and has of precision value between 59% and 63%.

Machhour Naoufal, Nasri M'barek[6] developed a content based image retrieval system using a method based colour string coding and genetic algorithms. CBIR uses the visual features of the image. Visual features can be local or global. Example of local features [7], [8], [9] are colour, shape, texture. Example of global descriptors are Invariant Moment, Histogram Oriented Gradients [10], [11]. The results shows that all the precision values exceed 0.6 and can reach 1. In other works, the precision value can be below 0.5 and never reached to 1.0.

N. S. Vassilieva[12] presented a survey of common feature extraction and representation techniques and metrics of the corresponding feature spaces. The quality of image retrieval system depends mostly, first of all, on the feature vectors used, which describes image content. Here, a detailed classification of feature is given and results of experiments related to image retrieval and classification problem are presented. It suggests that, development of image retrieval system requires to solve multidimensional indexing problem and to visualize system responses. Another important thing is to provide the user with a convenient way of query formulation.

David G. Lowe [13] presented a method for extracting distinctive invariant features from images. SIFT key-points are described which are shown to be invariant to image rotation, scale. It provides robust matching in case of affine distortion, noise and changes in illumination. With these highly distinctive features object recognition is also possible. A method for object recognition is presented in this paper. Huge amount of key- points can be extracted from images which benefits in extracting small objects among clutter. For matching small objects, small local features area available. For images with blur and noise, large key-points are suitable.

Feng Guo, Jie Yang, Yilei Chen, Bao Yao [14] studied the theory of SIFT matching. They used the Euclidean distance between SIFT feature points to measure the similarity, and the RANSAC algorithm is used to eliminate the mismatch[15]. SIFT has a very good invariance on rotation, scaling, brightness and a certain degree of stability on changes in perspective, affine transformation, noise.

Yong Kang Peng, Yi Lai Zhang, Xi En Cheng, Yi Cheng Li, Shi Dong Zhao [16] proposed a joint feature consisted of the chromatic feature and the structural feature. They also proposed a joint feature of the object that can efficiently address the object using the SIFT feature data and the hue-saturation colour descriptor. The detection algorithm based on this joint feature is proposed. The experiments show both quality and quantity of results. The proposed method can effectively and accurately detect object of simultaneously using the SIFT feature and hue saturation colour descriptor.

Yanyan Xu, Jiaying Gong, Lizhi Xiong, Zhengquan Xu, Jinwei Wang, Yun-qing Shi [17] presented a privacy preserving content-based image retrieval method based on orthogonal decomposition. In this method the image is divided into two different components. Encryption and feature extraction is performed separately on these components. A cloud server can directly extract features from encrypted image. These extracted features are compared with queried image to retrieve images. This system is basically depends on text retrieval.

Zhihua Xia, Neal N.Xiong, Athanasios V. Vasilakos, Xingming Sun [18] proposed a scheme that supports CBIR over encrypted images without revealing the sensitive information to the cloud server. The visual features are encrypted by using secure KNN algorithm. Cloud server can directly calculate similarity score from encrypted features. Cloud server can rank the retrieved results without additional communication overheads. The feature vectors are first extracted from the images. Then for increasing the efficiency of search pre-filter tables are constructed with the locality-sensitive hashing. It is a text based image retrieval system. It heavily relies on captions and annotations of images.

Abeer Esa A M Alomairi, Ghazali Sulong [19] studied the factors influencing CBIR system. Image retrieval processes are divided into two types Text Based Image Retrieval and Content Based Image Retrieval. In Text Based Image Retrieval users use keywords or description to the images as query for the retrieval of relevant images. The disadvantage of this approach is there is more chance of errors in labelling. This is because different annotators labels images according to their understanding about image content. Too much time is consumed in annotating each image in large database and the process of image tagging in large databases is highly error prone.

Tao He, Yong Wei, Zhijun Liu, Guorong Qing, Defen Zhang [20] proposed a content based image retrieval method based on SIFT feature. For a given query image SIFT feature vector is established. Then feature vector library is searched to obtain visual similarity images. In this method SIFT descriptor is exploited to represent visual content of images. After that distance ratio is used as a threshold to control the number of matched featured points. The efficiency of this method has been proven experimentally.

