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Query by Sketch- A content based image retrieval system

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***Abstract*— Development in digital photography has led to a huge collection of still images that are stored in digital format. As the demand for digital images increases, the need to store and retrieve images in an efficient manner arises. Most of the available image search tools, such as Google Images and Yahoo! Image search, are based on textual annotation of images. In these tools, images are manually annotated with keywords and then retrieved using text-based search methods. The performances of these systems are not satisfactory. Therefore, the field of content-based image retrieval has emerged as an important research area in computer vision and image processing. The key issue in image retrieval is how to match two images according to computationally extracted features. . The proposed approach gives maximum freedom to the user by using user-produced pictorial queries (sketches) depicting the wanted image(s), extracts visual features from the images and allows the comparison of database images with queries ,thereby providing best possible retrieval efficiency and time.**

Fields that can benefit from CBIR applications are almost countless. Among them are art galleries, architectural and engineering design, interior design, geographic information system, weather forecasting, retail, fabric and fashion design, , law enforcement and criminal investigation and picture archiving.

***Keywords*— Sketch based image retrieval (SBIR), indexing, shape features**

I. INTRODUCTION

Advances in data storage and image acquisition technologies have enabled the creation of large image datasets. In order to deal with these data, it is necessary to develop appropriate information systems to efficiently manage these collections. Image searching is one of the most important services that need to be supported by such systems. In general, two different approaches have been applied to allow searching on image collections: one based on image textual metadata and another based on image content information (Figure1).

The first retrieval approach is based on attaching textual metadata to each image and uses traditional database query techniques to retrieve them by keywords. However, these systems require a previous annotation of the database images, which is a very laborious and time-consuming task. Furthermore, the annotation process is usually inefficient because users, generally, do not make the annotation in a systematic way. In fact, different users tend to use different words to describe a same image characteristic. The lack of systematization in the annotation process decreases the performance of the keyword-based image search. These shortcomings have been addressed by the so-called *Content-Based Image Retrieval (CBIR) systems[1]*.In these systems, image processing algorithms (usually automatic) are used to extract feature vectors that represent image properties such as color, texture, and shape. In this approach, it is possible to retrieve images similar to one chosen by the user (*query-by-example or sketch*). One of the main advantages of this approach is the possibility of an automatic retrieval process, contrasting to the effort needed to annotate images.

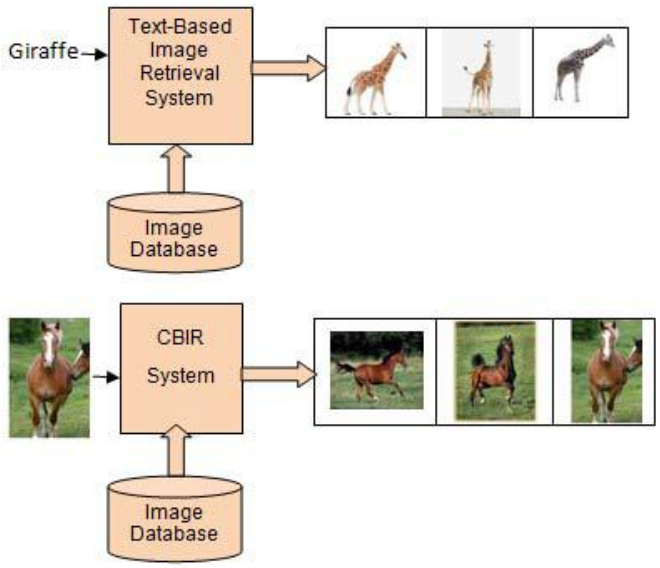

Figure 1. Scheme diagrams of a text-based image retrieval system (up) and a content-based image retrieval system

A typical CBIR system views the query image and the images in the database as a collection of features, and ranks the relevance between the query and any matching image in proportion to a similarity measure calculated from the features. These features are typically extracted from shape, texture, intensity, or color properties of the query image and the images in the database. These features are image signatures and characterize the content of images, with the similarity measure quantifying the resemblance in content features between a pair of images.

The creation of CBIR systems involves research on databases and image processing, handling problems that vary from storage issues to friendly user interfaces. Images are particularly complex to manage – besides the volume they

occupy; retrieval is an application-and-context-dependent task. It requires the translation of high-level user perceptions into low-level image features (this is the so-called "semantic gap" problem). Moreover, image indexing is not just an issue of string processing (which is the case of standard textual databases). To index visual features, it is common to use numerical values for the *n* features. In this context, the main challenges faced are the specification of indexing structures to speed up image retrieval and the query specification as a whole.

