Mosaic Defect Detection in Digital Video

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Abstract: The video quality can be degraded because of physical problems such as repeated projection, low-quality compression/decompression, or bad chemical decomposition of the original recording material. It becomes increasingly important to locate degraded video (video with defects) with the wide application of digital media. One common video defection is mosaic, where several even square combined together and the original image information is lost. In this paper, after analyzing the characteristic of the mosaic defect in detail, a mosaic defection detection approach in the spatial domain is proposed. Four even squares are detected firstly and the intersection points of these squares are selected as the features of mosaic macro block (MMB), and a mosaic consists of several MMBs. On the other hand, a fast and effective detection algorithm in the edge domain is proposed based on the analysis of existing approaches. Two tricks are adopted to speed up the detection: a new template matching strategy and the preprocessing of the edge image. Experiments are carried out and the results show that the proposed algorithms have good performance.

Key Words: Digital Video Defect; Detection; Spatial Domain; Edge Domain;

1 INTRODUCTION

Video defects are mainly caused by e.g. storage conditions (moisture, vinegar syndrome, dye fading), improper handling (scratches, dust, dirt), and/or poorly maintained equipments (scratches, unsteadiness). There exist a large amount of valuable video resources that have been contaminated by various kinds of defects. To recover those video data [1-4], it is crucial to first locate those defects. A direct way to locate the defect is to scan the video by the human being. However, there are too many such video to scan frame by frame. On the other hand, the results got by this way is affected greatly by the 'scanner'.

Computer vision aims at migrating human being's vision capabilities onto a normal computer. Then the computer can automatically understand surround situations to assist people in making decisions and/or to direct itself carrying out work that cannot normally be done by people. Recently, computer vision applications are booming not only in industry fields but also in everyday life [5]. Two biggest advantages brought by computer vision are efficiency (so subsequent action can be carried out immediately) and automation (so work can be done without intervention). For this purpose computer vision technique is the perfect choice to detect the defect in the video for its advantages mentioned in above.

There exist various kinds of digital video defects. Their characteristics can be totally different from each other. There have been some efforts by the BRAVA consortium [6] during 2000–2002 attempting to standardize for the community the names and types of defects that can occur in archived videos and films. An exhaustive list of descriptions is given at [7]. The defect detection in degraded video has also been studied for a long time. A pioneer work on designing an automatic system to detect dirt and sparkle was carried out by Storey at the BBC as early as 1985 [8]. A natural extension of this idea was presented by Kokaram around 1993 that is built on top of motion compensated differences to tolerate possible movement in-between [9]. This type of detector is named 'Spike Detection Index' (SDI). In 1996, Nadenau and Mitra proposed the Rank Order Detector (ROD) that uses a spatial-temporal window for inference [10].

In this paper, the characteristic of image with mosaic is analyzed in detail. Two mosaic defection detection algorithms are proposed. Several images with mosaic is tested with the proposed algorithms and the performance of the algorithms is compared with the existing approach. The paper is organized as follows: The video mosaic defects to be tackled are introduced and analyzed in detail in Section 2. Two simple while effective mosaic flaw detection algorithms are proposed in Section 3, one in spatial domain and another in edge domain. Experiment results are then shown in Section 4. And finally conclusions are drawn in Section 5.

2 MOSAIC DEFECTION

As shown in Fig. 1, a mosaic consists of several solid color square, or Mosaic Block (MB). The edge maps of the original image and the mosaic-contaminated correspondence are shown in Fig. 1(b) and (d) respectively. The edge regularities caused by the MBs are obvious. It should be pointed out that there is no edge information between MBs with same

Fig. 1. Original image (a) and edge (b), as well as mosaic image (c) and edge (d).

intensity.

3 MOSAIC DETECTION

In the following subsection, two mosaic defection detection algorithms will be proposed in the spatial domain and the edge domain, respectively.

3.1 Mosaic Detection in spatial domain

In the spatial domain, according to the characteristic of the mosaic, we can detect the mosaic with the following two steps: 1) detect the even square; 2) get the edge of the even square. The intersection point O of the edge is detected and a mosaic macro block is detected, as shown in Fig. 2. For a given point O in an image, we can calculate two moments as the feature of the MB, i.e. mean and variance. Say that M_A and D_A are the mean and variance of square A, respectively. And M_B, M_C, M_D and D_B, D_C, D_D are the means and variances of square B, C and D, respectively.

If D_A is greater than a threshold D_{th}, which means the square is not an even field, move O to the next pixel. Otherwise, using the same method on D_B、D_C、D_D to check the other 3 squares are MBs or not.

If the variances of the four squares are small enough, we can use the difference of the means M_A, M_B, M_C, M_D to tell whether the four squares come from a mosaic macro block and the point O is the cross point of four MBs. For example, if the difference of the means M_A, M_B is greater than a threshold M_{th}, we can say that there is edge between this two squares field and each square is a MB.

