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Improved techniques for Image Retrieval

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Abstract: In this paper we are going to discuss content based image retrieval system considering multiple features as color, texture, shape and spatial features to overcome the drawbacks of traditional text based image retrieval and previous content based image retrieval system which considered only single or double features for matching similarity between images. Here we apply a sequence of algorithms for extracting color, texture, shape and spatial features in CBIR for more accurate results, color feature vectors and clusters are formed using statistical color moments along with hierarchical and K-means clustering technique and for texture feature extraction Gabor wavelets algorithm is implemented and on these features extracted images shape features are extracted by implementing invariant moments then on this result images spatial feature is computed using the concept of quad tree decomposition and now on retrieved images relevance feedback analysis is performed for automatic indexing of images for future.

Keywords: CBIR, Clustering, Color moments, Gabor wavelet, invariant moments, quad tree decomposition

I. INTRODUCTION

In content-based systems search is performed by considering actual contents of the image rather than keywords, tags, and annotations associated with the image. This metadata based image retrieval technique can produce much non-relevant result in the search result. So this technique may be inefficient, expensive due to involving manual descriptions and may not be able to capture all keywords to describe the image. The term 'content' in this context might refer to colors, shape, textures, spatial or any other information that can be derived from the image itself. The basic idea of CBIR technique is to generate automatically image descriptors directly by analyzing the actual contents of the images [1]. Different techniques for image retrieval can be implemented as Query by example, Query by Semantic retrieval and other query methods [2].

In Query by image example as search for a particular image, it is a query technique that involves providing the CBIR system with an example image that it will search based upon this criteria as follows-

a. A preexisting image may be supplied by the user or chosen from a random set already existing image database.
b. The user draws a rough scene for approximation of the image they are looking for.

In Query by Semantic retrieval similar as category searching, the user makes a request like "find pictures of buildings" or even "find pictures of Indira Gandhi". This type of open-ended task is very difficult for computers to perform .While with this type of method not only images but also documents related to these keywords can also be retrieved in undesirable manner.

Other query methods include browsing for example images as similar to search by association where there is no clear vision about the query image, navigating customized/hierarchical categories, querying by some image portion (rather than the complete image), querying by multiple example images, and querying by direct specification of image features.

Here in this paper before searching image, some image clusters are computed by grouping images by its similarity in color features. Retrieval algorithms as texture, shape and spatial feature extraction techniques are applied on cluster centers to find the best match to the query image. Then query image is compared to all those clusters images whose cluster centered image is more similar to the query image. Thus due to clustering query image not need to be compared with all database images only with clustered images for faster speed [3].Here image retrieval is based in color, shape, texture and spatial features can be computed individually and simultaneously in the combination option, when all the algorithms are applied one after the other, and each algorithm is applied only over the previous result images. Here we are extracting 4 features as color, texture, shape and spatial as explained in figure 1.

Here no any single feature is sufficient for similar image retrieval therefore multiple features are extracted for matched image comparison [4]. In this research work some modified techniques are merged with previous existing techniques for improved image retrieval. In this paper part 2 methodology used for feature extraction has been described, in part 3 feedback analysis has been done ,in part 4 performance of this CBIR system has been measure, in part 5 result has been discussed and in part 6 we conclude for the future work.

