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An Innovative Technique of Content Based Image Retrieval System

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Abstract: ***There are large numbers of resources, on websites which people can use to produce and store images. So the retrieval mechanism and processing of the desired image from the database has become important. For many years researchers has been working on image retrieval processes. In this paper an innovative technique of image retrieval using content based image retrieval is proposed. This research aims to improve the performance of CBIR using wavelet decomposition by D4 wavelet. After image decomposition feature matrix is obtain which has color, texture and shape feature. A feature vector matrix is formed and is clustered using k-mean clustering. The feature vector matrix is stored in index file according to its cluster. The highly efficient image matching takes place using f-norm theory. After applying the f-norm formula that the complete matrix is compared using f-norm matching and Euclidean distance is calculated. The use of progressive retrieval strategy is to provide balance between computational complexity and retrieval accuracy. In this paper we compared the retrieval performance of proposed content based image retrieval system with the exiting technique of haar wavelet. The proposed research produces better results than haar wavelet.***

Keywords: f-norm, feature vector matrix, Euclidean distance, D4Wavelet.

I. Introduction

Concept based image retrieval is also called as description based image retrieval or text based image retrieval. In concept based image retrieval user poses the query using natural language text, subject heading, keywords or annotations of the image. Text-based image retrieval uses traditional database techniques to manage images. [1] These systems do not actually understand the actual content of the images. Metadata is used for image indexing in concept based system. The Content based image retrieval systems are used to extract image features, index those using appropriate structures and efficiently process user queries providing the required answers. The query processing includes segments and features extraction and search in the feature space for similar images.

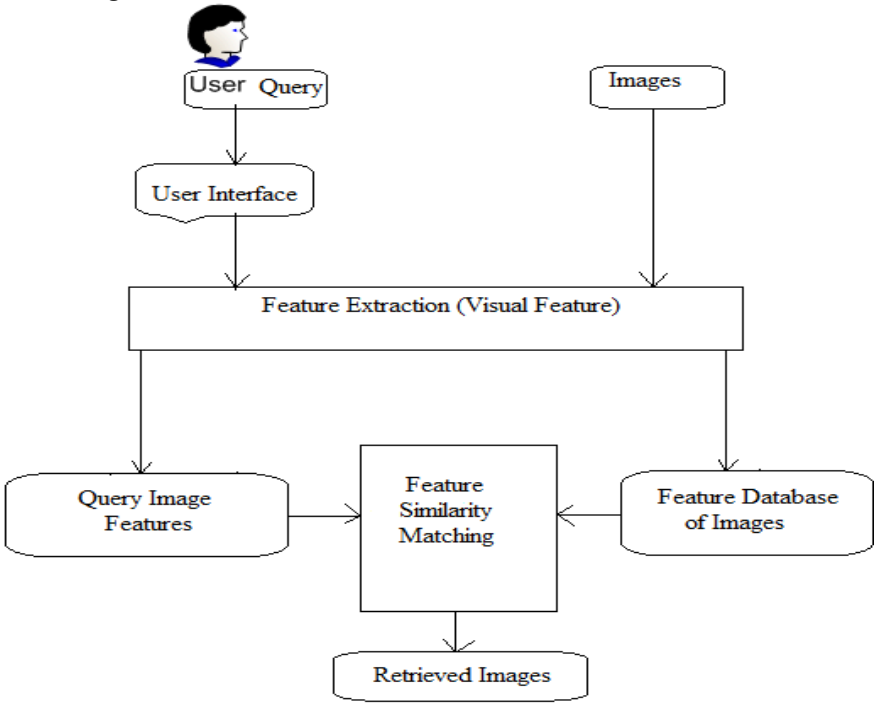


Figure 1.1: Basic Architecture of a CBIR system

Content based image retrieval is an approach by which image is retrieved from the database using actual content like color, shape, texture and spatial layout rather than text. Various methods, techniques and approaches are followed to form a content based image retrieval system which can search, identify and retrieve images from databases. To provide a more accurate image retrieval method various features can be combined for accurate results. So color, texture and shape features are combined with certain other techniques for feature extraction, similarity matching, clustering to provide effective results.

