ROBUST BLOCK-BASED TV LOGO DETECTION AND INPAINTING

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ABSTRACT

A new block-based logo detection algorithm is proposed in this work to efficiently detect various kinds of logos in any position in the TV videos. The proposed system employs several observations such as logo present, shot distribution knowledge and logo characteristics to detect the real TV station logo and exclude subtitles in the TV broadcast video. In addition, the side-match vector quantization technique is employed to inpaint the detected logo region in order to obtain the restored image. The proposed system have been tested on several hours of real TV videos and achieving 99% correct labeling.

1. INTRODUCTION

Logos are widely applied to television (TV) programs to announce the copyright of the producer thereof or the service provider. Most program watchers feel bothered while the logo occupies a corner of a screen of a TV set or a monitor. In addition, the display cells for displaying the logo on the PDP (Plasma Display Panel) will burn out or have lower performance in contrast to the other display cells on the PDP some day. A program recorded in an optical disc such as a digital versatile disc (DVD) would probably have a logo for similar purposes. Therefore, the fully automated logo detection algorithm is needed to overcome these problems [1, 2, 3, 4].

A TV station logo is designed precisely to be easily distinguishable from the rest of the scene. There are several visual characteristics corresponding to this property. First, logos have very sharp inner and outer edges and high contrast of neighboring logo regions. Second, pixels inside the logo are going to be relatively static. Since the above characteristics are inherent for logo regions in video frames, this specific region could be detected. Several papers have been proposed to detect TV logos [5, 6]. The previous work assumes that the logo is the only one static object in video frames; however, there are various kinds of special effects such as subtitles in current TV videos and they will affect the correction of logo detection.

In this paper, we proposed a block-based algorithm to efficiently detect TV station logos in videos for various kinds of purposes such as commercial detection, logo removal and etc. The hierarchical block-based scheme and shot distribution knowledge are employed to quickly check the static regions so-called logo candidates in videos. Then, multiple-scan lines are used to analyze the logo position and size in order to determine the final logo region. Finally, the side-match technique is employed to inpaint the logo region [7]. According to simulation results, our proposed algorithm can successfully detect TV station logos and obtain a restored video clips.

The rest of this paper is organized as follows. Section 2 reviews the characteristics of the TV logos. The proposed block-based logo detection algorithm is described in Section 3. Section 4 discusses the ways to inpaint the detected logo region. Simulation results are shown in Section 5. Concluding remarks are given in Section 6

2. BACKGROUND

Before we detail algorithm of logo detection, the paper will mention the types of logos we want to detect. In general, logos can be grouped into the forms of opaque, transparent ,and animated. The adjacent frames of opaque logo are identical so that it makes the logos easiest to detect in that we can simply seek out the value of pixels that stay consistent. In fact, the values of pixels in the case of opaque logo are variable, but the value of its vibration is subtle. On the another hand, it is not easy to detect the pixels of the transparent logo because it produces the value of pixels that is changing from frame to frame to make the user hard to trace the vibrations. The third case is animated logo which is such a complex case that makes values of the pixel change unpredictable from frame to frame. Meanwhile, it increases the difficulty of detection. In this essay, we will only present the process of opaque logos to correctly recognize the location of opaque loge.

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3. TV STATION LOGO DETECTION

3.1. Pixel-Based Logo Detection

The blockdiagram of the logo detection algorithm is shown in Fig. 1. In the first step, the system will divide the whole video clips into a sequence of the frames. The method to find the reference frame is to take the first one of the sequence of frame. At the same time, it must exist the logo in the reference frame in order to inquiry the difference between reference frame and others. In this step, we alter the color frame into the its luminance frame in which each pixel only contains gray pixel.

Then, the reference frame are subtracted by all the following frame. In addition, only the relative position of pixel can precess the procedure of subtraction. After the end of the subtraction, the system will create a register which is formed by the result value of the subtraction which is absolute value. The method of setting a new mask-array are formed by comparing the value of pixel in difference-array with a threshold. If the value of pixel in relative position of difference-array is beyond the threshold, we set the value in the same position of mask-array to be 0. Otherwise we set the value as 1 while the value is smaller than the threshold.

