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Detection of Smoking in Elevator Using Average Intensity Measure

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Abstract

Smoking in elevators would give children and weak women a deadly blow. Latest no-smoking laws and increasing the price of cigarettes decreased smoking rate drastically. However, since this phenomenon is a transient one, the smoking rate seems to be increasing again to the previous level. In our research, we above all chose people who smoked in elevators. The method of sampling key frame is Average Intensity Measure. This method uses average intensity of whole image for each RGB color channel in order to detect scene change. If white color (255) occurs by a certain pixel after reducing the subject domain of sampled key frame to face domain, it is considered as smoking. These extracted scenes could be provided as a evidence of forensics in police stations or courts.

Keywords: *smoking, Average Intensity Measure, scene change, RGB color channel, forensic*

1. Introduction

Habitual smoking causes various diseases such as cancers (of the lungs, throat, mouth, larynx, stomach, bladder, pelvis, ureter, and pancreas), ischemic heart disease, cerebrovascular disease, chronic obstructive pulmonary disease, low birth weight infant, miscarriage, premature birth, and so forth [1]. Fire due to smoking could also widely occur in many different forms. Smoking is a fundamental cause to increase fire occurrences with universal behaviors [2]. Against this backdrop such as USA government reports on smoking and health, these various policies and reports are expected to contribute to non-smoking [3].

According to the National Assembly's passage of a revised bill to promote public health on December 8 in 2012, citizens are heatedly debating the issue on a regulation that all business places with over 45 pyeong (general restaurant, bar-rooms, coffee cafes all over the country) are designated as non-smoking areas.

Public smoking must not be permitted since it injures our own health. Secondhand smoking in everyday life is a kind of invisible hazard to the health (such as lung cancer) of our own children and lowers the learning ability of our own children. Nowadays, we could frequently see the absurd and senseless smoking in elevators. This irrational behavior comes out repeatedly even in elevators with CCTV (Closed-Circuit Television).

This paper makes a research on forensic proof data by using a scene change detection method, Average Intensity Measure, and detecting smokers in elevators. We perform related woks in Session 2 and works on the Average Intensity Measure. In Session 4, an actual experiment for detection is performed, and we make conclusions in Session 5.

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2. Related Work

The most universal method for scene change detection detects values by calculating difference values that are expressed by given characteristics among continuous frames. Even though the detected values have higher accuracy, there are some problems of restrictions for robustness of these algorithms [4].

Histogram comparison is the most universal tool for scene change detection. Tonomura *et al*. [6-7] proposed the simplest method to extract shot boundary on the basis of critical point, by use of histogram comparison of gray level. Ueda *et al*. [8][9] used change rate of color histogram to detect scene boundary. Nagasaka *et al*. [7] performed several simple statistical comparisons on the basis of gray level and color histogram. Zhang *et al*. [5] discovered the fact that histogram method is an appropriate exchange factor between accuracy and velocity, by considering pixel difference, statistical difference, and several histogram methods. Nagasaka *et al*. [7] proposed X2-test which emphasized movement of camera and object as well as difference value between two frames. But, the overall performance of X2-test is not better than linear histogram comparison method by Tonomura *et al*. [6] and has a demerit that its volume of calculation increases.

In a recent study, [10] proposed a simple approach for sensing objectionable videos by observing scene changes into different video genres. In [11], extraction method detects difference value using modified color-X2-test and it was normalized. Next, we find frames that have occurred scene change in successive frames using the four-step algorithm of scene change detection.

3. Average Intensity Measure

In this research, we perform scene change detections by use of images that CCTVs in elevators make for security. As a core task of this research, scene change detection segments the video systematically and hierarchically. That is to say that it extracts key frame in order to bind frames that are dependent on the key frame.

There are two methods to divide video; the first is to divide the video by frame per hour and the other is to divide the video by scene change detection in this paper. The first one does not consider characteristics that the video has in dividing it, but divides by the number of frames per hour. In general, the video is run by 30 frames or 24 frames per second, but this method divides video by 3 frames per second or per minute. The video is divided only by time, but characteristics or inner information of the video cannot be known. The second method is related to scene change detection, which divides the video by scene change detection on the basis of given critical point. Since this method divides the video according to its own color, shape, partial information, and so on, it is very effective in detecting frames with huge scene change in video.

