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Efficient content based image retrieval system

Deepika Thenappan[1], K Saravanan[2]
[1] M. Phil. Research Scholar, Department of Computer Science, PRIST University, Thanjavur, Tamil Nadu, India
[2] Research Guide, Department of Computer Science, PRIST University, Thanjavur, Tamil Nadu, India

Abstract
Content-based image retrieval is an area that has been so active in the past few years to organize digital pictures by their visual features based on the application of computer vision techniques to image retrieval problem in large databases. The aim is to analyze the current state of the method in content-based image retrieval technique to retrieve images on the basis of automatically derived features like color, texture, and shape. The action of matching the features of query image with features of database image is performed using various distance measures and the performance of various distance measures is also compared to find suitability of the particular method for image retrieval and outcomes are compared for various distance measures in terms of 'Time and Efficiency'. The primary methodology is to perform the similarity check between images. The techniques and approaches that are used for calculating the resemblances between extracted features are explained.

Keywords: content-based image retrieval, distance measures, retrieval accuracy

1. Introduction
An image retrieval system is a computer system that is used for surfing, searching and to retrieve the images from a large database or from different sources like internet. The long-established and universal methods of retrieving images utilize some methods of adding data about data such as inscription, keywords, or subtitle to the images so that retrieval can be performed over the glossary words [1]. The term content does refer to colors, textures, features, and shapes or any other information that could be derived from the image itself. Content-Based Image Retrieval is fascinated because most of the web-based image search engines depend purely on the metadata. The Content-Based Image Retrieval does consist of retrieving the most visually parallel images to the given query image from the huge repository of images [2]. The image retrieval depends on the extraction of all applicable characteristic quantities that detail the desired contents of images. Additionally the suitable skepticism, event, index and search techniques are required. As processors become progressively capable, the deployment of broad image databases for a variety of applications has now become reusable. The issues of searching for digital images in large databases become the easiest way [3]. Content-based underlined the search that figures out the contents of the image rather than the metadata like descriptions is associated with the image. Earlier, the technologies that were used to search textual information about images required humans to manually define each image in the database. CBIR extracts visual attributes such as color, texture, shape and spatial information of each image in the repository system and stores in a different repository within the system called 'feature database'. The users provide query image to the system. The system then automatically extract the visual attributes of the query image in the same mode as it does for each image in the database and then classify images in the database whose feature vectors match that of the query image and sorts the best similar objects according to their similarity value [4]. Because of the enormous increase in image database sizes as well as its huge distribution in various operations, the need for CBIR development arose vastly. CBIR systems are involved and this is been required in multiple fields such as architectural and design in engineering, collecting geographical information, remote sensation, preventing crimes in different areas, diagnosis in medical field, military, navy, army, air force, retail catalogs, intellectual property, information technology, photograph archives, multimedia, art collections and so on.

2. Distance measures of content-based image retrieval
The common method to compare two images in content-based image retrieval is using an image distance measure. This image distance measure compares the similarity of two images in different dimensions like color, texture, and shape. The block diagram of CBIR is shown in figure 1.

