BILLBOARD ADVERTISING DETECTION IN SPORT TV

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ABSTRACT

Precise visibility measuring of billboard advertising is a key element for organizers and broadcasters to make cost effective their sport live relay. However, this activity currently is very manpower and time consuming as it is manually processed for the moment. In this paper we describe a technique for detection of commercial advertisement in sport TV. Based on some a priori knowledge of sport field and commercial advertisement, our technique makes use of fast Hough transform and text's geometry features in order to extract advertisement from sport TV images . Our experiments show that our technique achieves more than 90% accuracy rate.

1 INTRODUCTION

Multimedia indexing is a key technology for a large number of applications, ranging from media asset management to content-based alert and tracking. In this paper, we focus our attention on a key application for sport organizer and TV broadcaster which is visibility measuring of billboard advertising. For the moment, this application is very time and manpower consuming as it is only manually processed by operators. Such a solution becomes impractical especially when a series of matches, for instance football, takes place at the same time, or different versions of a sport event are broadcasted in different countries.

There exists in the literature a list of algorithms for automatic text extraction form digital video images. [1][2][3][4][5][6]. As we have discovered by our experiments, none of these techniques work. Basically, all these automatic text extraction techniques have been designed to extract artificial texts which are big enough, well lined and well contrasted with the background. However, for commercial advertisement in TV images, none of these properties remains true as we can see in Fig.1 . We rather have advertisement text which is small and appears in tilt rectangle or even trapezoid. They can also be partially occulted. The shape of the advertisement changes as well when camera moves in order to track sportsmen.

In this paper, we propose a technique for detecting billboard advertising according to some a priori knowledge such as geometry features and color of sport ground and billboard in TV images. Indeed, the size of any sport ground usually appears large in TV images. In order to reduce the computation complexity, we eliminate the part of sport ground from analysis for billboard advertising using simple color feature. As the advertisement billboard always appears between the sport ground and spectator stadium, advertisement regions are delimited by two parallel lines that we extract by a fast Hough transform [7]. Finally, advertisements are segmented by a histogram-based analysis which separates text from the background [1][8][9].

The rest of the paper is organized as follows : section 2 describes the principal steps of our billboard advertising detection and recognition system (BADRS). Section 3 depicts our fast Hough transform based method to extract parallel lines delimiting advertisement billboard from a TV image. Section 4 introduces histogram-based analysis for potential billboard regions detection. Section 5 shows some experimental results, conclusion and discusses future work.

2 THE ARCHITECTURE OF BDRS

In order to accelerate billboard region detection, we propose to perform some pre-procession in order to focus on potential billboard regions while filtering out regions of a TV image which actually correspond to sports ground (the lawn). This pre-processing is to delimiting potential billboard region segmentation (PBR). This step might lead to throw out the whole image from further processing if, for example, the sport ground occupies the whole image. The second step aims to segment the input potential billboard region into multiple advertisement texts delimited by small rectangle text blocks, tilt rectangle or trapezoid. Fig.2 gives the overview of the system architecture.

The first step of potential billboard region segmentation proceeds by converting an input color image into gray level image, applying Sobel filter for edge detection, then

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fast Hough transform on the resulted edge image for line detection. Generally, our fast Hough transform generates a set of lines from the edge image. We filter out two lines delimiting a potential advertisement billboard region by some a priori knowledge on the sport ground. The region delimited by these two lines is then considered as the potential advertisement billboard region. Advertisement regions are then segmented from the potential billboard region by a histogram-based analysis which has also been used in our automatic text recognition method [1].

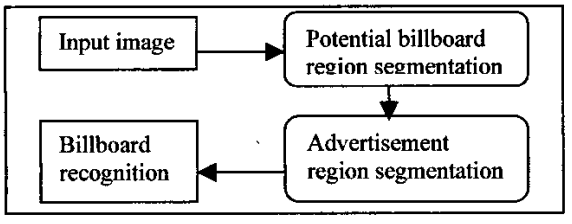

Figure 2. System of billboard detection and recognition.

