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Performance Efficiency of Quantization using HSV Colour Space and Vector Cosine Angle Distance in CBIR with Different Image Sizes

S.Niranjanan
Asst. Prof., Computer Science Department,
Mohamed Sathak College of Arts and Science,
Sholinganallur, Chennai-600 119

S.P.Raja Gopalan, PhD.
Prof., Dept. of Computer Science& Engineering,
GKM College of Engineering & Technology,
Chennai – 600 063

ABSTRACT

Content Based Image Retrieval (CBIR) is an active research field in the past decades. Against the traditional system where the images are retrieved based on the key word search, CBIR systems retrieve the images based on the visual content. Even though some of the modern systems like relevance feedback system which improves the performance of CBIR systems exists, the importance of retrieving the images based on the low level features like Colour, Texture and Shape still determine the development of CBIR systems and cannot be undermined. Colour Histograms, Histogram Distance Measurements, Colour Spaces and Quantization play an important role in retrieving images based on similarities. In this paper, a novel method is presented for determining the efficiency of different quantization methods using HSV Colour space and measuring the Vector Cosine Angle distance of the images with different sizes of images like 256 X 256, 128 X 128, 64 X 64, 32 X 32, 16 X 16 and 8 X 8 pixels for efficient image retrieval and comparing the time utilized for retrieval in each sizes and measuring the Overall efficiency.

General Terms

Content Based Image Retrieval (CBIR).

Keywords

Content Based Image Retrieval (CBIR), HSV Colour space, Vector Cosine Angle distance, quantization.

1. INTRODUCTION

Content Based Image Retrieval (CBIR) describes the content of the image using the visual features like Colour, Texture and Shape. It retrieves the images based on the visual contents rather than the traditional model of key word annotations of the contents. Even though it has many advantages, Italso has the major problem known as semantic Gap.In the semantic Gap, the description of the images using the low level features is unable to match the semantic intended by the user in his/her queries. Thus large number of false positive images are retrieved by the CBIR systems. The number of false positives are reduced when the spatial distribution of the visual features are integrated[1]. Even though some of the modern systems like relevance feedback system are introduced to improve the performance of CBIR exists, the importance of retrieving the images based on the low level features like Colour, Texture and Shape still determine the development of CBIR systems and cannot be undermined.In many cases they are the bottlenecks for development of CBIR techniques. A very basic issue in designing a CBIR system is to select the most effective image features for representing the image contents. Colour, Texture and Shape features are of the important and great majority primitive image descriptors in CBIR systems. Colour feature is one of the most reliable and easier visual features used in Image retrieval. It is robust to background complications and is independent of image size and orientation [18]. A lot of techniques available for retrieving images on the basis of Colour similarity from image database [3]. Colour Spaces, Colour Histograms, Histogram Distance Measurements, Size and Quantization play an important role in retrieving images based on similarities.

2. COLOUR HISTOGRAM

A colour histogram is a high dimensional feature vector, having greater than 100 dimensions.The comparison of histograms is computationally intensive. The colour histogram is widely used as an important colour feature indicating the contents of the images in content-based image retrieval (CBIR) systems. Especially, histogram-based algorithms are considered to be more effective for colour image indexing.

The global distribution of pixels of an image is described in Colour histogram, and it is insensitive to variations in scale and easy to calculate. The colour histogram for an image is constructed by counting the number of pixels of each colour. There are many difficulties with histogram based retrieval. The first of these is the high dimensionality of the colour histograms. Even with drastic quantization of the colour space, the image histogram feature spaces can occupy over 100 dimensions in real valued space. The large dimensionality also increases the complexity and computation of the distance function

An image histogram refers to the probability mass function of the image intensities. This is extended for Colour images to capture the joint probabilities of the intensities of the three Colour channels. More formally, the Colour histogram is defined by

$$h_{A,B,C}(a,b,c) = N \cdot Prob(A=a, B = b, C = c)$$

where*A* , *B* and *C* represent the three Colour channels (R,G,B or H,S,V) and *N* is the number of pixels in the image. Computationally, the Colour histogram is formed by discretizing the Colours within an image and counting the number of pixels of each Colour.

