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PhD thesis abstract

# Restoration of optical soundtracks in motion picture films by digital image processing

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*To be defended on: December 09th, 2009, at 2.30 p.m.*
*In: Grand amphithéâtre, on the site of Fontainebleau*

The restoration of old motion picture films is an active research field. The restoration of the optical soundtrack however has only been performed in the audio domain, in spite of the fact that it is recorded as a continuous image located between the images of the film and the sprocket holes.

The restoration of the optical soundtrack directly at the image level has several advantages. First of all, the defects are visible, therefore we do not need to know their audio equivalent to be able to restore them. Moreover, the optical soundtrack has several geometrical properties that can be used for its restoration. Finally, such a restoration makes it possible to recover the original version of the soundtrack, since it only cancels the defects which are due to the film ageing.

Two types of optical soundtracks exist: the most common are variable area soundtracks, which contain a transparent region located between two symmetrical opaque regions. The width of the transparent region is directly proportional, at each instant, to the audio signal amplitude. For the restoration of this kind of soundtracks, we have developed algorithms for the correction of azimuth deviation, the detection of the symmetry axis and for the symmetry enforcement as well. Then, a segmentation step is performed for defects removal, and finally, an anti-aliasing correction is applied in order to cancel the noise which is due to the segmentation step.

The second type is called variable density soundtracks, in which the intensity of each line is proportional, at each instant, to the audio signal amplitude. For the restoration of those soundtracks, we have developed an algorithm for the detection and the correction of azimuth deviation. Then, a clipping algorithm is performed for defects removal. This last algorithm is parameterized automatically in such a way that it minimizes the total variation of the resulting audio signal and thus minimizes the noise.

We have also studied the problem of badly exposed optical soundtracks. This problem is due to light propagation during film duplications. Its effects are present in both image and audio domains. We have developed several indicators at the image level for the detection of badly exposed optical soundtracks. These indicators are based on the morphological properties of this problem on one side, and on the dissymmetry which it introduces to soundtrack edges on

the other side. A comparison between these indicators has been performed in order to study the credibility of each one of them. Finally, two restoration methods have been developed. The first one is a morphological approach that makes it possible to restore the shapes of peaks and valleys of the soundtrack. For less damaged cases, the second method matches the gray levels of the image against a look up table corresponding to the detected amount of bad exposure.

We have also discussed how the parallelization and the communication are performed between all the developed modules and studied the problem of their integration into the whole restoration system.

The evaluation of our restoration algorithms has been carried out by sound experts. We have also set up blind listening tests in order to have a more objective assessment.