Key frame extraction technique for efficient video compression

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Abstract : Huge usage of data (text, image, and video) via communication media like internet, wireless communication, cellular phones made the media very popular by the flow of data. Researchers accepting this as a challenge to develop best techniques in this area, such as compression of data, image and video. Video is collection of images which are placed sequentially to give meaningful information. Video compression is a method by which redundant data can be decreased and removed from the video data. In the proposed work, two key frame extraction methods are presented. First method will compare two frames from video and identifies the differences between two frames and the second method will identifies the similarities between two frames from video based on these two concepts redundant data is identified and separated key frames from the video. The techniques used in proposed work are evaluated by different news channel datasets and results obtained are encouraging.

Keywords: Video compression, Key frame extraction, frame difference, frame similarity.

I. Introduction

The term video can be defined as a series of images which are displayed in the same sequence and such sequence is called frames. Set of such frames will carry huge amount of data. Data can be in the form of text, image or video. Now a day's requirement of any information can be collected through videos. So, storing and accessing such videos became necessary for the data user. The major drawback of video is its size. Hence reducing the size of video is very important task, this can be done by video compression technique. This area became very emerging topic for research work [1].

Video is nothing but a sequence of images or frames. Digital video can be represented efficiently with the help of compression technique. It is a process to represent a compact video there by reducing the video storage. The reverse process is called De-Compression. Compressed video is smaller in its size compare to un-compressed video. Once the video is compressed, video data becomes smaller in its size then it can be placed in less space and transferred faster in network. Bit-rate plays very important in the video compression. The efficiency of video compression can be measured by bit-rate for given resolution and frame-rate. The compression is more efficient if it results in lower bit-rate [2].

II. Related work

In the video sequence key frame is a known as image frame which will represent and explain the video content briefly. Key frame is not only used to express the video clearly but also reduce the space of memory required to process the video data. Video compression is a technique through key frame extraction method can be performed efficiently. So, storage organization, recognition and retrieval of video data can be performed more efficiently and conveniently. Depending on the video content few or more frames are extracted as key frames. Effective and well organized key frame extraction method is possible to present major part of the video in less time and store the same video in less space. Extraction of key frames can be performed in different ways based on: i. Shot boundary method ii. Image frame information iii. Motion analysis iv. Clustering.

In the first method directly very first and last frame is selected as key frames or from the frame sequence in between frame is considered as key frame from the video. Advantage of this method is simple to analyze and implement but disadvantage is that not much efficient to identify the true key frame actually. Second method explains about calculation of average of frames and representing them in the form of histogram, by calculating average of pixel value of every frame and average of statistic histograms of all frames. Third method is based on the optical flow of each pixel in frame and motion quality of the frame. According to the author fourth method is most effective compared to other two. In this method group the frames based on the visual content and each group is called as a cluster and from each cluster one or more frames are selected as key frames based on most representative sequence of frame [3].

Nature of the key frame can be static or dynamic. Based on this concept key frame extraction method can be classified broadly in two kinds: First method is based on Sequential approach and second method is based on cluster approach. In the first approach key frame is selected temporal information and visual features. Key frame is extracted when there is major difference in the visual content of frame. In the cluster based approach, the video data is divided into clusters and one or more key frame represents each cluster [4].

According to the paper [5] simple way of identifying a key frame is, first frame is selected as key frame from each and every frame set. But this cannot be an efficient method because without observing other frames blindly selecting every first frame as key frames not a better way.

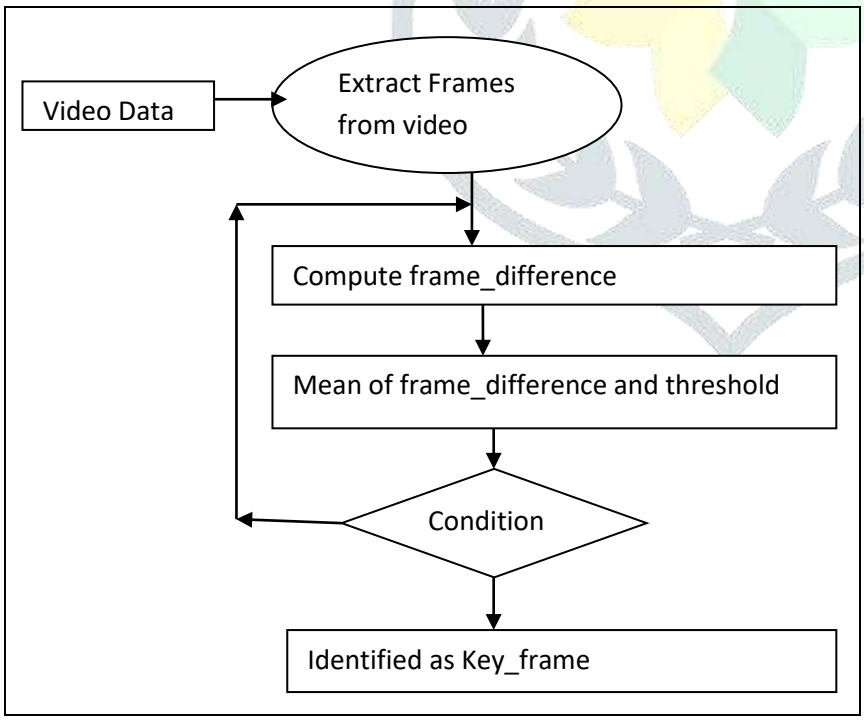
This paper presents a way to select key frame from video. From this method every frame is noticed for Har wavelet and spatial based featured are extracted. Spatial features are extracted by calculating average intensity and identifying high intensity position defined over 3x3 images. At different resolution frequency points are estimated. Randomness is analyzed between the frames and key frame is selected if the randomness is high [6].