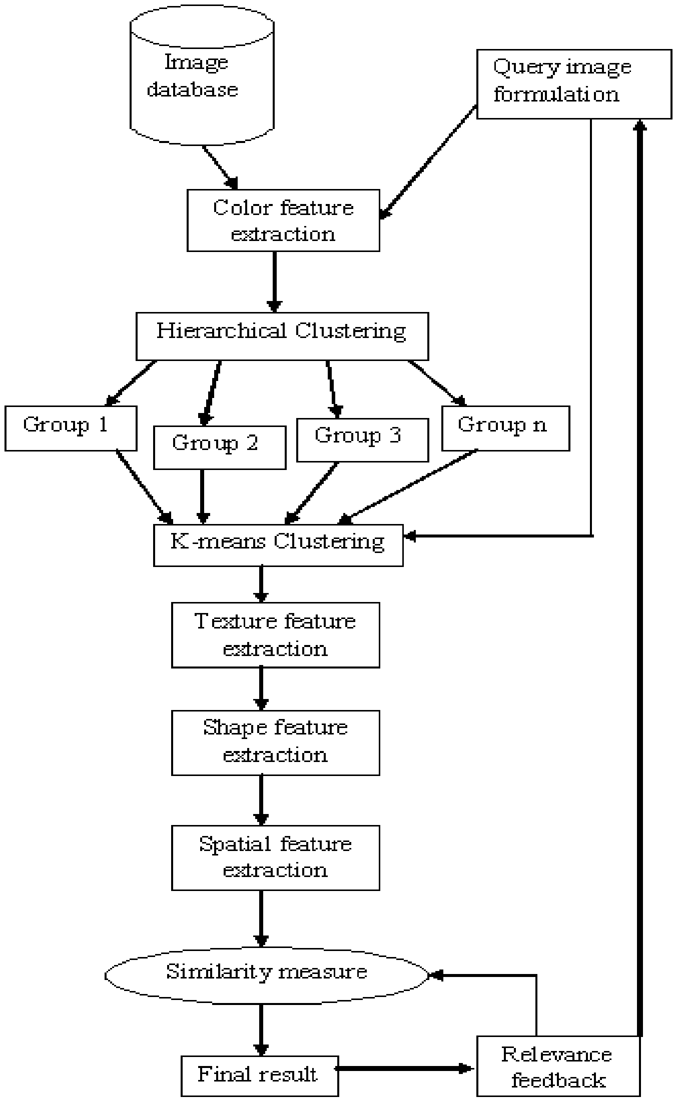

Figure 1.Working model of proposed CBIR system

II. PROPOSED METHODOLOGY

A. Color feature extraction:

It is the most common visual feature for recognition and matching purpose for images. Only this feature is not sufficient for comparison of images because same color images may be different semantically [5]. For implementing this system, this feature is extracted using the concept of color moments for red, green and blue component of color separately as mean, variance and skewness which are used for representation of color distribution of images.[4] These are computed as-

$$\text{mean} = \mu_i = \frac{1}{N}\sum_{j=1}^{N} f_{ij}$$

$$var = \sigma_i = \left[\frac{1}{N}\sum_{j=1}^{N}\left(f_{ij} - \mu_i\right)^2\right]^{\frac{1}{2}}$$

$$\text{skewness} = s_i = \left\{\left[\frac{1}{N}\sum_{j=1}^{N}\left(f_{ij} - \mu_i\right)^3\right]^{\frac{1}{2}}\right\}$$

Where f_{ij} is the value of the i-th color component of the image pixel j, and N is the total number of pixels in the image. Feature vectors for 3 components of color as red, green and blue are: (μR, σR , sR,, μG, σG , sG μB, σB , sB)

B. Cluster Formation:

Clusters of similar images are formed by considering similar color descriptors [6]. Before the searching starts, clusters are formed by applying hierarchical and k-means clustering one after other for fast and accurate image retrieval [3]. No of clusters computed by hierarchical clustering are fed as input for k-means clustering for improving accuracy. When the images in database are clustered retrieval time is summation of 3 factors-

a. Calculation of the similarity between the query and the cluster centers.
b. Calculation of the similarity between the query and the images in the nearest clusters
c. Ranking the images [7].

Goal of performing clustering is to group similar images into clusters and to compute the cluster centers, so that during retrieval, the query image need not be compared exhaustively with all the images in the database.[8] To retrieve similar images for a given query image, the query image is initially compared with all the cluster centers. Then a subset of clusters that have the largest similarity to the query image is chosen and all the images in these clusters are compared with the query image. Most search engines calculate the similarity between the query image and all the images in the database and rank the images by sorting their similarities so retrieval time in this case is more than in this proposed CBIR system. Here query image don't need to be compared with all data base images.