Substantial quantization of the Colour space is needed, since the typical computer represents Colour images with up to 224 Colours. The main issues regarding the use of Colour histograms for indexing involve the choice of Colour space and correct quantization of the Colour space.When a perceptually uniform Colour space is chosen uniform quantization may be appropriate. If a non-uniform Colour space is chosen, then non-uniform quantization may be needed.

The HSV Colour space offers improved perceptual uniformity. It represents with equal emphasis the three Colour variants that characterize Colour: Hue, Saturation and Value (Intensity). This separation is attractive because Colour image processing performed independently on the Colour channels does not introduce false Colours.

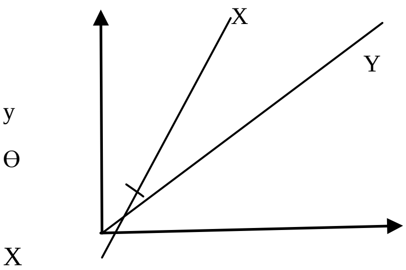
There are several distance formulas for measuring the similarity of Colour histograms. The Colour distance formulas arrive at a measure of similarity between images based on the perception of Colour content. Three distance formulas that are used normally for image retrieval are histogram Euclidean Distance, histogram IntersectionDistance and histogram Quadratic (cross) Distance [13]. There are many other histogram distance formulas like Vector Cosine Angle Distance, Correlation Distance and Spearman Distance etc.,.

3. HISTOGRAM VECTOR COSINE ANGLEDISTANCE

If two vectors X and Y are considered, where X≡ (x_1, x_2, …… x_n) and Y ≡ (y_1, y_2, ….. y_n), then cos Θ may be considered as the Cosine of the vector angle between X and Y in n dimension. Formally, Vector Cosine Angle Distance is defined as follows.

$$VCAD = \frac{\sum_i x_i y_i}{\sqrt{\sum_i x_i^2}\sqrt{\sum_i y_i^2}} = \frac{X.Y}{\|X\|\|Y\|}$$

The Vector Cosine Angle Distance between two 2-dimensional vectors (X_1,X_2) and (Y_1,Y_2) is as shown below



VCAD (X,Y) = cosΘ

One important property of Vector Cosine Angle is that it gives a metric of similarity between two vectors. This makes it easy to combine distance between two images using multiple features.

Count the number of pixels that correspond to a specific Colour in quantized Colour space for computation of histogram. In order to compare histograms of two images, first specific codes for all histogram bins are to be generated.

4. COLOURSPACE QUANTIZATION

A Color quantization is a process that reduces the number of distinct colors used in an image.The intention of Colour quantization is that the new image should be as visually similar as possible to the original image. For a true color image, the number of the kind of colors are up to 2^{24} = 16777216, so the direct extraction of color feature from true color will lead to a large computation. In order to reduce the computation, without a significant reduction in image quality, some representative color is extracted, to represent the image, thereby reducing the storage space and enhancing the process speed [5]. The effect of color quantization on the performance of image retrieval has been reported by many authors in [14] [16] [17] and [20], with different quantization schemes, like RGB (8X8X8), Lab (4X8X8), HSV (16X4X4), Lu*v* (4X8X8).

