Comparison of Different Distance Metrics to Find Similarity between Images In CBIR System

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Abstract— content based image retrieval use low level feature (color, shape, texture) of image for retrieving similar image from image database. This paper presents a novel system for texture feature extraction from grayscale images using gray level co-occurrence matrix (GLCM). It works on statistical texture feature of image. Texture feature of image is referred to as repeated homogenous pattern in an image. This texture feature is classified into three categories Statistical, structural and spectral. Among these we extract second order statistical texture feature from image using GLCM. These features are Energy, correlation, contrast, homogeneity, entropy. Different distance metrics are used to find the similarity between images. The experiment is conducted on own texture database. Accuracy of result and time complexity of design algorithm for CBIR system is calculated.

Keywords- *CBIR, GLCM, Texture Analysis, Statistical Method, Texture Features, Distance Metric.*

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I. Introduction

With the development of internet and the availability of image capturing device such as digital cameras, image scanners, the size of digital image collection is increasing rapidly. Efficient image searching, browsing and retrieval tools are required by user from various domains [1]. To overcome this problem the research in image retrieval is started. Initially text based image retrieval system is developed in 1970 [1] called TBIR.

TBIR system work on text annotation of image but there are lot of problem associated with them. In TBIR annotation of images requires human input which is expensive and time consuming for large image database. Another problem is that these annotations are subjective and different user use different annotations for same image. Also it is difficult to write all information about image used for image retrieval. Due to this problem new approach to content based was proposed called content based image retrieval (CBIR)

For the first time Kato et.al. [2] Described the experiments of automatic retrieval of image from a database by color and shape feature using the terminology CBIR. The objective of CBIR is to retrieve image relevant to a query from a database [3]. In conventional CBIR approach an image is usually represented by a set of features, where the feature vector is a point in a multidimensional feature space. Each feature tries to capture only one property of the image [4]. CBIR is another approach which works on image feature rather than text annotation. Image features are color, texture, shape and spatial information are called low level feature of image.

Color is visual attribute of image .There are several technique for color feature extraction but color histogram is one of the popular technique used for color feature extraction. QUBIC [5], NETRA [5], Visual seek [5] are existing CBIR system based on color feature.

Texture of an image is referred to as repeated homogeneous pattern present in image. Approach to describing texture can be roughly classified into three categories namely statistical, structural and spectral. The statistical approach characterizes texture by the statistical properties of the gray-levels of the pixels in an image. the structural approach assumes that texture is formed with simple primitives called 'Texel' (texture elements). The spectral approach is based on the analysis of power spectral density function and filtering theory in the frequency domain [6].Texture feature based existing CBIR systems are ADL [5], photo finder [5], Blob world [5], candid [5], CBVQ [5].

Shape is a visual feature of image used to describe the shape of different object present in an image. Shape based CBIR system measure the similarity between two images using shape. FIR [4], MARS [5], Picasso [5], PicTOSeek [5] are the example of shape based CBIR system.

Spatial information of image is distribution of color in image. For example: a picture of small town with blue sky. In this picture bottom part contain trees and house and top part of image contain blue color sky. This spatial information is used for matching and retrieval of similar image in CBIR system.

Among these features, we used texture features for design and development of CBIR system. CBIR system used in many application [7] like crime prevention, web searching, education and training, medical diagnosis, journalism and advertising, fashion and interior design, GIS and remote sensing.

In this CBIR system there are three basic steps and these are feature extraction, feature comparison, indexing and retrieval. Feature extraction is one of the most important parts in designing a CBIR system. The extracted feature should be well separated in the feature space to produce effective discrimination between images [4]. Block diagram of CBIR system is show in Fig 1.

Fig.1 shows feature extraction module extract feature from image database and query image. Feature comparison module compare the feature of query image to the feature of images in image database and find similar images. Indexing and retrieval module perform indexing on similar images and retrieve these images.

In section 2 texture feature extraction using Gray level co-occurrence matrix (GLCM) and distance metrics are discussed. Result and discussion are given in section 3 and conclusion is presented in section 4.

