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CBIR Approach Based On Combined HSV, Auto Correlogram, Color Moments and Gabor Wavelet

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Abstract: ***Content based image Retrieval is an active research field in past decades. Against the traditional system where the images are retrieved based on the keyword search, CBIR system retrieve the images based on the visual content. The large numbers of images has posed increasing challenges to computer systems to store and manage data effectively and efficiently. This paper implements a CBIR system using different feature of images through four different methods, three were based on analysis of color feature and other one based on analysis texture feature using gabor wavelet coefficients of an image.***

Keywords- CBIR, Gabor Filter Transformation, Color Correlogram, HSV.

1. Introduction

Now days, CBIR (Content based image retrieval) is a hotspot of digital image processing techniques. CBIR research started in early 1990's and is likely to continue during the first two decades of 21st century [1].The growing demands for image retrieval in multimedia field such as crime prevention, Fashion and graphic design and biometrics has pushed application developers to search ways to manage and retrieve images more efficiently. Manual browsing the database to search for identical images would be impractical since it takes a lot of time and requires human intervention. A more practical way is to use content based image retrieval (CBIR) technology. CBIR has provided an automated way to retrieve images based on the content or features of the images itself. The CBIR system simply extracts the content of the query image matches them to contents of the search image. CBIR is defined as a process to find similar picture or pictures in the image database when a query image is given. Given a picture of a car, the system should be able to present all similar images of a car in the database to the users. This is done by extracting the features of the images such as color, texture and shape [1]. These image features is used to compare between the query image and images in the database. A similarity algorithm is used to calculate the degree of similarity between those two images. Images in the database which has similar images features to the query image (acquiring the highest similarity measure) is presented to the user.

CBIR refers to techniques used to index and retrieve images from databases based on their visual content. Visual content is typically defined by a set of low level features extracted from an image that describe the color, texture and/or shape of the entire image [2]. CBIR is the retrieval of images based on visual features such as color, texture and shape. Before CBIR was widely used to retrieve images, researchers relied heavily on text-based retrieval. Various image retrieval systems [3], including Query by Image Content (QBIC) and Visual Seek has been built, based on the low-level features for general or specific image retrieval tasks. Both the text and content based techniques have their own characteristics, advantages and disadvantages. By combining them, parts of their disadvantages can be overcome. The existing image retrieval systems are with either text-based or image-based queries, but not both. Hence, a system with integrated methods is highly needed [4].

2. PROPOSED TECHNIQUE

Content based Image Retrieval is designed to retrieve images from the available database. Various techniques have been selected to be used in the various steps of the proposed algorithm. The images are analyzed on the basis of color moments and auto correlogram. Also Gabor wavelet is used to calculate the mean squared energy which act as the primary image content identifying feature.

2.1 Algorithm

The proposed algorithm for feature extraction and storage is:

Step 1: Load the image for analysis.

Step 2: Resize to size 384x256.
Step 3: Quantize the image into Hue, Saturation and Value (HSV) into 8x2x2 value.
Step 4: Apply Colour Auto correlogram on the UINT8 image.
Step 5: Extract first 2 colour moments from each Red, Green and Blue Planes of image.
Step 6: Convert image to Gray Scale for Gabor Wavelet Transform.
Step 7: Apply Gabor Wavelet (no. of scales = 4 and no. of orientation = 6) to calculate mean squared energy and mean amplitude.
Step 8: Combine the results of steps 3 to 7 and store to dataset.

The proposed algorithm for image retrieval from storage is:

Step 1: Load stored values from dataset.
Step 2: Load query image.
Step 3: Extract features for query image (As given in feature extraction algorithm above).
Step 4: Match the feature values stored in database.
Step 5: Retrieve the images which show maximum matching scores using Support Vector Machine.

2.2 Hue, Saturation and Value (HSV)

We evaluate the content based image retrieval HSV color space of the images in the database. The HSV stands for the Hue, Saturation and Value, provides the perception representation according with human visual feature. The HSV model, defines a color space in terms of three constituent components: Hue, the color type Range from 0 to 360. Saturation, the "vibrancy" of the color: Ranges from 0 to 100%, and occasionally is called the "purity". Value, the brightness of the color: Ranges from 0 to 100%. HSV is cylindrical geometries, with hue, their angular dimension, starting at the red primary at 0°, passing through the green primary at 120° and the blue primary at 240°, and then back to red at 360° [8, 9]. The HSV planes are shown as Figure 2.1.

