Fast Mosaic Detection for Real-time Video Based on Template Matching Strategy

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***Abstract*—Currently, most of the existing algorithms about mosaic video detection are complex and time-consuming, suitable for off-line video. For real-time video, fast and simple mosaic detection is important. This paper proposes a kind of mosaic template matching strategy for fast detecting mosaic defects in real-time video. First, we analyze the feature of mosaic edge image and preset some templates of mosaic block. Secondly, we use the Canny edge detector algorithm to get the edge image, and then pre-process it in the horizontal and vertical directions. Finally, we detect the mosaic point of intersection with the template matching strategy. The experimental results show that the proposed method can efficiently and quickly detect the mosaic image, which has actually been implemented on probation in a TV station.**

***Keywords*—template matching; mosaic; edge detection; real-time video; canny operator**

I. INTRODUCTION

With the development of digitized video signal, a television program is compressed and coded before transmitted, and decoded after the Set Top Box (STB) receives it. Therefore, a degraded video could be possibly caused by data loss and bit error. Traditionally, manual overseeing, a primary method of finding video defects in TV video signal quality monitoring systems, is time-consuming and hard sledding. As computer technologies have been generally used in the video detection field, digital image analysis and signal processing are increasingly employed to automatically detect video quality index in TV program monitoring systems. On the other hand, because of the large number of video programs, manual detection is impractical.

Video defects, such as a black frame, frozen frame and mosaic block, frequently appear in TV video [1]. However, the two former can be easily distinguished, and the latter that causes degraded video is comparatively difficult to find. A scholar proposed a mosaic detection method according to the edge feature of gray image based on difference edge detection algorithm combined with the character of chromatism component signal [2]. Another scholar presented a mosaic detection algorithm of video image based on grid expansion [3]. This algorithm traverses the image pixels with the way of grid-based expansion and finds the rectangular area with similar pixels in the image, which is the mosaic. Another scholar [4] presented a fuzzy clustering based on FCM (Fuzzy C-Means) and a template matching method of detecting video mosaic pieces, which compares every point with one of four templates from the top-left corner to the bottom-right corner point-by-point. However, existing mosaic detection methods are basically complex and time-consuming, unsuitable for real-time video detection.

Therefore, in this paper we propose a simple and faster mosaic detection method based on template matching, which analyzes the feature of mosaic edge image and presets some templates of mosaic block, and then detects the mosaic defect quickly with the template matching strategy. It will shorten the time of detection, which is suitable for real-time video.

II. FEATURE EXTRACTION OF MOSAIC IMAGE

MPEG (Moving Pictures Experts Group) video stream is used in SDTV (Standard Definition Television). MPEG-2 basic stream of digital video is based on a layered structure that consists of six layers: video sequence, group of pictures, picture, slice, macro-block and pixel block. Among these layers, except for the macro-block layer and pixel block layer, the data of the rest four layers are all started with corresponding Start Code (SC), acting as a role of synchronization marking code which is a specific code different from the other data. Once a transmission error code or loss of synchronism appears for some reason, the decoder can cast about for new Start Code to achieve synchronization. So the desynchrony effect is limited within the corresponding layer, while the video stream has the data loss or error bits [5]. SDTV signal is mostly transmitted as MPEG-2 video stream. Because MPEG-2 coding is based on Discrete Cosine Transform (DCT), the distortion area of the degraded video always appears as a block or bar, which is regarded as mosaic block in digital TV video. The original image is shown in Fig. 1(a). As a result of the data loss or bit error, the encoder cannot work, and then the image decoded based on DCT displays a mosaic block, as shown in Figure 1(b).

(a) (b)

Figure 1. (a) Original image (b) Mosaic image with DCT

The feature of the mosaic image as illustrated above is obvious that the mosaic area has monochromatic blocks, and the blocks take on the same size. Furthermore, it shows single grey in the same block. While we use some methods of edge detection to get the edge of the image, a square or half-baked square will come forth in the mosaic area. Owing to the advantage of the Canny algorithm in image edge detection domain [6] [7], we use the Canny edge detection to get the edge image of Fig. 1 respectively, as shown in Figure 2(a) and (b). Differing from other parts in the image, the mosaic area has the obvious character that the edge of the mosaic block is trenchant, and the edge image with mosaic block displays the rectangle shape. Though some edges on the side of the mosaic block cannot be extracted because of the discrepancy of gray scale within adjacent blocks is too small, we can still detect the mosaic point of intersect with the template matching.