II. Experiment

In this section we describe the experiment conducted for research. We use own texture database consist of 23 class of images and each class contain 7 images. Each image is rotated in different angle like 0^o, 30^o, 60^o, 90^o, 120^o, 180^o and 270^o

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degree the size of each image is different. All images in this database are gray scale images and they are used for experiment. An example of image from each class is shown in Fig.2 Table I. Gives detail about own texture database used in experiment.

TABLE I. PROPERTY OF OWN TEXTURE DATABASE

Property	Own Texture Database
Size	Size of each image in this database is different
Type	Grayscale images
No. Of Texture Image Class	23
No. Of Images Per Class	7
Image Is Rotated In Angle	0o, 30o, 60o, 90o, 120o, 180o, 270o

A. *Texture Feature Extraction Method*

Texture feature analysis play important role in the field of image processing. It is an active research topic in the field of computer vision and pattern recognition. It involves four basic problems: classifying images based on texture content, segmenting an image into region of homogeneous texture, synthesizing texture for graphics application and establishing shape information from texture cues [8]. There is no precise definition of texture. It can be defined as the repetitive patterns of pixels found in the image [9].texture can be used for image identification. Structural arrangement of surface in an image is given by texture feature. Texture can be classified as directional, non-directional, smooth, rough, coarse, fine, regular, and irregular. Texture feature of image can be either global or local. Global texture feature extract visual information from whole image where as local texture feature is focused on particular object or region in an image.

In this proposed work we use statistical method for texture analysis. This method classified into three category first order statistics, second order statistics and high order statistics. Among these we use second order statistics features for texture analysis. GLCM method is used for texture feature extraction from grayscale image. It contains statistical information of pixel relationship in an image. Haralick [10] extract 14 statistical features from image using GLCM. These features are called texture feature. We use five texture features in second order statistics namely contrast, correlation, energy, homogeneity and entropy are extracted from gray scale image using GLCM. These features are

1. Energy or Angular second moment

Energy means uniformity. Texture uniformity is measured by energy that is repetitions of pixel pairs. It can be given as

$$ENG = \sum\sum M^2(i,j) \quad (1)$$

2. Correlation

Gray level linear dependencies in the image are measured by correlation. It can be given as

$$COR = \frac{\sum\sum ijM(i-j) - \pi x \pi y}{\varphi x \varphi y} \quad (2)$$

Where $\pi x, \pi y, \varphi x, \varphi y$ are the mean and standard deviations of Mx and My. Mx is the sum of each row in co-occurrence matrix and My Is the sum of each column in Co-occurrence matrix.

3. Contrast

Contrast is the difference between highest and lowest value of contiguous set of pixels. Local variation in an image is measured by contrast or variance of gray level in an image is indicated by contrast. it can be given as

$$CON = \sum\sum (i-j)^2 M(i,j) \quad (3)$$

4. Homogeneity

Homogeneity measure the image homogeneity called inverse difference moment. It can be given as

$$HOM = \sum i \sum j \frac{1}{1+(i-j)^2} M(i,j) \quad (4)$$

5. Entropy

Disorder or Complexity of an image is measured by Entropy. Entropy is small when an image is texturally uniform. entropy can large when an image is texturally not uniform. It can be given as

$$ENT = -\sum\sum M(i,j)\log[M(i,j)] \quad (5)$$

After extracting these texture features from both image database and query image different distance metrics are used for matching and retrieval of similar images from image database.

B. *Distance Metrics*

1. Euclidean Distance

Euclidean distance is straight line distance between two pixels. In 2D the Euclidean distance is

$$\sqrt{(P1-P2)^2 + (Q1-Q2)^2} \quad (6)$$

2. CityBlock Distance

Cityblock distance measure the path between pixels based on 4 connected neighborhoods. In 2D the cityblock distance is

$$|P1-P2| + |Q1-Q2| \quad (7)$$

3. Chebyshev Distance

Chebyshev distance called maximum co-ordinate difference. In chebyshev distance all 8 adjacent cell from the given point can be reached by unit. In 2D the chebyshev distance is