C. Texture feature extraction:

This feature describes the structural arrangement of surface of images. Due to this feature, sea and water or tree and leaves can be differentiated [5]. Existing gabor wavelet transformation method is used here for texture feature extraction due to analyzing frequency content of image, texture representation and discrimination[9]. This transform represent variations of images at different scales. This technique can tolerate the distortion for pattern recognition tasks as multi-resolution. For this feature descriptors are computed by correlation between query image and gabor filters with each wavelet at different frequencies and directions. A gabor filter is obtained by modulating the sinusoid form of image with the Gaussian envelope as

$$g(x, y, \theta, \phi) = \exp\left(-\frac{x^2+y^2}{\sigma^2}\right)\exp\left(2\pi\theta i(x\cos\phi + y\sin\phi)\right)$$

Where σ is the standard deviation of the Gaussian function in the x and y directions and $\omega = 2\pi\theta$ denotes the spatial frequency. [10]Family of Gabor kernels can be obtained from this equation by selecting different center frequencies and orientations. These kernels are used to extract features from an image. For given an input image I(x, y), the Gabor Wavelet features are extracted by convolving I(x, y) with g(x, y) as in this equation

$\phi(x,y) = g(x,y) \otimes I(x,y)$ where $\otimes$ denotes the 2-D convolution operation [11].

From this texture feature can be extracted as follows which is similar to the functionality of previous equation -

D. Shape feature extraction:

It is also visual feature for the retrieval of images based on similarity for identification and distinguishing related areas of image [5]. There are different types of shape representation techniques but here in this research work we are considering invariant moments as shape feature descriptors. Invariant moments are weighted average of image's pixel intensities. These have important role in pattern analysis for recognition of objects or images [12]. This shape retrieval technique is independent of translation, rotation and scaling. For a M×M dimensional image that has gray function f (x, y), where (x, y from 0 to M − 1) then two-dimensional moments is given as,

$$m_{pq} = \sum_{x=0}^{x=M-1} \sum_{y=0}^{y=M-1} (x)^p \cdot (y)^q f(x, y) \quad p, q = 0, 1, 2, 3 \cdots$$

If function is translated by an amount *(a, b)* then moment is defined as follows

$$\mu_{pq} = \sum_x \sum_y (x+a)^p \cdot (y+b)^q f(x, y)$$

Thus the central moments *mpq* or *µpq* can be computed from this equation on substituting $a = -x$ and $b = -y$ as follows

$$\overline{x} = \frac{m_{10}}{m_{00}} \text{ and } \overline{y} = \frac{m_{01}}{m_{00}}$$

$$\mu_{pq} = \sum_x \sum_y (x - \overline{x})^p \cdot (y - \overline{y})^q f(x, y)$$

Scale invariance is a feature of objects that does not change if scales of length, energy, or other variables, are multiplied by a common factor. When a scaling normalization is applied the central moments change as, Scale invariant Moments ηij where $i + j \geq 2$ can be computed in case of both translation and changes in scale by dividing the corresponding central moment by the properly scaled (00) th moment, using the following formula

$$\eta_{pq} = \mu_{pq} / \mu_{00}^{\gamma}, \quad \gamma = [(p+q)/2] + 1$$

Feature vectors used in this research work are based on the eight invariants moments of second and third order, according to Hu (1962) and Flusser [13] and T. Suk. [14].Thus complete and independent se of invariant moments are as follows which have been implemented in MATLAB and combined with other feature extraction techniques in this research work.