ManimalaSinglia [8] concluded that, the HSV quantization (16,4,4) with Histogram Intersection Distance gives best performance then the other colour spaces and the averageretrieval time of HSV Colour space gives the optimum value, considering the precision and recall values. Bo Di [4] quantized HSV Colour space, 19 hues step 20 (0, 20, 40, …, 360), 4 saturations, step 0.25 (0.173, 0.423, 0.673, 0.923) and 5 values, step 0.25 (0, 0.25, 0.5, 0.75, 1.00). Muhammad Riaz et al [9] defined: 18 hues, step 20 (350, 10, 30, 50… 350), 5 saturations, step 0.2 (0, 0.2, 0.4, 0.6, 0.8, 1.0) and 3 values, steps 0.25 (0, 0.5, 0.75, 1.0).Ch. Kavitha et al [6],[7] defined 8 hues, step (316-20, 21-40, 41-75, 76-155, 156-190, 191-270, 271-295 and 296-315), 3 saturations, step (0-0.2, 0.2-0.7 and 0.7-1.0) and 3 values, step (0-0.2, 0.2-0.7 and 0.7-1.0) and concluded that colour and texture features of image sub blocks combined with normalized Euclidean distance yields better performance results.M.BabuRao et al [2] defined 8 hues, 3 saturations and 3 values.Wasim Khan et al [19] defined 18 hues, 3 saturations and 3 values.SangohJeong [13] used 18 hues, 3 saturations, 3 values and concluded that the Histogram Intersection-based image retrieval in HSV Colour space is most desirable among six retrieval methods including histogram euclidean distance in RGB Colour space, histogram intersection in RGB Colour Space, histogram quadratic (cross) distance in RGB Colour Space, histogram euclidean distance in HSV Colour space, histogram intersection in HSV Colour Space, histogram quadratic (cross) distance in HSV Colour Space mentioned in considering both computation time and retrieval effectiveness. RajshreeDubey et al [12] have found that the histogram Euclidean distance and histogram intersection distance in HSV Colour space are most useful among histogram distance measures in the average sense. Vishal Chitkara [15] found that Variable-Bin Allocation (VBA) performs better than Constant-Bin Allocation (CBA) and the VBA approach not only performs better, but also consumes less resources, which is an important feature.Niranjanan et al [10], [11] concluded that the HSV Colour Space Quantization (2, 2, 2) with Histogram Euclidean Distance and (2, 2, 10) with Histogram Intersection Distance under a uniform size of 256 X 256 pixels gives better performance.

5. PROPOSED MODEL

5.1 Methodology

In this paper the issue of image database retrieval based on Colour using HSV colour space is addresed. Histogram search characterizes an image by its Colour distribution. Before extracting the maximum Colour from each segment the input image is converted to HSV and adaptive segmentation is applied on the HSV Colour space. This will compute the feature vector. Different quantization of hue, saturation and value are used. In this experiment, codes were generated for 10 different hue steps, 3 different saturations steps and 3 different value steps (10 H x 3 S x 3V) 90 HSV histogram models. Accordingly codes were generated for more Histogram bins and then, histogram Vector Cosine Angle distances were computed in each quantized Colour space. Minkowski - Form Distance Matrics is used to calculate the distance.

The corresponding image is first resized todifferent sizes of images like 256 X 256, 128 X 128, 64 X 64, 32 X 32, 16 X 16 and 8 X 8 pixels,then converted from RGB to HSV Colour space using known equations, and then it is partitioned into m number of areas based on different ranges of hue, saturation and value. In the next step each area is partitioned into n number of segments based on the number of pixels it contains. After getting those segments the maximum Colour occurrence in each segment is calculated using the hue histogram information and this is used as a feature vector. Finally, the feature vector for query image is compared with the feature vector of the database images. The proposed system has been implemented and verified

5.2 Maximum Colour Selection

The images are converted from RGB to HSV using the conversion formula as follows

$$H = \cos^{-1}\left\{\frac{½[(R-G)+(R-B)]}{\sqrt{(R-G)^2+(R-B)(G-B\,)}}\right\}$$

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

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

After the execution of these equations H, S and V will have values 0-255. To convert hue into angle that ranges from 0° to 360°, value and saturation from 0 to 1 following equations are used

H = ((H/255) * 360)mod360

V = V/255

S = S/255

After conversion from RGB to HSV the next design parameter is the quantization of the Colour space. The HSV Colour space is cylindrical. The long axis represents value: blackness to whiteness. Distance from the axis represents saturation: amount of Colour present. The angle around the axis is the hue: tint or tone. Since hue represents the most significant characteristic of the Colour, it requires the finest quantization. In the hue circle the primaries red, green and blue are separated by 120 degrees.

