Comparison of Color Feature Extraction Methods in Content based Video Retrieval

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ABSTRACT
As large amount of visual information is available on web in form of images, graphics, animations and videos, so it is important in internet era to have an effective content based video retrieval system. Content based video retrieval uses query by video clip approach which is a good alternative because the users could not always say clearly what they want. As there are number of video search engine (Goggle, YouTube) which search for relevant videos based on user “keyword” or “term”. But very less commercial video search engine are available which search videos based on visual image/clip/video. That’s why here we have implemented a system that is searching for relevant video based on color feature in response of user query (visual clip/video).

Keywords
Video Segmentation, Key Feature Extraction and Color Feature Extraction.

1. INTRODUCTION
As in internet era most difficult task is to retrieve the relevant information in response to a query. To help a user in this context various search system/engine are there in market with different features. In web search era 1.0 the main focus was on text retrieval using link analysis. It was totally read only era. There was no interaction in between the user and the search engine i.e. after obtaining search result user have no option to provide feedback regarding whether the result is relevant or not. In web search era 2.0 the focus was on retrieval of data based on relevance ranking as well as on social networking to read, write, edit and publish the result. Due to Proliferation of technology the current search era (web search 3.0) based on contextual search. Where rather than ranking of a page focus is on content based similarity to provide accurate result to user.

This paper is mainly focusing on comparison of different color feature extraction techniques. Section II explains detail of Video Retrieval system with emphasis on different color feature extraction. Sections III demonstrate the experimental results of different color extraction techniques. Paper is concluded in section IV.

2. CONTENT BASED VIDEO RETRIEVAL
Due to rapidity of digital information (Audio, Video) it become essential to develop a tool for efficient retrieval of these media.

With help of this paper we are presenting a video retrieval system which provides accurate and efficient result to a user query based on color. The video retrieval system is a web based application as shown in fig.1 which consists of following processing:

2.1 Client Side Processing
From client machine user can access the GUI of the system and an individual is able to perform following operations with help of this module.

- Registration of video.
- Searching of video

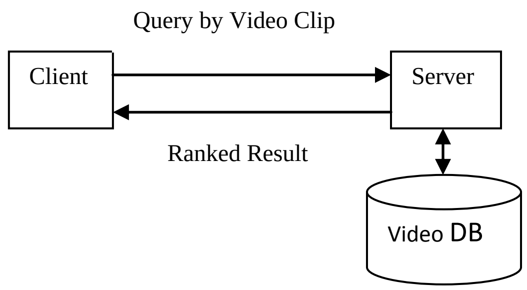


Fig.1 Content Based Video Retrieval System

2.2 Server Side Processing
The core processing will be carried out at server side to minimize the overhead on client. Client will make a request for similar type of videos by providing query by video clip [1]. On reception of this query by video clip, server will perform some processing on query video as well as on videos in its database and extract the video which are similar to query video. After retrieving the similar videos from the database, server will provide the list to the client in prioritized order [2]. To accomplish this following operations are carried out at the server.

- Video segmentation and key frame extraction
- Feature extraction
- Matching of received key frame features with feature database.
- Provide the resultant video to client in prioritized order.

The details of these operations are explained as follows:

3. VIDEO SEGMENTATION AND KEY FRAME EXTRACTION
In order to extract valid information from video, process video data efficiently, and reduce the transfer stress of network, more and more attention is being paid to the video. In order to

extract valid information from video, process video data efficiently, and reduce the transfer stress of network, more and more attention is being paid to the video processing technology. The amount of data in video processing is significantly reduced by using video segmentation and key-frame extraction [6],[9]. Fig. 2 shows the basic framework of key frame extraction for a video.

