Scene Change Detection Algorithm on Compressed Video

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Abstract:

This paper propose scene change detection algorithm using coefficient of forward prediction macro-block, backward prediction macro-block, and intra-coded macro-block on getting motion estimation. Proposed method detect scene change with correlation according picture type forward two picture or forward and backward two picture on video sequences. Proposed algorithm is high accuracy and can detect all scene change on video, and detect to occur scene change on P, B, I-picture.

Keyword : Scene Change Detection, Macro-block, motion estimation

1. Introduction

Recently multimedia data are very rapidly increasing by development of information and communication technology. Video sequence data of multimedia are very large, and increase demand of effective data processing every year. When use communication network as information transfer media, technique of accurate information detection and processing within rapid time is very important. There need function of automatically video parsing for video detection. Video parsing is consisted with video division and index, and video stream of video division step are divided with shot as video unit. Shot is smallest video unit data; it is edit the picture to get with camera moving. Shot is consisted with cuts, fade, and wipe etc.. Boundary of video shot is scene change and scene change detection is divided with each shot. So, scene change detection of video parsing is the core technique.

The general scene change detection method is calculation difference of pixels. Scene change is decided with large value as calculating difference all current pixels and just forward pixels. This method is very simple but it has defect so sensitively react in transfer of camera. Also scene change is mistaken detection because measured value shows greatly in sudden change of light. Unlike this, one another method that compare with histogram of two pictures is the most general method that find shot boundary in video data. This method reflects general information of frame but occur case that not recognize to change of locally frame because ignore local information of frame. Also there is shortcoming that there is much calculation amount for recognizing general information of frame.

We proposed scene change detection algorithm using coefficient of forward predicted macro-block, backward predicted macro-block, and intra-coded macro-block in motion estimation and compensation on MPEG domain. Scene change is decided as comparing with coefficient of three macro-blocks of I, P, and B-picture of previous or next position and coefficient of three macro-block of current picture. This algorithm is able to defect a variety of scene change and any position in MPEG sequence (I, P, or B-picture), and also it entails significant saving computational complexity.

2. MPEG-2 video layer structure and GOP

2.1 Video layer structure of MPEG-2

MPEG-2 video layer structure are consisted of sequence layer, GOP layer, picture layer, slice layer, macro block layer, and block layer etc.. Sequence layer screen group are which consecutiveness and the importance function of sequence header is permitted revival on the way of bit stream. It can stick among data of picture occasionally, but sequence header permits changing of only quantization matrix. It means that macro block return by regulation value in case that do not change quantization matrix.

Sequence header is place the most basic and general information exist, horizontality size and verticality size of screen, aspect ratio of elemental area, the picture rate, the bit rate, video buffering verifier size, limitation of parameter flag, are connected contents of the two flag loading , and two quantization matrixes.

2.2 GOP and picture type

There are three picture type on regulate MPEG-2 as I, P and B-picture. I-pictures (intra-coded picture) are coded independently, entirely without reference to order picture. P-pictures (predictive-coded picture) and B-pictures (bidirectionally predictive-coded picture) are compressed by coding the differences between the picture and reference I-picture or P-pictures, thereby exploiting the similarities from one picture to the next.

P-pictures obtain predictions from temporally preceding I-picture or P-picture in the sequence, whereas B-pictures obtain predictions from the nearest preceding and/or upcoming I-picture or P-pictures in the sequence. Different regions of B-pictures may use different predictions, and may predict from preceding pictures, upcoming pictures, both, or neither. Similarly, P-pictures may also predict from preceding pictures or use no prediction. If no prediction is used, that region of the picture is coded by intra techniques.

In a closed group of pictures P-pictures and B-pictures are predicted only from other pictures in the group of pictures; in an open group of pictures the prediction may be from pictures outside of the group of pictures.

GOP layer is smallest unit of screen group which become unit of random access have time from information for edit and sequence beginning, and are connected time code, closing GOP, and broken link flag etc..

Display cycle is given for set to M value distance 3 from P picture to next P picture from 0 to 14. Frame sequence is different from the frame of encoder and displayed. Figure 1 show the example of temporal picture structure.