$$I_1 = \eta_{20} + \eta_{02}$$

$$I_2 = (\eta_{20} - \eta_{02})^2 + (2\eta_{11})^2$$

$$I_3 = (\eta_{30} - 3\eta_{12})^2 + (3\eta_{21} - \eta_{03})^2$$

$$I_4 = (\eta_{30} + \eta_{12})^2 + (\eta_{21} + \eta_{03})^2$$

$$I_5 = (\eta_{30} - 3\eta_{12})(\eta_{30} + \eta_{12})[(\eta_{30} + \eta_{12})^2 - 3(\eta_{21} + \eta_{03})^2] + (3\eta_{21} - \eta_{03})(\eta_{21} + \eta_{03})[3(\eta_{30} + \eta_{12})^2 - (\eta_{21} + \eta_{03})^2]$$

$$I_6 = (\eta_{20} - \eta_{02})[(\eta_{30} + \eta_{12})^2 - (\eta_{21} + \eta_{03})^2] + 4\eta_{11}(\eta_{30} + \eta_{12})(\eta_{21} + \eta_{03})$$

$$I_7 = (3\eta_{21} - \eta_{03})(\eta_{30} + \eta_{12})[(\eta_{30} + \eta_{12})^2 - 3(\eta_{21} + \eta_{03})^2] - (\eta_{30} - 3\eta_{12})(\eta_{21} + \eta_{03})[3(\eta_{30} + \eta_{12})^2 - (\eta_{21} + \eta_{03})^2].$$

$$I_8 = \eta_{11}[(\eta_{30} + \eta_{12})^2 - (\eta_{03} + \eta_{21})^2] - (\eta_{20} - \eta_{02})(\eta_{30} + \eta_{12})(\eta_{03} + \eta_{21})$$

E. Spatial feature extraction:

Spatial information is the information related to any image that can be linked to the location geographically.[5] Two images having the similarity in color and size are not necessarily to be similar if spatial feature of their region differs. A symbolic image is a logical representation of the original image where each image objects or regions are uniquely labeled with symbolic names. For spatial information extraction, the local objects or regions within the image and their relative positions within the image are necessary to be identified. There should be perfect placement of local regions and objects and their relative position for spatial feature matching. Quad-tree decomposition concept is used here spatial feature extraction. It is an iterative process of dividing the image into equal sized sub-images based on intensities. After the query image and images in database are decomposed based on intensity then each block of query image is compared with the blocks of data base images blocks. Another feature can be incorporated for comparison for decomposition in place of considering intensity to improve retrieved image result. Here in this research work we compare quad tree blocks of query image and database image by considering color moment descriptors because it is more simpler but this algorithm can be improved by considering another feature for the basis of quad tree decomposition.

F. Similarity measurement:

After different feature extraction single image is not retrieved while there is a list of images so they have to rank in an order on the basis of similarity matching with the query image. Many distance metrics can be used as similarity matching. The query image is more similar to the database images if the distance is smaller. These metrics will affect the retrieval performance of retrieval system.[4] In this research work for similarity measurement between query image and database images statistics distance metric is used which is defined as-

——— where ———.

For calculating the convergence distance between query image and database image some threshold limit is defined for each algorithm, For each search algorithm, a threshold is defined as the greatest possible distance between query image and database image, such that database image are returned in the searched result. Increasing these values, more results are retrieved in the search algorithms; decreasing these values, search is more restrictive and fewer results are retrieved.

III. RELEVANCE FEEDBACK ANALYSIS

It is automatic, iterative approach to know user's views [15]. This is performed to increase the accuracy and relevance of retrieved result. When a user marks relevant images corresponding to any query image, a new file with the name of the query image is created in the corresponding folder. For example, for the query image 'red-flower.jpg', with 15 relevant images corresponding to it, a xml file 'red-flower.

jpg.xml' is created storing information of all its relevant images.

Images which are marked as relevant views by the user are the first retrieved in result and displayed according to their similarity and threshold values when the same query is put again in future, order by percent of match. After the relevant images, the rest of the retrieved results, if any, are shown. Thus this analysis is performed for automatic image indexing for further image retrieval with accuracy, relevance and speed.