$$Max(|P1-P2|, |Q1-Q2|) \quad (8)$$

4. Cosine Distance

The cosine similarity between two vectors is measure that calculates the cosine of the angle between them. In 2D the angle cosine distance is

$$\frac{\sum_{k=1}^{n} PiQi}{\sum_{k=1}^{n} Pi \sum_{k=1}^{n} Qi} \quad (9)$$

5. Canberra Distance

In Canberra distance metric equations the numerator signifies the difference and denominator normalizes the difference. Thus distance value never exceeds one being equal to one. Thus it would seem to be a good expression to use which avoids scaling effect. When Canberra distance metric is used result is always fall in the range [0, 1]. In 2D the Canberra distance is

$$\sum_{k=1}^{n} \frac{|Pi - Qi|}{|Pi| + |Qi|} \qquad (10)$$

Pi is feature vector of image database and Qi is feature vector of query image.

C. Algorithm for Designing CBIR System

Algorithm **CBIR**
INPUT: image database (TEXTURE), query image (QUERY).

OUTPUT: display images from TEXTURE that is similar to QUERY.

PROCEDURE:
1: Load image database TEXTURE.
2: Compute GLCM matrix for direction 0o, 45o, 90o, 135o.
3: Extract texture features contrast, correlation, energy, Homogeneity and entropy from TEXTURE using GLCM.
4: Load QUERY from TEXTURE and extract texture Feature contrast, correlation, Energy, homogeneity and Entropy using GLCM.
5: Compare texture feature of QUERY with TEXTURE
6: Perform indexing on matching images and retrieve them.

III. Result and Discussion

Design algorithm is implemented in matlab 7.8.0(R2009a). Before extracting texture feature from image. Images in texture database are resized to 128*128. Results and performance of algorithm is checked on own texture database.

In this experiment one image from each class in image database is selected as query image. The texture feature extracted from both query image and image database. The extracted texture features are represented as feature vector and different distance metrics are used to measure the similarity between query image and images in image database.

A retrieval score is computed according to the following evaluation criteria. The system returns seven closest images to the query image. Query image is also displayed in seven closest images because distance from query image to itself is zero. The number of irrelevant images is computed as the number of images displayed that do not belong to the class of query image. In addition to the number of images that belong to the query image class but it is not displayed by the system. The average retrieval score for each class is computed as

[1-(irrelevant images/7)]*100.

Tables II to VI and Fig. 3 to 7 show average retrieval score for each class in own texture database using different distance metrics.

TABLE II. Average Retrieval Score for Class1 to Class8.

Distance Metrics	Average retrieval score for each class (in percentage)				
	Class1	Class2	Class3	Class4	Class5
Euclidean Distance	71.43	100	57.15	57.15	71.43
Cityblock Distance	57.15	85.72	71.43	57.15	71.43
Chebyshev Distance	85.72	100	57.15	57.15	57.15
Cosine Distance	57.15	28.58	42.86	57.15	85.72
Canberra Distance	100	71.43	57.15	57.15	57.15

TABLE III. Average Retrieval Score for Class6 to Class10

Distance Metrics	Average retrieval score for each class (in percentage)				
	Class6	Class7	Class8	Class9	Class10
Euclidean Distance	100	57.15	100	42.86	57.15
Cityblock Distance	100	71.43	100	42.86	57.15
Chebyshev Distance	85.72	57.15	100	42.86	57.15
Cosine Distance	71.43	57.15	57.15	42.86	57.15
Canberra Distance	57.15	57.15	100	57.15	57.15

TABLE IV. Average Retrieval Score for Class11 to Class15

Distance Metrics	Average retrieval score for each class (in percentage)				
	Class11	Class12	Class13	Class14	Class15
Euclidean Distance	42.86	57.15	71.43	100	28.58
Cityblock Distance	42.8 6	57.15	100	100	28.58
Chebyshev Distance	28.58	57.15	57.15	100	28.58
Cosine Distance	28.58	57.15	100	85.72	28.58
Canberra Distance	57.15	57.15	57.15	100	42.86

TABLE V. Average Retrieval Score for Class16 to Class20

Distance Metrics	Average retrieval score for each class (in percentage)				
	Class16	Class17	Class18	Class19	Class20
Euclidean Distance	57.15	57.15	85.72	57.15	57.15
Cityblock Distance	71.43	57.15	85.72	57.15	57.15
Chebyshev Distance	57.15	57.15	57.15	57.15	57.15
Cosine Distance	57.15	57.15	57.15	57.15	57.15
Canberra Distance	71.43	57.15	57.15	57.15	57.15

TABLE VI. Average Retrieval Score for Class21 to Class23.

