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Study of Content Based Image Retrieval System Using Similarity Features

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Abstract: Content based image retrieval is the research field that provides an effective way to search the image from the database. Research objective of this article is to design and development of algorithm and data structure for efficient image retrieval from large database with color histogram, texture and multiple distance measures. This research paper discuss about the Image retrieval problem and types of Image retrieval technique. In the next section authors talked about Text based Image Retrieval (TBIR) and Content based Image Retrieval (CBIR). There were lots of research carried out in Content based and Text based retrieval, so in the last section is about research methodology in the field of image and text retrieval.

Keywords: TBIR, CBIR, MIR, QBIC, GLCM, ITML, MAP, PCA, LDA, ICA, SVM, NN, DCT

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I. INTRODUCTION

With the amount of digital information growing at a rapid rate with no end in prospect, it is clear that finding an item of interest from the large set of data will become more and more difficult. Looking at each one to find the right image is simply not an option because it is too time consuming and may be irritated. Content-based image retrieval is the research field that attempts to address this issue of finding the images of interest by analyzing and comparing the content of all images in a collection. Since the early 1990s the field has evolved significantly and has made great leaps forward. "The early years" of image retrieval were summarized by Smeulders et al.[1] painting a detailed picture of a field in the process of learning how to successfully harness the enormous potential of computer vision and pattern recognition. The number of publications increased dramatically in only a matter of years. The comprehensive reviews of Lew et al.[2] and Datta et al.[3] provide a good insight into the more recent advances in the entire field of multimedia information retrieval and, in particular, content based image retrieval. The design and development of effective and efficient CBIR systems are still a research problem, because the nature of digital images involves two well-known problems: the semantic gap and the computational load to manage large file collections The main tasks for CBIR systems are similarity comparison, extracting feature signatures of every image based on its pixel values and defining rules for comparing images[4]. Content-based image retrieval systems very often work on query-by-image-example basis. Namely, the query image is fed to the system, and the system is asked to retrieve further examples of similar kind[5].

II. IMAGE RETRIEVAL PROBLEM

As processors become increasingly powerful, and memories become increasingly cheaper, the deployment of large image databases for a variety of applications have now become realizable. Databases of art works, satellite and medical imagery have been attracting more and more users in various professional fields for example, geography, medicine, architecture, advertising, design, fashion, and publishing. Current image retrieval techniques can be classified according to the type and the nature of the features used for indexing[6].

- Text-based Image Retrieval (TBIR)
- Content-Based Image Retrieval (CBIR)

Problems with traditional methods of image indexing[3] have led to the rise of interest in techniques for retrieving images on the basis of automatically-derived features such as color, texture and shape and the technology now generally referred to as Content-Based Image Retrieval (CBIR).

- **Text Based Image Search/Retrieval**

In text-based retrieval, images are indexed using keywords, subject headings, or classification codes, which in turn are used as retrieval keys during search and retrieval. Text-based retrieval is non-standardized because different users employ different keywords for annotation. Textual information about images can be easily searched using existing technology, but requires humans to personally describe every image in the database. This is impractical for very large databases, or for images that are generated automatically, e.g. from surveillance cameras. It is also possible to miss images that use different synonyms in their descriptions. Systems based on categorizing images in semantic classes like "cat" as a subclass of "animal" avoid this problem, but still face the same scaling issues.

- **Content Based Image Search/Retrieval**

The main goal of CBIR is efficiency during image indexing and retrieval, thereby reducing the need for human intervention in the indexing process. One of the main tasks for CBIR systems is similarity comparison; extracting feature signatures of every image based on its pixel values and defining rules for comparing images. These features become the image representation for measuring similarity with other images in the database. An image is compared to other images by calculating the difference between their corresponding features.

III. CBIR (CONTENT BASED IMAGE RETRIEVAL)

Content-based image retrieval (CBIR) uses the visual contents of an image such as *color*, *shape*, *texture*, boundary, region and *spatial layout* to represent and index the image. In typical content-based image retrieval systems as shown in figure 1, the visual contents of the images in the database are extracted and described by multi-dimensional feature vectors. The feature vectors of the images in the database form a feature database[1]. To retrieve images, users provide the retrieval system with example images or sketched statistics. The system then changes these examples into its internal representation of feature vectors.