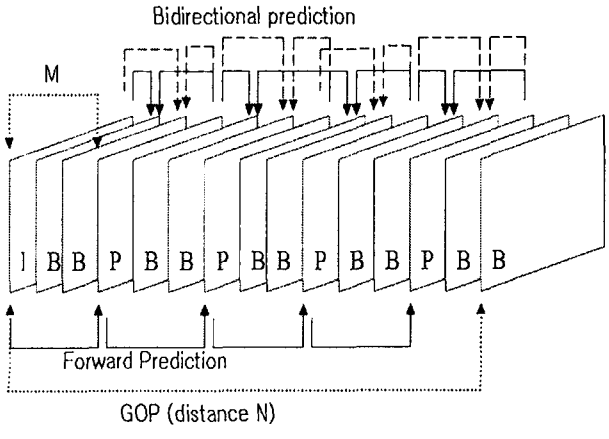

Figure 1 Example of temporal picture structure

3. Scene change on compressed video

Passing of video data divide cut, shot, and episode etc. Construct of video is framed that corresponding to film is smallest unit of displaying in one picture. The cut is scene change in video, and shot is smallest part of video denomination film by one camera action, and episode is units that consist with logical same contents by serial shot. Therefore, structured video is consisted of serial divided episode by contents conversion, and each episode is consisted of shot that is unit of scene change. The cut is part that scene change consists in video, and shot is smallest part of video denominations that is divided with cut and is filmed by one camera action. Usually, the scene change is happened in shot and cut. Figure 2 show the sequence construction of video.

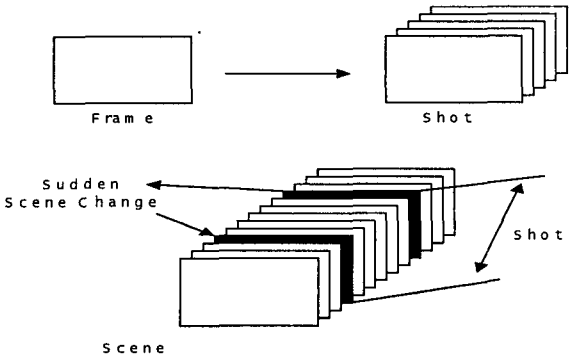

Figure 2 Sequence construction of video

The scene change is divided by rapid transition and gradual transition. In camera, change rapid transition is that break and fade-in, fade-out video and gradual transition by various kinds edit effect such as dissolve. It is not scene changes that consider the moving of camera such as zooming and panning. Also, video division is greatly divided division by non-compression video stream and division by compression video stream according to the object picture. Scene change is when brightness value excesses the threshold value comparing confrontation pixel between two frames in SCD detector method about existent non-compression video stream. But, this method has shortcoming in partial change in picture. Histogram comparison method was proposed for solving these problems. It is judged as scene change when histogram variety exceeds any threshold value. There are two methods on using histogram. One is histogram comparison method; it is compared with histogram difference of each pixel. It is judged as scene change when histogram distribution is less than regular threshold value. Difference of pixel brightness value is decided with histogram of pixel on same position because changing of pixel value distribution is random when scene change is occurred. Another

method use difference of average brightness, it is judged as scene change when difference of average brightness value of current frame dividing with previous frame exceeds threshold value. But these methods did not reflect contents information of video figure, color, and texture etc because mainly depend on distribution of brightness value of picture.

4. Proposed algorithm for Scene change detection

Proposed algorithm is able to detect scene change using coefficient of forward predicted macro-block, backward predicted macro-block, and intra-coded macro-block in motion estimation and compensation. Forward predicted macro-block means correlation of previous picture, backward predicted macro-block means correlation of next picture, and intra coded macro-block means correlation of previous picture on I-picture. Therefore, pictures don't have correlation of previous and next picture when scene changes occur.

Scene change is decided as comparing with coefficient of three macro-blocks of I, P, and B-picture of previous or next position and coefficient of three macro-block of current picture. Value of forward predicted macro-block, backward predicted macro-block, and intra-coded macro-block are get by calculating coefficient of macro-block of each picture. Whole size is decreased by dividing value each macro-block with 10. Macro-block value of previous picture, next picture and current picture compare with previous setting bound value. Correlation of current picture is decided with coefficient value of intra coded macro-block and if their values are more than 20 it don't have correlation of previous and next picture. And correlation of previous or next picture is decided with value of backward predicted macro-block and forward predicted macro-block when it's value is 0, it don't have correlation and it's value is more than 10, it have correlation. If scene changes exist then correlation of previous picture is nothing and correlation of next picture is exist only.

If the scene changes occur on I-picture then B-picture doesn't predict moving to reference I-picture on pictures, and don't perform the forward motion estimation of P-picture. Therefore coefficients of backward prediction macro-block on the previous two B-pictures are 0. Also coefficients of backward predicted macro-block on the previous P-picture are 0. It is same the following function.

$$F\_MB[i-1]>10\ \&\ B\_MB[i-1]==0 \quad (1)$$

$$F\_MB[i-2]>10\ \&\ B\_MB[i-2]==0 \quad (2)$$

$$I\_MB[i+1]>20\ \&\ B\_MB[i+1]==0 \quad (3)$$

At here, F_MB is forward prediction macro-block, B_MB is backward prediction macro-block, I_MB is intra-coded macro-block, and i is frame's number.

