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Content Based Image Retrieval Using Sobel's Edge Detection Algorithm

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Abstract

This paper presents an efficient Content Based Image Retrieval (CBIR) system using Sobel's edge detection algorithm. Content Based Image Retrieval (CBIR) is a process to retrieve a stored image from database by supplying an image as query instead of text. This can be done by proper feature extraction and querying process. A universal content based image retrieval system uses color, texture and shape based feature extraction techniques for better matched images from the database. In proposed CBIR system, shape features are used. Edge detection is a fundamental tool in image processing and computer vision. To do analysis of the shape of image there are different techniques one way is that first upon finding out edges of respective image and then matching the shape of identified images. We use the Prompt edge detection method to detect edge points, these edge points are detected using the Sobel edge detection algorithm. These features are then compared to the features of the images which are already stored in our image database and most similar images are retrieved.

1. Introduction

Because of the recent advancements in computer technology and the revolution in the way the information is processed, increasing interest has been developed in automatic information retrieval from huge databases. In particular content based image retrieval has gain a considerable attention and, consequently, improving technology for the content-based querying systems becomes more challenging [1].

"Content-based" means that the search will analyze the actual contents of the image rather than the metadata such as keywords, tags, or descriptions associated with the image. Here the 'content' refers to shape or edge information that can be derived from the image itself. CBIR is desirable because most web based image search engines rely purely on metadata and this produces a lot of false detection in the results [2]. Content based image retrieval (CBIR) is a technique in which images are indexed by extracting their low level features and image retrieval is only based upon these indexed image features. In an effective image retrieval system, the user poses a query and the system should find images that are somehow relevant to the query. Thus, a way of representing the query, a way of representing images, and a way of comparing a query and an image are needed. This kind of approach is known as querying by content [5].

There are large numbers of edge detection operators available, each designed to be sensitive to certain types of edges. Variables involved in the selection of an edge detection operator include:

- **Edge orientation**

The geometry of the operator determines a characteristic direction in which it is most sensitive to edges. Operators can be optimized to look for horizontal, vertical, or diagonal edges.

- **Noise environment**

Edge detection is not easy in noisy images, since both the noise and the edges contain high-frequency content. Attempts to reduce the noise result in blurred and distorted edges. Operators used on noisy images are typically larger in scope, so they can average enough data to discount localized noisy pixels. This results in less accurate localization of the detected edges.

- **Edge structure**

Not all edges involve a step change in intensity. Effects such as refraction or poor focus can result in

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objects with boundaries defined by a gradual change in intensity. The operator needs to be chosen to be responsive to such a gradual change in those cases.

Our approach in feature extraction is logical shape detection of image. Logical shape detection is also well known as edge detection technique. For edge detection we have many different techniques available that have been proposed times before. We have used Sobel's edge detection technique in our work.

2. Literature Survey

Content based image retrieval is the task of retrieve the images from the large collection of database on the basis of their own visual content. This section provides the survey of technical achievements in the research area of image retrieval, especially content based image retrieval (CBIR. The research in this field way began way back at the end of nineteenth century but this has gained impetus from 1970 onwards with the thrust from two major research communities, database management and computer vision. Many systems for content based image retrieval has been developed till now. But out of all the systems each and every system has its own pros and cons. The first microcomputer-based image database retrieval system was developed at MIT, in the 1990s, by Banireddy Prasaad, Amar Gupta, Hoo-min Toong, and Stuart Madnick. After that systems are being continuously developed for providing better results. Here in these sections we will discuss about some well known technologies which has been earlier developed for retrieval of images. Some of them are: IBM's QBIC, CLUE, VIRAGE, Image finder, Google image search,etc[7].

Several algorithms has been used for fast retrieval of images from the database. This improves the efficiency of searching mechanism. The algorithms like hierarchical clustering for fast image retrieval, boosting algorithm, etc. has been used to speed up the process of image retrieval.

Nowadays CBIR systems are the focus point of researches because of the tremendous growth in digital repositories. Storing image feature space is the most arduous work in CBIR systems. Once the images are indexed in an efficient way, then it is easy to retrieve the relevant images for the user. Indexing is used to arrange data in a certain order for efficient retrieval.

Several indexing algorithms are: Affinity hybrid tree, R-Tree, Hierarchical grid based indexing, etc.

3. Edge Detection and Sobel Operator

What are Edges in an image?

- Edges are significant local changes of intensity in an image.
- Edges typically occur on the boundary between two different regions in an image.
- Using edges we can produce a line drawing of a scene from an image of that scene.
- Important features such as (corners, lines, curves)can be extracted from the edges of an image.
- These features are used by higher vision computer algorithms for further processing.

Edges characterize boundaries and are therefore a problem of fundamental importance in image processing. Edges in images are areas with strong intensity contrasts – a jump in intensity from one pixel to the next. Edge detecting an image significantly reduces the amount of data and filters out useless information, while preserving the important structural properties in an image. There are many ways to perform edge detection. However, the majority of different methods may be grouped into two categories, gradient and Laplacian. The gradient method detects the edges by looking for the maximum and minimum in the first derivative of the image [8]. The Laplacian method searches for zero crossings in the second derivative of the image to find edges. Edge detection is a necessary preprocessing step in most of computer vision and image understanding systems. The accuracy and reliability of edge detection is critical to the overall performance of these systems. Earlier researchers paid a lot of attention to edge detection, but up to now, edge detection is still highly challenging [3]. There exist several methods for edge detection such as Sobel, Robert, Prewitt, Canny, etc. These methods have been proposed for detecting transition in images. In this project we are going to retrieve images based on the features of the images. These features can be color, edge or texture of the image. As edge being a prominent feature of an image, we are extracting edges as the features of the image using Sobel's edge detection algorithm [4].

