REMOVAL OF BLOTCHES ON MULTIPLE DOUBLE SIDED VARIABLE AREA CODE SOUND TRACKS USING MATLAB

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ABSTRACT

Motion pictures have been restored using digital methods since the 1980s. In the last couple of years this has even been possible for educational institutions which mostly have a smaller financial budget than research institutions.
Most local faults such as scratches, dirt blotches or film patches can be repaired manually at a computer screen. This needs a lot of user interaction and therefore is an expensive restoration variant which can only be carried out for selected historical documents. Therefore the aim is to find solutions how to reliably restore optical sound tracks in fully automatical procedures. This paper deals with the authentic restoration of minor local faults using MatLab as the implementation plattform.

1 INTRODUCTION

Recordings of old movies, as well as the respective optical sound tracks are subject to deterioration. This is caused by changes of the chemical characteristics of the original material. Therefore almost 90% of all silent movies and half of all sound movies produced before 1950 are irreparably destroyed [1].
Film restoration and film preservation has been done for decades, whereby both have been performed manually and not in digital form. Film preservation mostly just means making copies of a movie from old substrates on to new ones while all local faults such as scratches, dirt and dust are utterly copied to the new substrates and new faults may arise. Due to the progressive development of technical equipment and steadily declining prices it is nowadays also possible for universities to carry out research on digital restoration [2].
For the development and testing of algorithms MatLab has evolved as a quasi-standard in most fields of research. It provides a vast set of tools which makes it very powerful especially in cooperation with the "Image Processing Toolbox" and was therefore chosen as the development plattform.

2 SPECIFICATION OF OPTICAL SOUND TRACKS

The use of optical sound recording is one of the possibilities storing the audio-track on the film. The principle of this procedure is the same for an audio track as it is for the picture.
For displaying the picture or playing the audio the material is scanned using light-dependent sensors. The collected light is converted into electrical signals which are amplified. The principle is shown in Figure 1, which also gives an idea of how minute an optical sound track is compared to the film picture. In order to restore optical sound tracks they are scanned with 512 pixels per line and 2000 lines per frame.

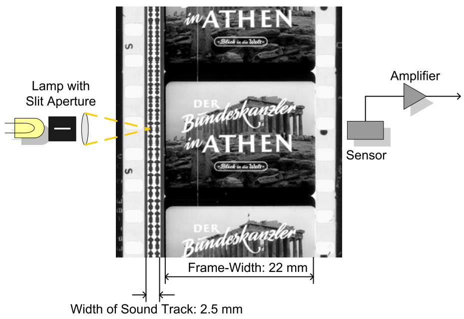

Figure 1: Optical Sound Track

3 RESTORATION-PROCEDURE

The restoration procedure is demonstrated on a blotch as shown in Figure 3. The developed algorithm and MatLab application can of course also be applied to other local faults if the fault area is known. The principle remains the same and is shown as restoration-method in Figure 2. A blotch as shown in Figure 3 is chosen because it is very suitable for the proposed method.
The application requires an optical sound track with a marked fault region as input. This means that the area has to be known which is to be restored. An algorithm how to detect this kind of blotches on optical sound tracks is given in [3].

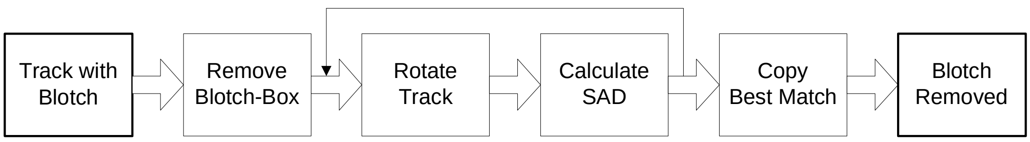

Figure 2: Restoration-Method

In Figure 3 a part of an optical sound track with a blotch is shown.
This type of optical sound track is known as “Multiple Double Sided Variable Area Code” and consists of 13 symmetrical traces. The type of blotch shown is very common [5] and appears when there is dirt on the film positive during the copying process. The grey levels were inverted during the development. Natu-rally this also applies to scratches and other local faults.

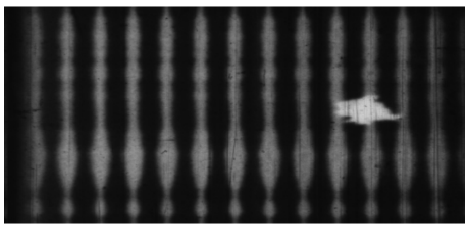

Figure 3: Optical Sound Track

The blotch is cut out in a rectangular area and, as shown in Figure 4, this region is then rotated horizontally in extent of the region's height. During every rotating-step the "sum of absolute distances" (SAD) is calculated for the transition area.

As used in [4] and modified to fit this example, the "Sum of Absolute Distances" is defined as:

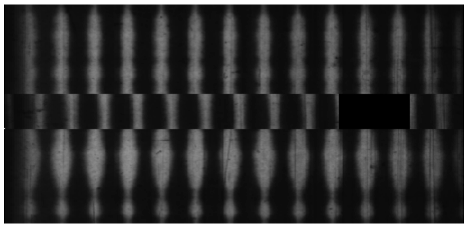

Figure 4: Area Rotation

$$SAD = \sum_{x=0}^{b-1} \sum_{y=0}^{h-1} \left| B_2(x,y) - B_1(x,y) \right| \tag{1}$$

Hereby b denotes the width and h the height of the same sized regions B_1 (steady part) and B_2 (rotated part) for the upper and lower transition area shown in Figure 5. The pixel values are referenced with the coordinates x and y. The SAD is calculated in order to detect the "best match", which means the least difference between the transition area between the rotated sound track. The greater the similarity between the transitions the smaller the resulting SAD values. This is done for the upper (SAD_{upper}) and lower (SAD_{lower}) transition area independently. Then the values for the averaged SAD graph, as shown in Figure 6, are calculated:

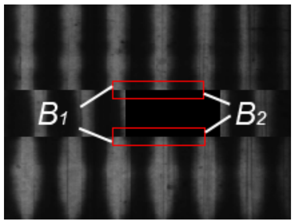

Figure 5: Compared Regions B1 and B2

$$\overline{SAD}_i = \frac{1}{2}\left(SAD_{upper,i} + SAD_{lower,i}\right), \tag{2}$$

where $i = 1,\ldots,512$ refers to the rotation of the area in pixels. Therefore a displacement of 512 pixels is a complete rotation. Now every rotation position has a calculated $\overline{SAD}_i$.