It should be noted that if D_{th} is set to zero. All pixels of a square should have exactly the same value if the square is a MB. So, to make the algorithm is robust to the noise, it is better to set D_{th} bigger than zero, and adjust it according to the noise density of the image. For the threshold M_{th}, the bigger the parameter M_{th} is, the harder the four squares being looked

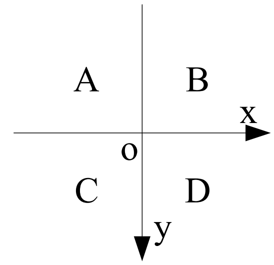
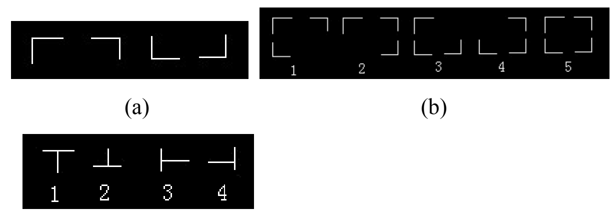


Fig. 2. Detect the mosaic macro block in the spatial domain. A, B, C and D are four connected even field with different gray value. The edges of these four fields intersect at the point O.



(a) (b)

(c)

Figure 3. Templates for th Mosaic detection. (a) Templates of the four rectangle corner used in [11], (b) Mosaic block template combinations in [11], (c) Our template.

as the MMB of mosaic, especially when the image is a gray image converted from a color image. To overcome this problem, we can use the following method to decide a four squares field is come from a MMB of mosaic if the difference of any three square field is greater than M_{th}.

3.2 Mosaic Detection in edge domain

As shown in Fig. 1, the edge regularities of mosaic is obvious. In [11], four rectangle corners, as shown in Fig. 3(a), are used as the detection templates. If three or four of such corners are found, then a MB is declared (there are in total five kinds of MB combination, as shown in Fig. 3(b)). When the number of detected MBs is bigger than certain threshold, the frame is detected as a frame with mosaics. To speed up the detection process, a simpler template matching algorithm is proposed to locate the mosaics in this paper. Instead of detecting each MB directly, we locate the intersections of four MBs. The templates adopted for the intersections are shown in Fig. 3(c). As we will see, for the proposed approach, if any one template is found in the frame, four MBs are also found. This will greatly save the computation time. Moreover, beforehand, a preprocessing procedure can be carried out with all the possible MB intersection positions as the output. The template matching will then only need to be done at these positions, speeding up the whole detection process even further.

Considering the above analysis, a mosaic detection algorithm is proposed as follows:

Step1: For a given original image, such as image a in Fig. 4, calculate the edge map of the image (b in Fig. 4, Edge map is a binary image, and we can get it by Canny edge detection [12]).

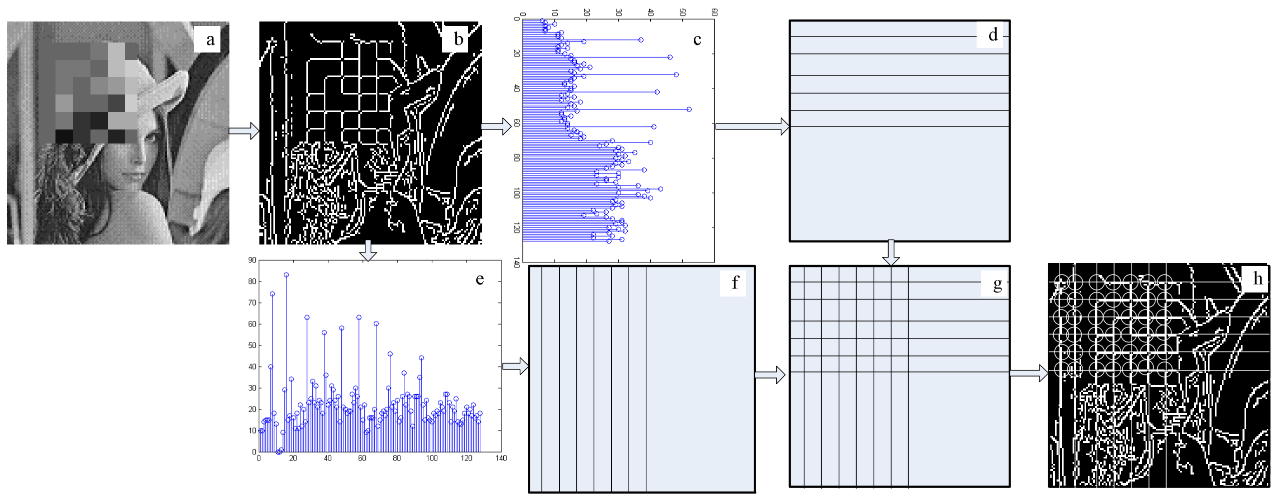


Figure 4. Preprocessing for the mosaic detection.

Figure 5. The image with mosaic, (a) is big mosaic, (b) is middle mosaic, (c) is small mosaic, (d) is all mosaic.

Figure 6. Detected results with the spatial domain approach, where '+' is the position of MB crossed, and (a), (b), (c), (d) are the results of corresponding to the (a), (b), (c), (d) in Fig. 5.