3 PARALLEL LINES BASED SEGMENTATION AND HISTOGRAM ANALYSIS

The basic idea is to detect the two lines delimiting an advertisement billboard first for further analysis. A input RGB image is first converted into a gray level image. We then apply Sobel filter to obtain a binary edge image with the threshold (0.7~0.85). This edge image is smoothed by a median filter in order to eliminate noise. Our fast Hough transform [7] is then applied in order to detect lines on this smoothed edge image, usually generating less than 8 lines. Now we need to identify the two lines delimiting the advertisement billboard, leading to a potential billboard region (PBR). For this purpose, some a priori knowledge on sport ground is used. Indeed, as a billboard advertising aims at attracting attention of spectators, the designer usually sets up advertisement which strongly contrasts with its surrounding background. Furthermore, as the billboard is set up on the border of sport ground, the large contrast between sport ground color and the billboard's one is the first hint that we use in order to identify the first billboard delimiting line upper the sport ground. For instance, the ground of a football match is always green whereas the ground of a tennis match is red, orange or green.

We define f(x,y)=1 if I(x,y) $\in$S. S is the color set characterizing the color of a sport ground : S={ $r_0<r<r_1$, $g_0<g<g_1$, $b_0<b<b_1$, }. Consider a line CL detected by our fast Hough transform, we define the following indicators measuring color contrast between sport ground color and advertisement billboard color :

$$SUMB=\sum_{x,y} f(x+2,y) \qquad (x,y)\in CL \quad (3.1)$$

$$SUMU=\sum_{x,y} f(x-2,y) \qquad (x,y) \in CL \quad (3.2)$$

where I(x,y) is the RGB values of a pixel (x,y) within the image. Let SUM be the total number of points of CL. If

$$\frac{SUMB}{SUM}>0.55 \quad and \quad \frac{SUMU}{SUM}<0.2 \qquad (3.3)$$

then this line is determined as bottom line of a potential billboard. We denote this line by BLPB. Let R_0 and θ be the polar coordinates of BLPB line from Hough transform. We then have the following correspondence between Cartesian coordinates (x,y) and polar coordinates (R, θ) : tan(θ)=y/x and r=xcos(θ)+ysin(θ). In our implementation , formulas (3.1), (3.2), (3.3) are assessed less than seven times. They are very efficient to filter out false bottom billboard lines extracted from, for instance, outer runway and others building in stadium. They greatly accelerate processing time for BLPB detection.

Next step aims at detecting the upper line of the potential billboard (ULPB). As a TV sport image usually contains a part of stadium such as runway and other buildings, our fast Hough transform actually delivers several lines above the previous bottom line of a potential billboard (BLPB). Thus we need to identify the one which is the upper line delimiting a potential billboard (ULPB). The basic idea is to analysis the variation of white points on lines. We notice that the upper border of an advertisement billboard conveys much more white pixels than other lines, whatever a billboard is white text with black background or vice versa. We first define a function summarizing white points in a line segmented by our fast Hough transform :

$$quan(R,\theta)=\sum_{x,y} BW(x,y) \qquad x\cos(\theta)+y\sin(\theta)=R \quad (3.4)$$

where BW is the binary image after threshold from gray level images, BW(x,y) is pixel value of pixel (x,y).

$$grad(R,\theta)=\frac{quan\ (R-1,\theta)+quan\ (R-2,\theta)}{quan\ (R,\theta)} \qquad R=R_0-3, R_0-4,\ldots \quad (3.5)$$

If grad(R, θ)<0.8, then the line defined by R, θ is considered as ULPB.

Once a PBR is detected, we need to partition the potential billboard region into one or multiple single billboard child regions, each child region containing a single billboard advertisement. Our technique is based on the following property that we have discovered : between two single billboard advertisements, there is always a non-text background color in order to separate two advertisements. On the previous binary image, such a separating region is formed only by white column or black column. We propose to define an indicator measuring the percent of white or black points in such a region. If such an indicator is bigger than 95%, then this region is considered as the connect part of two billboard advertisements.

