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A study on removal algorithm of flicker noise on old film sequences

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ABSTRACT

This document is the study about flicker noise embedded in the old tape or old movie film. The purpose of the study is to improve the identification accuracy and the elimination rate of the noise caused mainly by the film scratches. Based on the traditional gray value and threshold method, a new circuitous detection method is used to adjust the threshold, so that the detection rate of noise is improved. The method is confirmed to have a good effect on the detection and repair of flicker noise and the tape or movie film repaired shows a satisfactory visual effect.

1. Introduction

The embedded noise is relatively common in old film (tape) or movie film. Flicker noise is more common for high-definition digitized image, especially the light and shade flicker are particularly conspicuous, which occupy the entire column pixel area and have serious impact on the visual effects.

Especially in the old films, the time intensity flicker is a common pseudo sequence. In order to eliminate this kind of noise, the time fluctuation image intensity method is used and the image sequence storage compression format is used to improve the coding efficiency. Using the temporal and spatial differences and the means to automatically correct the brightness flicker, the low-complexity algorithm is explored to achieve the detection and repair methods of noise.

The indirect noise detection method about area scratch noise precise positioning improves the detection rate of the noise and the repairing effect is improved further. It was proved on the basis of the flicker noise simulation and the classroom experiments.

2. About flicker noise

2.1. The reasons for the formation of the flicker noise

- Projector touch scratch.
- The tapes were placed for many years.
- The precious image products were not well protected by the chemical processing.
- Adverse copy.

Combining with the image, a linear scratch is shown in the vertical direction and it will continuously appear in a few frames. As shown in Fig. 1, the arrow is referred to the location of the scratch. This paper puts forward a new method for the detection and elimination of the scratch.

The image removing noise algorithm is described as follows: Using the region growing technique, the image will be divided into different zones, the pixel with a certain similarity in these regions meet certain silimilarity rules. Then, according to the pixels of each region, the threshold value suitable for regional characteristics is calculated.

Finally, according to each threshold binarization image is obtained separately for each area. This algorithm has an obvious effect on the extraction of topic information of gray image. But the complexity of this algorithm is not significantly improved [2] like histogram computation methods [1].

In order to reduce the complexity of the algorithm, a method of processing image frame sequence assembly algorithm based on waveform matching has been proposed [3]. The algorithm is that the waveform information is extracted from the reference region of each image frame, and introduces a stepwise refinement and obtains the stitching parameters to determine the overlap between image frames and horizontal displacement. In spite of relatively small computation quantity and fast processing speed, this algorithm is not used widely, because the detection accuracy is not

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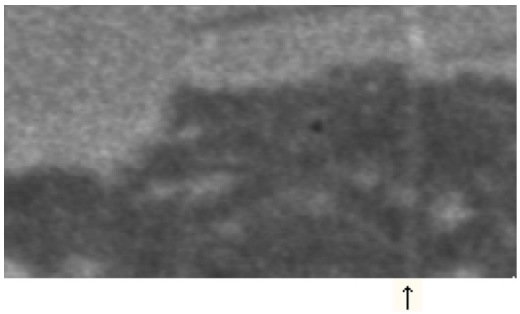

Fig. 1. Scratch film.

high, and the higher demands on the resource and environment are necessary for the complex scratches.

For scratch detection, the detection methods of frame image unit are usually used [4]; however, the image data are continuously recorded in each frame image. Because the scratch often occurs in several consecutive frame images, the scratch cannot be detected easily if using traditional frame image. In order to solve the problem, the relevant frame image continuous processing mode is used as the experimental object.

2.2. The mathematical model of the flicker noise

Flicker noise elimination can be used in the mathematical model and the formula of flicker. Flicker parameters represent the brightness value of the original image. In the two adjacent frame images, when the objects move, flicker noise embedded in the frame image does not have effect on flicker parameters. Using this function, the approximate location of flicker noise in the image frame can be deduced.