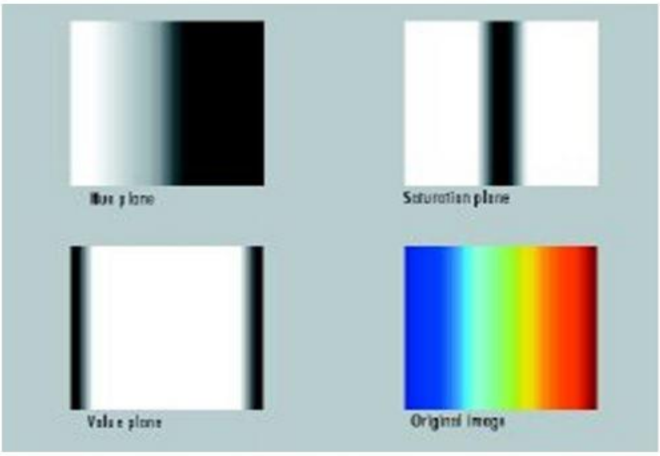


Figure 2.1: The Different planes of HSV color space

The quantization of the number of colors into several bins is done in order to decrease the number of colors used in image retrieval, J.R. Smith [10] designs the scheme to quantize the color space into 166 colors. Li [9] design the non-uniform scheme to quantize into 72 colors. We propose the scheme to produce 15 non-uniform colors. The formula that transfers from RGB to HSV is defined as below:

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

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

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

The R, G, B represent red, green and blue components respectively with value between 0-255. In order to obtain the value of H from 0o to 360o, the value of S and V from 0 to 1, we do execute the following formula:

H= ((H/255*360) mod 360
V= V/255
S= S/255

2.3 COLOR AUTO CORELLOGRAM

The definition of the correlogram is the following [2],[3]. Let [D] denote a set of D fixed distances {d1… dD}. Then the correlogram of the image I is defined for level pair (gi, gj) at a distance d .

$$\gamma_{g_i, g_j}^{(d)}(\mathbf{I}) \equiv \Pr_{p_1 \in \mathbf{I}_{g_i}, p_2 \in \mathbf{I}} \left[p_2 \in \mathbf{I}_{g_j} \middle\| p_1 - p_2 = d \right]$$

Which gives the probability that given any pixel p1 of level gi, a pixel p2 at a distance d in certain direction from the given pixel p1 is of level gi.

Autocorrelogram [2], [3] captures the spatial correlation of identical levels only:

$$\alpha_g^{(d)}(\mathbf{I}) = \gamma_{g,g}^{(d)}(\mathbf{I})$$

It gives the probability that pixels p1 and p2, d away from each other, are of the same level gi. The distance measure between the histograms, autocorrelograms, and correlograms is the L1-norm that is computationally light method and used in [2] and [3].

2.4 COLOR MOMENTS

For a color image, the RGB model is the well-known color model. However, it is not a uniform color model. The YIQ model is more related to the human perception, since it can isolate luminance and chrominance. Hence, in this paper, we perform image retrieval using the YIQ model. Because a probability distribution is uniquely characterized by its moments [3], the color distributions of the Y, I, and Q components of an image can be represented respectively by its color moments. The first color moment of the i-th color component (3 , 2 , 1 = i) is defined by

$$M_i^1 = \frac{1}{N}\sum_{j=1}^{N} p_{i,j} \ ,$$

where p i,j is the color value of the i-th color component of the j-th image pixel and N is the total number of pixels in the image. The h-th moment, h = 1, 2, 3….. of i-th color component is then defined as

$$M_i^h = \left(\frac{1}{N}\sum_{j=1}^{N}\left(p_{i,j} - M_i^1\right)^h\right)^{\frac{1}{h}}$$

Take the first H moments of each color component in an image s to form a feature vector, CT, which is defined as

$$\begin{aligned} CT &= [ct_1, ct_2, \ldots, ct_Z] \\ &= [\alpha_1 M_1^1, \alpha_1 M_1^2, \ldots, \alpha_1 M_1^H, \alpha_2 M_2^1, \alpha_2 M_2^2, \ldots, \alpha_2 M_2^H, \alpha_3 M_3^1, \alpha_3 M_3^2, \ldots, \alpha_3 M_3^H], \end{aligned}$$