IV. PERFORMANCE MEASUREMENT

Performance of any image retrieval system is measured by accuracy which is defined as the ratio of the number of relevant images retrieved to the total number of images retrieved expressed in percentage.

$$\text{Accuracy} = \frac{\text{Number of relevant images}}{\text{Total number of images retrieved}} \times 100$$

Where, total number of images retrieved = number of relevant images + number of irrelevant images

For example, if an image query result in 100 images with 75 relevant images, then the accuracy of the retrieval system is given by:

$$\text{Accuracy} = \frac{75}{100} \times 100 = 75\%$$

Accuracy is the essential factor for evaluation as direct measurement of the quality and user satisfaction of the image retrieval system.

V. RESULTS

Retrieved image result obtained by considering only single feature is not consistent and relevant. More than one feature are mandatory for accurate and improved image retrieval.

The GUI has 4 main sections:

a. Database Section: This section is for selecting the database location and adding new images to database. The supported image formats are .bmp, .jpg and .png. A preview of the selected image is displayed on the top-right side of this section.

b. Selected Image Section: This section is for displaying a preview of the query image after selecting the query image.

c. Search Section: This is for selecting the search algorithm, based on which feature similar images have to be retrieved.

d. Result Section: Once a search has been completed, the results section is revealed in the right side. User can select the images from the retrieved image listing and get the preview of result images.

Here in figure 2 simple view of image retrieval system with database section, selected image section and search section has been shown .While considering only color feature result obtained is displayed in figure 3, considering only texture, obtained image result is shown in figure 4, considering only shape feature for image similarity in figure 5, retrieved image result is shown in figure 6 and considering color, texture, shape and spatial features for similar image retrieval, result is shown in figure 7 which is improved, more relevant and better performance image result than previous. So no any single feature is sufficient or perfect for finding similarity among images.