This paper gives an algorithm which will explain about the key frame extraction method from the video. This method extracts the unique key frame by identifying the difference in the histogram between two successive frames. Calculating mean and standard deviation of absolute difference then computing the threshold and compare the difference threshold [7]

The paper [8] explains about Distributed Video Surveillance, Discrete Wavelet Transform and Color Set Partitioning for Hierarchical Trees.

A video data compression is proposed in this paper using quadratic Bezier curve fitting. Euclidean space R^1 or R^3, takes color variation and luminance of spatial location as input points, approximated valued are received from quadratic Bezier least square fitting. Output is the difference between included data and original data. QBC (Quaratic Bezier Curve) is made of three control points P_0, P_1 and P_2. P_0 and P_2 are called end control points and middle control point is identified by point P_1. The Quaratic Bezier Curve is crossed by the way of end control points and middle control point will decide the shape of the curve. By generating key frames of end points, key frames of mid points and adding frame difference to interpolated frames to reproduce the original video frames [9].

The proposed algorithm functions as shown in fig.1



Algorithm takes input video which is collected from the different news channels such as BBC, AajTak, and NDTV etc. From the video every frame is extracted, compute the successive frame difference and then take mean of frame differences. Consider this mean as a threshold value. Check the condition given in the algorithm, if the condition satisfies, then that frame is selected as key frame, else repeat the process.

Algorithm_Based_On_Frame_Difference (ABOFD):

In the presented work, based on successive frame difference, key frame extraction technique is proposed and presented in ABOKFD

Step	**1:**	Read the input video
Step	**2:**	Extract all frames from video
Step	**3:**	Read frame (i) for i=1 to (number_of_frames-1)
Step	**4:**	Compute the frame_difference between frame (i) and frame (i+1) using Euclidean Distance algorithm, where i=1 to n-1
Step	**5:**	Compute mean of all frame_difference and consider this as a threshold_value
Step	**6:**	if ((frame_difference) > (frame_difference(i-1) && ((frame_difference (i) > frame_difference (i + 1)) && (frame_difference (i) > threshold_value)
		frame (i) considered as key_frame
step	**7:**	else
		repeat step 2 for all n-1 frames

In the algorithm-1 distance between the frames is calculated using Euclidian distance algorithm (refer equation-1), which is mainly used to find the difference of two successive frames.

$$\sqrt{(p_1 - q_1)^2 + (p_2 - q_2)^2 + \ldots + (p_n - q_n)^2} = \sqrt{\sum_{i=1}^{n} (p_i - q_i)^2} \quad (1)$$

To perform frame difference operation, need to compute the difference in the video frames.

Where p_1 is previous pixel position, p_2 is present pixel position, q_1 is previous pixel position, q_2 is present pixel position.

Alorithm_Based_On_Frame_Similarity (ABOFS): In the present work, the correlation based key frame extraction technique is proposed and presented in algorithm-2. In this work, based on experimentation threshold value is chosen as 0.8.

Step	**1:**	Read the input video
Step	**2:**	Extract all the frames from the video
Step	**3:**	Read frame (i) For i =1 to (number_of_frames-1)
Step	**4:**	Compute the frame_similarity between frame (i) and frame (i + 1) using correlation analysis technique.
Step	**5:**	Set the threshold_value to 0.8
Step	**6:**	if (frame_similarity < threshold_value)
		then frame (i) considered as key_frame
step	**7:**	else
		Repeat step 2 for all n-1 frames.

In the algorithm-2, the correlation coefficients of two frames are computed using equation (2).

$$r = \frac{\sum_m \sum_n (A_{mn} - \bar{A})(B_{mn} - \bar{B})}{\sqrt{\left(\sum_m \sum_n (A_{mn} - \bar{A})^2\right)\left(\sum_m \sum_n (B_{mn} - \bar{B})^2\right)}} \quad (2)$$

Where A is input frame, B is frame to be compared $\bar{A}$ = mean2 (A), and $\bar{B}$ = mean2 (B)

III. Result and Discussion:

In this paper the proposed methods are evaluated by considering various MPEG videos collected from various sources such as CNN, BBC, and NDTV Etc. In this paper initially each and every frame is extracted from the video, some of the special frames are extracted as key frames from ABOKFD and ABOKFS are shown below.

ABOKFD

ABOKFS

Among collected videos and the experiment results are shown in the table (T-1).

Sl.No.	Dataset on news video	Sample	No. of frames	Key-Frames	
01	CNN	S1	6454	M1	11
				M2	38
02	BBC	S1	1093	M1	04
				M2	02
		S2	4302	M1	16
				M2	61
03	NDTV	S1	1844	M1	10
				M2	08
04	Suvarna	S1	1287	M1	02
				M2	12
05	DD	S1	809	M1	04
				M2	12
		S2	816	M1	16
				M2	47

Table T1 (experimental results)

By comparison of experiment results of ABOFD and ABOFS we observed that the performance of ABOS is better than ABOD. And ABOS satisfies the need of extraction method for key frames.

IV. Conclusion:

The proposed work presents a couple of innovative algorithms for videos to extract the key frames. The first methodology directly works on gray level values of successive frames. The second methodology is mainly based on co-relation between two successive frames. The experimental result shows that second methodology is giving more valuable results then the first methodology. Both the algorithms are completely subjective and performance is based on change in content video, stability of video.

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