A large number of images have been tested for deciding which step could yield best results and made different steps in Hue, Saturation and Value. In this experiment, 10 Hue models with various steps were designed which varies from 5to 180 hues, Step 5 (355, 360, 5, 10, 15, … 355), Step 10 (350, 360, 10, 20, … 350), Step 15 (345, 360, 15, 30, . 345), Step 20 (340, 360, 20, 40, … 340), Step 24 (336, 360, 24, 48, … 336), Step 30 (330, 360, 30, 60, … 330), Step 60 (300, 360, 60, … 360), Step 90 (270, 360, 90, … 270), Step 120 (240, 360, 120, 240) and Step 180 (180, 360, 180).Also 3 Saturation models with various steps were defined which varies from 2 to 10 Saturations, Step 0.5 (0, 0.5, 1.0), Step 0.2 (0, 0.2, 0.4, 0.6, 0.8, 1.0) and Step 0.1 (0, 0.1, 0.2, … 1.0).In the same way 3 Values models with various steps were defined which varies from 2 to 10 Values, Step 0.5 (0, 0.5, 1.0), Step 0.2 (0, 0.2, 0.4, 0.6, 0.8, 1.0) and Step 0.1 (0, 0.1, 0.2, … 1.0.

As a result, a large array of 2*2*2 = 8 to 72*10*10 = 7,200 number of different areaas are available, each representing different Colour distribution of the image.After partitioning into *m* number of areas, HSV information spaced image is further divided into *n* number of segments depending upon the number of pixels in each area. The areas which have more pixels are partitioned into more number of segments and the areas which have fewer pixels are divided into less number of segments. Through this procedure the distribution characteristics for the Colour tone distributed in the corresponding image is got. After extracting this Colour distribution information from the image, the maximum Colour occurrence in each segment is calculated by using hue histogram of the image and HSV value of that pixel which is used to make a feature vector. Such operations are carried out for the entire image and then feature vector is computed.

Following equation is used to partition each area in n number of segments; n can have different values for different areas.

$$n_{i=((X_i/T))*TS} \qquad 0<i<=m$$

Where$n_i$represents the number of segments in area i, $X_i$represents the number of pixels in area i(where iranges from *1* to *m*), *T* represents total number of pixels of the image and *TS* represents total number of required segments of the entire HSV image. After executing the equation huehistogram is computed for each segment. From that histogram, the each Colour occurrence in that segmentcanbe easily detected. The maximum Colour occurrence from each segment is selected and used its HSV value to compute the feature vector. This feature vector is used for comparison with the images in the database and matching for each image is calculated using Minkowski Metric (LM norm) equation. Segments in each area of the query image are compared with the corresponding area of the database image and for this comparison Minkowski Metric is used as shown below:

$$d_{M(i,j)=}\left(\sum_{k=1}^{P}\left|(x_i^k - x_j^k)\right|\right)^{1/M}$$

Where, p is the dimension of the vector x_i^k is the k^{th}element of x_i.Three special cases of the LM metric are of particular interest, namely, L =1, 2, ∞.

A Matlab program using these different quantization schemes is programmed to retrieve images from a fixed size data base using a query image and converting the images to the size equivalent to the Query Image and comparing them.The time consumed for displaying the resultant images is stored in a database along with the quantization variants data. The screen shots of retrieved images are also stored with appropriate names.

5.3 Algorithm For Proposed Scheme

Step 1: Load database in the Mat lab workspace.

Step 2: Resize the image for appropriate size like [256,256], [128,128], [64,64], [32,32], [16,16] and [8,8].

Step 3: Convert image from RGB to HSV.

