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Shot Boundary Detection Using Shifting of Image Frame

Rahul Kumar Garg[1], Gaurav Saxena[2]
[1]Arya College of Engineering & IT, Jaipur (Rajasthan)
[2]Jaypee University of Engineering & Technology, Raghogarh, Guna. (M.P)
rahulkumargarg08@gmail.com[1], gaurav.saxena@juet.ac.in[2]

***Abstract*- Detection of shot boundary is the key step for identification of visual content of the video data. In this paper we propose a method of shot boundary detection with a novel logic of frame comparison. In our method, current frame of the video data is compared with the shifted version of the previous frame of that video and by using suitable threshold, shot boundary is declared. The experimental results show that the obtained results are more effective and accurate than the existing methods.**

I. INTRODUCTION

Due to the advancement in the multimedia technology, in the computer systems and in compression technology, there is a huge amount of data is available over the internet [1]. To enable efficient browsing, searching and retrieval, it is necessary to process the video data first. Shot boundary detection is the first and key step for structure analysis of the video [2]. It makes the video data more manageable. It also makes the user understandable about the video content.

To process and analyse the video on the basis of the visual content of the video, the video structure analysis is the preliminary stage. Videos are structured according to a descending hierarchy of video clips, scenes, shots and frames [3]. Video structure analysis aims at segmenting a video into a number of structural elements that have semantic contents [4], including shot boundary detection, key frame extraction and scene segmentation.

Shot is sequence of frames generated by continuous camera operation and represents a continuous action in time and space. Shots are basic unit of a video. Once the shot is identified, the further analysis of content and interpretation can be performed on such units. Abrupt change is also called as cut, is the instantaneous transition from one shot to next and it is the simplest concatenation of the two successive shots. On the other side, changes occur over the multiple frames in gradual transition of shot [2].

Gradual changes can also be classified as fade-out, fade-in, dissolve and wipe. Fade-out is a gradual transition of a scene by diminishing overall brightness and contrast to a constant image (usually a black frame). Fade-in is a reverse transition of fade-out. Dissolve is a gradual superimposition of two consecutive shots and wipe is a type of film transition where one shot replaces another by travelling from one side of the frame to another or with a special shape [1].

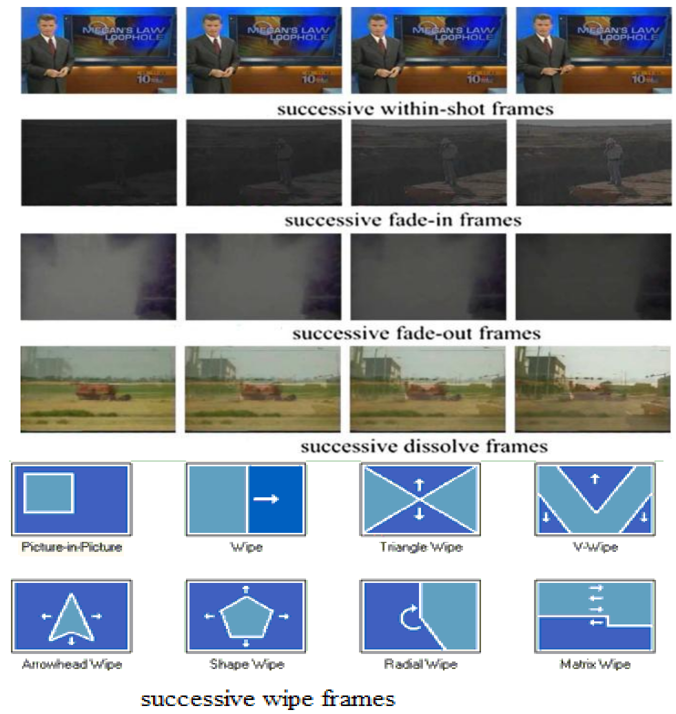

Fig 1 Shot transitions

II. PREVIOUS WORK

This section presents a brief introduction to some of the shot boundary detection approaches. Different approaches have been proposed over the past years using the different features like pixel difference, statistical difference, compression difference, edge difference, motion vector and histogram comparison to measure the visual discontinuity.

Method for shot boundary detection usually first extract the visual feature from each frame of video, then measures similarities between frames using the extracted features, and, finally detects shot boundaries between frames that are dissimilar.
Shot boundary detection methods can be classified in two categories as threshold based and statistical learning based.

Threshold based approach detects the shot boundaries by comparing the measured pair wise similarities between frames with a predefined threshold. When a similarity is less than the threshold, boundary is declared. Threshold can be global, adaptive or global and adaptive combined. Global threshold based algorithms use the same threshold over the whole video. Adaptive threshold based algorithms compute the threshold locally within a sliding window [4]. Detection performance is improved when an adaptive threshold is used.