Hadjer Lacheheb, Saliha Aouat [21] proposed an image retrieval system is based on visual content. A content based image retrieval system based on integration of new mean SIFT descriptor and HSV (hue, saturation, value) histogram as global feature is suggested. The basic idea behind content based image retrieval is separating descriptors and then clustering descriptors of each type in k-clusters. Here, Mean sift and HSV colour histogram with K-means clustering is used. In this system the combination of local and global features is used for more appropriate results.
Gholam Ali Montazer, Davar Giveki [22] proposed a CBIR system. CBIR extracts features of query image and try to match them with the extracted features from images in the databases. After extracting image features using SIFT, k-means clustering is applied on feature matrix extracted by SIFT. Then two new kinds of dimensionality reductions are applied to make SIFT features more efficient. Here, the advantage of SIFT is taken and also decrease the memory storage used by SIFT features. In addition to this to compare images it is not required to run the time consuming matching algorithm of SIFT. Two important drawbacks of SIFT are stated in this paper as memory usage and matching time. With the proposed method there is no loss of discriminative power of SIFT while the size of feature matrix is highly reduced.
André Araujo, Bernd Girod [23] proposed a technique for video retrieval using image queries. Retrieving videos from large databases using image queried has many important applications like brand monitoring and content linking. They proposed an asymmetric comparison technique for fisher vectors and explore query or database items with varying amounts of cluster. The basic idea is to carefully select the type of visual information to use in such comparison, efficiently ignoring clutter that is typical in this case. They introduced two different video descriptors that can be directly compared against image descriptors. The proposed descriptors are compared against recent pre-trained CNN features. This technique outperforms such CNN features substantially and consistently.
Ms. Ghatage Trupti B., Ms. Patil Deepali E., Prof. Takmare Sachin B. [24] suggested that although Discriminative Embedded Clustering (DEC) method outperforms related state-of-the-art clustering approaches, and existing joint dimensionality reduction and clustering methods, but it has some limitations. DEC is based on k-means; therefore, with increased data size the number of iterations to complete the clustering process also gets increase exponentially. We found that Hub-Based DEC is better than other techniques. It requires less time for execution for different data set sizes and produces more accurate result than DEC. DEC including hub based clustering has maximum efficiency over individual algorithm.

IV. SUMMARY

There are various systems for Content Based Image Retrieval. But for dealing with high dimensional data there are some limitations. For retrieving images from high dimensional data it is better to cluster the data and then retrieve results from clustered data. For clustering high dimensional data DEC is a better approach which reduces the effect of curse of dimensionality. But the drawback of this approach is, use of k-means for clustering. Therefore, as number of dimensions increases the number of iterations required and computation time also increases exponentially. Another thing is, in clustering, centroids or medoids are used as a cluster centre. Instead of them if hub points in the high dimensional data are taken as cluster centre produces more accurate clustering results. In Hub-Based DEC algorithm major hub points in high dimensional data are taken as a cluster centre. Thus, it produces more accurate clustering results and takes less time for convergence.
The quality of image retrieval system depends heavily on the feature vectors used. Therefore, by taking high level features of images instead of low level colour intensity feature will produce better image retrieval results. Hub-Based DEC has to be improved using better feature vector. SIFT is a better feature for an image. It is invariant to scale and rotation. Using SIFT descriptors huge information about images can be extracted which will benefit in finding more relevant images in databases.
Some CBIR systems on cloud environment are available; however they depend on text for image retrieval. In these systems excess time is consumed in manually annotating each image in large database, which may be error prone. SIMIR is a system in which features descriptors are separated and clustered into k-clusters. But again, how to choose the value of k is a problem. We propose a system where the number of potential hub points with no overlapping clusters can be taken as cluster centre, so this problem can be solved.

V. CONCLUSION

There are various systems for CBIR but no appropriate system for retrieving images from high dimensional data is available. Many text-based systems are available but having their own limitations like manual annotations of

images, large labour requirement for annotation, and inaccuracy in labelling data. Therefore, development of a Content Based Image Retrieval System for high dimensional data is required. After reviewing various CBIR systems we found that different techniques are available having their own advantages and limitations. We need to focus on the limitations of CBIR systems such as retrieval speed and complexity and attempt to improve their efficiency.

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