Flicker Reduction in Old Films

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Abstract

This paper deals with the reduction of flicker in old films. This artifact appears as global, quick and random variations of the luminance and contrast between consecutive frames of a sequence. Initially, we present a method based on the correction of mean and variance parameters of the sequence. However, although this method reduces mean and variance variation between frames, it does not yield good visual results. Finally, an algorithm based on the histogram matching is proposed. This method provides much better visual results.

1 Introduction

Old films often present a number of degradations such as scratches, flicker, warping, dust, noise, etc. In this paper, we concentrate on the problem of frame flicker. It consists on global intensity variations between two consecutive frames. The figure 1 shows two consecutive frames of a shot of the Charles Chaplin film *His new job* (1915), where flicker can be easily perceived.

Figure 1: Two consecutive frames of a sequence of the film "His new job".

Few researchers have addressed this problem. This may be because the problem may seem very easy to solve. However, this is not the case, since a simple change in the image mean intensity is not sufficient to solve the problem.

In [?] the difficulty of flicker reduction is treated, and they claim that the use of noise suppression techniques may also reduce the flicker. In [?] an afine transformation of the intensity is proposed. Here we propose two techniques. The first one also uses an affine transformation; the transformation parameters are found on a basis of a time model of mean and variance variations.

The second method, tries to find a non-linear intensity transformation in order to achieve that the transformed image intensity is statistically similar to the other neighbour frames.

The rest of the paper is organized as follows. In section 2 we present the method based on mean and variance corrections based on time models. Section 3 explains the technique used to find the nonlinear transformation. Finally, section 4 presents some conclusions.

2 Time model Method

The flicker effect is due to different physical reasons. In practice, for our purpose it suffices to say that if we analyze the time variations of the mean and variance of each frame in an old film, two components appear:

- Random variations.
- Periodic variations.

Moreover mean and variance present a linear tendency due to the real evolution of this parameters in time.

the parameters of these three components can be estimated and then we can eliminate. First, we estimate the linear tendency. Then this linear tendency is substracted. Secondly, the parameters of the periodic variation are found. Then, the periodic variation is substracted. Finally, the rest is considered to be the random component.

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Figure 2 shows the time variation of the frames mean intensity along time. Also, it displays the linear tendency and all but the random component, after model fitting. The same process can be made over the sequence variance.

Once that we have found the three contributions, we obtain the target mean variation as a linear combination of the three components. This combination uses a factor of 1 for the linear tendency and small factors for the other two components. Using the original and target mean and variance we compute the affine transformation parameters that yield the desired result for each frame.

The results that can be obtained are shown in figure 3. Aadir

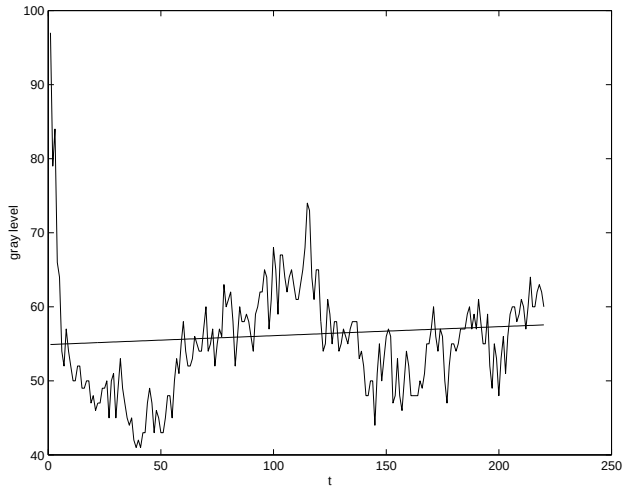

Figure 2: Mean of the frames, linear tendency and *linear+periodic* component

Figure 3: Result of time model method applied to frames of figure 1.

3 Histogram matching Method

This method is based on histogram equalization technique [?, ?] which consists of changing the image histogram into a uniform histogram.

The idea of our method is as follows. Imagine that we have two histograms: the original frame histogram and the target histogram of that frame. The target histogram for a certain frame is computed by averaging the histograms of neighbour frames. We can easily compute the transformation from each histogram into a uniform one. If we apply the first transformation to the original frame would obtain a uniform histogram. Then the inverse of the second transformation applied to the equalized frame will give an image with a histogram similar to the target histogram.

Let $T_1[r]$ be the intensity transformation used to change the original histogram into a uniform one. Let $T_2[r]$ be the intensity transformation used to change the target histogram into a uniform one. The global transformation from original histogram to target is:

$$H[r] = T_2^{-1}[T_1[r]]$$

It suffices to build a LUT from the above equation to make the transformation efficiently.

Figure 4 shows the histograms of the images in figure 1. It can be easily seen that a simple affine transformation can not turn a histogram into the other. In figure **tal**, the target histogram is shown (the same for both frames). In figure **cual** the transformation for each frame can be seen. Finally **imagenes**

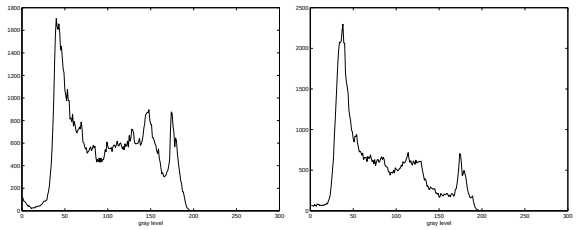

Figure 4: Histograms of images in figure 1.

In order to preserve the natural evolution of histogram in the sequence, each frame suffers a transformation to change its histogram into the averaged histogram of the image one and the histograms of adjacent images.

4 Conclusions

In this paper has been demonstrated that a method based on the change of bright and contrast of the image sequence in order to eliminate the flicker effect is not efficient. However, our method based on histograms equalization solves the problem and it has been explained here, too.

Many sequences proceeding from some comercial films and others supplied by "Comunidad

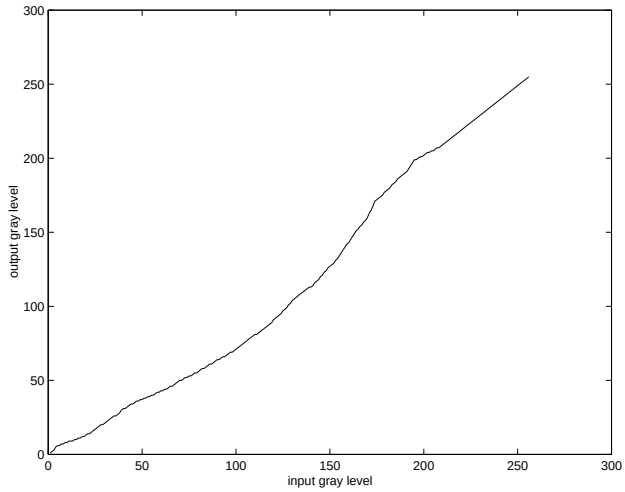

Figure 5: Transfer function of change histogram process.

Figure 6: Result of histogram method applied over frames of figure 1.

Valenciana Television (Canal 9)" has been analyzed using both methods, manifesting the satisfactory results of the second one. Original sequences and corrected ones can be found in *http://gpiserver.dcom.upv.es/restoration.html*.

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