Step 4: Generate the histogram of hue, saturation and value

Step 5: Generate no. of signatures n for hue, m for saturation and x for value.

Step6: Store the signature of database images into the mat file

Step 7: Load the Query image.

Step 8: Apply the procedure 2-7 to find signature of Query image.

Step 9: Determine the normalized Vector Cosine Angle distance of signature of Query image with stored signature of database.

Step 10: Sort the normalized Vector Cosine Angle distance values to perform indexing.

Step 11: Display the result on GUI.

Step 12: Create a folder in the name of corresponding variants

Step 13: Create a file in the name of corresponding variants & save

Step 14: Apply the procedure 2-13 for various Hue, Saturation and Value steps

5.4 Performance Evaluation

The performance of retrieval system can be measured in terms of its recall and precision. Recall measure the ability of the system to retrieve all the models that are relevant, while precision measures the ability of the system to retrieve only models that are relevant. This histogram has a high recall and precision of retrieval, and is effectively used in content-based image retrieval systems. They are defined as:

$$Precision = \frac{Number\ of\ relevant\ images\ retrieved}{Total\ number\ of\ images\ retrieved} = \frac{A}{A+B}$$

$$Recall = \frac{Number\ of\ relevant\ images\ retrieved}{Total\ number\ of\ relevant\ \ images} = \frac{A}{A+C}$$

Where A represent the number of relevant images that are retrieved, B, the number of irrelevant items and the C, number of relevant items those were not retrieved. The number of relevant items retrieved is the number of the returned images that are similar to the query image in this case. The number of relevant items in collection is the number of images that are in the same particular category with the query image. The total number of items retrieved is the number of images that are returned by the search engine.

6. EXPERIMENTAL RESULTS

Only 7 relevant images of the particular query image typehave been purposefully kept in the database folder along with other irrelevant images. A 3 X 3 matrixis designed for showing the resultant retrieved images in the result window. Out of the total 9 images in the resultant matrix only 7 relevant images can be retrieved by the program and the other two images are selected based on the nearest Vector Cosine Angle distance. Hence the combination of different Hue, Saturation and Value steps which achieved retrieving all the 7 relevant images from the database folder in the least time is the best possible combination for image retrieval in HSV colour space. In the present Vector Cosine Angle Distance, none of the Quantization variants retrieved all the 7 relevant images. Hence, the next better possibility of retrieving 6 relevant images out of 7 relevant images was considered.

Table 1 contains all the combinations of Hue, Saturation and Value steps for all different sizes of images which resulted in retrieving 6 out of all the 7 possible relevant images from the database folder and whose Recall value is equal to 0.857143.

The present work with the result of HSV Colour Space Quantization with Vector Cosine Angle Distancewith least time consumption in different sizes as listed below gives a better alternative than other Quantization schemes.

In 256 X 256 pixel images, the HSV slice (2,10,2)recovered the Images in 35.6142Secs.

In 128 X 128 pixel images, the HSV slice (2,10,2) recovered the Images in 10.2485 Secs.

In 64 X 64 pixel images, the HSV slice (2, 5, 2) recovered the Images in 2.9226 Secs.

In 32 X 32 and 16 X 16 pixel images, no HSV slice had recovered 6 relevant Images out of 7. Only 5 relevant images out of 7 are recovered and hence not considered.

In 8 X 8 pixel images, the HSV slice (2, 5, 10) recovered the Images in 1.7708 Secs.

7. CONCLUSION

The above results show that it can be possible to retrieve 6 relevant images out of 7 of uniform size 8 X 8 pixels from the databases by adopting only 2 slices of Hue (i.e. 0 –180and 180– 360), 5 slices of Saturation (i.e. 0 – 0.2, 0.2 – 0.4, 0.4 – 0.6, 0.6 – 0.8and 0.8 – 1.0) and 10 slices of Value (i.e. 0 – 0.1, 0.1 – 0.2, 0.2 – 0.3, 0.3 – 0.4, 0.4 - 0.5, 0.5 - 0.6, 0.6 – 0.7, 0.7 – 0.8, 0.8 – 0.9 and 0.9 – 1.0) in 1.7708Secs than the other sizes like 16 X 16, 32 X 32, 64 X 64, 128 X 128 and 256 X 256.