The similarities /distances between the feature vectors of the query example or sketch and those of the images in the database are then calculated and retrieval is performed with the aid of an indexing scheme. The indexing scheme provides an efficient way to search for the image database. CBIR is the process used for automatic indexing and retrieval of images that are depends on the content of images known as features. Features like low level features and high level features are used. The low level features such as color, texture and shape. High level features include human perception. Implementation of image retrieval using only single feature cannot provide a good solution for accuracy and efficiency. So multi features are used for efficient retrieval and accuracy.

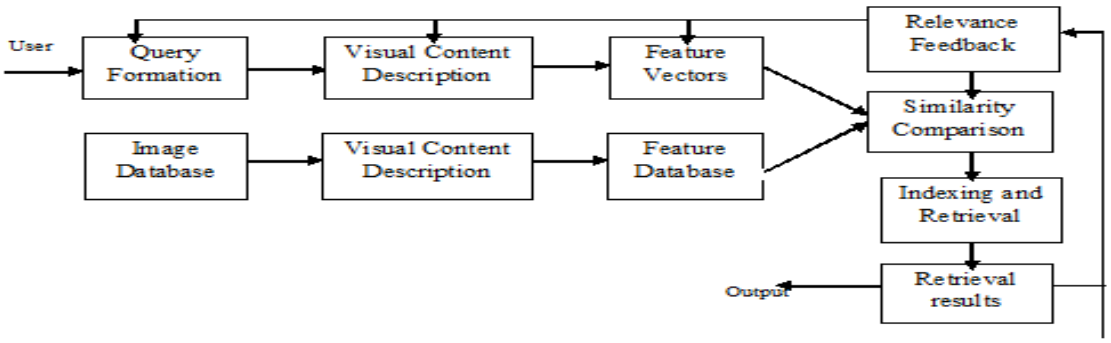

Figure 1: Content-based image retrieval system

Content based image retrieval (CBIR) provides an effective way to search the images from the databases. The feature extraction and similarity measures are the two key parameters for retrieval performance. A similarity measure plays an important role in image retrieval. The difference between the user's information need and the image representation is called as the semantic gap in CBIR System[1]. If this semantic gap is reduced then system is said to be efficient. The semantic gap problem and the performance accuracy issues in a Content Based Image Retrieval System (CBIR) can be efficiently overcome by the Relevance Feedback mechanism.

- **Various Distance Metrics used in CBIR**

Content based image retrieval (CBIR) provides an effective way to search the images from the databases. The feature extraction and similarity measures are the two key parameters for retrieval performance. Similarity measures also termed as distance metric plays important role in Content based image retrieval. Content-based image retrieval calculates visual similarities between a query image and images in a database. Therefore, the retrieval result will not be a single image but a number of images ranked by their similarities with

the query image. Different similarity measures will affect retrieval performances of an image retrieval system significantly so, it is important to find best distance metric for CBIR system. The query image will be more similar to the database images if the distance is smaller. Using pyramid structured wavelet decomposition, energy levels are calculated. These energy levels are compared by calculating distance between query image and database images using the different similarity metrics[7] such as Euclidean, Manhattan, Canberra, Square Chord, Chi-square etc.

- **Various Search Engines for CBIR**

Content based image retrieval for general-purpose image databases is a highly challenging problem because of the large size of the database, the difficulty of understanding images, both by people and computers, the difficulty of formulating a query, and the issue of evaluating results properly. A number of general-purpose image search engines have been developed.

In the commercial domain, QBIC[8] is one of the earliest systems. Recently, additional systems have been developed such as VIR[9], AMORE[10], and WALRUS[11]. In the academic domain, MIT Photobook[12] is one of the earliest systems. Berkeley Blobworld[13], Columbia Visualseek and Webseek[14], Natra[15], and Stanford WBIIS[16] are some of the recent well known systems.

IV. LITERATURE SURVEY

A. W. M. Smeulders et al[1] discussed about the working conditions of content-based retrieval, patterns of use, types of pictures, the role of semantics, and the sensory gap. Similarity of pictures and objects in pictures was reviewed for each of the feature types, in close connection to the types and means of feedback the user of the systems is capable of giving by interaction. In this, aspects of system engineering: databases, system architecture, and evaluation was discussed.

