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# VisualRank for Image Retrieval from Large-Scale Image Database

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*Abstract*— **VisualRank provide ranking among images to be retrieved by measuring common visual features of the images. The similarity between images is measured by measuring similarity within extracted features like Texture, Color and Gray Histogram. Image ranked higher, when most of image features matched to features of query image. In this paper, VisualRank approach is based on k-means clustering and minimum distance findings among images is used. The results of experimental study of proposed algorithm are shown with analysis of resultant image features. The images are retrieved based on selection of images with maximum similarity features.**

*Index Terms*— **VisualRank, GLCM, K-means clustering**

## I. Introduction

A huge amount of image data has been produced in diversified areas due to modernisation in engineering practices. It becomes difficult and imperative problem in searching images from varying collection of image features[2]. Though image search is one of the most popular applications over internet but in most of search engines it depends on text based searching method. Image retrieval process does not have active participation of image features. Image feature extraction and image analysis is quite complicated, time consuming and expensive process[1]. When a number of keywords added to the same database, there will be repeatedly problems due to differences in sympathetic, reliability of awareness over time, etc[3], due to which image searching based on text search possesses some problems like relevancy.

When query with varying qualities like shape, size, color etc is fired, less relevant or less important images may appear on the top and important or relevant images at the bottom of the search result page[4].The reasons behind is difficulty in keywords association with images, large variable image qualities and semantic perception of images. VisualRank approach will significantly improve the image ranking when many of the images will contain same futures. In some of the images these feature may occupy main portion of the image, whereas in others, it may occupies only a small portion. Repetition of similarity futures among the images provides significant implementation to the VisualRank for image retrieval[1].

There are two main challenges in captivating the concept of inferring common visual themes to creating a scalable and effective algorithm. The first challenge involved image processing required and seconds the need of evolving the mechanism for ranking images based on their similarity matches.[5]

The transformations of raw pixel data to a small set of image regions were provided to image retrieval by applying segmentation. Regions are coherent in colors and texture. These region properties were used for image retrieval[2]. The descriptor and detector were developed for faster computations and comparisons. It was found that the correspondence between two images with respective repeatability, distinctiveness and robustness was helpful. Here corners, blob and T-junction of images were considered or selected as point of interest, then feature vector was created having representation of neighbourhood of every interest point. Lastly minimum distances were found by measuring Euclidian distance and depending on minimum distance matching between different images were carried out[6]. In Topic Sensitive PageRank approach, set of PageRank vector was calculated offline for different topics, to produce a set of important score for a page with respect to certain topics, rather than computing a rank vector for all web pages[7].

W. Zhou *et al*. provide canonical image selection by selecting subset of photos, which represents most important and distinctive visual word of photo collection by using latent visual context learning[8]. In canonical image selection, images were selected in greedy fashions and used visual word of images and Affinity propagation [10] clustering for similarity findings.

VisualRank approach depends on visual features among the images that uses K-means clustering algorithm. In the implementation the images were retrieved using traditional image retrieval method, after that the features like energy, homogeneity, correlation, contrast, color and gray histogram were extracted. Results were obtained by using K-means clustering and then measurement of minimum distances among the images. VisualRank to large-scale image search using page ranking provides effective results of image retrieval.

In this paper image retrieval methods and actual implementation of VisualRank for Image retrieval is covered. This is followed by experimental results and discussions worth.

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## II. IMPLEMENTATION OF VISUALRANK

To ensure the usefulness of VisualRank algorithm for image retrieval in real sense, experiments were conducted using MatLab 7.10 environment on the images collected directly through Google Image. It was concentrated on the 200 small size image database with seven different query images like "Taj Mahal", "Coca Cola", "Cap", "Sea", "Bat", "Bricks" and "Sprite". In these four images from collection of database images were retrieved based on their Texture, Color and Gray Histogram features stored in xls file.

### *A. Feature Generation and Representation*

The texture features were measured using Gray-Level Co-occurrence Matrix (GLCM), It considered the spatial relationship of pixels. The number of occurrence of pixel pairs with certain values and specified spatial relationship occurred in an image provides characteristics of texture values by creating GLCM [9].