Distance Metrics	Average retrieval score for each class (in percentage)		
	Class21	Class22	Class23
Euclidean Distance	57.15	100	42.86
Cityblock Distance	57.15	71.43	28.58
Chebyshev Distance	57.15	100	57.15
Cosine Distance	57.15	42.86	28.58
Canberra Distance	57.15	85.72	57.15

The performance of CBIR system on own texture database is observed by using five distance metrics. Average retrieval Score of Distance Metrics for all class in texture database can be calculated by using the formula

ARS=Sum (average retrieval score per class)/total Number of Classes

Table VII shows average retrieval score of each distance metrics in texture database.

TABLE VII. AVERAGE RETRIEVAL SCORE OF DISTANCE METRICS.

Distance Metrics	Average Retrieval Score in own Texture Database (in percentage)
Euclidean Distance	66.46
Cityblock Distance	66.46
Chebyshev Distance	63.98
Cosine Distance	55.28
Canberra Distance	64.60

Graphical representation of average retrieval score of all distance metric in own texture database is shown in Fig 8.

We calculate the time complexity of designed algorithm for CBIR system in three sections that is time required for feature extraction from image database, time required for feature extraction from query image and time require for indexing and retrieval of similar images. This is shown in table VIII and Fig.9

TABLE VIII. TIME COMPLEXITY OF ALGORITHM.

Algorithm	Execution Time In Second (Minimum)	Execution Time In Second (Maximum)
Feature Extraction From Image Database	5.000	5.999
Feature Extraction From Query Image	1.000	1.999
Indexing And Retrieval Of Matching Image	0.4000	0.8000

IV. . CONCLUSION

We have designed and develop the CBIR system for own texture database. It extract global texture feature from both query image and images in image database. These extracted texture features are stored as a feature vector. After feature extraction the selection of similarity distance metrics is difficult task for CBIR system. When retrieval rate of CBIR system is not efficient researcher try new distance metric or search a new method for feature extraction. In order to overcome these difficulties we implement such a method which increases the retrieval rate of CBIR system. In this CBIR system to find the similarity between query image and images in image database five distance metrics are used. The accuracy of result given by CBIR system is analyzed on the basis of five distance metrics separately. From result we find that average retrieval score of Euclidean distance metrics and cityblock distance metrics is equal and high as compare to other distance metrics. So it gives the best result in CBIR system. Also we calculate the time complicity of algorithm used for designing CBIR system. It can take 5.0 to 5.999 seconds for feature extraction from image database, 1.0 to 1.999 seconds for feature extraction from query image and 0.400 to 0.800 seconds for indexing and retrieval of matching images.

REFERENCES

[1] Ying Liu, Dengsheng Zhang, Guojun Lu, " Wei-Ying Ma, Asurveyofcontent-basedimageretrievalwithhigh-levelsemantics", Pattern Recognition Society. Published by Elsevier Ltd, 40, 2007, pp. 262-282.

[2] H.B. Kekre, Sudeep D. Thepade, and Varun K. Banura, "Image Retrieval Using Texture Patterns Generated from Walsh-Hadamard Transform Matrix and Image Bitmaps", Springer-Verlag Berlin Heidelberg,CCIS 145,2011,pp. 99-106.

[3] Parichat Kinnaree, Singthong Pattanasethanon, Somsak Thanaputtiwirot, Somchat Boontho, "RGB Color Correlation Index for Image Retrieval", Procedia Engineering. Published by Elsevier Ltd, 8, 2011, pp. 36-41.

