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Content Based Image Retrieval Algorithm Using Colour Models

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Abstract: Digital Image Processing mainly deals with changing the nature of the image as required. An image can be viewed as group of pixels in terms of Image processing. Images are processed mainly to improve the Pictorial information. Content Based Image Retrieval (CBIR) is an emerging and developing trend in Digital Image Processing. CBIR is used to search and retrieve the query image from wide range of databases. Many Features and algorithms can be used for efficient image retrieval. In this paper an efficient image retrieval algorithm based on CCM (Colour Co-occurrence Matrix) is proposed. The CCM for each pixel of an image is found using the Hue Saturation Value (HSV) of the pixel and then compared with CCM of the images in the database and the images are retrieved.

Keywords: Content based image retrieval (CBIR), Pixels, Image, Hue Saturation Value (HSV), Colour Co-occurrence Matrix (CCM)

I. INTRODUCTION

Image processing is any form of signal processing where the input can be a photograph or a video frame and the output may be either an image or a set of parameters related to the image. An image retrieval system is a system which allows us to browse, search and retrieve the images. Content Based Image Retrieval is the process of retrieving the desired query image from a huge number of databases based on the contents of the image. Colour, texture, shape and local features are some of the general techniques used for retrieving a particular image from the images in the database. Content Based Image Retrieval systems works with all the images and the search is based on comparison of features with the query image.

The main components of CBIR are the features which includes the Geometric shape, colours and the texture of the image. Features can be of two types like local features and global features. Object recognition can be done easily using the local features. The next component is the associated text in which the images can also be retrieved using the text associated with the image. The other component is the relevant feedback where it helps to be more precise in searching the relevant images by taking up the feedbacks of the user.

Biomedicine, Military, Education, Web image classification and searching are some of the areas where the CBIR technique finds its prime importance. Some of the examples for the current CBIR are Viper which is Visual Information Processing for Enhanced Retrieval, QBIC which is Query by Image Content and Visual seek which is a web tool for searching images and videos. CBIR mainly decreases the heavy workload and overcomes the problem of heavy subjectivity.

Images can be compared by forming the CCM (Colour Co-occurrence Matrix) for the query image as well as the images in the database. For this the Hue Saturation Value is obtained for each and every pixel of the image and the CCM is formed using the relevant formulas. This CCM of the query image is compared with those images in database and the resulting images are sorted based on the similarity. This method can increase the accuracy and helps the user to obtain the results quickly.

II. CONTENT BASED IMAGE RETRIEVAL

In early days because of very large image collections the manual annotation approach was more difficult. In order to overcome these difficulties Content Based Image Retrieval (CBIR) was introduced. Content-based image retrieval (CBIR) is the application of computer vision to the image retrieval problem. In this approach instead of being manually annotated by textual keywords, images would be indexed using their own visual contents .The visual contents may be colour, texture and shape. This approach is said to be a general framework of image retrieval .There are three fundamental bases for Content Based Image Retrieval which are visual feature extraction, multidimensional indexing and retrieval system design. The colour aspect can be achieved by the techniques like averaging and histograms. The texture aspect can be achieved by using transforms or vector quantization .The shape aspect can be achieved by using gradient operators or morphological operators. Some of the major areas of application are Art collections, Medical diagnosis, Crime prevention, Military, Intellectual property, Architectural and engineering design and Geographical information and Remote sensing systems. [13]

2.1 RETRIEVAL BASED ON COLOUR

Several methods for retrieving images on the basis of colour similarity are being used. Each image added to the database is analysed and a colour histogram is computed which shows the proportion of pixels of each colour within the image. Then this colour histogram for each image is stored in the database. During the search time, the user can either specify the desired proportion of each colour (75% olive green and 25% red, for example), or submit a reference image from which a colour histogram is calculated. The matching process then retrieves those images whose colour histograms match those of the query most closely [13].