M. S. Lew et al[2]described about the Multimedia information retrieval (MIR), its limitations and challenges towards the retrieval of images from large data bases. Fundamental necessities for a multimedia information retrieval system are also discussed such as Searching for a particular media item and Browsing and summarizing a media collection. Some major research challenges are important to the MIR research community such as; Semantic search with emphasis on the detection of concepts in media with complex backgrounds; Multi-modal analysis and retrieval algorithms specially between the various media including text and context information; Experiential multimedia exploration systems; Interactive search, emergent semantics, or relevance feedback systems; and Evaluation with emphasis on representative test sets and usage patterns.

R. Datta et al[3] surveyed, analyzed, and quantified the current progress and future prospects of image retrieval. The work also discusses about the significant challenges involved in the adaptation of existing image retrieval techniques to build systems that can be useful in the real world. In this, the early years of image retrieval with progress in the field in the current decade and conjectured specific future directions alongside has been described. The work also shows the impact of image retrieval on different fields of study such as multimedia, machine learning and computer vision.

A. Vadivel et al[4] proposed a detailed study of the performance of different distance metrics for a number of color histograms on a large database of images. In the work, color histograms as well as four commonly used distance metrics were considered. From the results the authors concluded that Manhattan distance gives the best performance in terms of precision of retrieved images. Another important observation is that Vector Cosine Angle distance, which considered as the do-facto distance metric in text retrieval, performs almost the same as Euclidean distance for content-based image retrieval applications also.

M. Hatzigiorgaki and **A. N. Skodras**[5] described the effect of the similarity metric on the image retrieval by content. It has been realized that the number of histogram bins does not affect profoundly retrieval efficiency. Query-by-image-example was used in all tests. Some commonly used distance measures, as the Euclidean distance; do not result in good retrieval performance, while others perform well in the vast majority of the tests. The Canberra and Wave-Hedges metrics seem to be beneficial from the retrieval efficiency and the computational complexity points of view.

M. Madugunki et al[6] mentioned the detailed classification of the CBIR system. They illustrated the efficiency of different techniques used in CBIR. The authors compared the different techniques as well as the combinations of them to improve the performance and also compared the effect of different matching techniques on the retrieval process.

S. Patil and **S. Talbar**[7] compared the different distance metrics for texture image retrieval using a large database of 972 texture images. Using pyramid structured wavelet decomposition, energy levels are calculated. These energy levels are compared and distances between query image and database images are calculated using different distance metrics. From the results it is concluded that performance of Square chord and Square Chi-squared distances is better than the conventional Euclidean and Manhattan distances. Also Canberra and Bray-Curtis retrieves images with distances less than one, which avoids scaling effect. The feature extraction and similarity measures are the two key parameters for retrieval performance. A similarity measure plays an important role in image retrieval.

M. Flicker et al[8] developed the QBIC (Query by Image Content) system to explore content-based retrieval methods. QBIC allows queries on large image and video databases based on example images, user-constructed sketches and drawings, selected color and texture patterns. Two key properties of QBIC are its use of image and video content-computable properties of color, texture, shape, and motion of images, videos, and their objects-in the queries, and its graphical query language in which queries are posed by drawing, selecting, and other graphical means.

G. Rafiee et al[17] presented the comprehensive survey on patch recognition, which is an important part of content-based image retrieval. Three major categories of state-of-the-art techniques including supervised learning, unsupervised learning, and relevance feedback approaches in reducing the gap between visual features and image concepts have been investigated. To achieve this, the latest classification, clustering, and interactive methods have been thoroughly discussed.

M. Mary Helta Daisy et al[18] analyzed the features such as texture & shape. Gabor filter was used to extract texture features from images. Shape feature was extracted by using Fourier Descriptor and the centroid distance. Morphological closing operation combined with Gabor filter gives better retrieval accuracy. Using combined texture and shape feature for retrieving the images the retrieval performance was improved other than using any one of the single features.

C. Faloutsos et al[20] described a set of novel features and similarity measures allowing query by color, texture, and shape of image object. The work expressed the effectiveness of the QBIC system with normalized precision and recall experiments on test databases. In this work, specifically two problems were addressed to consider the efficient indexing of these features such as; for our feature vectors, the desired distance function is not Euclidean, and/or the vectors have high dimensionality.