[4] Minakshi Banerjee, Malay K. Kundu, Pradipta Maji, "Content-based image retrieval using visually significant point features", Fuzzy Sets and Systems. Published by Elsevier Ltd, 160, 2009, pp. 3323–3341.

[5] Remco C. Veltkamp, Mirela Tanase,"Content-Based Image Retrieval Systems: A Survey", Department of Computing Science. Utrecht University, http://www.cs.uu.nl.

[6] P.W.Huang,S.K.Dai, "Image retrieval by texture similarity", Pattern Recognition Society. Published by Elsevier Science Ltd, 36, 2003, pp. 665–679.

[7] G. Quellec, M. Lamard, G. Cazuguel, B. Cochener, C. Roux, "Wavelet optimization for content-based image retrieval in medical databases", Medical Image Analysis. Published by Elsevier Ltd, 14, 2010, pp. 227–241

[8] [8]Zhenhua Guo,Lei Zhang, David Zhang, "Rotation invariant texture classification using LBP variance (LBPV) with global matching", Pattern Recognition Society. Published by Elsevier Ltd, 43, 2010, pp. 706-719.

[9] Milind V. Lande, Praveen Bhanodiya and Pritesh Jain, "An Effective Content-Based Image Retrieval Using Color, Texture and Shape Feature", Springer Journal, 2014.

[10] R.M. Haralick, K. Shanmugam, I. Dinstein, Textural Features for Image Classification, IEEE Transactions on Systems, Man, and Cybernetics, 3, 6, 1973, pp. 610–621, 1973.

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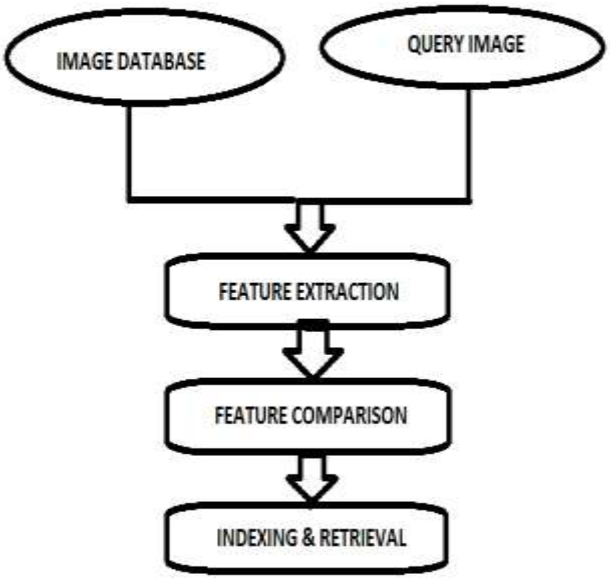