A method of scene change detection, Average Intensity Measure, expresses Intensity distribution for pixels in images. The horizontal axis expresses the light intensity value of 256 level images. The vertical axis expresses the number of frequency for intensity. Average Intensity Measure divides frames for the video that is collected by CCTV. Average Intensity Measure uses average brightness of the whole image for each RGB color channel, so as to detect scene change.

Let us assume that color frame, f_n, has three color components like $f_n(p)=(R, G, B)^T$ of each pixel. The Equation (1) shows the average of each RGB component of frame f_n with width w and height h.

$$A_n = \frac{\sum_p f_n(p)}{w \ h} \qquad (1)$$

And, this Equation is transformed to Equation (2) when the average of absolute difference between the present frame and the next frame is divided by the absolute difference between the present frame and the prior frame.

$$D_n = \frac{\left|A_n \quad A_{n+1}\right|}{\left|A_{n\ 1} \quad A_n\right|} \qquad (2)$$

The difference is added in average brightness of each color channel in order to get discontinuous value. Scene change is detected by the following Equation (3).

$$\sum D_n \begin{cases} > T_{cut} & shot\ cut \\ \le T_{cut} & no\ shot\ cut \end{cases} \qquad (3)$$

In other words, a scene change is detected when the sum of absolute difference is larger than the critical value. We use this implementation at first. But, in most cases, ΣD_n is large in case of shot with comparatively small changes between the present frame and the next frame and with very small and few changes between the present frame and the prior frame. This case would certainly cause many wrong detection results. On the contrary, when there is some difference between the prior frames, the discontinuous value could be comparatively small when detecting scene changes. So, we can define the following Equation.

$$D_n = \left|A_{n\ 1} \quad A_n\right| \qquad (4)$$

The Equation 4 is more excellent than the Equation 2. We could conclude that smoking occurs when the value 255 of pixel for white stick (cigarette) for these detected key frames appears within the range, 200 to 300 pixels.

4. Experiments

First of all, smokers should be extracted from videos that are recorded in the CCTV cameras of elevators. For further study, we excluded the case that there are many people in an elevator. In this research, we just considered the case that there is only one person in an elevator.

We used Visual C++ 2011 as a programming compiler on Windows Vista 7 and Smile Cam SD290U as a camera. The SD290U is a kind of smile rotation dome camera with the capability to photograph the left and the right and to remotely control 90 degree per second. It also has the ability to move according to the movement of objects as well as the function DVR to store its own image.

Above all, we considered the first method of dividing the video by the number of frames per time. The elapsed time when an elevator goes from the 1st floor to 20nd floor is 38 seconds. If the elevator does not stop, the average time is 36 seconds. There are 36 key frames when detecting scene change by 1 frame per second. The following Figure 1 shows the first method to divide by the number of frames.

We decided on videos of elevators where there is a person on target. We excluded cases wherein a person gets in an elevator in the middle stories and the case when there are two or more persons in an elevator. In general, when a person gets in an elevator on the middle stories, a smoker in the elevator stops his or her smoking. So, we excluded the case from the target of the experiment.

Since a key frame is extracted until 60 seconds regardless of the contents of the video in the method of Figure 1, the frame cannot be a representative one of the video. It is useful when seeing and winding the video fast. Figure 2 explains the method with detecting scene change by use of Average Intensity Measure for the targets of CCTV. The critical value T_{cut} is 5,000.