Statistical based approach regards shot boundary as a classification of task in which frames are classified as shot change, no shot change depending on the features that they contain [3].

A large number of methods were proposed. Pair wise comparison of pixels which is also called as template matching, evaluates the differences in color or light intensity between two similar pixels in two consecutive frames [5, 6]. These approaches are sensitive to camera motion and the movement of the object.

Two features of the histogram difference and the pair wise comparisons of pixels in the clustering method have been combined and the results was that when these filtered features are complementary, they end in the recognition of existing shot and higher accuracy.

In another method, author used the information theory to recognize the abrupt and gradual shot boundaries. Method relies on the mutual information and joint entropy between the frames [7]. The information theory measure provides good results because it exploits the inter frame information in a more compact way than frame subtraction.

In this paper, a novel method has been proposed to detect the abrupt shot boundaries by reducing the effect of the camera motion and object motion by shifting he video frame with a Δx and Δy in x and y direction respectively.

III. PROPOSED METHOD

In this paper we are representing a novel method of abrupt shot boundary detection based of the shifting of the frame of the video data by a small amount Δx in x-direction and Δy in y-direction and then error between this shifted frame and next frame of the video is measured and decision is taken on that error.
The basic idea behind the shifting of the video frame is that the shifted video frame is less sensitive to the camera motion and object motion which reduces the false detection of shot boundaries.

Shifting of image:-

(a) (b)
Fig 2 (a) Video frame (b) Shifted video frame

Flow Chart:

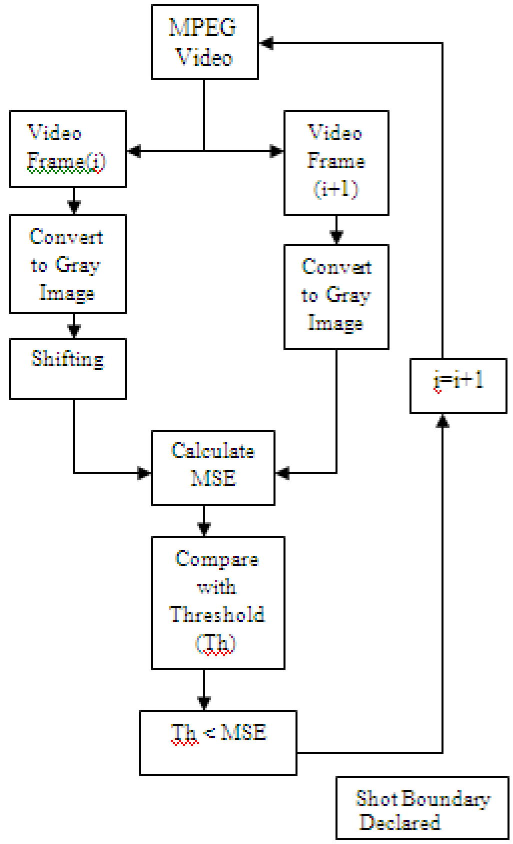

Fig 3- flow Chart of Shot Boundary Detection
Implementation:-

In this work, we estimate the normalized mean square error between the shifted video frame of current video frame and the next video frame and it is repeated over the entire video.

This method follows the following step-wise method--

Compute the 256 bin gray image of the video frame pi and pi+1.

$$Y(\text{luminance}) = 0.299\,R + 0.587\,G + 0.114\,B$$

Shift the pi by Δx in x-direction and then again shift this shifted image by Δy in y-direction and obtain a new image qi.

$$q_i(x, y) = p_i(x + \Delta x, y + \Delta y)$$

Calculate mean square error [8] between the q_i and p_{i+1}, which is the simplest and mostly used full reference quality metric. Formula for mean square error (MSE) is given as follows-

$$MSE = \frac{\sum_{i=1}^{M}\sum_{j=1}^{N}(X(i,j) - Y(i,j))^2}{M.N}$$

Repeat the step 1, 2 and 3 over the entire video frames and compute the MSE for all video frames.

Compare this MSE with the global threshold. If MSE is greater than the threshold, abrupt shot boundary is declared.

Now the performance of the system is measured, following the TRECVID evaluation protocols in terms of Recall, Precision and F-measure, respectively, defined as [1]

$$Recall\,(R) = \frac{Correct}{Correct + Miss} \times 100$$

$$Precision\,(P) = \frac{Correct}{Correct + False} \times 100$$

$$F\_Measure\,(F) = \frac{2 \times Precision \times Recall}{Precision + Recall} \times 100$$

IV. EXPERIMENTAL RESULT

In this section, experimental results on the dataset are presented. The proposed method was tested on the reference video test set. Video set are characterized by significant camera effects like zoom-ins/outs, pans and significant object and camera motion inside one shot.