The data insertion subsystem is responsible for extracting appropriate features from images and storing them into the image database. This process is usually performed off-line. The query processing, in turn, is organized as follows: the interface allows a user to specify a query by means of a query pattern and to visualize the retrieved similar images. The query-processing module extracts a feature vector from a query pattern and applies a metric (such as the Euclidean distance) to evaluate the similarity between the query image and the database images. Next, it ranks the database images in a decreasing order of similarity to the query image and forwards the most similar images to the interface module.

The aim is to develop a content based image retrieval system, which can retrieve using sketches in frequently used databases with the best possible retrieval efficiency and time. The user has a drawing area where he can draw those sketches, which are the base of the retrieval method. Using a sketch based system can be very important and efficient in many areas of the life. In some cases we can recall our minds with the help of figures or drawing.

The CBIR systems have a big significance in the criminal investigation. The identification of unsubstantial images, tattoos and graffities can be supported by these systems. Similar applications are implemented in [2], [3], [4]. Another possible application area of sketch based information retrieval is the searching of analog circuit graphs from a big database. The user has to make a sketch of the analog circuit, and the system can provide many similar circuits from the database. The use of CBIR can result in powerful services that can benefit biomedical information systems. Three large domains can instantly take advantage of CBIR techniques: teaching, research and diagnostics. There are several digital libraries that support services based on image content. One example is the digital museum of butterflies.

II. Related works

SBIR problem is first introduced in Query by Visual Example (QVE) [5]. The novelty of this work is due to the transformation of images and sketches to an edge representation. The similarity of edges in sketch and images are then computed. QVE needs more computational power.

Other Sketch-based image retrieval (SBIR) systems are QBIC [6] and VisualSEEK [7]. In these systems the user draws color sketches and blobs on the drawing area. The images were divided into grids, and the color and texture features were determined in these grids. The applications of grids were also used in other algorithms, for example in the edge histogram descriptor (EHD) method. The application of Edge Histogram Descriptor (EHD) was first proposed in the visual standard MPEG. The edge information derived from each of the 16 non overlapping blocks of an image is categorized in to horizontal, vertical, diagonal and anti-diagonal and non-directional histogram bins .A total of 80 edge histogram bins are used in this method.

An improvement of EHD was proposed in [8]. Since EHD deals with only local distribution of edges. The performance of image retrieval can be improved by deriving semi global and global edge histogram from the local edge histogram. This uses 150 histogram bins.

The major disadvantage of any histogram based image retrieval approaches is that it is based on global properties of the image and not on topological properties like shape.

Recently, in [9] a new approach based on oriented gradients computed on each edge point is presented. They provided a benchmark for evaluating the performance of large scale sketch-based image retrieval systems. The retrieval rate of this descriptor is dependent on database content and it is not rotation invariant.

Chabot [10] integrates image content retrieving based on color information with text based queries. Its interface allows user to search and update the image database. This system does not include texture and shape descriptors.

III. Our Work

In this section the purpose and the overall structure of our system is discussed. The functionalities of different modules and methods used are explained.

There are no widely used sketch based image retrieval systems now. The measure of research in this area is growing day by day due to its wide applications in various important fields of life. Our purpose is to develop a a sketch based image retrieval system where the user has a drawing area, where he can draw all shapes and moments, which are expected to occur in the given location and with a given size. Though SBIR systems are effective, its efficiency and retrieval time is a challenging factor. Inorder to make the SBIR system more viable, we have used database indexing for faster and efficient retrieval.

The system building blocks include a preprocessing subsystem, which eliminates the problems caused by the diversity of images. Using the feature vector generating subsystem our image can be represented by numbers considering a given property. The database management subsystem provides an interface between the database and the program. Based on the feature vectors and the sample image the retrieval subsystem provides the response list for the user using the displaying subsystem.

The overall structure is as shown in Figure 2. The content-based retrieval as a process can be divided into two main phases. The first is the database construction phase, in which the data of preprocessed images is stored in the form of feature vectors – this is the off-line part of the program. This part carries out the computation intensive tasks, which has to be done before the program actual use. The other

phase is the retrieval process, which is the on-line unit of the program.