Where Z = H.3 and α1, α2, α3 are the weights for the Y, I, Q components. Based on the above definition, an image is first divided into X non-overlap blocks. For each block a, its h-th color moment of the i-th color component is defined by Mha,i. Then, the feature vector, CBa, of block a is represented as

$$\begin{aligned} CB_a &= [cb_{a,1}, cb_{a,2}, \ldots, cb_{a,Z}] \\ &= [\alpha_1 M_{a,1}^1, \alpha_1 M_{a,1}^2, \ldots, \alpha_1 M_{a,1}^H, \alpha_2 M_{a,2}^1, \alpha_2 M_{a,2}^2, \ldots, \alpha_2 M_{a,2}^H, \alpha_3 M_{a,3}^1, \alpha_3 M_{a,3}^2, \ldots, \alpha_3 M_{a,3}^H] \end{aligned}$$

From the above definition, we can get X feature vectors. However, there are many similar CBa‘s among these feature vectors. In order to speed up the image retrieval, we will find some representative feature vectors to stand for these feature vectors. To reach this aim, a progressive constructive clustering algorithm [16] is used to classify all CBa‘s into several clusters and the central vector of each cluster is regarded as a representative vector and called as a primitive of the image. Before describing the algorithm, several definitions and measures are stated. The central vector, PCk, of the k-th cluster is defined by

$$PC_k = [pc_{k,1}, pc_{k,2}, \ldots, pc_{k,Z}] = \frac{\sum_{j=1}^{n_k} CB_j^k}{n_k} = [\frac{\sum_{j=1}^{n_k} cb_{j,1}^k}{n_k}, \frac{\sum_{j=1}^{n_k} cb_{j,2}^k}{n_k}, \ldots, \frac{\sum_{j=1}^{n_k} cb_{j,Z}^k}{n_k}],$$

where CBkj ,I = 1,2,……nk, belongs to the k-th cluster and nk is the size of the k-th cluster. In addition, the Euclidean distance between CBa and PCk is defined as follows:

$$d_{a,k} = \sqrt{\sum_{i=1}^{Z}(cb_{a,i} - pc_{k,i})^2} \ .$$

According to the above definitions, the progressive constructive clustering algorithm is described as follows.

Step 1: For an image, randomly choose a block r in the image and take its feature vector
CBr as the central vector, PC1, of Cluster 1.
Step 2: Take CBa of block a, which is not processed, and find its nearest central vector, PCk, from the existing clusters. If da,k’ is larger than a predefined distance threshold, Td, go to Step 4.
Step 3: The CBa is put in the k-th cluster and PCk is updated according to Eq. (1). Go to Step 5.
Step 4: Create a new cluster and take CBa as the central vector of the new cluster.
Step 5: If all blocks have been processed, exit; otherwise, go to Step 2.

The advantage of this algorithm is that the clustering process is fulfilled in one iteration. After all CBa’s have been classified, the central vector of each cluster is regarded as a primitive of the image. Note that during the construction of an image database, all primitives will also be attached to each image as the feature vectors for retrieval purpose. Since the distance threshold, Td, is fixed for all images, the number of clusters varies for different images. To treat this situation, a method to evaluate the similarity between two images with different number of feature vectors will be proposed.
The extraction of different features is one of the major stages in designing a reliable image retrieval system.The features of an image can be broadly classified into global shape features like texture, shape histogram, color histogram, moments etc.

2.5 GABOR FILTERS (GF):

The extraction of texture of an image is accomplished by using a set of Gabor Filters. GABOR Filters are a group of wavelets capturing energy at a specific frequency and a specific direction. The expansion of a signal using this basis provides a localized frequency description, therefore, capturing local features/energy of the signal. Texture features can thus be extracted from this group of energy distributions.
A 2D Gabor function g(x,y) and its Fourier transform G(u,v) are defined as follows;

$$G(x,y)=(1/2\pi\sigma x\sigma y)\exp[-1/2(x^2/\sigma_x^2+y^2/\sigma_y^2)+2\pi jWx]$$

$$G(u,v)=\exp\{-1/2[(u-W)^2/\sigma_u^2+v^2/\sigma_v^2]$$

Where σu=1/2 πσx and σv=1/2 πσy
A set of self-similar functions can be generated from dilation and rotation of the Gabor function g(x,y)

$$G_{mn}(x,y)=a^{-m}G(x^{'},y^{'})$$

Where a>1
X’=a-m(x cos θ + y sin θ) and y’=a-m(-x sin θ + y cos θ);
Θ =nπ/N;
m and n specify the scale and orientation of wavelet respectively with m=0,1,….M-1 and n=0,1,…N-1
M is the number of scales and N is the number of orientations. For a given image I(x,y), the discrete GABOR wavelet