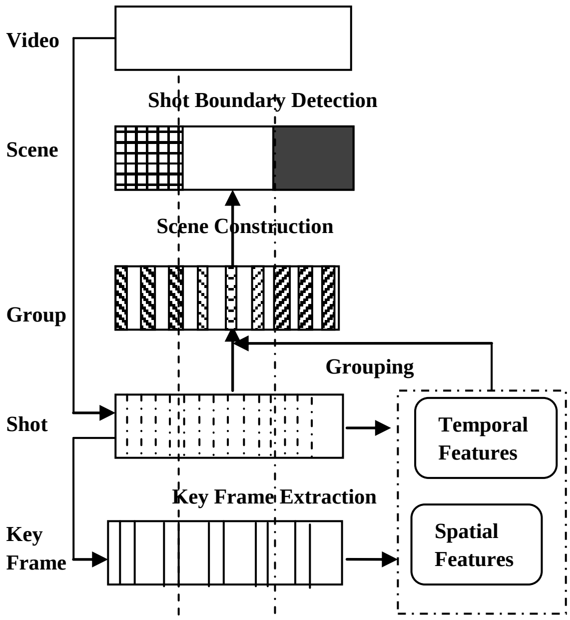


Fig. 2: The basic framework of the key frame extraction.

For implementation of this phase we have used the Java Media Framework Plug in API's.

3.1 Color Feature Extraction

A key function in the content based video search system is feature extraction. A feature is a characteristic that can capture a certain visual property of an image either globally for the whole image, or locally for objects or regions.

Color is an important feature for image representation which is widely used in image retrieval. This is due to the fact that color is invariance with respect to image scaling, translation and rotation [5]. The methods which we will use to extract the color features of key frame are:

3.1.1 Color Histogram

The color histogram is defined as a set of bins where each bin denotes the probability of pixels in the image being of a particular color. A color histogram H for a given image is defined as a vector:

$$H=\{ H[0],H[4], \ldots\ldots H[i] \ldots\ldots\ldots H[N]\}$$

Where i represents a color in the color space .$H[i]$ is the number of pixels in color i in that image, and N is the number of bins or the number of colors in the adopted color model. For sample image of fig. 3, the *Average RGB* method returns the 3 values which signify the probability of red, green and blue color in an image as follows:

H={133.2238,103.3203,86.1000}

For sample image of fig. 3, the *global color histogram*, method returns 64 color values represent the probability of pixels in the sample image of a particular color. However, it does not include information concerning the color distribution of the regions, so the distance between images sometimes cannot show the real difference between images.

Fig. 3 Sample Image (320*240)

This problem is overcome by *local color histogram* where initially we segment the image into blocks and then to obtain a color histogram for each block. We have divided the sample image into 16 blocks (4*4). From each block we are obtaining the 64 color values which show the probability of color in that block only. Hence we are getting total 1024 values of complete image. To find the similarity between two images we compute histogram on each region and comparison is made between a region in one image and a region in same location in the other image.

However, since the local color histogram only compares regions in the same location, when the image is translated or rotated, it does not work well. So to overcome this problem one can use the color moment of an image which are invariant to translation or rotation.

3.1.2 Color Moment

This method is based on assumption that the distribution of color in an image can be interpreted as a probability distribution. Probability distributions are characterized by a number of unique moments which are as follows:

- *Moment 1: Mean*
  Mean can be understood as average color value in the image
- *Moment 2: Standard Deviation*
  The standard deviation is the square root of the variance of the distribution.
- *Moment 3: Skewness*
  Skewness can be understood as a measure of the degree of asymmetry in the distribution.

Fig. 4 shows 9 moments (3 moments for 3 color channels) of sample image (fig. 3).

$$\begin{bmatrix} 0.5224 & 0.40519 & 0.3376 \\ 0.0862 & 0.0881 & 0.0915 \\ -0.0789 & -0.0733 & -0.0806 \end{bmatrix}$$

Fig. 4 Color moment of sample Image

Here the rows correspond to each of our moments and the col umns to our channels. Once calculated, these moments provide a measurement for color similarity between images [11]. A function of similarity between two image distributions is defined as the sum of the weighted differences between the moments of the two distributions i.e.

$$D_{mom}\left(I_1,I_2\right)=\sum_{i=1}^{r} w_{i1}\left|E_i^1-E_i^2\right|+w_{i2}\left|\sigma_i^1-\sigma_i^2\right|+w_{i3}\left|S_i^1-S_i^2\right| \quad (1)$$

Where I_1 and I_2 two images for which system is computing distance.

