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A Review on Content Based Image Retrieval

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***Abstract*: Content Based Image Retrieval (CBIR) system receives paramount importance now days. This is because of its wide applicability found in many areas including medical, science, security, Bioinformatics and entertainments. It has emerged as one of the growing field of research in engineering and the sciences. CBIR system searches large image database based on the contents of the images. The recent work carried out in this field is focused to achieve efficiency and accuracy in the image retrieval process. The major limitations encountered during review of the literature are an effective representation of image by extracting visual contents, mismatches found due to semantic gap between image representation and user's interpretation of the image and high dimensional feature vectors.**

***Keywords*: CBIR, VGG16, Deep learning, CNN**

1. Introduction

In today's world, due to the technological advancement vast amount of digital information is generated every day. To organize and handle such voluminous information properly is a very crucial task. This can be achieved using Content Based Image Retrieval (CBIR) system. CBIR system allows automatic storing, browsing and searching of large amount of images as per user's interest [1]-[3]. During last decades, many efforts have been carried out by a number of researchers to develop effective and efficient CBIR system [3]. Traditional methods used for image retrieval are based on the annotation of keywords. Images annotation is time consuming process because it is difficult to describe their contents with words. In CBIR, the image annotation is not required. As it retrieves the desired images from the large image database based on the features which are extracted from the images.

In general, CBIR system, the input given is in the form of an image. First feature extraction of input query image and images present in the database is done using some feature extraction techniques. Then the feature vectors of query image and the images present in image database are compared. And the result is generated after similarity matching [3]. However, most of the techniques suffer from some drawbacks. The main issues in the field are an effective representation of image using visual feature extraction, reduction in the dimensionality of the digital image and another is to reduce mismatches occurred due to semantic gap between low-level and high level features [3].

The fig. 1 shows block diagram of basic CBIR system in which, the visual contents of the database images are extracted by the feature extraction methods and represented in the form of feature vector. The feature vector of images in the database form a feature database. The retrieval process is initiated when the user gives the query image to the system. The query image is converted into the internal representation of feature vector by using same feature extraction methods that was used for the image database feature vector. The similarity measure is used to calculate the distance between the feature vector of query image and target images in the feature database. The images are ranked according to their similarity value and presented as output of CBIR system.

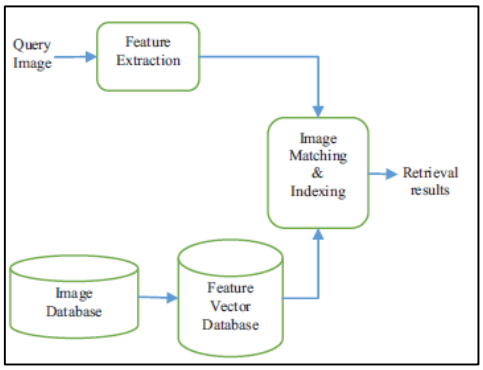

Fig. 1. Block diagram of basic CBIR system

2. Background and related works

This section all the necessary concepts needed to understand the development of the content based image retrieval system. It consists of the following steps:

A. Image Database

First step in the design of any CBIR system is to create the image database. Some standard image dataset are present for testing purposes, they are Wang Database and test1 database, MPEG-7 dataset, UCI repository.

B. Input

The input required to CBIR system is in the form of an image. A user can give the similar image as input as per his/her desire.

C. Feature Extraction

This is a very important step in the design of CBIR system.

In this step the image is represented using its contents. For effective CBIR system, the image representation could be more accurate one [3]. Hence, choosing the features to represent the rich contents of the image is very crucial. There are two types of visual contents low-level color, shape and texture and high level semantic contents [1]. Some CBIR system uses a single feature to extract the contents like color based Chabot, CHROMA [3], [6], texture based ADL, CBVQ [3], [6] and shape based SQUID, SYNAPSE [3], [6]. While the recent CBIR system uses the combination of these features to represent the image like Photo Finder [6], developed by the Alta Vista, uses the color, shape and texture features. Blob world [6], CANDID [6], Draw Search [6] also uses a combination of all these features. If combinations of features are used to describe the image, the image content can be more effectively represented which will result in the effective CBIR system [1], [3]. Some CBIR system uses MPEG-7 standard descriptors for feature extraction. The MPEG-7 visual standard specifies the set of descriptors for color e.g. Color Layout, Domain Color, Scalable Color, Color Structure descriptors), shape e.g. Region and Contour Shape Descriptors and texture e.g. Homogeneous Texture, Texture Browsing, Edge Histogram Descriptor. The advantages of the MPEG-7 feature descriptor are its interoperability to characterize multimedia contents and guaranties to achieve content retrieval efficiencies.