Figure 1. Block Diagram Of CBIR System

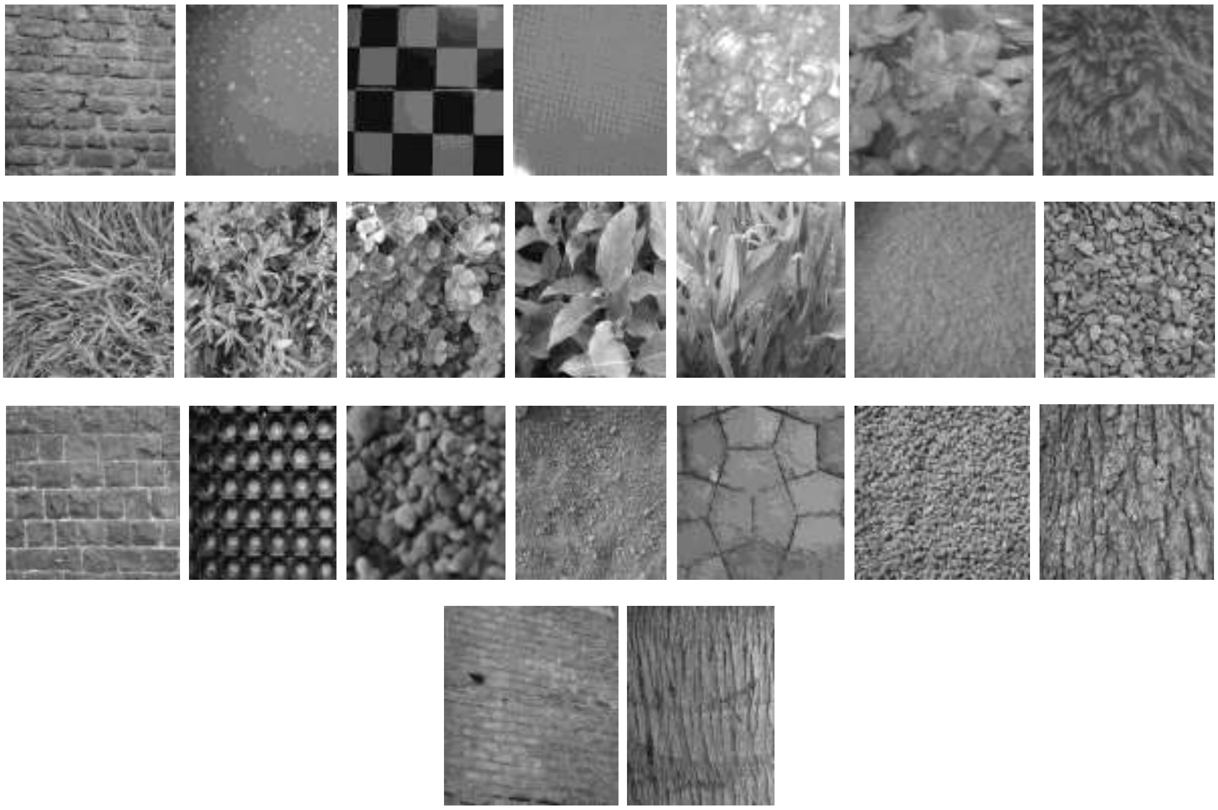

Figure 2. Own Texture Image Database.

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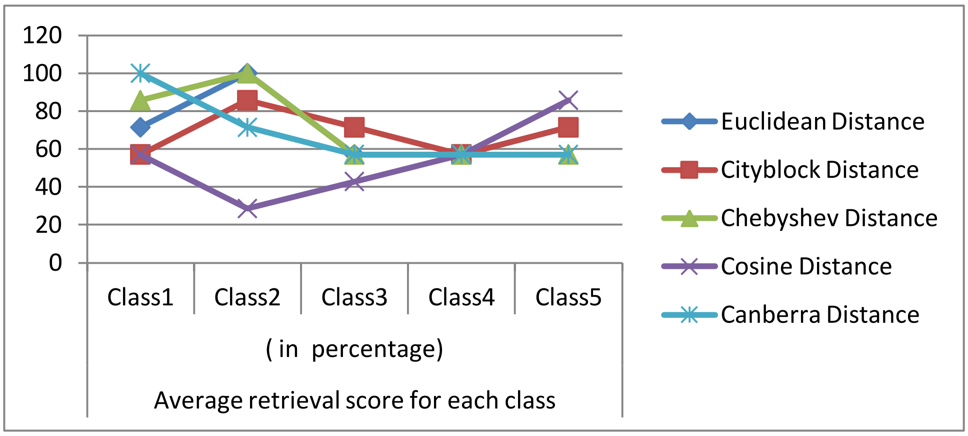

Figure 3. Average retrieval score for class1 to class8.