2.2 RETRIEVAL BASED ON STRUCTURE

The ability to match on texture similarity can often be useful in distinguishing between areas of images with similar colour. A variety of techniques has been used for measuring texture similarity in which the best established rely on comparing values of what are known as second-order statistics calculated from query and stored images. Essentially, these calculate the relative brightness of selected pairs of pixels from each image. From these it is possible to calculate measures of image texture such as the degree of contrast, coarseness, directionality and regularity, or periodicity, directionality and randomness. Alternative methods of texture analysis for retrieval include the use of Gabor filters and fractals. Texture queries can be formulated in a similar manner to colour queries, by selecting examples of desired textures from a palette, or by supplying an example query image. A recent extension of the technique is the texture thesaurus, which retrieves textured regions in images on the basis of similarity to automatically-derived code words representing important classes of texture within the collection.

2.3 RETRIEVAL BASED ON SHAPE

The ability to retrieve by shape is perhaps the most obvious requirement at the primitive level. Unlike texture, shape is a fairly well-defined concept and there is considerable evidence that natural objects are primarily recognized by their shape. A number of features characteristic of object shape (but independent of size or orientation) are computed for every object identified within each stored image. Queries are then answered by computing the same set of features for the query image, and retrieving those stored images whose features most closely match those of the query. Two main types of shape feature are commonly used global features such as aspect ratio, circularity and moment invariants and local features such as sets of consecutive boundary segments. Alternative methods proposed for shape matching have included elastic deformation of templates, comparison of directional histograms of edges extracted from the image, and shocks, skeletal representations of object shape that can be compared using graph matching techniques. Queries to shape retrieval systems are formulated either by identifying an example image to act as the query, or as a user-drawn sketch. Shape matching of three-dimensional objects is a more challenging task particularly where only a single 2-D view of the object in question is available.

2.4 RETRIEVAL BASED ON OTHER FEATURES

One of the oldest-established means of accessing pictorial data is retrieval by its position within an image. Accessing data by spatial location is an essential aspect of geographical information systems, and efficient methods to achieve this have been around for many years. Similar techniques have been applied to image collections, allowing users to search for images containing objects in defined spatial relationships with each other. Improved algorithms for spatial retrieval are still being proposed. Spatial indexing is seldom useful on its own, though it has proved to be effective in combination with other factors such as colour and shape. Several other types of image feature have been proposed as a basis for CBIR. Most of these rely on complex transformations of pixel intensities which have no obvious counterpart in any human description of an image.

Most such techniques aim to extract features which reflect some aspect of image similarity which a human subject can perceive, even if he or she finds it difficult to describe. The well-researched technique of this kind uses the wavelet transform to model an image at several different resolutions. Promising retrieval results have been reported by matching wavelet features computed from query and stored images. Another method giving interesting results is retrieval by appearance. The advantage of all these techniques is that they can describe an image at varying levels of detail (useful in natural scenes where the objects of interest may appear in a variety of guises), and avoid the need to segment the image into regions of interest before shape descriptors can be computed. Despite recent advances in techniques for image segmentation, this remains a troublesome problem.

III.RELATED WORKS

Rui.Y in his paper has proposed a survey of technical achievements in area of image retrieval. They have brought into light, the demand for the CBIR in real time application. They also proposed the past and current achievements in indexing and extracting the visual feature of the images [2]

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A.W.M.Smeulders has provided the steps carried out in content based image retrieval process. The features used for retrieval are also spoken here. The disadvantages like need for databases, role of similarity and problems of evaluation are also discussed. [3]

Ahonen.T presented a paper where content based image retrieval systems are used for facial recognition and texture. Classification in image retrieval. An operator called local binary pattern is used for image retrieval, where the LBP value is found for each pixel in Query image and compared with the LBP value of data base images and images are retrieved. [6]

Tai X.Y in his paper has given the use of content based image retrieval systems in the Medical field and it provides more knowledge about how the CBIR can be used in real time medical application. [12]

Huang.P.N has given a design of a two stage content based image retrieval system which mainly used the similarity measure, based on texture. Thus image retrieval technique is more enhanced.

Subrahmanyam Murala presented a novel image indexing and retrieval algorithm is proposed using local tetra patterns (LTrPs) for content-based image retrieval (CBIR). The standard local Ternary pattern (LTP) and local Binary pattern (LBP) encode the relationship between the referenced pixel and its surrounding neighbours by computing gray-level difference .Using this difference, the images are compared and retrieved.[8]

Aigrain et al has discussed the main principles of automatic image similarity matching for database retrieval, emphasizing the difficulty of expressing this in terms of automatically generated features. They have reviewed a selection of current techniques for both still image retrieval and video data management, including video parsing, shot detection, key frame extraction and video skimming. The paper concludes that the field is expanding rapidly, but that many major research challenges remain, including the difficulty of expressing semantic information in terms of primitive image features, and the need for significantly improved user interfaces. CBIR techniques are likely to be of most use in restricted subject domains, and where synergies with other types of data can be exploited.