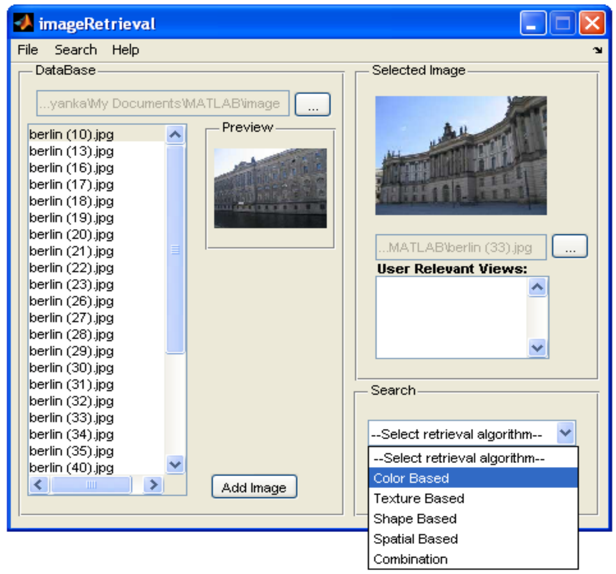

Figure2.Snapshot of developed CBIR

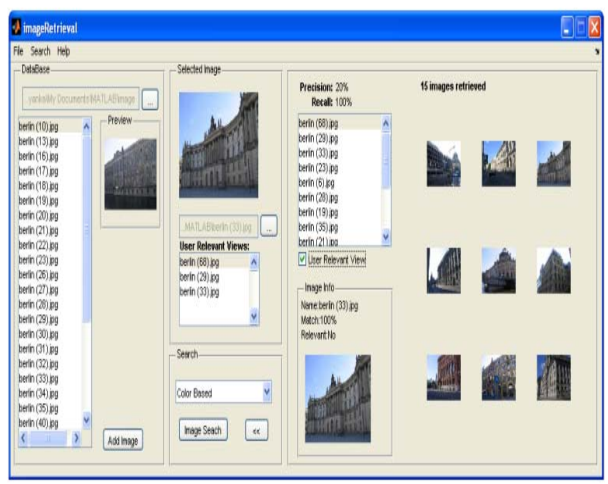

Figure 3 Image retrieval based on color feature

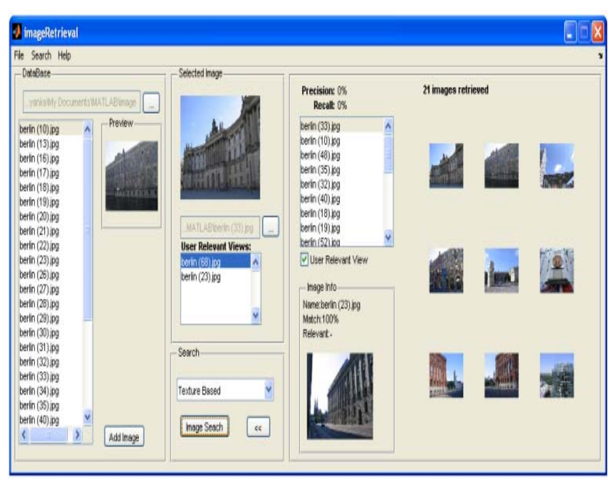

Figure 4 Image retrieval based on texture feature

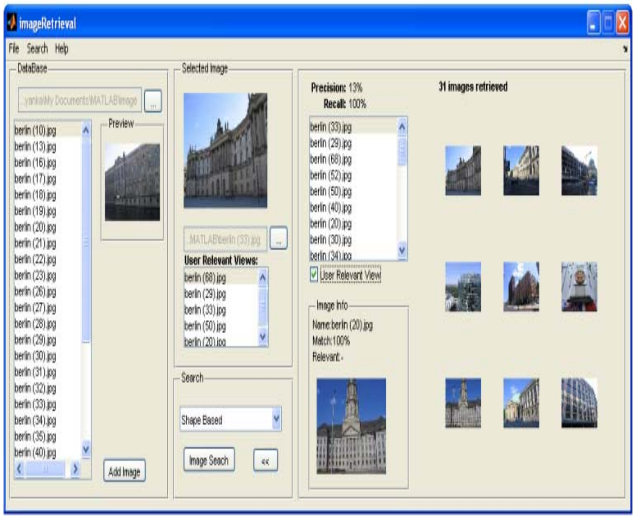

Figure 5 Image retrieval based on shape feature

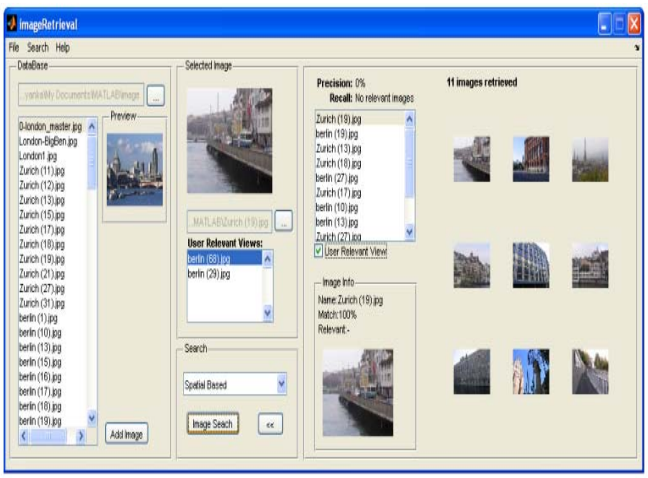

Figure 6 Image retrieval based on spatial feature

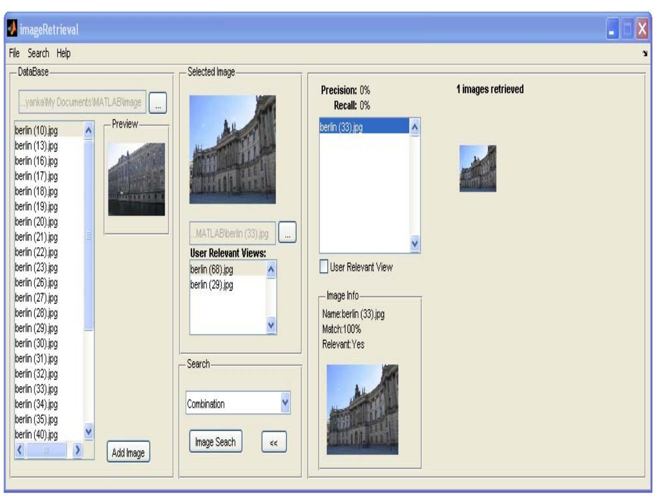

Figure 7 Image retrieval based on color, texture and shape features

VI. FUTURE SCOPE

In this research work not only single feature is considered, more than 1 features color, texture, shape and spatial features are extracted simultaneously for improved, accurate similar image retrieval. For future some weightage can be given for the features, all feature should not be given same importance it should be given on the basis of database used and on the application because in a huge database weighted combination of features can give optimal image search result. For example if query image is related to machine parts then more weightage should not be given to color feature or texture feature. It is more beneficial to assign more weight for shape feature. So this factor will be considered for future in this developed CBIR system for improved image retrieval result.

VII. REFERENCES

[1]. Linh Viet Tran, “Efficient Image retrieval with Statistical Color Descriptors”, PhD thesis No.810, Linkoping Studies in Science and Technology, may 2003.

[2]. Kavitha H et al, “ Content Based Image Retrieval - A survey” International Journal of Advanced Research in Computer Science, Vol. 4 (1), January 2013, 14-20.

[3]. Priyanka Gupta et al, “Utilization of hierarchical and flat clustering for content based image retrieval” International Journal of Advanced Research in Computer Science, Vol. 3 (7), Nov.-Dec. 2012, 203-205