3.1.3 Color Coherence Vector

In Color Coherence Vector (CCV) approach, each histogram bin is partitioned into two types, coherent and incoherent. If the pixel value belongs to a large uniformly-colored region then is referred to coherent otherwise it is called incoherent [4]. In other words, coherent pixels are a part of a contiguous region in an image, while incoherent pixels are not. For sample image of fig. 3, this method returns 128 values. 64 values represent the color coherence vector and another 64 values represent color incoherence vector.

The number of coherence regions can be used for matching of two images and this could improve the effectiveness of retrieval [7]. The distance metric between two color coherence vectors is computed as follows:

$$D_{ccv}(I_1,I_2)=\sum_{K=1}^{N}[|H_1^c(k)-H_2^c(k)|+|H_1^s(k)-H_2^s(k)|] \quad (2)$$

Where H_i^c and H_i^s are the histograms of coherent and non-coherent pixels respectively.

3.1.4 Integration Approach

As Global color histogram method does not include information concerning the color distribution of the regions, Local Color Histogram fails when the image is translated or rotated, Color moment method do not encapsulate information about spatial correlation of colors. So to obtain the exact and accurate result from a video database we are using an integrated approach [3] of color feature extraction methods where we are providing options to user to select any of combination of above described techniques as shown in fig. 5.

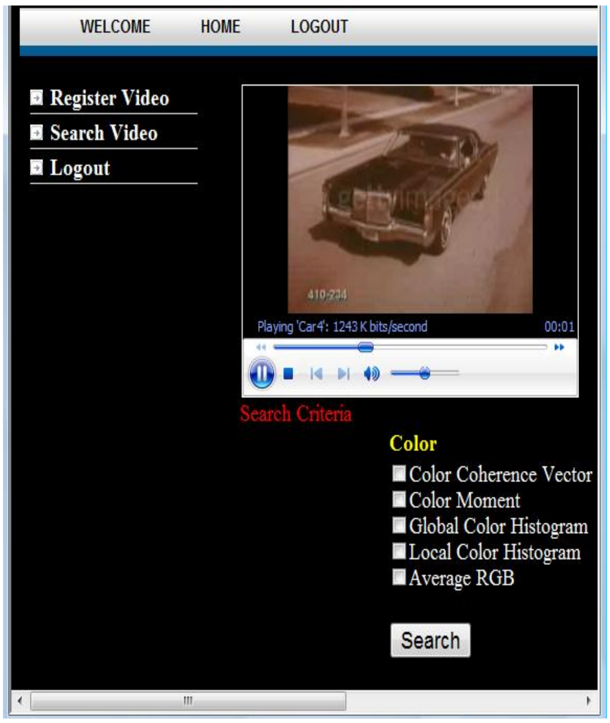


Fig. 5 GUI at Client Side for Search

With this approach the feature vectors in different feature classes are combined into one overall feature vector. The system compares this overall feature vector of the query image to those of database images, using a predetermined similarity measurement. User can select one or more checkboxes according to their own choice. To retrieve more relevant data one should select integration of all these techniques.

4. MATCHING AND RETRIEVAL OF VIDEOS

In retrieval stage of a video search system, features of the given query video is also extracted. After that the similarity between the features of the query video and the stored feature vectors is determined as shown in fig. 6. Computing the similarity between two videos can be transformed into the problem of computing the similarity between two feature vectors [8]. This similarity measure is used to give a distance between the query video and a candidate match from the feature data database. The similarity measure plays a major role as the original feature space in deciding "close or "far"[8]. Euclidean distance [10] is used here for similarity measures.