Thus 2 X 5 X 10 = 100 slices split in 8 X 8 pixel size is more than sufficient to retrieve 6 relevant imagesout of 7 in much lesser Time over other sizes. **Thus it is concluded that the HSV colour space Quantization (2,5,10) with Histogram Vector Cosine Angle distance under a uniform size of 8 X 8 pixels gives better performance than other variations of Hue, Saturation and Value quantization models in image retrieval**.

HSV Experimental Image Results of Least Time Consuming Quantization Variants

Size 256 X 256 - HSV (2, 10, 2) - 35.6142 Secs

Size 128 X 128 - HSV (2, 10, 2) - 10.2485 Secs

Size 64 X 64 - HSV (2, 5, 2) - 2.9226 Secs

Size 8 X 8 - HSV (2, 5, 10) - 1.7708 Secs

HSV Experimental Results of Most Desirable Quantization Variants

Full Performance in Intel i7 with 16 GB RAM

Table 1 Results where Recall = 0.857143, Precision = 0.666667 and retrieved 6 relevant images out of 7.

Hue, Saturation and Value steps				Hue, Saturation and Value Slices	Vector Cosine Angle Distance Comparison (Time in Secs) with Different Sizes Where Recall =0.857143 (Only 6 out of 7 Available Relevant Images Recovered out of Total of 9 Images Including 2 Irrelevant Images)					
SL. NO.	HUE Step	SATURATION Step	VALUE Step		256 X 256	128 X 128	64 X 64	32 X 32	16 X 16	8 X 8
1	5	0.1	0.1	72, 10, 10	NA	NA	NA	NA	NA	NA
2	5	0.1	0.2	72, 10, 5	NA	NA	33.064	NA	NA	NA
3	5	0.1	0.5	72, 10, 2	877.1498	220.0204	54.0178	NA	NA	NA
4	5	0.2	0.1	72, 5, 10	NA	NA	NA	NA	NA	1.9808
5	5	0.2	0.2	72, 5, 5	NA	NA	NA	NA	NA	NA
6	5	0.2	0.5	72, 5, 2	NA	NA	29.1827	NA	NA	NA
7	5	0.5	0.1	72, 2, 10	NA	NA	NA	NA	NA	NA
8	5	0.5	0.2	72, 2, 5	NA	NA	NA	NA	NA	NA
9	5	0.5	0.5	72, 2, 2	NA	NA	NA	NA	NA	NA
10	10	0.1	0.1	36, 10, 10	NA	NA	NA	NA	NA	NA
11	10	0.1	0.2	36, 10, 5	NA	NA	18.1171	NA	NA	NA
12	10	0.1	0.5	36, 10, 2	444.5443	111.963	28.1321	NA	NA	NA
13	10	0.2	0.1	36, 5, 10	NA	NA	NA	NA	NA	1.8662
14	10	0.2	0.2	36, 5, 5	NA	NA	NA	NA	NA	NA
15	10	0.2	0.5	36, 5, 2	NA	NA	15.7158	NA	NA	NA
16	10	0.5	0.1	36, 2, 10	NA	NA	NA	NA	NA	NA
17	10	0.5	0.2	36, 2, 5	NA	NA	NA	NA	NA	NA
18	10	0.5	0.5	36, 2, 2	NA	NA	NA	NA	NA	NA
19	15	0.1	0.1	24, 10, 10	NA	NA	NA	NA	NA	NA
20	15	0.1	0.2	24, 10, 5	NA	NA	13.2388	NA	NA	NA
21	15	0.1	0.5	24, 10, 2	299.9656	76.3728	19.5651	NA	NA	NA
22	15	0.2	0.1	24, 5, 10	NA	NA	NA	NA	NA	1.8198
23	15	0.2	0.2	24, 5, 5	NA	NA	NA	NA	NA	NA
24	15	0.2	0.5	24, 5, 2	NA	NA	11.1691	NA	NA	NA
25	15	0.5	0.1	24, 2, 10	NA	NA	NA	NA	NA	NA
26	15	0.5	0.2	24, 2, 5	NA	NA	NA	NA	NA	NA
27	15	0.5	0.5	24, 2, 2	NA	NA	NA	NA	NA	NA
28	20	0.1	0.1	18, 10, 10	NA	NA	NA	NA	NA	NA
29	20	0.1	0.2	18, 10, 5	NA	NA	10.6704	NA	NA	NA
30	20	0.1	0.5	18, 10, 2	228.142	58.2995	15.3107	NA	NA	NA
31	20	0.2	0.1	18, 5, 10	NA	NA	NA	NA	NA	1.804
32	20	0.2	0.2	18, 5, 5	NA	NA	NA	NA	NA	NA
Hue, Saturation and Value steps				Hue,	Vector Cosine Angle Distance Comparison (Time in Secs) with					