Flicker mathematical model is that the flicker noise is represented by the mathematical formula [5], flicker noise luminance is irregular on the original image in the timeline, and the changes of the luminance values in space are continuous, so that it is easy to use mathematical equation expression (formula (1)):

$$In(x) = Qn(x)En(x) + Pn(x) \tag{1}$$

In the formula, Qn is a gain factor, Pn is the offset, x is the amount of spatial displacement, and In and En are representing respectively the noise image and the normal image gray level at different moments. $Qn(x)$ and $Pn(x)$ have a characteristic of the space x varying continuously with irregular time (n) changes. The parameters $Qn(x)$ and $Pn(x)$ of flicker noise are represented by 2 yuan quadratic equation as follows:

$$Tn(n1, n2) = \sum_{k-1}^{D1}\sum_{l-1}^{D2}(c_{k,l,n}, n_1k \cdot n_2l) \tag{2}$$

$D1$ and $D2$ represent power side of flicker parameters respectively in three directions of $n1$ and $n2$. $c_{k,l,n}$ is the coefficient of the polynomial and its value is determined by a normal random number.

3. Noise detection

3.1. Characterization

The scratch gray level is different in different images. The film gray level with a crisp image is high and the film gray level with a dark image is low.

In order to repair the image scratches, it is necessary to detect the detailed location of this type of noise. Firstly, the detection range is locked, but it is difficult to detect the scratches so that they are missed when the luminance difference around the detection object is small [6]. So it is necessary to save the images for the image scratch detection [7].

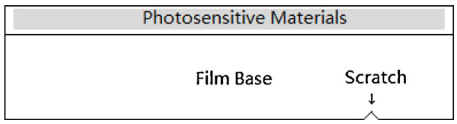

Fig. 2. Cross-section of scratch film.

The scratch profile contains a number of important information in the image. Image contour matching problem is based on scratch. Under the premise assumed to scratch image adjacent frame with similar relations by means of a complete system of orthogonal functions V matching algorithm [8]. First assessment of the degree of similarity is between the scratches by the V descriptor matching curve segments in order to determine, and then obtain the transformation parameters of the curve, the final image mosaic test. This algorithm looks at the overall characteristics of the contours and does not require local feature extraction; the idea is too complex for simple scratch contour algorithm.

In addition, coarse segmentation is completed using Canny operator and then correct borders, and by removing noise using the principle of mathematical morphology. Experimental results show that the method for low-quality image segmentation is better than the traditional segmentation method [9], but the main processing object of this study is the HD digitized image; the advantage of this type of algorithm is not obvious.

In fact, image information is saved in the consecutive frame image, so the damaged film scratch exists mainly in the continuous frame image. Using this characteristic, the noise judgment and the noise detection are done at the same time in several consecutive frame images.

3.2. Indirect detection

Firstly, the continuous frame image processing unit, record the vertically consecutive frame image information respectively.

Secondly, based on the filtering space in the vertical direction, the image data frequency is reduced. So it is possible to reduce the impact of luminance value changes in the image and obtain the image after preprocessing. For this image, centralized calculus and threshold processing means are used to detect image scratches.

Subsequently, the detection is repeated in order to improve the detection rate of image scratch. On the basis of the above detection threshold steps, when gray level fluctuates in the near threshold, the possibility of scratch noise is small. Otherwise, it is considered as scratch noise area. Using the first detection result, average filtering value is calculated and finds the possible area of image noise. In accord with the peak of gray level difference in this area, the threshold is adjusted again and the algorithm is refined to detect the same noise. It can avoid the false detection rate and can detect the small image scratches in a way.

Seen from Figs. 3 and 4, the gray level change regulation of the scratch image is similar to the neighboring image. So the scratch image information may be used to deduce the corresponding original image.

4. Noise removal and simulation

Usually, filtered considered is a variation of the intensity information in the horizontal direction on the one [10], while the example in Fig. 2 in the scratch marks line intensity information on changes in the vertical direction having the characteristics of the undulating stripped out from the filtering effect of the horizontal