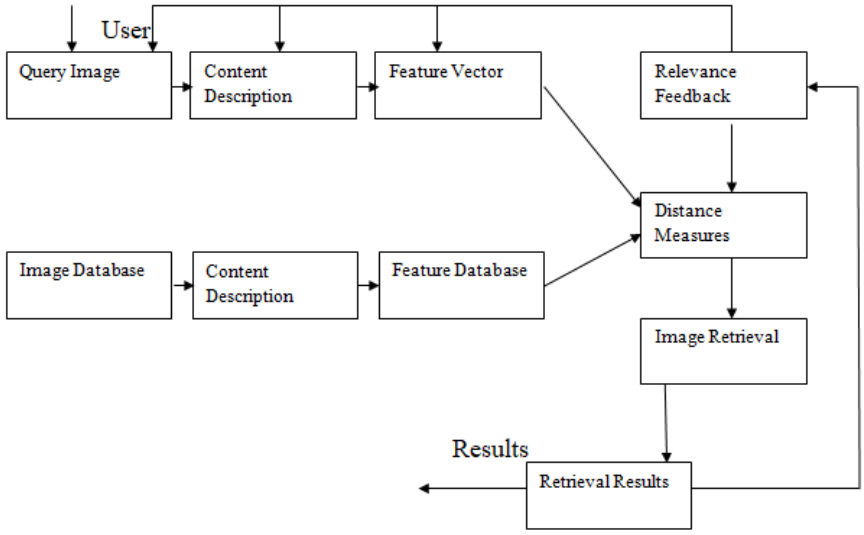

Fig 1: Block Diagram of the Content-Based Image Retrieval system

2.1 Color

In case if each and every color does belong to the same division or category that would be an effortless task to calculate and measure the similarities and find the distances between colors. Anyhow, the colors are visually anticipated as different categories [5]. The primary color category includes White, Gray, Red, Black, Orange, Yellow, Green, Blue, Cyan, and Purple. Further, colors are represented by only three values called RGB. Therefore we would need to consider that various colors are distributed composite in a three-dimensional color space. Hence that is difficult to notice arbitrary two colors as similar or different by linear distance model. As we are aware that human eyes could only observe similar colors and segregate various colors under the illumination change. Such kind of ability helps many computer vision technologies like visual tracking. The visual distance between two colors must satisfy the following principles:

1. If color 1 and color 2 look more similar than color 1 and color 3, Distance(C1,C2) < Distance(C1,C3)
2. If color 1 and color 2 look entirely different, Distance(C1, C2) = Maximum D or larger than Maximum D

Based on color similarity, computing distance measures are achieved by the process of computing the color histogram for each image which identifies the image pixel's proportion within an image that holds specific value called as colors [7]. Since color does not depend on image size and orientation, thoroughly in order to examine the images based on the colors they contain is one of the most commonly used techniques. The color searches usually include the comparison of color histograms as a necessary condition even though it is not the only method in use.

2.2 Texture

Texture metrics look for visual patterns in specific images and describe how they are spatially defined. Textures are being represented by texels that are placed into a number of sets depending on the number of textures that are detected in the image. Those sets not only define the texture but also where the texture is located in the image [8]. Texture being the difficult topic to serve, the recognition of textures in an image can be achieved basically by modeling the texture as 2 Dimension gray level variations. Anyhow, the issue is in identifying the patterns of neighbor or co pixel variation and that collaborates them with the particular class of textures such as smooth, silky or rough.

2.3 Shape

The shape does not refer to the particular shape (Square, rectangle, circle, hexagon, curve or triangle) of an image but to the shape of a particular region that is being hunted out. Shapes are determined by applying segmentation at first or the edge detection to an image [9]. Different methods use shape filters to identify and pinpoint the given shapes of an image. Methods like segmentation are tough enough to automate completely so that accurate detection of shape requires human intervention.

3. Measurement techniques

The transformation of distance provides the metric or measure of the separation of points in the image. The function called bwdist had been used to calculate the distance between each pixel and the most adjacent non zero pixels for all binary images. This bwdist function supports multiple distance metrics. There are several measurement techniques like Euclidean distance, City Block, Chebyshev, Quasi Euclidean distance, Chamfer Distance, Geodesic distance and Manhattan Distance.

3.1 Euclidean distance

The Euclidean distance is measured by the distance between two points in Euclidean space. Let us consider there are two points A and B in two-dimensional Euclidean spaces having A with the coordinates (a1, a2) and B with the coordinates (b1, b2). The hypotenuse of a right-angled triangle is formed by the line segment with endpoints of A and B. The distance between two points A and B can be defined as the square root

of summation of the squares of the difference between the subsequent coordinates of the points. The Euclidean distance between two points a = (ax, ay) and b = (bx, by) is defined as,

$$d(a,b) = \sqrt{(bx - ax)^2 + (by - ay)^2} \quad (1)$$

The Euclidean distance raster says how close each cell is to the nearest source and raster is defined which source zone and cell value are the closest. Also, the Euclidean directions identify the direction to the closest source cell.