The Sobel operator performs a 2-D spatial gradient measurement on images. It uses a pair of horizontal and vertical gradient matrices whose dimensions are 3×3 for edge detection operations. Standard Sobel operators, for a 3 × 3 neighborhood, each simple central gradient estimate is vector sum of a pair of orthogonal vectors. Each orthogonal vector is a directional derivative estimate multiplied by a unit vector specifying the derivative's direction. The vector sum of these simple gradient estimates amounts to a vector sum of the 8 directional derivative vectors [3].

The directional derivative estimate vector G was defined such as density difference/distance to neighbor. This vector is determined such that the

direction of G will be given by the unit vector to the approximate neighbor. Note that, the neighbors group into antipodal pairs: (a,i), (b,h), (c,g), (f,d). The vector sum for this gradient estimate:

G=((c - g)/R.[1,1]/R) + ((a – i)/R.[-1,1]/R) + (b – h).[0,1] + (f - d).[1,0]

Where, R = 2 . This vector is obtained as

G = [(c − g − a + i) / 2 + f − d , (c − g + a − i) / 2 + b − h]

Here, this vector is multiplied by 2 because of replacing the divide by 2. The resultant formula is given as follows:

G ′ = 2.G = [(c − g − a + i) + 2.(f − d), (c − g + a −i) + 2.(b − h)]

The following weighting functions for x and y components were obtained by using the above vector.

-1	0	+1
-2	0	+2
-1	0	+1

Gx

+1	+2	+1
0	0	0
-1	-2	-1

Gy

g

Fig: 1. Sobel operator

This sobel operator consists of a pair of 3×3 convolution kernels as shown in Figure. One kernel is simply the other rotated by 90°.These kernels are designed to respond maximally to edges running vertically and horizontally relative to the pixel grid, one kernel for each of the two perpendicular orientations. The kernels can be applied separately to the input image, to produce separate measurements of the gradient component in each orientation (call these Gx and Gy). These can then be combined together to find the absolute magnitude of the gradient at each point and the orientation of that gradient. The gradient magnitude is given by:

$$|G| = \sqrt{G x^2 + Gy^2}$$

Typically, an approximate magnitude is computed using:

$$|G| = |Gx| + |Gy|$$

This is much faster to compute. The angle of orientation of the edge (relative to the pixel grid) giving rise to the spatial gradient is given by:

$$ə = \arctan (Gy / Gx)$$

4. System Architecture

Content Based Image Retrieval is designed to retrieve the images by giving a image as an input instead of any text as in any web browsers. The aim behind it is to retrieve the perfect images which are actually similar to the required query image. In the proposed system, software is divided into two parts- user and admin. Admin part will input various images along with their details in the database. The features of these images are extracted and stored in the database. On other hand, when the user gives input as a query image, the features of that image are extracted and stored in the feature vector. Then the comparison is done between the feature vector and the feature database. Later indexing is applied on the images and the most similar images are displayed in the field of retrieved images.

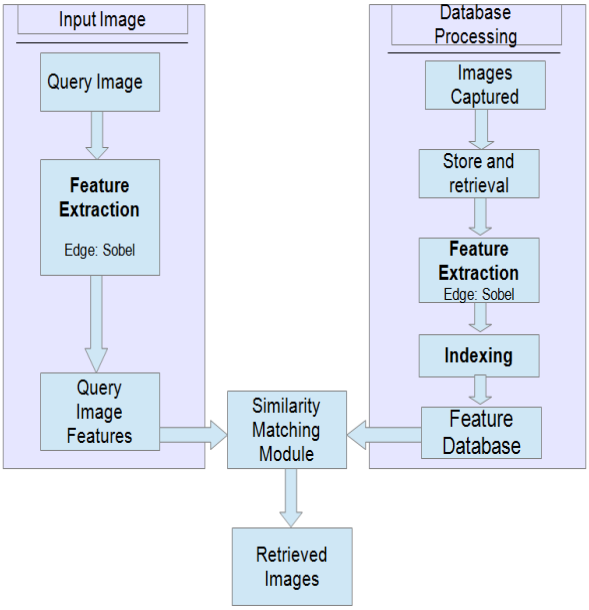

Fig: 2. Proposed System Architecture of CBIR

The figure 4.1 shows the general model of the Content-based Image Retrieval system. The above system has been divided into two phases. In the first phase image is fired as the query image which is to be searched and in the other phase the collection of images is maintained in the database from which the query image or the input image is to be compared. In input module, the feature vector is extracted from each input image and stored into the image database with its input image. When query image is entered into the query module, the feature vector of the query image is extracted. In retrieval module, the extracted feature vector of query image is compared with the images stored in the database. Similar images are retrieved according to their similarity with the query image. Finally the target image will be obtained from the retrieved images.

On the second level of the system the features extraction of images is carried out. The features are generally color, texture and edges of the images. Mostly color and e features are edge features are used for image retrieval. In our case we are going to use

edge features of an image for comparison. These edge features are extracted using Sobel's edge detection method.

5. Conclusion

Content-based image retrieval is currently a very important and active research in the field of multimedia databases. Since the explosive growth of image data in the large image archives need a more précised retrieval techniques to find the similar images. In this paper the Sobel's Edge detection method is used to detect the edges of images. Hence these methods prove to be more efficient than the methods used earlier for retrieval of similar-looking images.

6. Scope and Future Work

In the proposed system we are dealing with retrieval of images from the database based on the content of the image. The proposed system only retrieves image files. In our system presently we have used only one feature i.e edge of the image. In future we can use more features such as color and texture for feature extraction. As this approach concentrates only on retrieving of image files, in future this work can be expanded to retrieve the video files by using these features or modifying them.

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