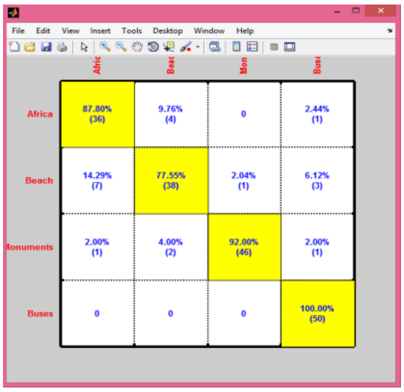
transform is given by a convolution Wmn=ΣΣ I(x1,y1) gmn*(x-x1, y-y1)…….4 where * indicates complex conjugate.

The features obtained are combined as per the description in the proposed algorithm and final results are acquired after the implementation.

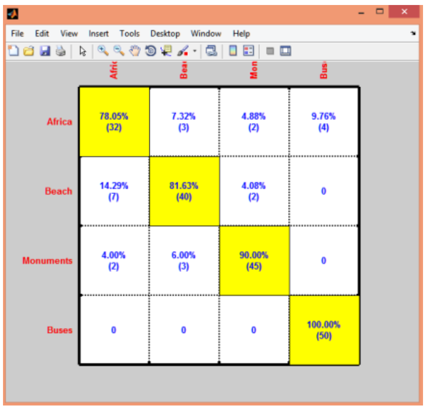
3. RESULTS

3.1 Support Vector Machine (SVM)

In machine learning there are two types of methods supervised and unsupervised. Supervised learning based on learn by result and unsupervised based on learn by example. Supervised learning takes input as a set of training data. Support vector machine is a supervised learning technique that analyzes data and identify pattern used for classification. It takes a set of input, read it and for each input desired output form [13] such type of process is known as classification, when if output is continuous than regression performed. SVM is one of the best known methods in pattern classification and image classification. It is designed to separate of a set of training images two different classes, (x1, y1), (x2, y2), .., (xn, yn) where xi in Rd, d-dimensional feature space, and yi in {-1,+1}, the class label, with i=1..n [1]. SVM builds the optimal separating hyper planes based on a kernel function (K). All images, of which feature vector lies on one side of the hyper plane, are belong to class -1 and the others are belong to class +1.



Case 1: SVM RESULT



Case 2: SVM RESULT

3.2 CONFUSION MATRIX

An error matrix, or often referred to as a confusion matrix, summarizes the relationship between the two sources of information. From an error matrix the images overall accuracy, producer's accuracy, omission errors, user's accuracy and commission errors can be determined (Jensen 2005).

The error matrix consists of a series of rows and columns. The headings of the rows and columns are the classes of interest. The columns contain the ground reference data while the rows contain the classified information. "The intersection of the rows and columns summarize the number of sample units (ie. pixels, clusters of pixels, or polygons) assigned to a particular category (class) relative to the actual category as verified in the field" (Jensen 2005). Within the diagonal of the matrix, the numbers represent the number of samples (ie. pixels) that were correctly identified. Numbers not found within the diagonals are errors (Jensen 2005).

```
SVM (1-against-1):
accuracy = 89.47%
Confusion Matrix:
    36     4     0     1
     7    38     1     3
     1     2    46     1
     0     0     0    50

Predicted Query Image Belongs to Class = 1
```

Case 1: CONFUSION MATRIX RESULT

```
SVM (1-against-1):
accuracy = 87.89%
Confusion Matrix:
    32     3     2     4
     7    40     2     0
     2     3    45     0
     0     0     0    50

Predicted Query Image Belongs to Class = 1
```

Case 2: CONFUSION MATRIX RESULT

4. CONCLUSION AND FUTURE SCOPE

CBIR is exciting technology but immature at the current stage. Other areas where image retrieval is beneficial are crime prevention (including identification of shoe prints and tyre tracks), architectural design (retrieval of similar previous designs and standard components) and medical diagnosis of diseases (retrieval of cases with similar features). Storage, retrieval and use of images in application areas (such as surveillance cameras video database) can have better identification of trespasser.