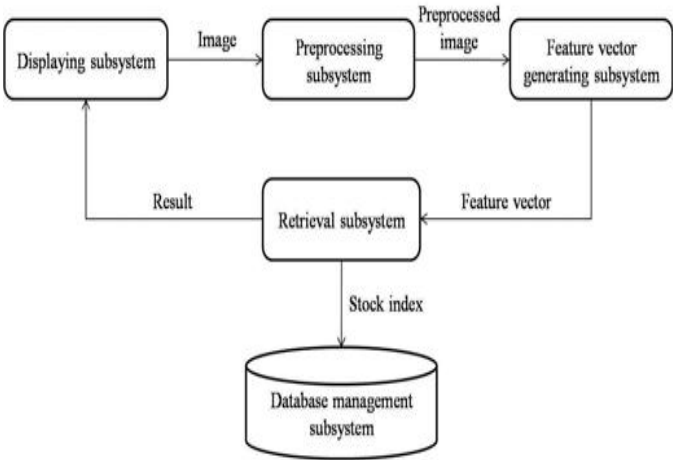

Figure 2. Overall structure of the system

A. PREPROCESSING SUBSYSTEM

There is difference between user drawn query sketch and images within a database. Before retrieving image data from sketched query, the image database need to be transformed to be easily understandable from a rough query image.

Simple database can be used for the system. Even then there will be disparities in the images. The size and resolution may vary. So they need to be scaled to a fixed resolution and size in the first place. Some images may be noisy and some may vary in illumination direction which makes the comparison of feature vectors difficult. Entropy filters and quantization techniques [11] are used to overcome these problems in this step. After these transformations, edges are detected using canny edge detection [12]. Canny edges provided the best cues for people to draw lines of the target objects.

B. FEATURE VECTOR GENERATION AND INDEXING

The preprocessed image is then used for extracting the feature vectors which are numerical values describing the image. In this work the shape features are used. The geometrical shape of objects in image is extracted. Four shape heuristics are used namely line, rectangle, triangle and circle.

Once the object has been extracted through segmentation and edge detection, we try to recognize the shape of object using calculated parameters and different heuristics. In the next step we store shape of object and geometrical parameters of the shape as its features. For example, for circle its area, parameter and centre parameters are stored.

All the information i.e. number of objects, shape of each objects, location of each objects, geometrical parameters of the shape for each object, and visual properties make the "contents of the image" which can be used for retrieval and understanding of image.

Once the features are extracted, they have to be indexed for efficient retrieval and within minimum time. In our work we have used database indexing which makes the search faster and efficient.

C. RETRIEVAL SUBSYSTEM

Once the feature vectors are indexed, the retrieval process can begin. Here the number of objects, its shape, location and parameters are used to compare between the image database and query vectors.

D. DATABASE MANAGEMENT SYSTEM

The feature vectors of the image database form the feature database. Database contains links to the images and with each link it contains information about the objects in the image. The retrieval process contacts the database system for the feature vectors.

E. DISPLAY SUBSYSTEM

User interface plays an important role in Sketch based image retrieval systems. Effective tools should be provided for sketching the query and viewing the results.

Here the users can sketch their query, upload images to the database and search for the results. The results can also be viewed in the interface. The number of results to show in the user interface is an important aspect. The first n pieces of results can be displayed, which conveniently can be placed in the user interface. This number depends on the resolution of the monitor.

IV. TESTS AND RESULTS

The system was tested on many random images. The testing metric used was precision. The precision value is the ratio of number of relevant hits to the number of retrieved hits.

The average precision value for other systems and our system is shown in table 1.

Method	HOG	EHD	Our System
Average Precision	42%	41%	45%

TABLE 1 Comparison with other systems.

V. CONCLUSION

The aim of the paper was to develop a sketch based image retrieval system that provided the best possible

efficiency and minimum retrieval time. While comparing with other histogram based systems our system performance is found to be better.

The most important consideration for this project is its possible applications. There are many possible applications for content based image retrieval systems, but considering the nature of system designed here the most obvious application is web based image retrieval. The sketched form of query image is ideal for construction of a system in which users could sketch their desired query into a browser window. With currently widely accessible systems like Google image search only capable of searching with meta-data such a system would fill a considerable gap in the market. The SBIR area is very highly researched and much development has been performed in the field. Very few widely accepted conclusions have however been made with no universally accepted technique proposed to retrieve images from a database based on a sketched query.

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