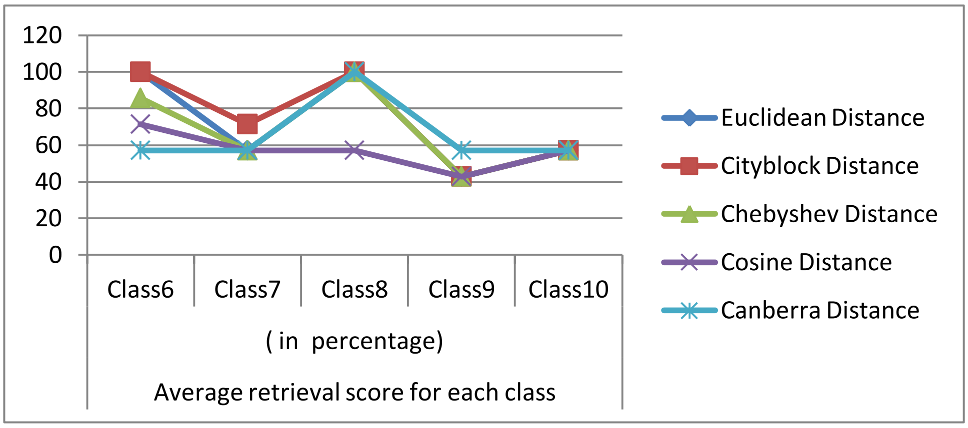

Figure 4. Average retrieval score for class6 to class10.

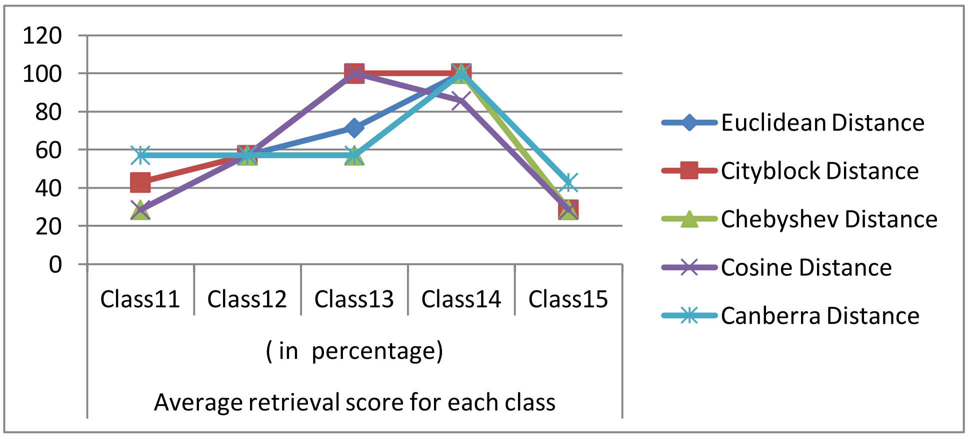

Figure 5. Average retrieval score for class11 to class15.

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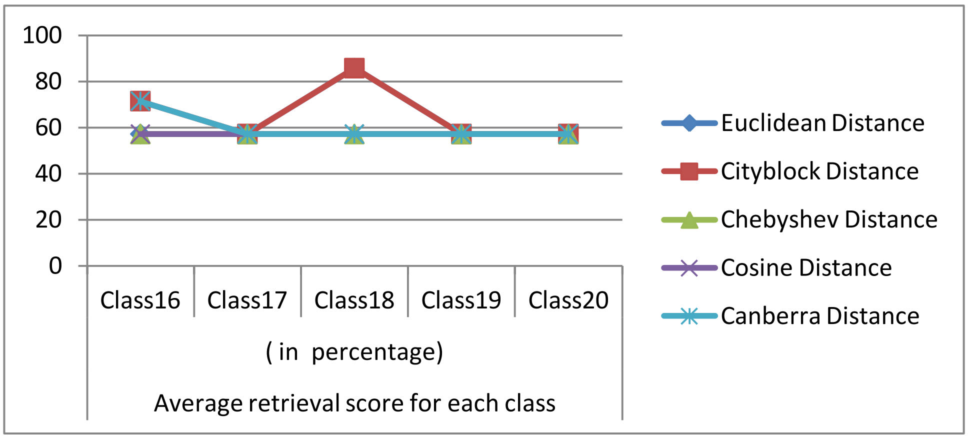

Figure 6. Average retrieval score for class16 to class20.