(a) (b)

Figure 2. (a) Canny detect result of original image (b) Canny detect result of mosaic image

The scholars [8] defined the template of the four rectangle corners and five mosaic block combinations as shown in Figure 3, and then they used the template matching to find the four corners of the rectangle. If the corners found fit one of the five mosaic block combinations as shown in Figure 3(b), then they can draw the conclusion that it is a mosaic block. However, in the process of detecting, because of the use of a complex detection algorithm based on support vector machine (SVM), it does not meet the demand for real-time video. In order to detect the mosaic faster, the scholars [4] and [9] defined the four "T" shape as the template of mosaic detection, as shown in Figure 4, which mainly searched the point of intersection around four mosaic blocks. As long as the point of intersection is found, four mosaic blocks around it will be detected. It shortens the time of detection, so that it is faster than the former method. But it is a pity that the mosaic blocks detected are incomplete, such as shown in Figure 5 [9]. In Figure 5(b), the crisscross points that had not been marked obviously belong to the mosaic point. Thereby, the number of points searched is below the threshold, and we can't regard it as mosaic image.

(a) (b)

Figure 3. (a) Template of the four rectangle corners; (b) Mosaic block combination

Figure 4 Template of the four "T" shape

(a) (b)

Figure 5. (a) Edge image with mosaic blocks; (b) Detect result of mosaic point marked with "*"

Considering each strongpoint of detection methods aforementioned, we defined a new template including "T" shade and crisscross, as shown in Figure 6. It seems complete comparatively.

Figure 6. "T" shape and crisscross template

III. Mosaic Detection Based on Template Matching

Most of existing mosaic detection algorithms are complex and time-consuming, which is unsuitable for real-time video. This paper proposes a simple and faster mosaic detection algorithm based on template matching. According to the above-mentioned analysis, the idea of a mosaic detection algorithm is illustrated as follows:

A. Calculating the Gray Gradient of Image

Using the Canny operator for edge detection, we compute the horizontal and vertical gray gradient respectively, namely the first derivative of gray.

B. Gaining the Binary Edge Image

After the gray gradient of image is calculated, it will designate where the edge line locates. In other words, binarization and edge detection will work on this image. According to the threshold selected, we make the gray gradient binary in the horizontal and vertical directions. If the value of the gray gradient is higher than the threshold selected, it will be set as 255; otherwise it will be set as 0. Thus, we get the binary edge image. The threshold is lower, and the more edge lines will be detected, and at the same time, the detection result is more easily affected by image noise. And conversely, if the threshold is higher, some edge lines will be lost, and it will cause some loss of picture detail.

C. Preprocessing the Edge Image

First, we sum the binary values of the gray gradient located in the same column in the vertical direction and then average the result. If the average is greater than or equal to the line threshold, we will draw a gray gradient line from the top down to indicate an edge line in this column. The line threshold is one ratio of 255. If the average is less than the line threshold, we will do nothing by contraries. And then, we do the same work in the horizontal direction; thereby we get two gray gradient line pictures in the horizontal and vertical directions.

D. Detecting the Mosaic Point of Intersection with Template Matching

The point where the horizontal and vertical gray gradient lines intersect is possibly the mosaic point of intersection, so it needs to be further detected. Centered around the candidate point, we count the number of points that binary value of gray gradient is 255 from the left, right, top and down directions respectively, as shown in Figure 7. If the number of points detected equal to the width or height of mosaic block in three or above directions, namely in accordance with one of the five templates as shown in Figure 6, then we can draw the conclusion that the point is the mosaic point of intersection with template matching.

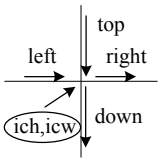

Figure 7. Detect mosaic point of intersection

E. Distinguishing the Mosaic Image

As mentioned above, if the mosaic point found is enough, the image can be regarded as the mosaic image. We trained many samples, and then set the number to 4 according to our experimental results.

IV. Experiment Results and Analysis

At first, we used the mosaic detection method based on template matching as mentioned above to detect the image as shown in Figure 2(b), and the result as shown in Fig. 8 is relatively exactly like Figure 5(b). That is to say the method is effective.