Each potential billboard is generally composed of text content and picture label. Advertisement commercial

agency proposes to absorb the view of spectator therefore the advertisement that they design has some specific features, for instance there is very big contrast between the background and content of advertisement. In general the color of the text of an advertisement is one color also the background color is other color. The distance feature of histogram of the billboard recognition is followed as

$$\text{histdist}(x)=|\max(hist(x))-\max(hist\_new(x))| \quad (3.6)$$

where function hist(x) is histogram of gray image of cropped candidate billboard. Function hist_new(x) defined as

$$\text{hist\_new}(x)=\begin{cases} 0 & |x-x0|<dist \\ hist(x) & otherwise \end{cases} \quad (3.7)$$

where x_0 is the point of maximum value of hist(x). Dist is a threshold , in our approach , the define field of hist(x) is 1,2,…,25, dist=4,when histdist>8, the small region is defined the advertisement board.

Second feature illuminates that text content of billboard is average partition in global billboard [9]. Text content of billboard is a average and continual text content, from start to end of text , every character must be a average partition. When we let white or black points of the binary image respect in vertical , its density function about white or black points is a average function. Fig.2 illuminates the gray images ,histograms, binary images and their density function projecting in horizontal.

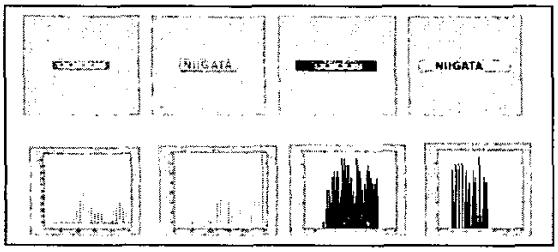

Figure 3. The first row images are the cropped gray and binary image of two billboards " adidas ", " niigata " . Second row images are corresponding to the histogram and density function projecting in horizontal of first row ones.

In [5], the detection of the sportsman, the football, some small objects, text in football match has applied some characters , such as the sport goal ,the line of the football court etc. We extract the feature for advertisement which is good than those ones and these features which we propose correspond to the advertisement billboard. When two lines are detected, in general the advertisement region is obtained and the calculation is very simple.

4 EXPERIMENTAL RESULTS , CONCLUSION AND FUTURE WORK

We have applied our billboard detection method to more than 200 football images. Each image is 240x320 bmp (24bits) file. Fig. 4 shows some results. Images on the first columns give potential billboard segmentation delimited by two white lines. As we can see, an advertisement billboard may appear simply parallel or tilt or even trapezoid with complex background. Images on the second columns show results once we segment a potential advertisement billboard into multiple child regions containing single advertisement text. They are delimited by white rectangle. Table 1 summaries experimental results. As we can see, the recognition rate is up to 91% .

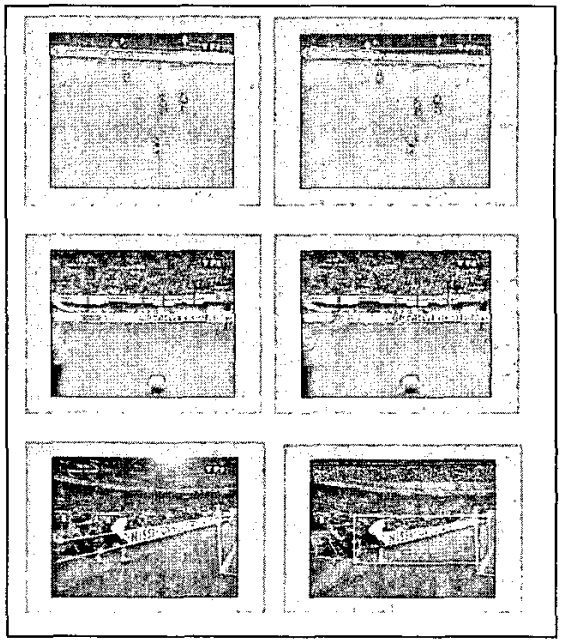

Figure 4. Potential advertisement region are detected in first columns image. Each billboard is recognized in second columns.

Frames number	advertisement frames	Detected	Missed	False detection
200	134	122	12	10

Table 1. Advertisement billboard detection result

However, when an advertisement billboard is set up in two sides of sports ground, the results of our technique may be confused in some frames. Another problem is related to occlusion of advertisement billboard. Currently we are working on a feature point based solution in order to improve advertisement billboard recognition rate even with some occlusion.

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