II. Proposed CBIR System

The proposed content based image retrieval system is based on decomposition of database images using D4 wavelet in the offline as well as in online for query image. With f-norm theory the extraction of image features takes place. A feature vector matrix is formed. After that k-mean clustering is applied on the database images. A feature vector matrix is formed and is clustered using k-mean clustering. The feature vector matrix is stored in index file according to its cluster. The highly efficient image matching takes place using f-norm theory. After applying the f-norm formula that the complete matrix is compared using f-norm matching and Euclidean distance is calculated. The use of progressive retrieval strategy is to provide balance between computational complexity and retrieval accuracy. During the image retrieval process decomposition, feature extraction and clustering are performed on query image and further the matching of the similarity takes place.

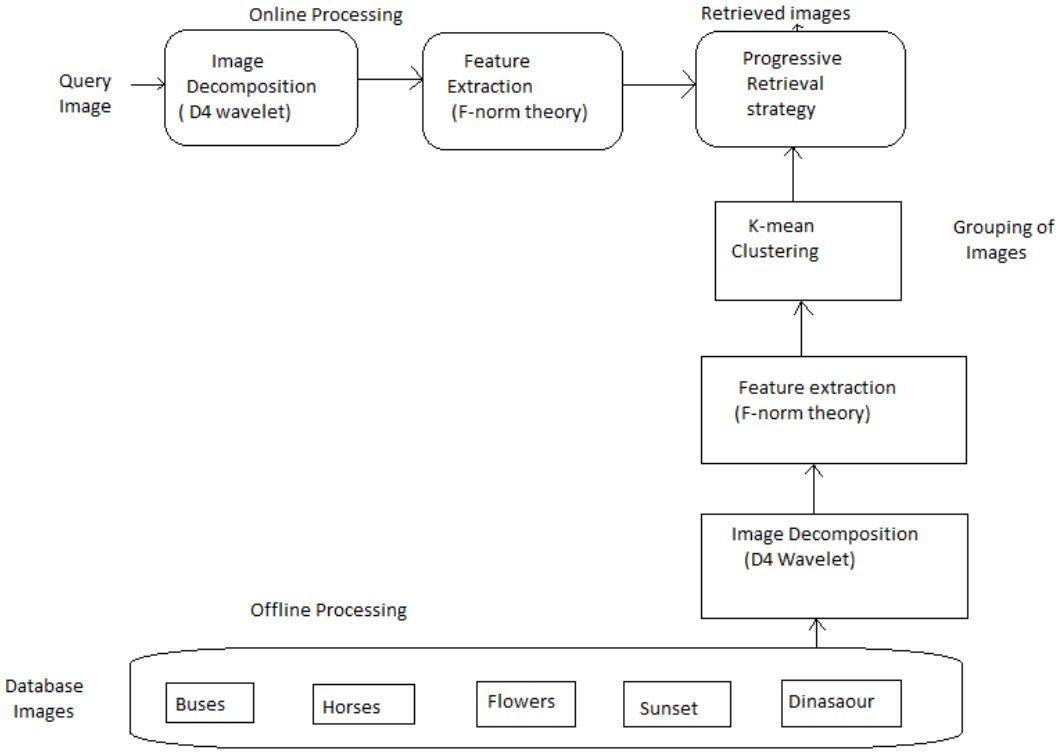


Figure 1.2: Structure of proposed CBIR system

III. Image Decomposition using D4 Wavelet

Content based image retrieval, allowing to automatically extracting targets according to objective visual contents of images. With appealing time frequency localization and multi-scale properties, wavelet transform proved to be effective in visual feature extraction and representation. It can be used to characterize textures using statistical properties of the gray levels of the points/pixels comprising a surface image. In CBIR, wavelet approaches mainly include wavelet histogram and wavelet moment of image, etc. Wavelet transform can be used to characterize textures using statistical properties of the gray levels of the pixels comprising a surface image**.** The wavelet transform is a tool that cuts up data or functions or operators into different frequency components and then studies each component with a resolution matched to its scale. I used D4 wavelet transforms to decompose color images into multilevel scale and wavelet coefficients, with which we perform image feature extraction and similarity match by means of F-norm theory and Euclidean distance has been calculated and measured to reach a particular cluster.[2]K-mean clustering is also applied to form cluster of images. A progressive retrieval strategy is used which contributes to flexible compromise between the retrieval speed and the recall rate. The retrieval performances are compared with the existing haar wavelet technique of CBIR system. The efficiency in terms Recall rate and retrieval speed is tested with five types of images and the results reflect the importance of wavelets and combination of techniques in CBIR. F-norm theory along with progressive retrieval strategy improves retrieval performance[3].

