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Video Summarization using Higher Order Color Moments

(VSUHCM)

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Abstract

The main aim of Video Summarization (VS) attempts is to provide a condensed view of the video by eliminating redundancies and extracting key frames from the video. This paper proposes a novel image - block based technique for video summarization by dividing the frames of the video into blocks and calculating the mean, variance, skew, kurtosis histogram of every block and comparing the same with the corresponding blocks of the next frame. The proposed technique successfully detects the shot boundary and keyframes by considering the distribution of colors in the image which are captured by higher order color moments. From every shot detected, the frame with highest mean and variance is selected as keyframe. The experimental results of the algorithm are compared with other key frame extraction techniques. The proposed technique gives comparable and even improved result in many cases.

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Keywords: video summarization, image block, key frame extraction,shot boundary detection, higher order color moments

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1. Introduction

The information is sourced through digital media such as movies, news, television shows and sports, and increasing day by day. However it would not be possible for an individual to watch its full content due to time limitation. In such situation it would be convenient to the user to see its summary wherein maximum information about the video can be apprehended.

1.1. Types of summaries

Video summarization includes static and dynamic video summarization[6, 9]. Static video summarization is called static video storyboard and dynamic video summarization is called dynamic video skimming[4].In static video summarization produces collection of key frames conveying maximum information about the video .But, dynamic video summarization produces short video that represents original video. Advantage of dynamic video summarization over static is expressiveness and entertaining due to audio and motion elements. On the other hand in static video summarizing there is no restriction over watching group of keyframes, since they are not restricted with time and sequence issue. As per user survey, the still pictures with limited exhibition space have been more acceptable than dynamic video summarization [5]. So, proposed method uses static video summarization.

1.2. Shot boundary detection and keyframe extraction

Video summarization process start with basic steps, Shot boundary detection and Key frame Extraction[5]. Video shot boundary detection process divide video into shots and from every shot one keyframe is selected which will convey maximum information of shot. This paper proposes a new approach (VSUHCM) for shot boundary detection and key frame extraction based on higher order moments image histogram, skewness and kurtosis.

2. Related work

Padmavathi Mundur, Yong Rao, Yelena Yesha[1] has proposed a keyframe-based video summarization technique using Delaunay Triangulation . Firstly the content of frame is used as multi-dimensional point data and Delaunay Triangulation method has been applied on it for clustering them. In the method proposed by this paper, first frames of video are extracted and shot detection is done .Then clustering is applied on video frames based on visual content to get key frames.

Sandra E. F, de Avila, Antonio da Luz Jr., Arnaldo de A. Araujo and Matthieu Cord[2] has proposed novel approach for video summarization. Two measure steps used in this paper are, Video Summarization and Quantitative Evaluation. First the video summary is produced using visual features and applying K-means algorithm.Second, a process is used to get quantitative measures of quality of summary involving different users.

Similarly, A method proposed by Zhao Guang-sheng[3].In this approach matching difference between two consecutive frames of video is computed along with different weights. Shot boundaries are detected on the basis of automatic threshold. Finally, using reference frame-based approach, key frames of video are extracted.

Miss.A.V.Kumthekar, Prof.Mrs.J.K.Patil[4] has proposed a method based on one of the lower level feature, color histogram. In this paper,the metrics used for key frame extraction are color histogram and edge detection. The basic purpose behind this is to remove redundancy of frames, along with less complexity and effective recognition efficiency.

Marco,Geraci and Montangero[5] has proposed technique STILL and MOVING video storyboard for the web scenario (STIMO).This method uses fast clustering algorithm that can be used to select the most representative visual contents using HSV frame color distribution.

In Xiaohua He and Jian Ling[6], a method for video summarization was proposed which uses the concept Temporally Maximum Occurrence Frame (TMOF).In this method First, the key frames are extracted from the video.Secondly,frames are clustered on the basis of the distance between their feature vectors. Finally, TMOF is constructed in each cluster and key frame is selected on the basis of smallest distance from the TMOF.

Mr. Sandip T. Dhagdi, Dr. P.R. Deshmukh[7] has proposed a novel approach for key frame extraction based on the block based Histogram difference and edge matching rate. Each frame is divided into blocks and the Histogram difference of every frame is calculated, and then prewitt operator is used to extract the edges of the candidate key frames.

Similar to earlier work, Dr Shobha G[8] has proposed new algorithm which uses Edge change ratio (ECR) .Firstly Edge change ratio algorithm is used to detect the shots of the video, and then key frame are selected from every shot.

Most of the techniques discussed above have used low level features such as color histogram, frame correlation, edge histogram but have not considered the distribution of the colors in the image. Much better results can be obtained if the distribution of colors is considered for shot boundary detection and key frame extraction. In this paper, we propose a novel technique for video summarization using higher order color moments, image skewness and kurtosis.

The proposed technique was applied to a sample of 10 videos selected from the Open Video Project[10] and compared our technique with DT[1], STIMO[5],VSUMM1[2] and VSUMM2[2].

3. The proposed system(VSUHCM)

The proposed system is divided into two stages, Shot Boundary Detection and Key Frame Extraction as shown in Fig.1

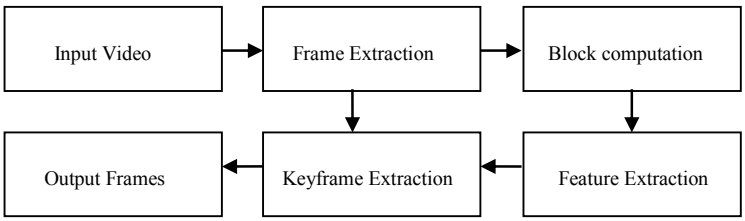


Fig. 1. Basic Block diagram Of VSUHCM.