The $\overline{SAD}_i$ values are calculated in order to achieve an averaged "best match" for both transition areas. This displacement in pixels values is refered to as area rotation and is drawn in x direction. The SAD itself is drawn in y direction of the graph in Figure 6.

As expected the values run from very high to very low. The low values show that the rotated area in the window is very similar to the transition area and the high ones the opposite. The "best match" can be found by $min\left\{\overline{sad_i}\right\}$. In this example a best match would be a rotation of 400 pixels.

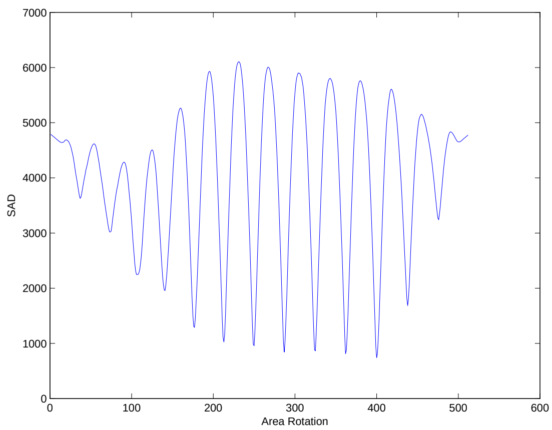

Figure 6: Averaged SAD graph

4 RESULTS

The faulty sound track with blotch is shown in Figure 7 and for comparison the result after copying the "best match" over the disturbed region is shown in Figure 8.

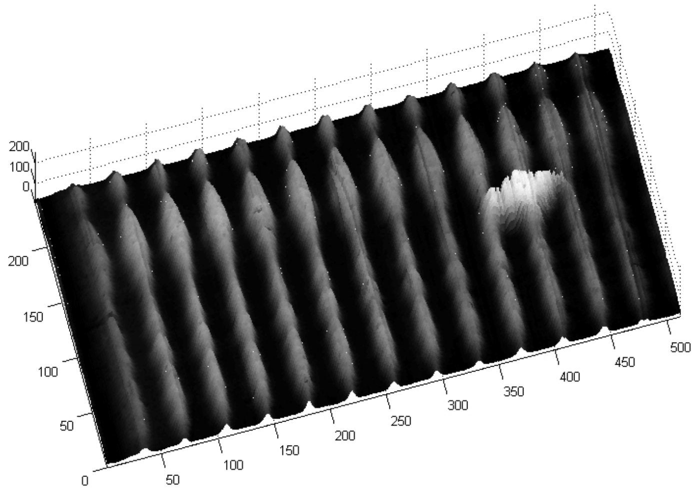

Figure 7: Optical Sound Track with Blotch

This type of restoration is one of the most authentic possible because only original data of the sound track are used. The aim of restoration should be to retain the state of the sound track as it was heard during its first presentation in front of an audience.
However, if this method does not show satisfactory results there are still possibilities to improve the restoraion even further. Some of these are discussed in the following section.

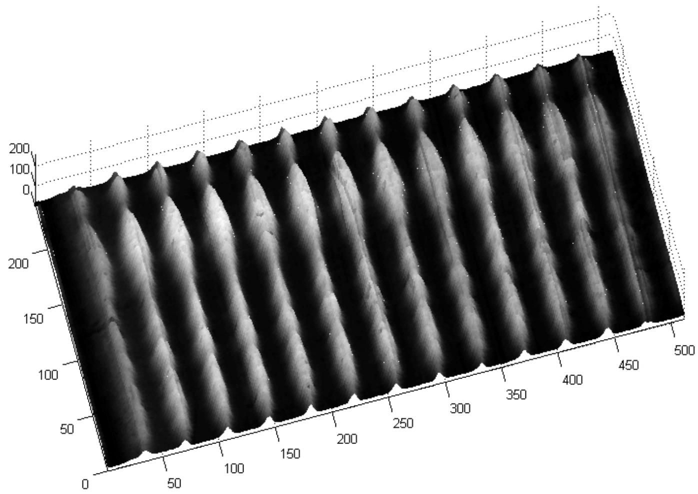

Figure 8: Restored Optical Sound Track

5 PROPOSED FUTURE WORK

- Smoothing of transition areas

While replacing parts of the sound track and therefore removing a fault it may happen that the values are different in the transition area between the original and replaced part. This disturbance can be reduced by linearly interpolating the values and therefore smoothing the transition.

- Detection of faults within the replacing region

In this approach the algorithm just searches for similarities in the transition area and then copies a whole region. This can lead to replacing the disturbed region by an even more disturbed one. The region's accuracy should be verified in another step.

- Rotation of single traces

An approach which will most probably offer even better results would be to replace the single traces which are in the disturbed region. Therefore the algorithm would have to be applied a couple of times to replace all traces instead of the whole region.

ACKNOWLEDGEMENTS

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