The color image decomposition is done using D4 wavelets. The resulting decomposition coefficient is employed to perform image feature extraction and similarity match by virtue of f-norm theory.

a) D4 Wavelet transform

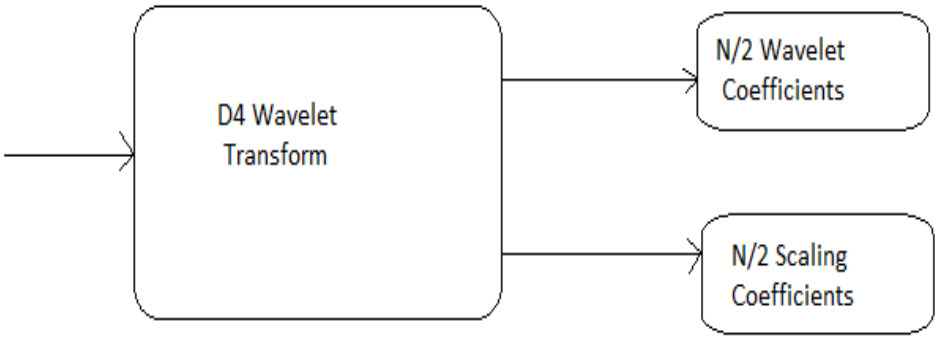


Figure 1.3: D4 wavelets forward transform

The Daubechies wavelet transform is named after its inventor the mathematician Ingrid Daubechies. The Daubechies D4 transform has four wavelet and scaling function coefficients. The scaling function coefficients are

$$h_0 = \frac{1+\sqrt{3}}{4\sqrt{2}}$$

$$h_1 = \frac{3+\sqrt{3}}{4\sqrt{2}}$$

$$h_2 = \frac{3-\sqrt{3}}{4\sqrt{2}}$$

$$h_3 = \frac{1-\sqrt{3}}{4\sqrt{2}}$$

Each step of the wavelet transform applies the scaling function to the the data input. If the original data set has N values, the scaling function will be applied in the wavelet transform step to calculate N/2 smoothed values. In the ordered wavelet transform the smoothed values are stored in the lower half of the N element input vector.
The wavelet function coefficient values are:
$g_0 = h_3$
$g_1 = -h_2$
$g_2 = h_1$
$g_3 = -h_0$

IV. Feature extraction, k-mean clustering and similarity criteria

Proposed CBIR algorithm is based on direct wavelet decomposition of image in RGB color space and utilizes the "query by example" method. With approaches mentioned above, database images are decomposed offline into multi-level coefficients from -1 to -J levels, with which, we can generate color feature database and perform similarity match between images. After decomposition, each resulting sub image is in fact a coefficient matrix, where, by special processing, large coefficients with more energy can be distributed in the upleft area, therefore, with F-norm theory we can well decrease the dimension of image feature and perform highly efficient image matching.[4]
To provide a more accurate image retrieval method various features can be combined to provide accurate image. So features are combined with certain other techniques for feature extraction, similarity matching, clustering to provide effective results. In spite of the significant advances made in imaging techniques, several practical factors often led to the average results in image retrieval of images. Therefore, it is necessary to improve the quality of the content based system for image retrieval.[5]
Daubechies wavelet transform are defined in the same manner as the haar wavelet with only difference between them is how the wavelets and scaling signals are described. Daubechies wavelet delivers a set of powerful mechanism for performing signals processing tasks.[6]
Content based image retrieval, allowing to automatically extracting targets according to objective visual contents of images. With appealing time frequency localization and multi-scale properties, wavelet transform proved to be effective in visual feature extraction and representation. It can be used to characterize textures using statistical properties of the gray levels of the points/pixels comprising a surface image. Wavelet transform can be used to characterize textures using statistical properties of the gray levels of the pixels comprising a surface image**.** The wavelet transform is a tool that cuts up data or functions or operators into different frequency components and then studies each component with a resolution matched to its scale. So the feature vector is obtaining using color, texture and shape feature of the images.[7]

a) Feature vector

Suppose A is a square matrix and A_i is its i^{th} order sub matrix where

$$A = \begin{bmatrix} a_{11} & \dots & a_{1n} \\ \dots & \dots & \dots \\ a_{n1} & \dots & a_{nn} \end{bmatrix}, \quad A_i = \begin{bmatrix} a_{11} & \dots & a_{1i} \\ \dots & \dots & \dots \\ a_{i1} & \dots & a_{ii} \end{bmatrix} \quad (i = 1 \sim n)$$