When the value of mask-array is 1, we assumes it might be the position of the logo, and repeated to do the fourth step and the fifth step. It means that we through each frame and compare it to the reference frames. When the value of mask-array is 0,we know that the relative position of the frame is not logo, and then we stop to do anything to the end. Finally, we should obtain a mask-array which included 0 (we decided that is not the position of logo)and 1(we decided that is the position of logo). So, we can use mask-array to extract the logo which is in the frame. In addition, the logo search is restricted to the four corners because of the position of logo always in the four corner of the frame. So, we decided that is not logo where is not in the four corners.

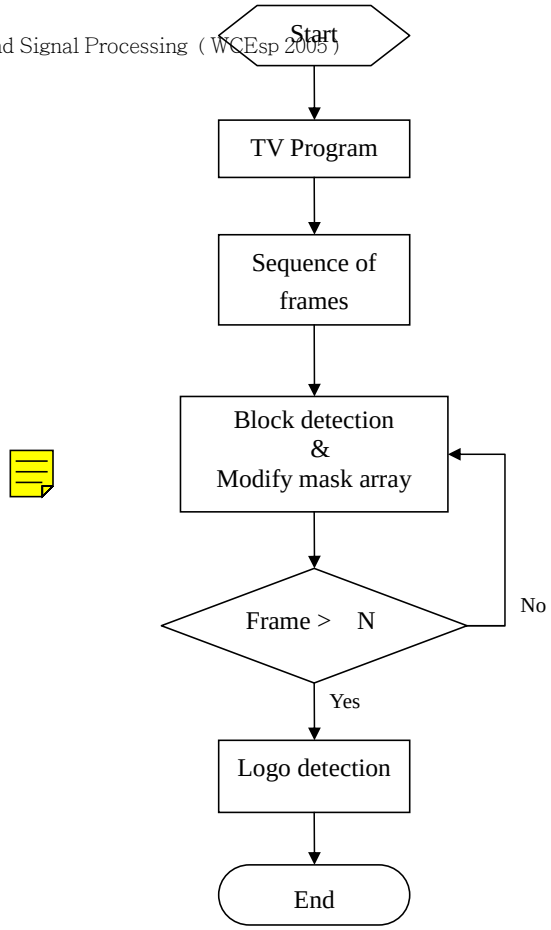

Figure 1: Illustration of the proposed logo detection scheme.

3.2. Block-Based Logo Detection

As for block-based logo detection, we will divide mask-array into numerous blocks which size maybe 2×2 array or 4×4 array or more. Then, the system will create a register to amount the 1 of mask-array in the block. On the other hand , we will create another register to amount the 0 of mask-array in the block. When the amount of 1 is great than the amount of 0, we assume that maybe the position of the logo and set all of the parameters in the block is 1, and repeated to do the fourth ,and fifth ,and sixth step. Otherwise, the amount of 1 is less than the amount of 0, we assume that is not the position of the logo and set all of the parameters in the block is 0, and then we stop to do anything to the end. Finally, we should obtain a mask-array which included 0 (we decided that is not the position of logo)and 1(we decided that is the position of logo). So, we can use mask-array to extract the logo which is in the frame.

In the previous algorithms, the logo search is restricted to the four corners because of the position of logo mostly in the four corner of the frame in order to avoid subtitles concern. However, it is not practice to assume the logo position in the four corner and restrict the logo size especially for nowaday TV programs. Therefore, we develop the multiple scanlines method to do the logo position and logo size analyses. The next section details this scheme.