IV. PROPOSED WORK

4.1 RGB Colour model

This model has primary colours like red, green, blue. Most of the CRT monitors and colour raster graphics make use of the RGB colour model. This model uses Cartesian coordinate system. The colours in this model are called “Additive primaries”, because desired colours can be produced by adding them together.

4.2. HSV Colour model:

HSV colour model stands for Hue Saturation Value colour model. This model describes colours in terms of their shades and brightness (Luminance). This model offers a more intuitive representation of relationship between colours. Basically a colour model is the specification of coordinate system and a subspace within that, where each colour is represented in single point.

4.2.1 Hue

HUE represents the dominant wavelength in light. It is the term for the pure spectrum colours. Hue is expressed from 0º to 360º. It represents hues of red (starts at 0º), yellow (starts at 60º), green (starts at 120º), cyan (starts at 180º), blue (starts at 240º) and magenta (starts at 300º). Eventually all hues can be mixed from three basic hues known as primaries.

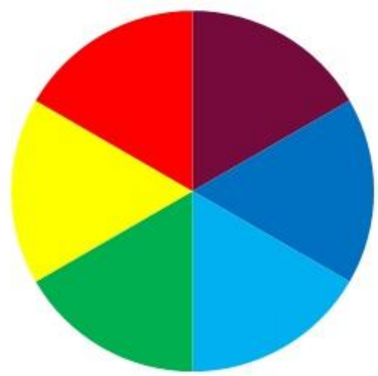

Figure 1. Colours of hue

4.2.2 Saturation

Saturation represents the dominance of hue in colour. It can also be thought as the intensity of the colour. It is defined as the degree of purity of colour. A highly saturated colour is vivid, whereas a low saturated colour is muted. When there is no saturation in the image, then the image is said to be a grey image.

4.2.3 Value

It describes the brightness or intensity of the colour. In other words value is defined as a relative lightness or darkness of colour.

4.3 Converting RGB to HSV colour model

HSV colours are said to lie within a triangle whose vertices are defined by the three primary colours in RGB space. The hue of the point **P** is given by the angle between the line connecting **P** to the centre of the triangle and line connecting the RED point to the centre of the triangle.

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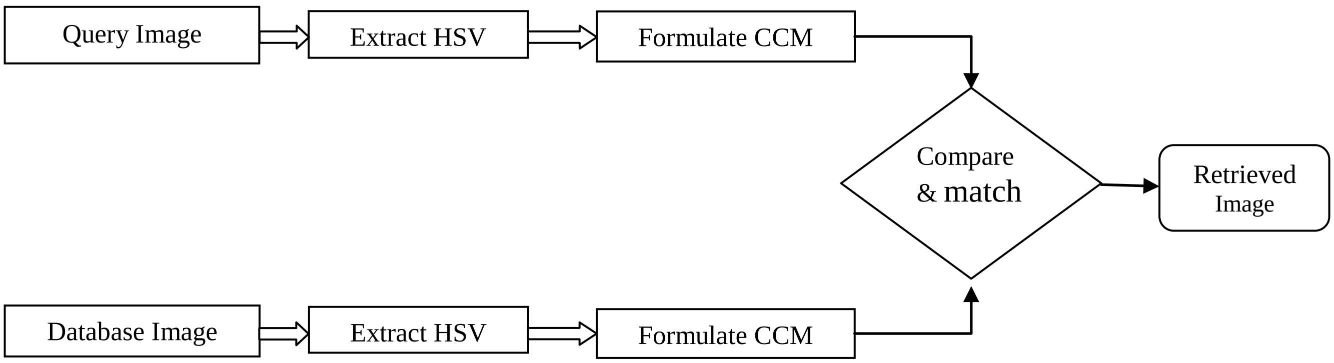

Figure.2 CBIR using HSV model

The saturation of the point **P** is the distance between the point **P** and centre of the triangle. The value (intensity) of the point **P** is represented as height of the line perpendicular to the triangle and passing through its centre. The greyscale points are situated onto the same line.