				Saturation and Value Slices	Different Sizes Where Recall =0.857143 (Only 6 out of 7 Available Relevant Images Recovered out of Total of 9 Images Including 2 Irrelevant Images)					
SL. NO.	HUE Step	SATURATION Step	VALUE Step		256 X 256	128 X 128	64 X 64	32 X 32	16 X 16	8 X 8
33	20	0.2	0.5	18, 5, 2	NA	NA	8.935	NA	NA	NA
34	20	0.5	0.1	18, 2, 10	NA	NA	NA	NA	NA	NA
35	20	0.5	0.2	18, 2, 5	NA	NA	NA	NA	NA	NA
36	20	0.5	0.5	18, 2, 2	NA	NA	NA	NA	NA	NA
37	24	0.1	0.1	15, 10, 10	NA	NA	NA	NA	NA	NA
38	24	0.1	0.2	15, 10, 5	NA	NA	9.4747	NA	NA	NA
39	24	0.1	0.5	15, 10, 2	192.3997	49.2683	13.1293	NA	NA	NA
40	24	0.2	0.1	15, 5, 10	NA	NA	NA	NA	NA	1.8146
41	24	0.2	0.2	15, 5, 5	NA	NA	NA	NA	NA	NA
42	24	0.2	0.5	15, 5, 2	NA	NA	7.8149	NA	NA	NA
43	24	0.5	0.1	15, 2, 10	NA	NA	NA	NA	NA	NA
44	24	0.5	0.2	15, 2, 5	NA	NA	NA	NA	NA	NA
45	24	0.5	0.5	15, 2, 2	NA	NA	NA	NA	NA	NA
46	30	0.1	0.1	12, 10, 10	NA	NA	NA	NA	NA	NA
47	30	0.1	0.2	12, 10, 5	NA	NA	8.2849	NA	NA	NA
48	30	0.1	0.5	12, 10, 2	155.868	40.3478	11.0477	NA	NA	NA
49	30	0.2	0.1	12, 5, 10	NA	NA	NA	NA	NA	1.7984
50	30	0.2	0.2	12, 5, 5	NA	NA	NA	NA	NA	NA
51	30	0.2	0.5	12, 5, 2	NA	NA	6.6919	NA	NA	NA
52	30	0.5	0.1	12, 2, 10	NA	NA	NA	NA	NA	NA
53	30	0.5	0.2	12, 2, 5	NA	NA	NA	NA	NA	NA
54	30	0.5	0.5	12, 2, 2	NA	NA	NA	NA	NA	NA
55	60	0.1	0.1	6, 10, 10	NA	NA	NA	NA	NA	NA
56	60	0.1	0.2	6, 10, 5	NA	NA	6.1834	NA	NA	NA
57	60	0.1	0.5	6, 10, 2	83.7707	22.1966	6.7446	NA	NA	NA
58	60	0.2	0.1	6, 5, 10	NA	NA	NA	NA	NA	1.7809
59	60	0.2	0.2	6, 5, 5	NA	NA	NA	NA	NA	NA
60	60	0.2	0.5	6, 5, 2	NA	NA	4.401	NA	NA	NA
61	60	0.5	0.1	6, 2, 10	NA	NA	NA	NA	NA	NA
62	60	0.5	0.2	6, 2, 5	NA	NA	NA	NA	NA	NA
63	60	0.5	0.5	6, 2, 2	NA	NA	NA	NA	NA	NA
64	90	0.1	0.1	4, 10, 10	NA	NA	NA	NA	NA	NA
65	90	0.1	0.2	4, 10, 5	NA	NA	4.9202	NA	NA	NA
66	90	0.1	0.5	4, 10, 2	59.6017	16.3202	5.196	NA	NA	NA
67	90	0.2	0.1	4, 5, 10	NA	NA	NA	NA	NA	1.774
68	90	0.2	0.2	4, 5, 5	NA	NA	NA	NA	NA	NA
69	90	0.2	0.5	4, 5, 2	NA	NA	3.6796	NA	NA	NA
70	90	0.5	0.1	4, 2, 10	NA	NA	NA	NA	NA	NA
Hue, Saturation and Value steps				Hue,	Vector Cosine Angle Distance Comparison (Time in Secs) with					