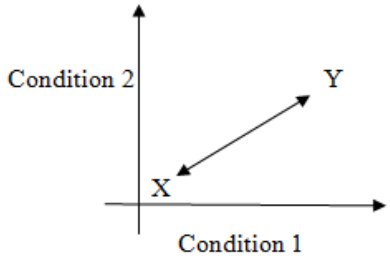

Fig 2: Euclidean distance metric

3.2 The city block distance

The city block distance is defined as the sum of the horizontal and vertical component in which the diagonal distance could be calculated by applying the Pythagorean Theorem. The city block distance is the path between the pixels based on a 4 connected neighborhood. The Pixels whose edges touches are 1 unit apart and pixels touch diagonally are 2 units apart. The city block distance is the summation of differences transversely dimensions. It has very less sensitive to outliers and has diamond shaped clusters. The city block distance is much faster to calculate but very less accuracy hence more errors can be encountered. It is the distance between two points in a grid that is based on the horizontal and vertical path in contrast to the diagonal.

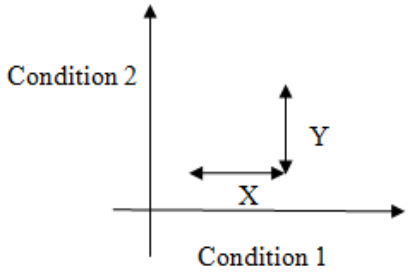

Fig 3: City Block Distance Metric

3.3 Chess board distance

The chessboard distance measures abruptly the path between the pixels based on an eight-connected adjacency. Those Pixels whose edges or corners touch are 1 unit apart. It follows the tactic of the chessboard as in the game of chess the minimum number of moves a king needed to go from one square on a chessboard to another square equals the chessboard distance between the centers of the squares. If the square has side length 1 as represented in 2-dimensional spatial coordinates with axes associated to the edges of the board. The chessboard distance is a metric that can be defined as the vector space where the distance between two points is the greatest of their differences along any coordinate dimension.

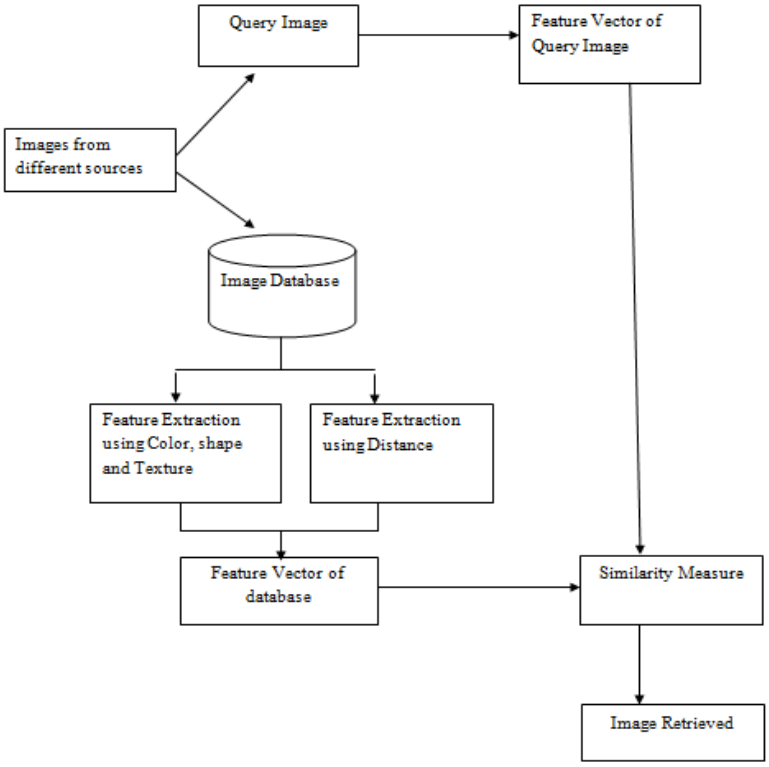

Fig 4: Proposed System of CBIR

4. Results and discussion

The database needs to be loaded to perform the image retrieval process. 500 images of 10 types had been created and loaded the images into the database. The query image is provided in accordance to which the similar images are to be retrieved and displayed. The Performance of Euclidean distance, City block distance, and Chessboard distance are measured depending upon these retrieval techniques. The images referred in figure 5 are used as query image and images are retrieved using Euclidean distance, City block distance, and Chessboard distance techniques.