If the scene changes occur on P-picture then previous B-picture doesn't motion estimation to reference P-picture, and don't perform the forward motion estimation of P-picture. And next B-picture doesn't motion estimation to reference P-picture. Therefore coefficients of backward prediction macro-block on the previous two B-pictures are 0 and coefficients of intra-coding macro-block are more than 20 according to the current image are coded. And coefficients of forward prediction macro-block on the next two B-pictures are 0.

$$I\_MB[i]>20\ \&\ B\_MB[i]==0 \quad (4)$$

$$F\_MB[i-1]>10\ \&\ B\_MB[i-1]==0 \quad (5)$$

$$F\_MB[i-2]>10\ \&\ B\_MB[i-2]==0 \quad (6)$$

$$F\_MB[i+1]==0\ \&\ B\_MB[i+1]>10 \quad (7)$$

$$F\_MB[i+2]==0\ \&\ B\_MB[i+2]>10 \quad (8)$$

If scene changes occur on first B-picture then coefficients of forward prediction macro-block on current B-picture are 0. And coefficients of forward prediction macro-block on next B-picture are 0. Also coefficients of intra-coding macro-block are more than 20. Because it doesn't perform forward motion estimation on the current picture and next coming B-picture. And it doesn't perform forward motion estimation on next coming P-picture.

$$F\_MB[i]==0\ \&\ B\_MB[i]>10 \quad (9)$$

$$F\_MB[i-1]>10\ \&\ B\_MB[i-1]==0 \quad (10)$$

$$F\_MB[i+1]==0\ \&\ B\_MB[i+1]>10 \quad (11)$$

$$I\_MB[i+2]>20\ \&\ B\_MB[i+2]==0 \quad (12)$$

If scene changes occur on the second B-picture then the current picture doesn't perform the forward motion estimation to reference previous B-picture, and previous B-picture don't perform the backward motion estimation to reference the current picture. Also on next coming P-picture don't perform the forward motion estimation. Coefficients of the forward prediction macro-block of the current picture and coefficients of the backward prediction macro-block of the previous picture are 0. So, next picture is performed intra coding and coefficients of intra coded macro-block are more than 20.

$$F\_MB[i] == 0 \,\&\, B\_MB[i] > 10 \quad (13)$$

$$F\_MB[i-1] > 10 \,\&\, B\_MB[i-1] == 0 \quad (14)$$

$$I\_MB[i+1] > 20 \,\&\, B\_MB[i+1] == 0 \quad (15)$$

If each function is all true using the given functions according to each picture on processing to code video sequence then it is judged with scene change.

5. Results of Experiment

We used two MPEG video sequences for experiment of proposed scene change detection algorithm. Experiment video sequences profile is MP@ML 320×240 size, 25 frames rate, GOP structure is 15 frames, and bit-rates is 1.5Mb/s. They are TV broadcasting program of TM5 video sequence and consist of 1000 frames. Test01 sequence is document video and test02 sequence is show program video. This will allow us to test our algorithm on MPEG artifacts due to the compression. The two video sequences contain several scene change contents, and camera motion.

Table 1 show scene change detection results of test01 sequence by using proposed algorithm. There are five scene change in test01 sequence and can detect all scene change by proposed algorithm.

Table 1 Scene change of test01 sequence

	1	2	3	4	5
Scene change at frame#	22	131	287	480	745
Picture type	B	B	B	I	B
Detection of proposed SCD method	D	D	D	D	D

D: Detection, X: Don't detection

Table 2 show scene change detection results of test02 sequence by using proposed algorithm. There are three scene change in test02 sequence and can detect all scene change by proposed algorithm. The scene change of 2nd is B-picture, 3rd is I-picture, 4th is P-picture. Therefore proposed algorithm can detect scene change any position on MPEG sequence.

Table 2 Scene change of test02 sequence

	1	2	3	4	5
Scene change at frame#	163	221	300	687	827
Picture type	B	B	I	P	B
Detection of proposed SCD method	D	D	D	D	D

D: Detection, X: Don't detection

Table 3 show the comparison performance of scene change detection compare with histogram method and proposed method. In the histogram method, the miss scene change detections are 1 at the test01 sequence and 2 at the test02 sequence. But proposed SCD method is none miss. Histogram method demand additional calculation and memory to obtain histogram of picture for the scene change detection. But proposed algorithm not required additional memory and reduce calculation amount, since it compare with coefficient of macro-block on getting motion estimation and selected threshold.

Table 3 Comparison performance of scene change detection

Video sequence	Number of frame	Number of scene change	Histogram method	Proposed method
Test01	1000	5	4	5
Test02	1000	5	3	5

6. Conclusion

We proposed scene change detection algorithm using coefficient of forward predicted macro-block, backward predicted macro-block, and intra-coded macro-block in motion estimation and compensation on MPEG domain. Scene change is decide as comparing with coefficient of three macro-block of I, P, and B-picture of previous or next position and coefficient of three macro-block of current picture.

Proposed algorithm can detect scene change any position on MPEG sequence. Proposed algorithm can detect all scene change and more efficient compare with histogram method. This algorithm is able to remarkably reduce times and calculation complexity for drawing special value of picture and can be able to process with little memory, and reduce time delay

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