The F-norm of Ai is given as:

$$\|Ai\|F = (\sum_{k=1}^{i} \sum_{l=1}^{i} |akl|^2)^{1/2}$$

Let $\Delta A_i = \| A_i\|_F - \|A_{i-1}\|_F$ and $\|A_0\|_F = 0$, we can define the feature vector of A as:

$V_{AF} = \{\Delta A_1, \Delta A_2 \dots \Delta A_n\}$

b) K-mean clustering

K-means clustering is a method of cluster analysis which aims to partition n observations into k clusters in which each observation belongs to the cluster with the nearest mean. Given a set of observations (x_1, x_2, …, x_n), where each observation is a d-dimensional real vector, k-means clustering aims to partition the n observations into k sets ($k \leq n$) $S = \{S_1, S_2, \dots, S_k\}$ so as to minimize the within-cluster sum of squares.[8]

$$\arg\min_{\mathbf{s}} \sum_{i=1}^{k} \sum_{\mathbf{x}_j \in S_i} \|\mathbf{x}_j - \boldsymbol{\mu}_i\|^2$$

where μi is the mean of points in S_i.

c) Similarity criteria

Define the Similarity α_i of ΔA_i and ΔBi as:

$$\alpha_i = \begin{cases} \min(\Delta A_i, \Delta B_i) / \max(\Delta A_i, \Delta B_i) --- \Delta A_i \neq 0 or \Delta B_i \neq 0 \\ 1 ---------- \Delta A_i = 0 or \Delta B_i = 0 \end{cases}$$

And we can thus give the similarity α of the matrices A and B as:

$$\propto = \sum_{i=1}^{n} ci \ \propto i$$ Where,

$$C_i = \frac{2i-1}{n^2} (i = 1,2,\dots,n) \quad , \quad \sum_{i=1}^{n} C_i = 1 \quad .$$

Obviously, the similarity $0 \leq \alpha \leq 1$.

And then Euclidean distance has been calculated for each cluster so that the similarity can be simplified.

d) Progressive retrieval strategy

The progressive retrieval strategy is used in order to balance between computational complexity and retrieval accuracy.[9]

1. Rough filtering: Starting from the maximal decomposition level –J, with the resulting LL coefficients, we calculate standard variances vectors of the query image and the database image as (σ_r^q, σ_g^q, σ_b^q) and (σ_r^d, σ_g^d, σ_b^d) respectively, after which , we can roughly filter database images as

$$F= (\beta\sigma_r{}^q < \sigma_r{}^d < \sigma_r{}^q /\beta) \ \&\& \ (\beta\sigma_g{}^q < \sigma_g{}^d < \sigma_g{}^q /\beta) \ \&\& \ (\beta\sigma_b{}^q < \sigma_b{}^d < \sigma_b{}^q/\beta)$$

Where, the filtering constant $\beta \in (0, 1)$ is used to adjust the sifted database images. If F is false, then database image can be identified as far apart from Query image and therefore is discarded; else, database image be kept for further match.

2. More precise filtering: with the obtained LL coefficients, which best reflect the general feature of image. The similarity criteria to determine more precise images, If a exceeds a given threshold, it means that mismatch occurs and it should be discard.

3. Iteration: J=J-1, and iterate step 1~ 4 till J = 0. Finally, retrieval results are fed back to users in the order of their similarity values.[10]

V. RESULTS

A database of 500 images of five typical groups of color images is taken to perform the experiment. Mostly all the images in database are of size 384x256 before decomposition. In the database five typical groups of color images are stored namely:

- Buses

- Flowers

- Sunset

- Horses

- Dinosaurs

Figure 1.4: Sample database images

There are five different groups of images. The five groups are sunset, flowers, horse, buses and dinosaurs. For the given query image there are retrieved images with number at the foot of each image indicates its similarity(α) to the example image. α values indicate the similarity between the query image and the images in the database .For similar images, α value is

1.Greater the α value greater is the similarity between the query image and the database image. Retrieved images are sorted according to their alpha values (degree of similarity). The filtering threshold is taken as 0.6.