Future scope of the CBIR technology is replacing more traditional methods of indexing and searching. However, the combined use of text and image features might bring better performance than either type of retrieval. Similarly, the combined use of content-based retrieval and content-based navigation promises to be a very powerful technique for identifying desired items of any type in multimedia systems.

The problem at present is how these different types of access method can best be combined. Developers and collection managers wishing to use combined techniques are searching for new implementations. For image database users such as graphic designers, the ability to retrieve specific images is of less usefulness.

Searching the Web for images is such a confusing process that almost any advance on current technology is likely to be beneficial. Improved search engines, capable of using both text and image features for retrieval, will be the requirement.

In conclusion, CBIR is clearly a technology with very high potential and needs to be manipulated with help of high efficiency algorithms.

References

[1] T.Prathiba, G. Soniah Darathi, "AN EFFICIENT CONTENT BASED IMAGE RETRIEVAL USING LOCAL TETRA PATTERN", International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, Vol. 2, Issue 10, October 2013.

[2] Ekta Ra24jput & Hardeep Singh Kang, "Content based Image Retrieval by using the Bayesian Algorithm to Improve and Reduce the Noise from an Image", Global Journal of Computer Science and Technology Graphics & Vision, Volume 13 Issue 6 Version 1.0 Year 2013.

[3] S. Mangijao Singh , K. Hemachandran, "Content-Based Image Retrieval using Color Moment and Gabor Texture Feature", IJCSI International Journal of Computer Science Issues, Vol. 9, Issue 5, No 1, September 2012.

[4] P. V. N. Reddy, K. Satya Prasad, "Color and Texture Features for Content Based Image Retrieval ", Int. J. Comp. Tech. Appl., Vol 2 (4), JULY-AUGUST 2011.

[5] J.-L. Shih and L.-H. Chen, "Colour image retrieval based on primitives of colour moments", IEE Proc-Vis, Image Signal Process, Vol. 149, No. 6, December 2002.

[6] Ms. K. Arthi 1, Mr. J. Vijayaraghavan 2, "Content Based Image Retrieval Algorithm Using Colour Models", International Journal of Advanced Research in Computer and Communication Engineering, Vol. 2, Issue 3, March 2013.

[7] Simardeep Kaur and Dr. Vijay Kumar Banga, "Content Based Image Retrieval: Survey and Comparison between RGB and HSV model", International Journal of Engineering Trends and Technology (IJETT) - Volume4 Issue4- April 2013.

[8] K.Ashok Kumar & Y.V.Bhaskar Reddy, "Content Based Image Retrieval Using SVM Algorithm", International Journal of Electrical and Electronics Engineering (IJEEE) ISSN (PRINT): 2231 – 5284, Vol-1, Iss-3, 2012.

[9] R.Senthil Kumar, Dr.M.Senthilmurugan, "Content-Based Image Retrieval System in Medical Applications", International Journal of Engineering Research & Technology (IJERT), Vol. 2 Issue 3, and March – 2013, ISSN: 2278-0181.

[10] H. Mohamadi, A. Shahbahrami and J. Akbari, "Image retrieval using the combination of text-based and content-based algorithms ", Journal of AI and Data Mining, Published online: 20 February 2013.

[11] B. Dinakaran, J. Annapurna, Ch. Aswani Kumar, "Interactive Image Retrieval Using Text and Image Content", BULGARIAN ACADEMY OF SCIENCES, CYBERNETICS AND INFORMATION TECHNOLOGIES • Volume 10, No 3 Sofia • 2010.

[12] S.Pavani, Shivani, T.Venkat Narayana Rao, Deva Shekar, " Similarity Analysis Of Images Using Content Based Image Retrieval System", International Journal Of Engineering And Computer Science ISSN:2319-7242, Volume 2, Issue 1, Jan 2013.