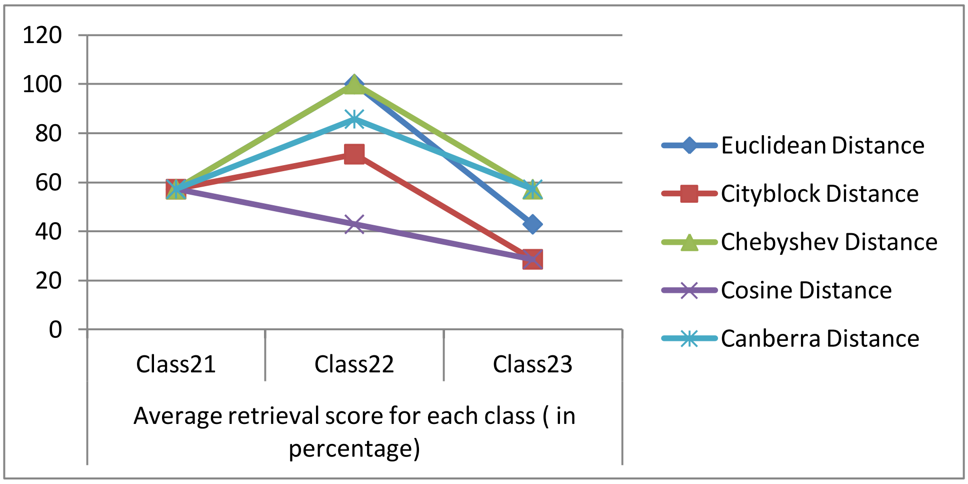

Figure 7. Average retrieval score for class21 to class23.

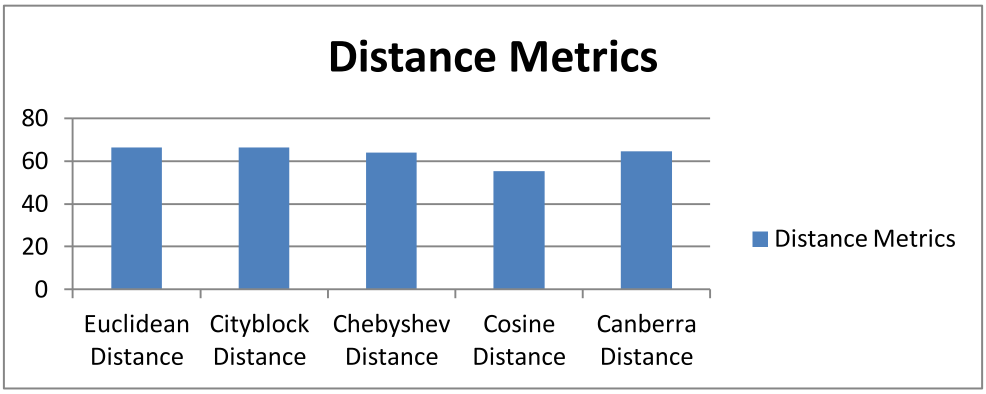

Figure 8. Average retrieval score of distance metrics.

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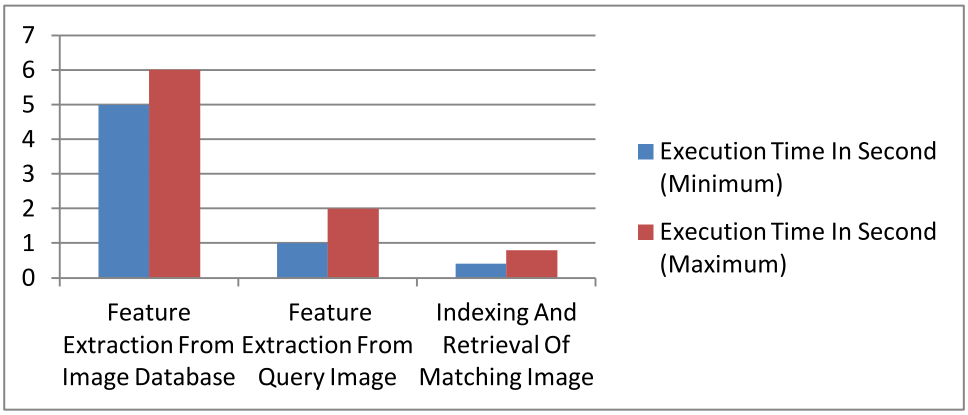

Figure 9. Time Complexity of Algorithm.