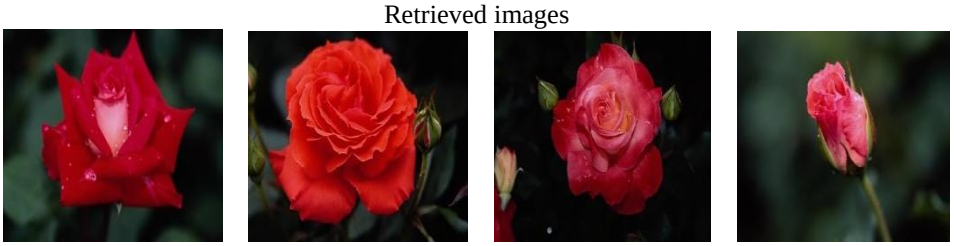
Query image

Retrieved images

0.73 0.74 1.00 0.77 0.74

Query image

Retrieved images



0.64 1.00 0.65 0.66

Query image

Retrieved images

0.60 0.77 1.00

The proposed system is compared with existing system using Haar Wavelet two performance measuring indices. The indices are recall rate and retrieval speed.

a) Recall rate: comparison between proposed system and system using Haar Wavelet at recall rate is shown in the figure 4.5. The performance of proposed system is better than of system using Haar Wavelet. The recall rate obtained in proposed system using D4 wavelet transform is high and is also the most apparent advantages of the wavelets in real time application.

$$\text{recall rate} = \frac{\text{total number of relevant images retrieved}}{\text{total number of relevent images in collection}}$$

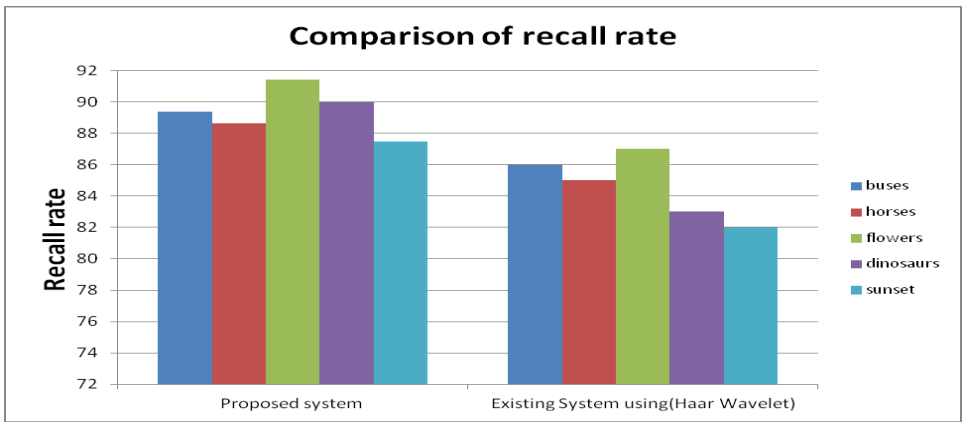


Figure 1.5: Comparison of recall rate

b)Retrieval speed: comparison between the proposed system and existing system using Haar Wavelet is shown in the figure 4.6. The performance of proposed system is better than of existing system using Haar Wavelet on retrival speed comparison. The two performance measuring indices shows that the importance of wavelet in the retrieval of an image in content based image retrieval system. The proposed sytem is taking less time to perform the intended tasks.