3.1. Shot boundary detection

The very first stage in summarizing a video is to segment the video into multiple shots. It is obvious that large changes in the video frame content occur at the shot boundaries. Image histogram acts as a graphical representation of the tonal distribution in a digital image. In the proposed method the metrics used for detecting shots of video are Image histogram, skewness and Kurtosis.

3.1.1. Algorithm of shot boundary detection

Step1: Extract frames from video.

Step 2: Partition the frame into m*n blocks .B (i,j,k) stands for the block of i,j at the k^{th} frame.

Step 3: Using Image histogram compute Mean (MD), standard deviation (STD),skewness(S) and Kurtosis(K) for every block.

Step 4: Compute the difference in blocks of two consecutive frames using values in Step2 and repeat the step for all blocks. E.g. for Block1

$$MD=| MDi-MD(i+1) | \quad (1)$$

$$STD= | STDi-STD(i+1) | \quad (2)$$

$$S= | Si-S(i+1)| \quad (3)$$

$$K=| Ki-K(i+1)| \quad (4)$$

Where i and i+1 are two consecutive frames

Step 5: Add all four differences to find out total difference Td.

$$Td=MD+STD+S+K \quad (5)$$

Step 6 : Using step 4 and 5 calculate Td for every consecutive frames

Step 7: Calculate threshold over whole video sequence by taking average of Td and multiplying it with α.

$$T=Td_{avg}*\alpha \quad (6)$$

α is tuning parameter and can vary from 1 to 10
Td_{avg}=Average of all T_d.

Step 8: Compare Td with threshold T.

Step 9: If Td (i,i+1) ≥ T then i is the end of previous shot and i+1 is start of next shot. (7)

3.2. Key frame extraction

A key frame is a frame that best represents the video content in an abstract manner. In proposed system to extract key frames above algorithm of shot boundary detection is applied over video sequence .Then from every shot a frame with highest mean and standard deviance is extracted. So, from every shot one key frame convening maximum information of that shot is extracted to form static video summarization.

3.2.1. Algorithm of key frame extraction

Step 1: Divide the whole video sequence into shots using above algorithm.

Step 2: Find frame with maximum mean, standard deviation from each shot**.**

Step 3: These frames form static summarization.

4. Result and analysis

The performance analysis of the proposed technique is done both quantitatively as well as qualitatively on the standard database such Open Video and comparing it with other video summarization techniques which have used the same videos.

4.1. Quantitative analysis

Table 1 gives the comparison of the proposed technique VSUHCM with five other video summarization techniques in terms of the number of keyframes extracted.

Table 1. Experimental result

Video	duration	Total frames	OV	VSUMM1	VSUMM2	DT	STIMO	VSUHCM
V21	1:48	3266	9	15	12	1	13	**14**
V28	1:57	3523	14	19	16	6	11	**12**
V29	1:03	1917	5	9	8	7	6	**7**
V30	0:59	1781	7	9	8	7	7	**9**
V31	1:23	2467	7	11	8	6	8	11
V32	1:29	2653	8	11	11	3	10	12
V33	1:47	3213	13	20	13	6	16	**10**
V34	2:19	4205	17	9	7	7	14	14
V47	1:11	2165	7	5	4	5	7	10
V59	1:10	2104	7	12	8	8	8	**8**

The results for videos V28 and V33, VSUHCM gives improved performance whereas for videos V29, V30, V21 and V59 it gives acceptable performance. The above results justify that a huge amount of information can be obtained from the distribution of colors in the image. The block computation technique used in the proposed algorithm helps to capture more detailed distribution of colors from the image. The Table 1 above shows that in most cases the proposed method achieves acceptable score, it can be said that the quality of the summary produced by proposed method and Open Video[10] is comparable.

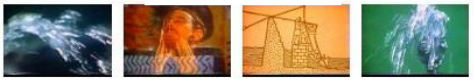
But, at the moment, it is acceptable that proposed method can be used as alternative to compare the quality and effectiveness of video summaries created by other approaches.

4.2. Qualitative analysis

In qualitative analysis the proposed system result on HD(high definition) video is shown as well as the proposed system video summary is compared with other techniques,OV[10],DT[1],VISTO[5],VSUMM1[2],VSUMM2[2] respectively.

Fig.2.VSUHCM result on HD quality video Wildlife.wmv having 901 frames.

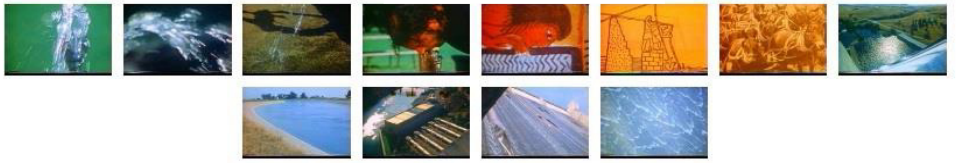
(a)



(b)

(c)

(d)



(e)

(f)

The great web of water,segment 01(v21)

Fig. 3.Video Summary result of (a) OV (b) DT (c) VISTO (d) VSUMM1 (e) VSUMM2 (f) VSUHCM

The video summarized result of the proposed technique covers all aspects of the video and does not contain any redundancy.

6. Conclusion and future scope

A novel approach for video summarization using image block mean, standard deviation, skewness and kurtosis histogram has been proposed. The proposed technique best captures the shot boundary detection and keyframes using the higher order color moments of the frames as well as removes redundancy. The proposed method give best results on high quality videos having less wipes effects. The future scope of the proposed method is to test on different genres of videos (cartoons, sports, tv-shows, talk-show). In addition, proposed method can be also be enhanced to achieve video skimming**.**

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