				Saturation and Value Slices	Different Sizes Where Recall =0.857143 (Only 6 out of 7 Available Relevant Images Recovered out of Total of 9 Images Including 2 Irrelevant Images)					
SL. NO.	HUE Step	SATURATION Step	VALUE Step		256 X 256	128 X 128	64 X 64	32 X 32	16 X 16	8 X 8
71	90	0.5	0.2	4, 2, 5	NA	NA	NA	NA	NA	NA
72	90	0.5	0.5	4, 2, 2	NA	NA	NA	NA	NA	NA
73	120	0.1	0.1	3, 10, 10	NA	NA	NA	NA	NA	NA
74	120	0.1	0.2	3, 10, 5	NA	NA	4.4624	NA	NA	NA
75	120	0.1	0.5	3, 10, 2	47.6637	13.2069	4.4755	NA	NA	NA
76	120	0.2	0.1	3, 5, 10	NA	NA	NA	NA	NA	1.7714
77	120	0.2	0.2	3, 5, 5	NA	NA	NA	NA	NA	NA
78	120	0.2	0.5	3, 5, 2	NA	NA	3.2884	NA	NA	NA
79	120	0.5	0.1	3, 2, 10	NA	NA	NA	NA	NA	NA
80	120	0.5	0.2	3, 2, 5	NA	NA	NA	NA	NA	NA
81	120	0.5	0.5	3, 2, 2	NA	NA	NA	NA	NA	NA
82	180	0.1	0.1	2, 10, 10	NA	NA	NA	NA	NA	NA
83	180	0.1	0.2	2, 10, 5	NA	NA	4.033	NA	NA	NA
84	180	0.1	0.5	2, 10, 2	35.6142	10.2485	3.7688	NA	NA	NA
85	180	0.2	0.1	2, 5, 10	NA	NA	NA	NA	NA	1.7708
86	180	0.2	0.2	2, 5, 5	NA	NA	NA	NA	NA	NA
87	180	0.2	0.5	2, 5, 2	NA	NA	2.9226	NA	NA	NA
88	180	0.5	0.1	2, 2, 10	NA	NA	NA	NA	NA	NA
89	180	0.5	0.2	2, 2, 5	NA	NA	NA	NA	NA	NA
90	180	0.5	0.5	2, 2, 2	NA	NA	NA	NA	NA	NA

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