We have three different videos like advertisement, song and a movie trailer with the following data.

Video	Duration	Frame size	Total frame
Video 1	1:00min	1280×720	1443
Video 2	2:05min	640×360	3016
Video 3	2:30min	426×240	3602

Table 1 Data Set of Video

Some frames of the test videos are following

For Video 1


Frame 49


Frame 57


Frame 200

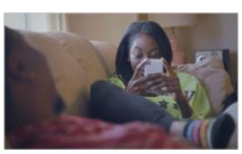
Frame 253

Fig (a)

For Video 2


Frame 22


Frame 39


Frame 145


Frame 200

Fig (b)

For Video 3


Frame 46


Frame 47


Frame 115


Frame 224

Fig (c)

Fig 4– Frames of the video; (a) video 1; (b) video 2; (c) video 3

Following graph shows the detected shot boundaries of the test video data.

For video 1

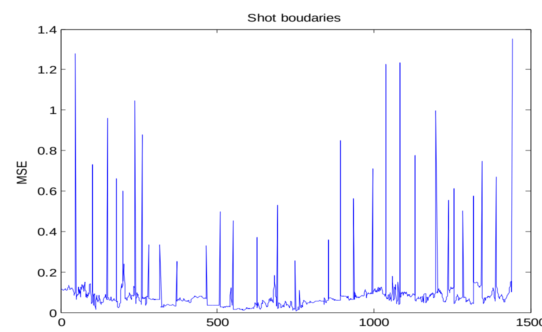

Fig 5- Shot boundaries of video 1

For video 2

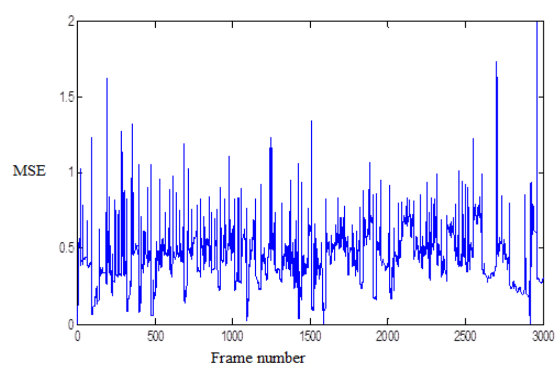

Fig 6- Shot boundaries for video 2

For video 3

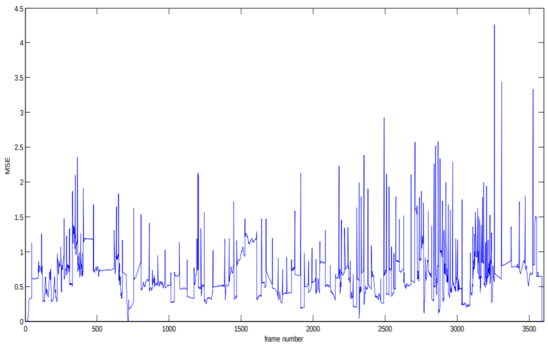

Fig 7-Shot boundaries for video 3

Dataset of Shot Boundaries

Table 2 Detected shots

Video	Total Frames	Correct	Missed	False	Precision %	Recall %	F – Measure %
1	1443	31	0	0	100	100	100
2	3016	101	3	6	94.33	97.08	95.68
3	3602	113	3	7	94.16	97.41	95.75

Table 3 Frame level accuracy of proposed method

Sequence	Number of Shots	Existing Method			Proposed Method		
		P	R	F	P	R	F
Video 1	31	96.55	87.5	91.80	100	100	100
Video 2	110	93.13	94.05	93.58	94.33	97.08	95.68
Video 3	123	90.99	92.66	91.81	94.16	97.41	95.75

Table 4 Comparison Table

Video	Total Frames	Total Number of Detected Shots
Video 1	1443	31
Video 2	3016	110
Video 3	3602	123

V. CONCLUSION

We proposed a new method for abrupt shot boundary detection in this paper. The proposed method tries to minimize the effect of the camera motion which results in false abrupt shot detection by shifting the video frame. Peaks in the graphs shows the shot transition in the video. Experiment on the three videos shows that the proposed method yields better detection performance and less dependent on the camera motion and object motions. This method found to be efficient and works better than the existing methods for a variety of videos.

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