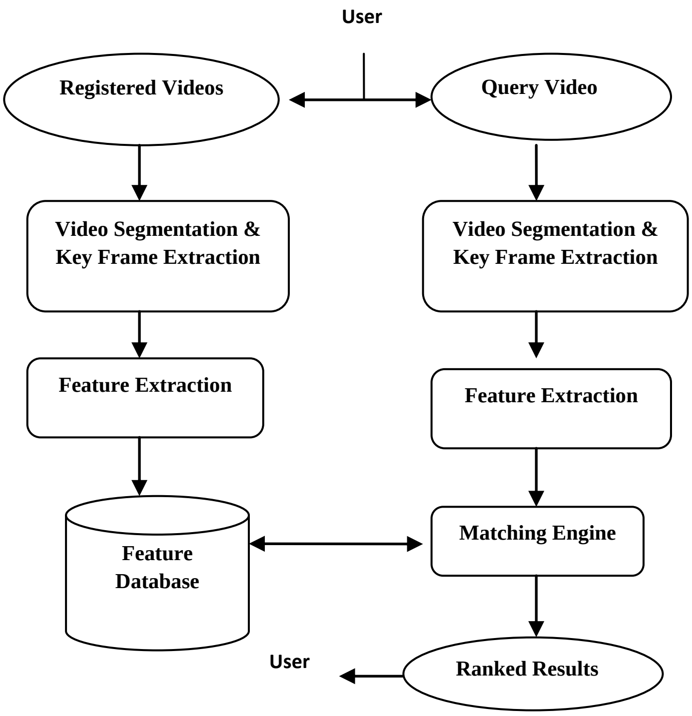


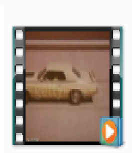
Fig. 6 Matching and Retrieval of videos

The final images are retrieved based on some ranking such as minimum distance measurements.

5. EXPERIMENTAL RESULTS

In order to compare the all above color feature extraction methods, we have registered three videos on the server as shown in Table I.

Table I
Registered Video with Attributes

Registered video	Length	Size	Total Frames	Key Frames Extracted
	9 sec	1.33MB	225	7
	3 sec	450KB	83	1
	6 sec	967KB	166	10

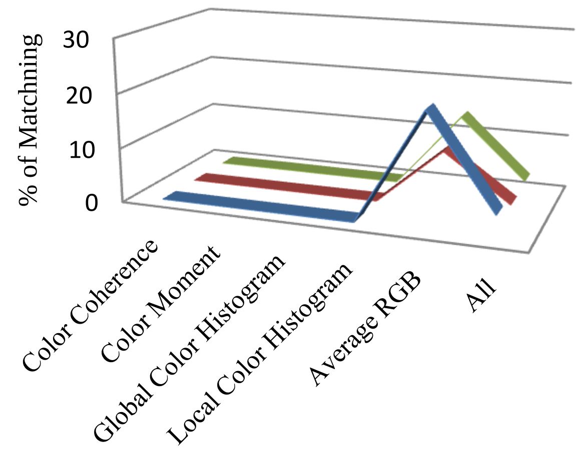
Whenever user will fire a query (video as query), system will extract the color features of query video and compare these features with the feature database and provide the ranked result based on percentage of matching. If two videos are similar the percentage of matching will be zero otherwise nonzero value. Table II shows the query video and other attributes of corresponding video.

Table II
Query Videos with Attributes

Query Video	Length	Size	Total Frames	Key Frames Extracted
	5 sec	795KB	131	2

Fig. 7 shows the behavior of different color extraction methods (Color coherence, Color Moment, Global color histogram, Local color Histogram, Average RGB and integration of all methods) in response of query video.

From fig. 7 one can conclude that car 2.avi is more similar to car4.avi, then car3.avi and car1.avi is least similar to car4.avi. At first glance car3.avi is looking more similar to car.avi but when we see the complete video one can easy interpret that car2.avi is more similar to car4.avi based on color.



	Color Coherence	Color Moment	Global Color Histogram	Local Color Histogram	Average RGB	All
Car1	0.061	0.071	0.081	0.113	20.94	4.253
Car2	0.017	0.025	0.019	0.047	10.61	2.144
Car3	0.027	0.088	0.035	0.064	13.88	2.820

Fig.7 Comparison of Color Feature Extraction Methods

To obtain accurate and relevant result as color is not only sufficient feature so one has to consider other features like texture, shape and motion.

6. CONCLUSION

The video search system facilitates the segmentation of the elementary shots in the long video sequence proficiently. Subsequently, the extraction of the color features using color histogram, color moment and color coherence vector is performed and the feature library is employed for storage purposes. One of advantage of this system is user not only search for a relevant video but one can register their videos on the web server.

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