D. Similarity Comparison

After the feature extraction step, feature vectors of query image and all the images present in image database, the similarity is computed. There are various measures available to calculate the similarity, some commonly and widely measures are: Minco ski and Standard Measures, includes Euclidean Distance, City block Distance, Infinity distance, Cosine Similarity. Statistical Measures are Pearson Correlation Coefficient and Chi-Square Dissimilarity. Divergence Measures include Kullback-Liebler Divergence, Jeffrey Divergence, Kolmogorov-Smirnov Divergence, Cramer-von Mises Divergence, other methods are Earth Mover's Distance, Diffusion Distance Output: In this step, most similar images relevant to input query image are displayed as an output.

E. Relevance Feedback

In order to improve the results, the user can give the feedback by interacting with the system. Based on the feedback given the results will further refine and output is generated accordingly. Relevance feedback mechanism iteratively correct errors made by the CBIR system and terminates when the user is satisfied with the retrieved images.

The above steps discussed describe the general working procedure of CBIR system. Recently CBIR system has received increasing interest to use Evolutionary algorithms (EA), in order to optimize the retrieval task. EA uses the concept of natural evolution to explore the solutions for complex real world problems. Some of the CBIR system developed using Evolutionary Algorithms are; the concept of Genetic algorithm is used in [4], [5], Evolutionary Programming in [12] and Particle Swarm Optimization in [13]. It is observed that CBIR system develop using Evolutionary Algorithms are more effective and efficient. In this paper, a novel Differential Evolutionary approach is suggested to develop a CBIR system. It is also a type Evolutionary Algorithm (EA) works on the concept of natural evolution. It is a population based algorithm with many advantages includes, finding true minimum regardless of initial parameter values, fast convergence and uses very few parameters.

The compact root bilinear CNN model is used in [7] to improve the efficiency of retrieval and retrieval speed. Ruigang Fu et. al. [8] used the combination of linear SVM and CNN to retrieve the images but for the different dataset, it is not able to fill the semantic gap. The VGGnet is used as pre-trained CNN in [8]. The PCA is used to reduce the feature vector size in [9] while the hash code is used in [10] to reduce the computational complexity. In [11], the CNN is used with a relevance feedback mechanism to retrieve the most relevant images.

3. Research in progress

The present work explores feature extraction using MPEG- 7 standard descriptors and searching process is optimized by using Differential Evolution algorithm. Further the optimized output received is refined using relevance feedback mechanism as per the user's interest. The overall concept of the proposed framework is as shown in figure 1. In step 1, image database is created by loading the number of images. Step 2 is a user interaction step. User can select/ give input query image, similar to images he/she wants. In step 3, feature space is created by extracting the contents of input image and images in the database, using MPEG-7 standard descriptor algorithm. It is the digital representation of the image. Next step 4 includes similarity comparison, in which process of searching is optimized by using Differential Evolution. The output obtained is further improved in step 5 by using relevance feedback mechanism.

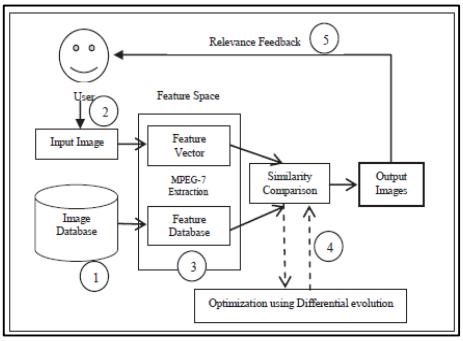

Fig. 2. Optimization of CBIR system using Differential Evolution

4. Conclusion

Here, a novel proposal is presented to develop the optimized content based image retrieval system using differential

evolution approach. In order to extract features to represent rich contents of the image, the MPEG-7 standard feature descriptors and CNN are suggested. It gives the details about various techniques also presents the comparison of all these feature extraction techniques. From the comparison of this techniques, it can be shown that the Gabor wavelet transform is used when there is requirement for efficient discrimination of texture feature. The other techniques can also well used for color and texture feature extraction in CBIR. Further the relevance feedback mechanism is used to refine the result as per user's interest. Thus attenuating the major problems of effective feature extraction and semantic gap identified in CBIR. The work is intended to optimize the searching process and improving the result.

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