Step2: Get the image line with the following procedure:

a. In the horizontal direction, sum the edge values (0 or 1) of the edge image with the same column number and get the horizontal image line (a vector and the dimension of it is same as the height of the image), as shown in Fig. 4c. Get the vertical image line by doing so in the vertical direction, as shown in Fig. 4e (Note that the processing in those directions can be done in parallel).

b. If the value of an image line, for instance in the horizontal direction, is smaller than certain threshold, the pixels on this line are definitely not the edge points of any processing can be carried out in another direction.

Step3: For the pixels on the intersections of the horizontal image lines and vertical image lines, if any one of the four templates given in Fig. 3(c) is detected, four MBs can be declared.

Step4: If there are enough number of MBs located in the frame, the frame is can be declared as a frame with the mosaic defect.

The algorithm diagram of the preprocessing for mosaic detection is shown in Fig. 4.

4 EXPERIMENTAL RESULT AND ANALYSIS

The spatial resolution of the video is 512*512, and the image is added different mosaic, as shown in Fig. 5. Fig 5. (a) is added the biggest mosaic in the face of the girl, (b) middle mosaic, and (c) smallest mosaic. Fig 5. (d) is added mosaic in the whole image.

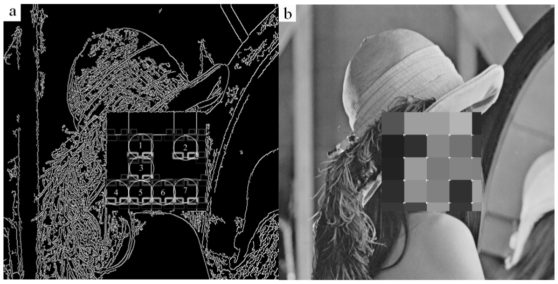


Figure 7. Detected results with the edge domain approach, where the detected even square with the approach proposed in [11] is noted by a circle. The note '+' is the position of MB crossed with our approach. As shown in the figure, all cross are detected.

4.1 Mosaic Detection in spatial domain

The detection results with the spatial domain approach are shown in Fig. 6. As shown in Fig. 6, for image with big mosaic, the false alarm ratio is lower than that of image with small mosaic.

4.2 Mosaic Detection in Edge domain

As shown in the figure, there is total 7 MBs is detected in Fig 7. (a). However, all cross are detected in Fig 7. (b). The results show that the proposed algorithm is highly robust.

5 CONCLUSION AND FUTURE WORK

In this paper, we propose an automatic video defect detection approach to locate several kinds of defects in video frames. A simple while effective algorithm is designed specially for mosaic frame detection. Experiments are carried out and the results show that the proposed algorithm is highly efficient and robust. In the future, the idea of the proposed approached can be widely applied to solve other problems for degraded video defect detection, such as digital drop out, betacam dropoput etc. [13].

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REFERENCES

[1] D Bertalmo M, Bertozzi A L, Sapiro G. Navier-stokes, fluid dynamics and image and video inpainting, Proceedings of IEEE Conference on Computer Vision and Pattern Recognition, Hawaii, 2001:355-362.

[2] Kwatra V, Schodl A, Essa I , et al. Graphcut textures: image and video synthesis using graph cuts. ACM Transactions on Graphics, 2003, 22(3):277-286.

[3] Wexler Y, Shechtman E, Irani M. Space-time completion of video. IEEE Transactions on Pattern Analysis and Machine Intelligence, 2007, 29(3):463-476.

[4] ZHANG Hong-ying, PENG Qi-cong. A Survey on Digital Image Inpainting. Journal of Image and Graphics. 2007, 12(1): 1-10.

[5] A Forsyth and J. Ponce, Computer Vision: A Modern Approach, Prentice Hall. 1st edition (August 14, 2002).

[6] http://brava.ina.fr.

[7] http://brava.ina.fr/brava_public_impairments_list.en.html.

[8] R. Storey. Electronic detection and concealment of film dirt, SMPTE J., pp. 642-647, June 1985.

[9] A.C. Kokaram, Motion Picture Restoration: Digital Algorithms for Artifact Suppression in Degraded Motion Picture Film and Video. Berlin, Germany: Springer-Verlag, 1998.

[10] M. J. Nadenau and S. K. Mitra, Blotch and scratch detection in image sequences based on rank ordered differences, in Proc. 5th Int. Workshop on Time-Varying Image Processing and Moving Object Recognition, Sept. 1996.

[11] Xiaodong Huang, Huadong Ma, Haidong Yuan. Video Mosaic Block Detection Based on Template Matching and SVM, The 9th International Conference for Young Computer Scientists, 18-21 Nov. 2008, Page(s):1082-1086.

[12] Canny, J., A Computational Approach to Edge Detection, IEEE Trans. Pattern Analysis and Machine Intelligence, 8(6): 679–698, 1986.

[13] Anil C. Kokaram. On Missing Data Treatment for Degraded Video and Film Archives: A Survey and a New Bayesian Approach. IEEE Trans. Image Processing, Vol.13, No.3, Mar 2004

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