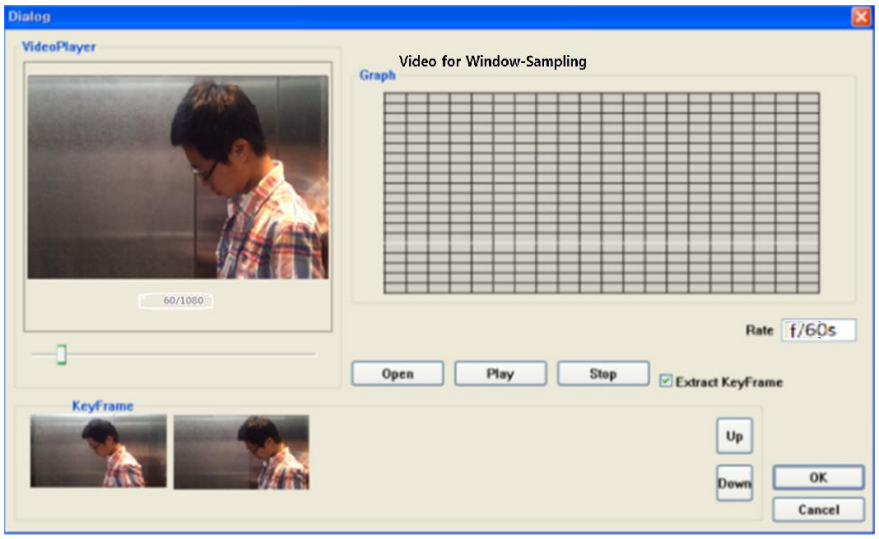

Figure 1. Division by the Number of Frames per Time

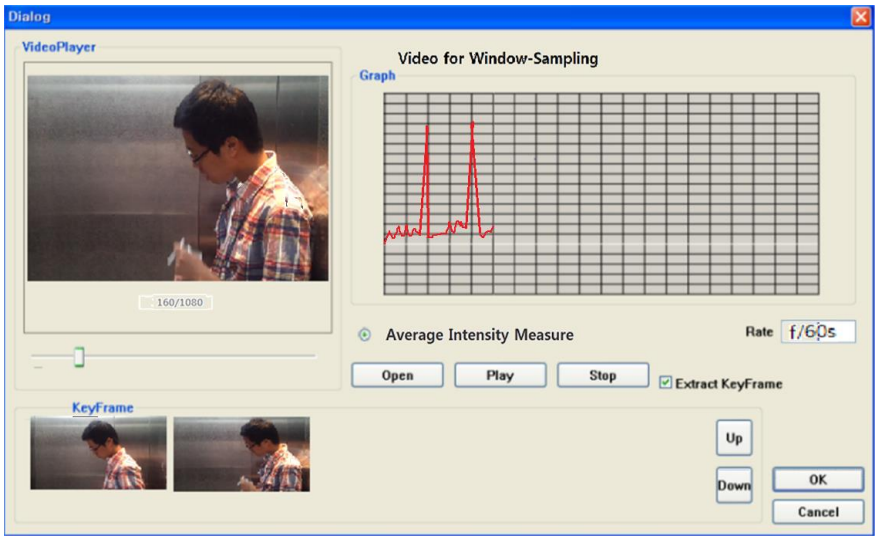

Figure 2. Division by Average Intensity Measure

In 20 videos of smoking detection, Table 1 shows the comparison table between the number of key frames by detecting difference value and the number of key frames by Average Intensity Measure.

Table 1. The Number of Detected Key Frames

Video	The Number of Key Frames by Detecting Difference Value	The Number of Key Frames by Average Intensity Measure
1	8	5
2	9	3
3	15	4
4	16	3
5	23	7
6	20	4
7	17	5
8	8	2
9	38	9
10	28	7
11	9	2
12	26	5
13	23	6
14	17	5
15	31	8
16	14	5
17	25	7
18	18	5
19	16	6
20	27	8

The Table 1 concludes that the number of key frames by detecting difference value increases as an elevator goes to higher stories. On the contrary, the number of key frames by Average Intensity Measure is very small.

Let us consider the case of detecting smoking for the target of extracted key frames. Like Figure 3, the target is expanded to the domain of 35 pixel from side to side on the basis of the face of the first frame. We can conclude that smoking occurs when the value 255 of pixel for white stick (cigarette) for these detected key frames appears within the range, 200 to 300 pixels.

Consequently, we detected only three videos from the videos with smoking. In case of smoking, most of the videos were detected. The cases of white-colored clothes were not detected since their domain is located from 200 and 300.

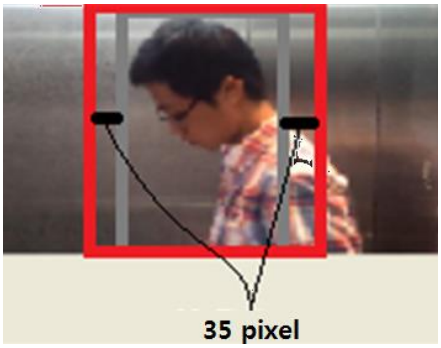

Figure 3. Domain of Smoking Detection

5. Conclusion

In this paper, we detected a person with misdemeanor, who smokes in an elevator. We used Average Intensity Measure as a method to detect key frames from CCTV. The target video is this detected key frame. We made experiments for the 20 target videos. The domain of face is expanded for each detected key frame. The pixel domain with white (255) stick was used for smoking. A video detecting a smoker would certainly be a decisive forensic proof to police station or law court.

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