R. Mohamad Rasli et al[21] discussed on the comparative method used in color histogram based on two major methods used frequently in CBIR which are; normal color histogram using GLCM, and color histogram using K-Means. Using Euclidean distance, similarity between queried image and the candidate images are calculated in this work. The authors compared the traditional color histogram with GLCM, color histogram with Gabor and color histogram with K-Means. From a set of testing, it is concluded that by using color histogram with K-Means proved to get better and accurate results compared to Color Histogram with GLCM and color histogram with K-Means clustering.

R. Xu and **D. Wunsch**[22] surveyed the clustering algorithms for data sets appearing in statistics, computer science, and machine learning, and illustrated their applications. The work summarized and concluded the survey with listing some important issues and research trends for cluster algorithms. At the preprocessing and post-processing phase, feature selection/extraction and cluster validation are as important as the clustering algorithms.

J. Collins and **K. Okada**[23] proposed a metric learning-based medical CBIR method and presented a systematic experimental comparison of various similarity measures by using a large public database. The experimental results demonstrated an advantage of the proposed ITML approach which outperformed other CBIR metrics that were tested. The work adopt a popular metric learning algorithm i.e. information theoretic metric learning (ITML) in this Medical-CBIR system. Mean average precision (MAP) a popular performance measure in the information retrieval field is used as a measure to quantify performance of our M-CBIR systems.

D. Jeyabharathi and **A. Suruliandi**[24] demonstrated the appearance-based feature extraction methods such as PCA, LDA and ICA to be useful for many applications such as Content Based Image Retrieval, Object Recognition. In this work, the classification algorithms SVM, NN has been also employed. The performance has been calculated in terms of Recognition Rate, F-score.

D. Heesch et al[25] compared a number of performance aspects of two rather different techniques for computing similarities between images against a simple vector space model approach. The work also illustrated that how the optimal feature combinations differ not only between queries but also between similarity models. The overall result from this study is that the more sophisticated learning techniques do not prove superior to the vector space model, while being computationally slightly more expensive.

D. Zhang and **G. Lu**[26] described and evaluated the different similarity measurements commonly used in image retrieval. The distances are evaluated using shape features and standard shape datasets. Experiment results show that in terms of both retrieval effectiveness and retrieval efficiency, city block distance and λ^2 statistics distance are more desirable than other distance measurements for determining image similarity. City block distance is simpler than λ^2 statistics distance, it is more desirable for online retrieval.

A. A. Goshtasby[27] reviewed the properties of various similarity and dissimilarity measures and identified their strengths and weaknesses. The similarity and dissimilarity measures are discussed in the context of two real problems. In one problem, an observed image and a number of saved images are given and it is required to determine the saved image that best matches the observed image. The second problem involves locating an object of interest in an observed image where the model of the object is given in the form of a template and the observed image is an image being viewed by a camera.

F. Malik and **B. Baharudin**[28] illustrated the issues of efficient extraction of features and the effective matching of images in the compressed domain. In this method the quantized histogram statistical texture features were extracted from the DCT blocks of the image using the significant energy coefficients of the blocks. CBIR method proposed is based on the performance analysis of various distance metrics using the quantized histogram statistical texture features in the DCT domain.

R. V. R. Chary et al, [29] described how the mean-mapping techniques can be used for the retrieval of images. The authors also discussed about the K-Means clustering algorithms. They proposed a system which concentrates on similarities in shape and size of the image. The images were extracted with high-class similarity. Images with similarities were retrieved using threshold values and analyzed.

V. CONCLUSION

Although CBIR has become an active research field for quite some time, it is still infantile. The most basic motivation of this work is to make contributions to this young field by identifying new problems and improving the performance of retrieval. The area of content-based image retrieval is a hybrid research area that requires knowledge of both computer vision and of database systems. Large image databases are being collected, and images from these collections made available to users in advertising, marketing, entertainment, and other areas where images can be used to enhance the product. These images are generally organized loosely by category, such as animals, natural scenes, people, and so on. Their access is dependent on a user being willing to browse large collections in order to select appropriate images. The problem involves developing a CBIR system which has efficient and effective feature extraction of the images as well as the distance measures. The basic aim of this work is to design and develop a scalable architecture to support fast querying of large database with users specified instructions. Further we need an algorithm for efficient image retrieval from large database using different methods and to design an algorithm, we need the different parameters and selection rules to achieve the reduction in time complexity.

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