Approaches to the elimination of defects of visual information

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Abstract - **This paper presents approaches to the elimination of defects and removal of visual information in digital image sequences. A small class of defects can be removed by physical processes. With the help of digital image processing techniques the recovery process can be adapted for each frame or even pixel.**

Keywords - **brightness, color variation, frame, restoration, vibrations.**

I. INTRODUCTION

To store and transfer images use different compression algorithms. They allow reducing the amount of memory for long term storage or reducing the required transmission rate information. When compressing is discarded useful information and artifacts become more visible. The defects of video content are noise and interference in the image because of the low sensitivity and crosstalk video channels, and during the subsequent rewriting, as well as for storage and playback.

II. DEFECTS

The detection of defects is the central step in the restoration process. Each scene is investigated with respect to local motion, global motion and the defects which should be eliminated. Approaches to the definition and to the elimination of defects of image sequences depend on the kind of the defect, as for example: dust and dirt, image vibrations, mold, scratches, heavily disturbed or missing frames, captions and logos, etc. There are three approaches to eliminate defects of the visual information presented in Table 1.

TABLE 1

ELIMINATION OF DEFECTS

Approaches to the elimination of defects of visual information		
One frame defects	Image vibrations	Brightness and Color Variation Reduction

III. ONE FRAME DEFECTS

Dust and dirt can have very different appearances. The pollution is local on the film material and thus they occur only in one frame of the image sequence. We call them one frame defects. Dust and dirt can be detected automatically by observing the brightness along motion trajectories.

The detection scheme is based on a three frame algorithm, which uses the two neighbors of the center frame, for which the one frame defects are detected. Motion is compensated for the neighboring frames. This corresponds to an estimation of the motion trajectories. Motion estimation is done by a robust two frame block matching algorithm.

On the classified one frame defects a post-processing step is required. The real area, which is occluded by a defect, is larger than the area of the classified pixels. This is caused by the gray value distribution of such defects. In the center area of a bright or dark spot the gray value difference to the neighboring frames is significant, while at the border this difference decreases to zero. Therefore, the border pixels of a bright or dark spot are not classified.

To get the optimal mask size for replacement of one frame defects the resulting mask of the classification is enlarged by morphological dilation. The amount of dilation depends on the size of the defects.

There are two requirements for the removal of one frame defects. First, image structure and second, image brightness must be estimated for the regions occluded by the defects. Missing image structures, induced by a large defect area, must be replaced. In addition brightness must be corrected because of flickering and local brightness variations from frame to frame. Image structure estimation from the surroundings of a defect is only possible if the defect area is very small (pixel range) and therefore the probability of difficult structure in this area is low. If the defect area increases, image content of the preceding and the subsequent frame must be used to estimate image structures for this region [1].

IV. IMAGE VIBRATIONS

Vibrations originate from the limited accuracy of the film transporting system in the movie camera or in the duplication machine. A second reason can be an unstable camera attachment during the shooting. Motion models are specified by a set of motion parameters. The used four parameter motion models is capable of describing translation, rotation and scaling, which fits with our requirement to model pan, tilt, rotation and zoom in an image sequence.

The basic algorithm is applied in conjunction with motion compensated iteration and a multi -resolution approach to improve the accuracy and the measuring range of the method. First we assume that the motion parameters are the same everywhere within one frame, then a local motion mask is introduced, to exclude locally moving objects from the area of interest for the global parameter estimation algorithm. The result is that the dominant object with its dominant motion is tracked through an image sequence. Dominant motion includes image vibration, but also camera pan, tilt, rotation and zoom is estimated. Image sequence stabilization is done by filtering the found dominant motion with respect to possible camera motions.

There are two approaches to estimate global motion parameters. One goes through the stage of estimating optical flow for a distinct number of points of interest and the other one estimate the 12 motion parameters directly from the image sequence. In the first approach, the correspondence between pixels or features in two successive frames has to be established to fit the desired motion model to the motion found for the feature points. The problem is to find good feature points, especially if image content is heavily disturbed or very noisy.

In the second approach, the correspondence problem is avoided. Motion parameters are estimated by using low level information only. The algorithm is a differential algorithm making use of the spatial and temporal gradient of an image. In the case of defected and noisy film this second approach is the more robust one.

Four dominant motion parameters are always estimated between two consecutive frames in the image sequence, thus four vibration disparity signals are generated for a whole scene [2].

V. One Brightness and Color Variation Reduction

The most common brightness and color variations fall into the categories Flicker and Lighting by mold, but there are rare variations of Darkening by mold and Local defects by mold.

There are at least two strategies to overcome the temporal brightness and color variations. First, to segment, to track and brightness (color) correct all objects through an entire scene. This method promises good results, but object segmentation enforces motion estimation and thus it is a time consuming task. Also the object segmentation itself has to be very reliable in heavily disturbed image sequences, otherwise false corrections can occur.

The second strategy, proposed here, can handle all categories mentioned above, except the Local defects by mold. (These variations with a spatially discontinuous change of brightness or color are partially handled by the one frame defect detection and removal).

For brightness or color correction a two step approach was chosen. Good frames so-called reference frames are determined and afterward the gray value distribution (in the case of monochrome images) or the three gray value distributions (in the case of color images) of all remaining frames in the image sequence are corrected. The reference frames can be detected either automatically or semi-automatically, depending on the amount of defects and depending on the image content. The distance from one to the next reference frame should be in the range of 5 to 20 frames.

The distance of reference frames is limited by the amount of image content change. The reason for this limitation is the assumption that image content varies not significantly from one to the next reference frame. If this condition holds then the gray value distributions of two consecutive reference frames are similar and thus the gray value distribution of a non-reference frame can be estimated by the gray value distributions of the closest reference frames in the image sequence.

The Temporal Global Brightness and Color Correction algorithm must be adapted for applying it to image sequences with Local varying gray value distributions. To handle such spatially local variations, the two step histogram transformation procedure is first applied to small regions of the actual processed frame and second, the resulting gray value distribution corrected regions are then merged to give the whole gray value distribution corrected image.

VI. Conclusion

Dust and image vibration handling algorithms are designed according to a two step approach, which makes expert user interaction with intermediate analysis data possible.

The proposed semi-automatic Temporal Global Brightness and Color Correction algorithm is able to correct Flicker in a very robust way with minimum time effort. Problems can occur if there is a large change in content between two reference frames (high amount of fast motion in the scene). This can lead to wrong changes in color caused by our correction algorithm.

Image vibration detection is done by dominant object tracking through an entire scene. Motion of the dominant object between consecutive frames is modeled with only four parameters for the entire image, resulting in a very robust behavior against local image disturbances and noise.

Elimination of defects of visual information, also known as the restoration of visual information is widely used in the film market, HDTV and other industries.

References

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