[4]. Priyanka Gupta et al, “Effective content based image retrieval techniques using clustering for multiple features” International Journal of Advanced Research in Computer Science, Vol. 3 (7), Nov.-Dec. 2012, 91-94

[5]. John Eakins, Margaret Graham,” Content-based Image Retrieval”, JISC Technology Application Report 39, October 1999.

[6]. Murthy V.S.V.S. et al. “Application of hierarchical and K-means techniques in Content based image retrieval”, International Journal of Engineering Science and Technology Vol. 2(5), 2010, 749-755

[7]. Santhana Krishnamachari, Mohamed Abdel Mottaleb, “Hierarchical clustering algorithm for fast image retrieval”,IS&T/SPIE Conference on Storage and Retrieval for Image and Video Databases VII, San Jose, California, January 1999 , pp .427-435.

[8]. V.S.V.S Murthy et al. “Content based image retrieval using Hierarchical and K-means clustering techniques” IJEST Vol. 2 (3), 2010, pp. 209-212.

[9]. Jie Y., Qiang Z., Liang Z. and Wuhan C. Y. “Texture Images Retrieval Based on the Gabor Wavelet Transfor” International Conference on Information Engineering, ICIE 2009, pp. 1:79-82.

[10]. Sujatha C. et al “An optimal solution for image edge detection problem using simplified Gabor wavelet” International Journal of Computer Science, Engineering and Information Technology (IJCSEIT), Vol. 2(3), June 2012,pp: 99-115

[11]. Y.P.Guan “Automatic extraction of lips based on multi-scale wavelet edge detection,” Computer Vision, Vol. 2(1),2008, pp.23-33.

[12]. Chaur Chin Chen et al, “Improved moment invariants for shape discrimination” Pattern recognition, Vol.26 (5), 1993, pp.683-686

[13]. J. Flusser, "On the Independence of Rotation Moment Invariants", Pattern Recognition, Vol. 33, 2000, pp. 1405–1410.

[14]. J. Flusser and T. Suk, "Rotation Moment Invariants for Recognition of Symmetric Objects", IEEE Trans. Image Proc., Vol. 15, 2006, pp. 3784–3790.

[15]. S. Antani, R. Kasturi, and R. Jain, "A survey on the use of pattern recognition methods for abstraction, indexing, and retrieval of images and video," Pattern Recognition , Vol. 35, no. 4, pp. 945–965, 2002..