Conversion formulas are given below as follows.

$$H = cos^{-1}\left\{\frac{\frac{1}{2}[(R-G)+(R-B)]}{\sqrt{(R-G)^2+(R-B)(G-B)}}\right\} \quad .... (1)$$

$$S = 1 - \frac{3}{R+G+B}[\min(R,G,B)] \quad .... (2)$$

$$V = \frac{1}{3}(R+G+B) \quad .... (3)$$

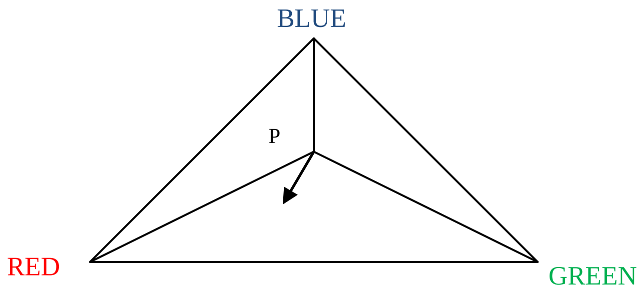

Figure 3. RGB to HSV conversion

Where

R, G & B represents RED, GREEN & BLUE.
H, S & V represents Hue, Saturation & Value.

4.4 Colour Co-occurrence Matrix (CCM)

A co-occurrence matrix is a matrix that is defined over an image to be the distribution of co-occuring values at a given offset. Value of an image is originally the gray scale value of a specified pixel. In our case we take the values to be the Hue, saturation and values of a specified pixel. The co-occurrence matrix is mainly used to measure the texture of the image and hence it is used for texture analysis. Features generated using these techniques are also called as Haralick features, because this concept was first introduced by Robert M Haralick. Texture measures like co-occurrence matrix and wavelet transforms have found applications in medical image analysis in particular. To carry out the retrieval process, a Query image is selected and the Hue, saturation and value of the pixels are taken and finally the colour co-occurrence matrix if formed using the formula below.

Colour co-occurrence matrix = 9H + 3S + V.... (4)

Here H, S and V correspond to Hue, saturation and value. The Hue values are from 20 to 316, saturation values are 0 to 1 and values ranges from 0 to 1.The CCM in the same way is found for the database images and the feature difference is found using the Euclidean distance. The images are matched for similarity using both the textural features and HSV of the pixels of the image. This process provides accurate retrieval results so that the query image is retrieved.

4.5 Euclidean distance

Euclidean distance measures the similarity between the two different feature vectors. The formula for Euclidean distance is shown below. Q and D are feature vectors of the Query image and database image.

Euclidean Distance = $\sqrt{\sum_{i=1}^{n}[Qi - Di]^2}$ .... (5)

V. EXPERIMENTAL RESULTS

After obtaining all necessary terms like Hue, saturation and value, colour co-occurrence matrix for number of images in the database, the results are calculated by using the Euclidean distance. According to their Euclidean distances the result is sorted and shown below.

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Figure 5.1 Input Query Image

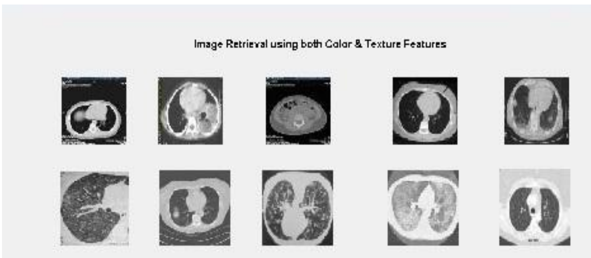

Figure 5.2 Output Retrieved Images

VI. CONCLUSION

The Retrieval algorithm presented in this paper mainly reduces the computational time and at the same time increases the user interaction. The retrieval accuracy is also increased to greater extent as the images are retrieved on the basis of both pixel information and colour feature. The results obtained are also less in number so that there is no need for the user to spend more time in analysis. Also the concept proposed here reduces the semantic gap. Since this idea is implemented in high level language like Mat lab, it can be used readily in many real time applications. The efficiency could be even more increased by taking into account several features at a time and compute the similarity to obtain more accuracy.

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