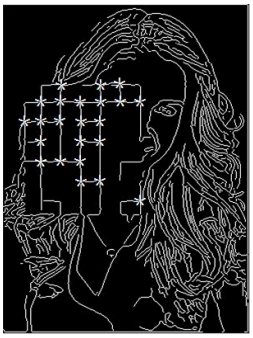

Figure 8. Detect result of mosaic point marked with "＊" on Fig. 2

Afterward, we applied the detection to our Digital TV Head laboratory and Media Assets Management laboratory, and detected the defects of digital video frames. The frame size of SDTV video is 720×576 pixels and the frame frequency is 25Hz. We regarded the detection speed, recall rate and false alarm rate as evaluation index in the experiment. Detection speed is the frame number of detecting per-second or the detecting time of one-minute video. The recall rate is the percentage of frames with mosaic block detected as mosaic frame. The false alarm rate is the percentage of frames without mosaic block as mosaic frame. The detection time depends on the bit-rate and picture scaling factor, and experiment results are shown in Table 1. It indicates the detection speed is fast; suitable for real-time video. As a consequence, we suggested 1:1 picture scaling for good performance of detection. If the detection speed needs to be faster, we can select 1:2 picture scaling.

TABLE 1. Detection Time of Different Videos

Video Bit-rate	Time of Different Video	Detection Time with Different Picture Scaling		
		1:8	***1:2***	***1:1***
25Mbps	12:13	6:05	6:28	9:08
	11:05	5:10	5:48	8:13
	10:32	4:57	5:41	7:19
	9:53	4:53	5:24	7:01
	9:03	4:34	5:03	6:33
	8:55	4:28	4:49	6:29
	7:58	3:46	4:14	5:50
500Kbps	16:07	3:10	3:19	4:29
	15:51	3:08	3:13	4:17
	15:09	3:04	3:08	4:13
	14:34	3:02	3:03	4:05
	9:45	1:40	1:42	3:50

Moreover, statistical analysis showed that the recall rate is about 98.3% and false alarm rate is about 3.5%. The recall rate will change while adjusting the threshold of mosaic points, and the false alarm rate will go up in some complex background.

V. Conclusion

The mosaic detection based on template matching presented in this paper has actually been implemented on probation in Zhejiang TV stations. It was widely applied at the Broadcasting Centre and the Resource Centre. The given alarm is in the form of sound or character. The response from users is that the detection software is kept in functional order. But some Chinese characters have the mosaic block feature in edge images, and while the game of go appears in the video image, it will cause error. Our future work will focus on distinguishing Chinese characters from real mosaic block.

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References

[1] F. Zhou, and J. Wei. "Monitoring black frame and frozen frame on TV video," *Cable Television Technology*, no. 16, pp. 89-92, 2005.

[2] M.-S. Su, W.-L. Hwang, and K.-Y. Cheng. "Analysis on multiresolution mosaic images," *IEEE Trans. Image Process,* vol. 13, no. 7, pp. 952-959, 2004.

[3] F. Ning, and F. Ye. "A mosaic detection algorithm of video image based on grid expansion," *Computer and Modern*ization, vol. 194, no. 10, pp. 63-65, 2011.

[4] Z. Liang. "Video mosaic block detection based on FCM and template matching," *Software*, vol. 33, no. 2, pp. 129-132, 2012.

[5] G. T. Jones, D. J. Parish, and I. W. Phillips. "A transform domain feature detection and concealment algorithm for errors in DCT encoded images," *Computers & Graphics*, vol. 25, pp. 671-680, 2001.

[6] Z. Chen, and L. Gao. "Optimized Canny operator edge detection," *Electronic Test*, no. 6, pp. 43-46, 2011.

[7] D. Demigny. "On optimal linear filtering for edge detection," *IEEE Transactions on Image Processing*, vol. 7, pp. 728-737, Nov. 2002.

[8] X. Huang, H. Ma, and H. Yuan. "Video mosaic block detection based on template matching and SVM," in *The 9th International Conference for Young Computer Scientists*, Nov. 18-21, 2008, pp. 1082-1086.

[9] S. Sun, B. Lei, J. Liu, and S. Zheng, "Efficient digital video defect detection based on OpenCV," *Computer Engineering and Applications*, no. 32, pp.144-146, 2010.