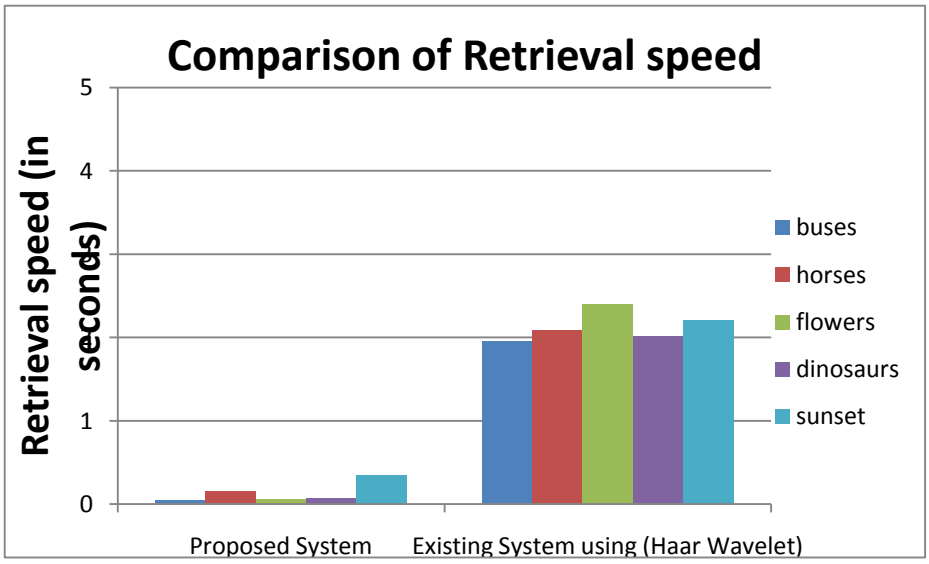


Figure 1.6: Comparison of retrieval speed

Table 1.1: Recall rate and retrieval speed of proposed approach

Categories of Proposed system	Recall rate	Retrieval speed
Buses	89.4	0.0441
Horses	88.66	0.151
Flowers	91.44	0.052
Dinosaurs	90	0.07
Sunset	87.5	0.336

VI. CONCLUSION

Content based image retrieval system is an emerging way of image retrieval from a large database. Although this area has been explored for decades, there is still a very large scope for achieving the accuracy of human visual perception in distinguishing images. In this approach we aimed to produce a content based image retrieval system which retrieves relevant images at fast retrieval speed. The proposed content based image retrieval approach uses D4 wavelet for wavelet decomposition of images. After that features are extracted using f-norm theory. K- mean clustering is used to form the cluster of images and similarity matching is done using f-norm theory and Euclidean distance is also calculated. We focus on recall rate and retrieval speed the two retrieval indices. We compared the retrieval performance of proposed content based image retrieval system with the technique of not using k-mean clustering in the system. In addition the progressive retrieval strategy helps to achieve flexible compromise among retrieval indices. The results are validated by using a set of test images including a 5 groups of images. We conclude from the results that the proposed system achieve high retrieval performance.

References

[1] Huang, T. and Rui, Y. (1999)"Image Retrieval: Current Techniques, Promising Directions, and Open Issues" Journal of Visual Communication and Image Representation 10, pp.39–62.

[2] Haralick, R.M., Shanmugam, K.and Dinstein, I. (1973), "Textural features for image classification" IEEE transactions vol. 3,pp. 610-621.

[3] Tamura, H., Mori, S. and T. Yamawaki,(1978), "Texture features corresponding to visual perception", IEEE Transactions on System, Man. and Cybernetics, vol.8, pp. 460-473.

[4] Chiu, C.Y., Yang, S. and Lin, H.C.(2002), "Learning human perceptual concepts in a fuzzy CONTENT BASED IMAGE RETRIEVAL system", 5th International Conference on Computational intelligence and Multimedia Applications, pp. 330-335.

[5] S. M. Zakariya, Rashid Ali, Nesar Ahmad (2010), "Combining visual features of an image at different precision value of unsupervised content based image retrieval" IEEE.

[6] Parul Preet, Kulvinder Singh Mann (2013), "An Approach of image retrieval using content based retrieval system" International Journal of Advanced Research in Computer Science and Software Engineering Volume 3, Issue 2, February 2013 ISSN: 2277 128X.

[7] Mathieu Lamard, Guy Cazuguel, Gw´enol´e Quellec, Lynda Bekri, Christian Roux, B´eatrice Cochener "Content Based Image Retrieval based on Wavelet Transform coefficients Distribution" Conference proceedings : Annual International Conference of the IEEE Engineering.

[8] S.R. Kodituwakku, S.Selvarajah (2007) "Comparison of color features for image retrieval" Indian Journal of Computer Science and Engineering Vol. 1 No. 3 207-211.

[9] Kulkarni, S.(2010)," Natural language based fuzzy queries and fuzzy mapping of feature database for image retrieval", journal of information technology and applications, vol. 4, pp. 11-20.

[10] Peter Howarth, Stefan Ruger (2004), "Evaluation of texture features for Content-based image retrieval" CIVR 2004, LNCS 3115, pp. 326–334, Springer-Verlag berlin Heidelberg