Normalized probability density $P_\delta(i,j)$ of the co-occurrence matrices can be defined as follows.

$$P_\delta(i,j) = \frac{\#\{|(p,q),(p+r,q+r)| \in G | f(p,q)=i, f(p+r,q+r)=j|\}}{\#G} \quad (1)$$

Where, $p, q = 0,1,\ldots..M$-1 are co-ordinates of the pixel, $i, j = 0,1,\ldots..L$-1 are the gray levels, $G$ is set of pixel pairs with certain relationship in the image. The number of elements in *G is* obtained as *#G*. *r* is the distance between two pixels i and j. $P_\delta(i,j)$ is the probability density that the first pixel has intensity value *i* and the second *j*, which separated by distance $\delta=(rp, rq)$.[9]

Energy measures textural uniformity i.e. pixel pairs repetitions. Energy is ranging 0 to 1 being 1 for a constant image. It returns the sum of squared elements in the GLCM. Energy is given by

$$Energy = \sum_{i,j} {P_{(i,j)}}^2 \quad (2)$$

Contrast is the difference in luminance and color that makes an object distinguishable. It measures the local variations in the Gray-Level Co-occurrence Matrix. Contrast is 0 for a constant image and it is given by

$$\text{Contrast}= \sum_{i,j} |i-j|^2 P_{(i,j)} \quad (3)$$

A correlation function is the correlation between random variable at two different points in space or time, usually as a function of the spatial or temporal distance between the points.

$$\text{Correlation}= \frac{\sum_{i,j} (i-\mu i)(j-\mu j) P_{(i-j)}}{\sigma_i \sigma_j} \quad (4)$$

Where $\mu_i$, $\mu_j$, $\sigma_i$, $\sigma_j$ are the means and standard deviations of $P_i$ and $P_j$ respectively. $Pi$ is the sum of each row in co-occurrence matrix and $P_j$ is the sum of each column in the co-occurrence matrix.

Homogeneity returns a value that measures the closeness of the distribution of elements in the GLCM to the GLCM diagonal. It has Range from 0 to 1 and homogeneity is 1 for a diagonal GLCM. Homogeneity is given by

$$Homogeneity = \sum_{i,j} \frac{P_{(i,j)}}{1+|i-j|} \quad (5)$$

Color features contain values of R, G and B. For better results rather taking color feature matching test for complete image, divided it into eight subregions.

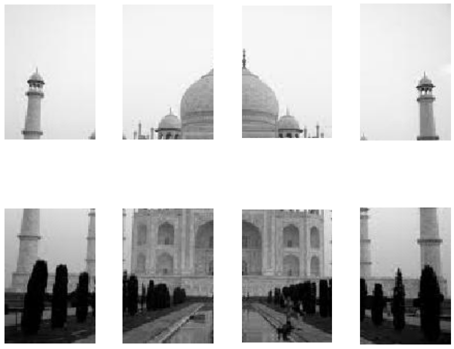

Fig. 1 Color Feature Extraction from Small Regions of Image

So that color feature contain in 8 × 3 matrix, measured values of R, G, B for 8 subregions as shown in Fig. 1.

A histogram is a graphical representation showing a visual impression of the distribution of data. For gray histogram uses a default value of 256 bins and for binary image histogram uses 2 bins.

### *B.* Effecting Clustering

K-means is one of the simplest learning algorithms that solve the well known clustering problem. The main idea is to define k centroids for k clusters, one for each cluster. The better choice is to place them as much as possible far away from each other. Here we initially made two centroids.

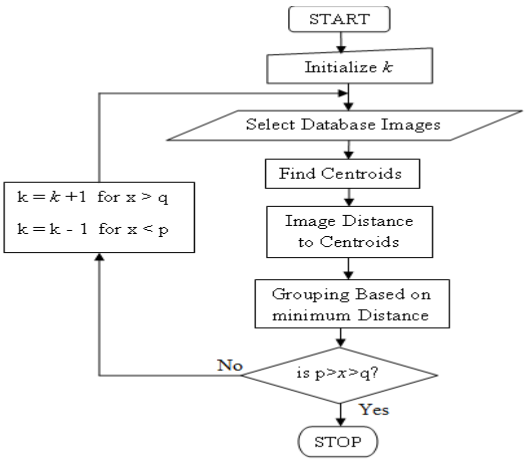


Fig. 2 Flowchart for K-means Clustering

Fig. 2 shows K-means clustering flowchart. Where, k is the number of clusters and x is the number of centroids. For finding centroids select number of images from database. To create grouping based on minimum distance such that each group contain minimum q images and maximum p images measure distance between images and centroids. Image database of 200 images were selected 14 maximum images and 4 minimum images for one cluster. When query was fired

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then based on query and cluster features, query finds the group of similar images having minimum image distance. The retrieval results are returned based on minimum distance between the images inside cluster with query image.

## III. RESULTS AND DISCUSSIONS

In feature extraction, the color features were measured by dividing original images into 16 subregions and color feature contains R, G and B components. Due to which each subregion having 1×3 values of color feature, so 16 subregions are containing 16×3 values. Total 48 values for entire image are measured.

The Gray Level Co-occurrence Matrix (GLCM) was computed in four directions for $0^0$, $45^0$, $90^0$, $135^0$. Based on the GLCM four statistical parameters energy, contrast, correlation and homogeneity were computed in four directions at four points, so total 64 values of texture features are returned.