[13] Srikanth Redrouthu, Annapurani.K, "Time Comparison of Various Feature Extraction of Content Based Image Retrieval", International Journal of Computer Science and Information Technologies, Vol. 5 (2), 2014, 2518-2523.

[14] Nidhi Singhai, Prof. Shishir K. Shandilya, "A Survey On: Content Based Image Retrieval Systems", International Journal of Computer Applications (0975 – 8887), Volume 4 – No.2, July 2010.

[15] Zainab Ibrahim Abood, Israa Jameel Muhsin, Nabeel Jameel Tawfiq, "Content based Image Retrieval (CBIR) using Hybrid Technique ", International Journal of Computer Applications (0975 – 8887), Volume 83 – No 12, December 2013.

[16] Latika Pinjarkar, Manisha Sharma, Kamal Mehta, "Comparison and Analysis of Content Based Image Retrieval Systems Based On Relevance Feedback", Journal of Emerging Trends in Computing and Information Sciences, VOL. 3, NO. 6, July 2012.

[17] Suchismita Das, Shruti Garg, G. Sahoo, "Comparison of Content Based Image Retrieval Systems Using Wavelet and Curvelet Transform", International Journal of Multimedia & Its Applications (IJMA), Vol.4, No.4, August 2012.

[18] K. Ashok Kumar & Y.V.Bhaskar Reddy, "Content Based Image Retrieval Using SVM Algorithm", International Journal of Electrical and Electronics Engineering (IJEEE) ISSN (PRINT): 2231 – 5284, Vol-1, Iss-3, 2012.

[19] R.Senthil Kumar, Dr.M.Senthilmurugan, "Content-Based Image Retrieval System in Medical Applications", International Journal of Engineering Research & Technology (IJERT) Vol. 2 Issue 3, March – 2013.

[20] Ling Shao, Senior Member, IEEE, Simon Jones, and Xuelong Li, Fellow, IEEE, "Efficient Search and Localization of Human Actions in Video Databases", IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS FOR VIDEO TECHNOLOGY, VOL. 24, NO. 3, MARCH 2014.

[21] H. Mohamadi, A. Shahbahrami and J. Akbari, “Image retrieval using the combination of text-based and content-based algorithms ", Journal of AI and Data Mining, Published online: 20 February 2013.

[22] Yushi Jing, Michele Covell, David Tsai, and James M. Rehg, Member, IEEE, "Learning Query-Specific Distance Functions for Large-Scale Web Image Search", IEEE TRANSACTIONS ON MULTIMEDIA, VOL. 15, NO. 8, DECEMBER 2013.

[23] Xaro Benavent, Ana Garcia-Serrano, Ruben Granados, Joan Benavent, and Esther de Ves, "Multimedia Information Retrieval Based on Late Semantic Fusion Approaches: Experiments on a Wikipedia Image Collection", IEEE TRANSACTIONS ON MULTIMEDIA, VOL. 15, NO. 8, DECEMBER 2013.

[24] J. Huang, S. R. Kumar, M. Mitra, W.-J. Zhu, R. Zabih, "Image indexing Using Color Correlograms", Proceedings of IEEE Conference on Computer Vision and Pattern Recognition , San Juan, Puerto Rico (1997).

[25]. T. Ojala, M. Rautiain en, E. Matinmikko and M. Aittola, "Semantic Image Retrieval with HSV Correlograms", Proceedings of 12th Scandinavian Conference on Image Analysis, Bergen, Norway (2001).

[26] D. Feng, W. C. Siu, and H. J. Zhang, “Fundamentals of Content-Based Image Retrieval, in Multimedia Information Retrieval and Management Technological Fundamentals and Applications.”New York: Springer, 2003.

[27] Nezamabadi-pour, H. & Kabir, E., (2004) “Image retrieval using histograms of uni-colour and bicolour blocks and directional changes in intensity gradient”, Pattern Recognition Letters, Vol. 25, pp1547-1557.

[28] Vadivel A. ,Majumdar A. K. & Sural Shamik, (2003) "Perceptually Smooth Histogram Generation from the HSV Colour Space for Content Based Image Retrieval", International Conference on Advances in Pattern Recognition, Kolkata, pp 248-251.

[29] J R Smith, “Integrated spatial and feature image system: Retrieval, analysis and compression “[Ph D dissertation], Columbia University, New York, 1997.

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