3.3. Postprocessing

The above procedures select at least one of the candidate regions as logo regions for indicating the logos. A position analysis and a size analysis procedures are shown in Fig. 2, where the order of performing these two procedures can be changed. Referring to Fig. 2(a) as an example, none of the candidate regions 2, 4 and 5 which are crossed by vertical and horizontal scanlines is rejected in the position analysis procedure and will not be labeled as a logo region. On the other hand, the remained candidate regions, for example, the candidate regions shown in Fig. 2(b), are sorted by their sizes in the size analysis procedure. As a result, the first m largest candidate regions are selected as logo regions, where m is a positive integer. For example, if m is equal to two, the

candidate regions are selected as the logo regions. Therefore, the logos respectively represented by the candidate regions are detected.

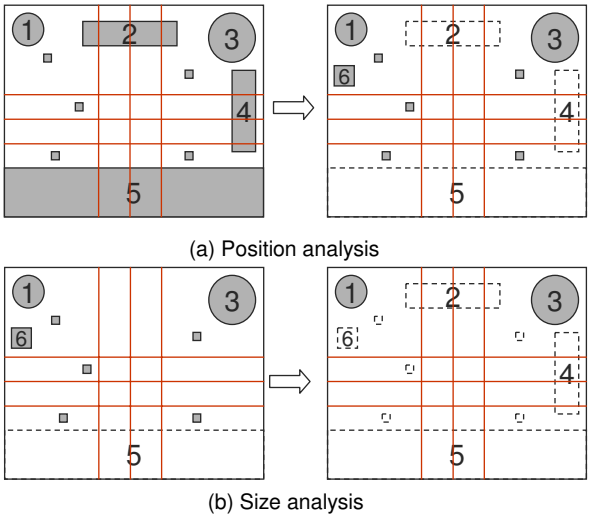

Figure 2: (a) position and (b) size analysis procedures via multiple scanlines.

4. LOGO REGION INPAINTING

Side-match vector quantization (SMVQ) is a well-known technique for still/moving image coding because of its low bit rate coding. SMVQ involves coding an image using information from the previous encoded image blocks. In this section, we leverage the SMVQ concept to achieve the logo region inpainting. The approach uses ideas from image content continuously from the exterior into the logo region to be inpainted. The detected logo region can be easily applied the SMVQ technique because our logo detection algorithm is the block-based method. Other VQ-related method such as gradient VQ also can be easily applied to smooth the boundary of the gradient of the detected logo region [8]. Finally, we can obtain the restored image without logos.

5. SIMULATION RESULTS

Experimental results are presented in this section to demonstrate the performance of the proposed block-based logo detection algorithm. In computer simulation, four well-known channels, CCTV, CTV, FTV and Hollywood are used to test our algorithm shown in Fig. 3. The tested MPEG-1 video sequences are in the CIF (352×288) format.

Figure 4 shows the TV station logo detection results for four different channels (CCTV, CTV, FTV and Hollywood) with the pixel level. Our proposed algorithm can successfully detect the TV station logos and exclude the subtitles. The multiple scanlines technique is very useful to select the real logo region and ignore the small region and compression noise effect.

Figure 3: Four well-known TV channels (CCTV, CTV, FTV and Hollywood).

Figure 4: Logo detection results of four well-known TV channels (CCTV, CTV, FTV and Hollywood) with pixel level.

Figure 5 shows the logo inpainting results in the luminance domain of FTV channel with side-match related technique in the luminance. As can be seen, the logo region can be inpainted perfectly even though the logo region contain some texture. Similar result for CTV cartoon content is shown in Fig. 6.

6. CONCLUSION

The block-based logo detection algorithm was proposed for TV content management for various kinds of purposes such as commercial detection, logo removal, PDP screen protection and other applications. The block-based hierarchical concept was employed to quickly find out the static region in

Figure 5: Logo inpainting results of FTV with side-match related techniques.

Figure 6: Logo inpainting results of CTV with side-match related techniques.

the videos. We transfer the domain knowledge on TV logos as multiple scanlines that are used to check the position and size of the logos to exclude the subtitles. Side-match related techniques are employed to inpaint the logo and try to get the acceptable results for human vision. As demonstrated in simulation results, TV logos can be isolated and recognized; therefore, logo detection has the ability to become a valuable tool for future digital home solutions.

7. REFERENCES

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