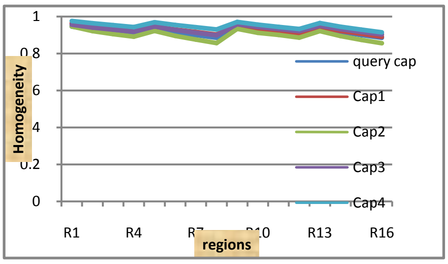
Gray histogram representation having values 0 to 255, which represent total representation of an image. For feature matching process 1 to 140 values were used, which provide good similarity matching and they were stored, so total extracted feature values of 252 for each image was presented.

After completing feature extraction and storage of database images, query image was fired and same six features of query image were measured. Fig. 3 shows the image retrieval results for different query images. VisualRank search for first four images retrieval from 200 database images of different categories were shown that are relevant to the image query.

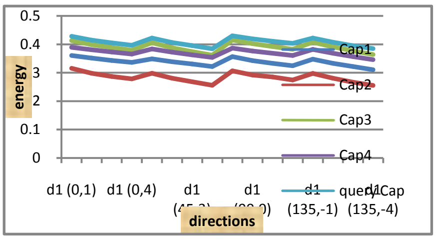

Fig. 3 Image Retrieval Results for different Query Images

The retrieval results for "Cap" are shown in Fig. 3. The extracted features values like homogeneity, energy, contrast, correlation, colors were provided in Fig. 4. Texture feature like energy, contrast, correlation, homogeneity were measured in four directions at four point of an image. The direction $0^0$, $45^0$, $90^0$ and $135^0$ are specified by offset value (0, 1), (-1, 1), (-1, 0) and (-1, -1) respectively.

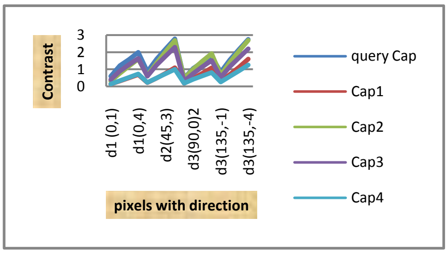
In texture feature homogeneity and correlation provide good matching values than energy and contrast values as shown in Fig. 4. The energy, contrast, correlation and homogeneity were having total 64 values, but single color feature was containing total 48 values. Comparing to texture features, color feature were highly matched among query image and retrieval images as shown in Fig.4 (e). Gray histogram has values from 0 to 255, but starting values provide good characteristic for matching features among images. The gray histogram is shown in Fig. 4 (f), but only starting 140 values were used with 48 color feature values and 64 texture feature values in image retrieval.



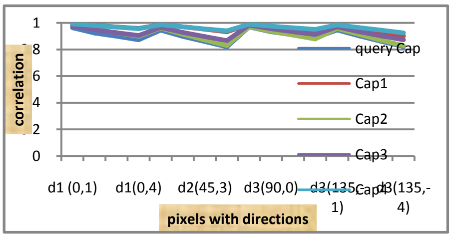

a) Homogeneity values



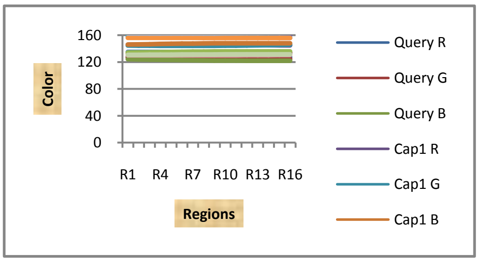

b) Energy values




c) Contrast values




d) Correlation values




e) Color values

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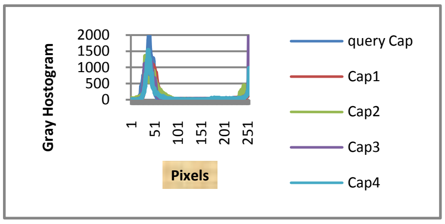


f) Gray Histogram values

Fig. 4 Extracted features values for retrieval images of query "Cap"

So combination of all values total 252 features values of energy, contrast, correlation, homogeneity, color and gray histogram were used to find similarity among the images. But color features were dominant in image retrieval results than texture and gray histogram features.

VisualRank provide relevant images from database depending on the similarities among the images. The feature extraction of database images was take some time, but once it completed then there was no need to follow feature extraction process again. The image retrieval results were return depending on random weightage of highest similarity matched images.

## IV. Conclusions

The VisualRank provide simple mechanism for image retrieval by taking in to account minimum distances among the images. After using VisualRank, the relevant images were returned at the top and if irrelevant images present are returned at the bottom in image search results. The similarity measurement of images was based on the common visual feature between the images. The images having more weightage than other images were ranked higher in image retrieval. Image clustering and finding the minimum distance among the images provides image retrieval results. VisualRank provide additional feature to current image search methods for efficient performance.

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