Fig 5: Test images used as the query image

Correctness is defined as the ratio between the number of relevant images retrieved and the total number of retrieved. Correctness percentage is used to know the good performance in retrieval. Reminisce is defined as the ratio between the number of relevant images retrieved and the number of relevant images in the database. The average correctness and average reminisce for the query images 201, 568 and 853 for different similarity cut off have been tabulated in Table 1. The similarity cut off is set to the values 25,30,40,50 and 60. The values of retrieved relevant images and total retrieved images for each image are tabulated. The total relevant images in the database are set to be the value 100. The correctness and reminisce for Euclidean Distance, Chessboard, and City block have been calculated. The increase in the similarity cut off which the user selected to indicate the higher threshold for the similarity measures for the process of retrieving similar images from the database. The average recall dropped down because of elimination of images that have less similarity. The average Correctness and definiteness increases since the retrieved images are highly similar because of higher cut-off.

Table 1: Calculation of correctness and reminisce for Euclidean Distance

Query Image	Similarity Cut off	Retrieved Relevant Images	Total Retrieved Images	Total relevant Images in the database	Correctness	Reminisce
Image 201	25	53	92	100	0.58	0.53
	30	51	81		0.63	0.51
	40	34	56		0.61	0.34
	50	17	27		0.63	0.17
	60	7	13		0.54	0.07
					0.60	0.32
Image 568	25	27	184	100	0.15	0.27
	30	22	140		0.16	0.22
	40	9	61		0.15	0.09
	50	5	23		0.22	0.05
	60	1	7		0.14	0.01
					0.16	0.13
Image 853	25	33	105	100	0.31	0.33
	30	27	80		0.34	0.27
	40	13	35		0.37	0.13
	50	6	14		0.43	0.06
	60	3	5		0.60	0.03
					0.41	0.16

The Measurement Techniques Euclidean, City block, and Chessboard have different Correctness and Reminisce percentage. The F measure is defined as the F score to test the accuracy. It can be stated as the weighted mean of Correctness and Reminisce about the test.

The Average F measure is computed by using the average correctness (denoted as C) and average reminisce (denoted as R). Average F measure along with the similarity cut off for Chessboard distance is shown in table 2

Table 2: Calculation of average F measure for Chessboard distance

Similarity Cut off	Average Correctness (C)	Average Reminisce (R)	Average F measure
			= 2 / (1/Avg.C + 1/Avg.R)
25	0.86	0.44	0.58
30	0.29	0.25	0.15
40	0.68	0.32	0.44

The graphical representation of measurement techniques comparison is shown in figure 6. The figure also shows the percentage of correctness and reminisces for each measurement technique.

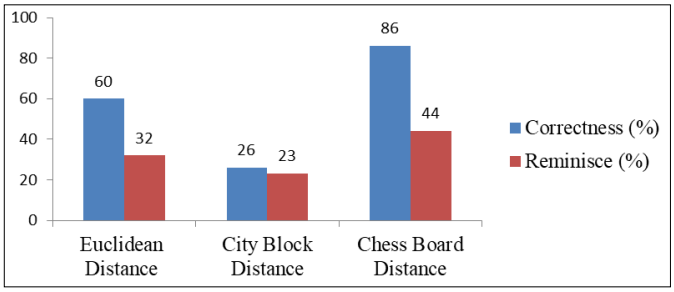

Fig 6: Comparison of Measurement Techniques

5. Conclusion

The experimental results clearly reveal that correctness and reminisce percentage of Chessboard distance (86 and 44 respectively) measurement technique is high when compared with Euclidean (60 and 32 respectively) and city block distance measurement techniques (26 and 23 respectively). The high percentage value of correctness and reminisce value shows the good performance in retrieving the images.

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