Bitrate Reduction in Asymmetric Stereoscopic Video with Low-pass Filtered Slices

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***Abstract*— In 3D video compression, similarities between the two views can be helpful in efficient video compression. One way to take advantage of these similarities is to have one of the views at high quality and lower the quality of the other view. In this study, we measured the bitrate reduction resulted from low-pass filtering horizontal slices in both views, with the corresponding slice in the other view kept at the original quality. Results showed that we can reduce the required bitrate for the stereoscopic video while keeping the 3D video quality close to the original video.**

***Index Terms*— stereoscopic video, asymmetric coding, bitrate reduction.**

I. Introduction

In video compression, spatial and temporal redundancies within a sequence of frames are removed as much as possible. In stereoscopic video, the similarity between the two views should also be taken into account to improve the compression efficiency. An auspicious technique for reducing the amount of data required for transmission of the stereoscopic video is to reduce the quality of one of the views and keep the other view at the original quality. This technique is based on the fact that the human visual system perceives high quality 3D even if only one of the views is of high quality [1].

Perkins [2] introduced the concept of mixed-resolution coding in 1992. He showed that the overall quality and sharpness perception of the mixed-resolution stereo pairs are similar to the high-resolution pairs. In [3], instead of down-sampling one of the views, low-pass filtering was used. The quality, depth and sharpness of the resulting stereo pair were rated close to the original stereo video in the subjective tests. In [4], an asymmetric sequence was built by degrading the luminance of one view and also removing its chroma information. The results showed similar quality to the original video sequence with significant bitrate reduction. While all these approaches try to reduce the bitrate required for transmission of the stereoscopic video, they are not fair for people with one dominant eye. If the high quality sequence is shown to the weak eye of the viewer, the overall quality of the 3D video will not be close to the high quality sequence. In order to make asymmetric coding fair, time interleaving the low quality views with high quality ones was tested in [5] but the subjective results showed that the cross-switch between the high and low quality views, was noticeable and annoying unless it occurred at the scene cuts.

In [6], we suggested a new method for asymmetric filtering of the stereoscopic video. We applied low-pass filtering to horizontal slices in both views while the corresponding slice in the other view is untouched. Subjective tests showed that for up to a specific level of filtering, the perceived sharpness, quality and depth of the resulting video sequences are close to the original stereoscopic videos, while the same amount of filtering was quite apparent in 2D videos. In this paper, we examine the bitrate reduction in our asymmetric stereoscopic videos. Performance evaluations show that significant bitrate reduction can be achieved with video quality close to the original video.

II. Test Setup and Evaluation

We considered two stereo video sequences. The videos were 10 seconds long and silent. They were captured by two identical HD camcorders. The first frame of our video sequences is shown in Fig. 1.

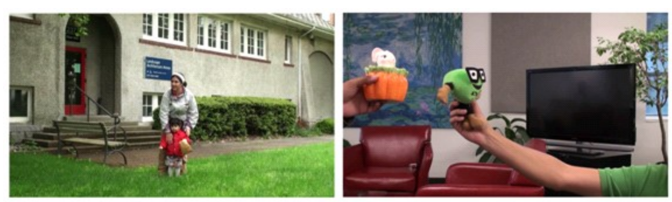

Fig. 1. The first frame of our two video sequences. Video1 is shown on the left while video2 is shown on the right.

Each frame was divided into 10 horizontal slices. Low-pass filtering was applied to every other slice in each view. Fig. 2 shows our filtering pattern in the right and left views.

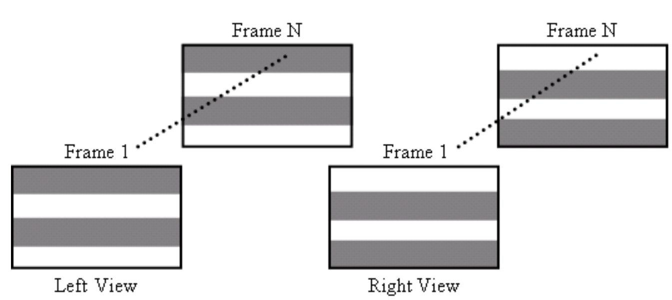

Fig. 2. Illustration of our filtering pattern. Grey areas represent filtered slices in each view of the stereoscopic video.

Our low-pass filter was a Gaussian filter with window size of 15. We examined different values for the sigma (1, 3, 10 and 30) for our Gaussian filter.

Subjective evaluations showed that we can low-pass filter alternate slices of both views (sigma up to 3) without significantly reducing the overall perceived quality of the stereo pair [6]. In this work, we examine the bitrate reduction due to the low-pass filtering of the stereo sequences.

The resulting video sequences are compressed with H.264 encoder and the total bitrate of the low-pass filtered sequences is compared with the bitrate of the original video.

III. RESULTS AND DISCUSSION

Table 1 shows the compression results for the two video sequences. As we can see from this table we can achieve reduced bitrate by applying low-pass filtering to horizontal slices in the stereoscopic video.

Table 1. Bitrate in Mbps for the two video sequences

	original	Sigma=1	Sigma=3	Sigma=10	Sigma=30
Video1	2.393	1.985	1.598	1.523	1.525
Video2	1.238	1.137	1.004	0.972	0.970

Fig. 3 shows the results of our subjective test for the first video sequence. The vertical axis shows the averaged rating for the quality of the asymmetric stereoscopic video. The horizontal axis shows the bitrate required for its transmission after compressing with H.264 encoder.

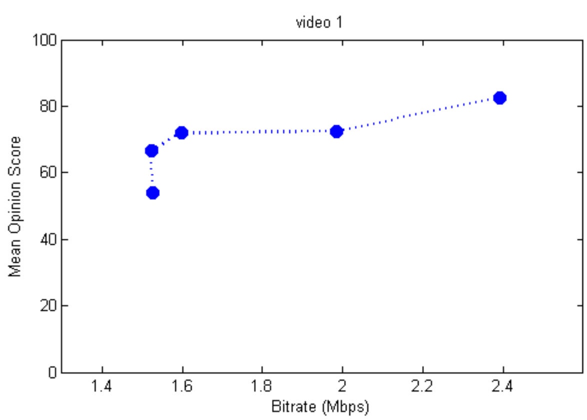

Fig. 3. Mean Score Opinion of the first stereoscopic video sequence versus the required bitrate with H.264 compression

For our first video sequence, the original video requires 2.393Mbps. As we increase the filtering strength, the required bitrate decreases at the cost of reduced quality. This figure shows that we can achieve bitrate saving and still have the video quality close to the original video. Furthermore, we can see that there is a threshold beyond which increasing the filtering strength will not result in reduced bitrate. As we can see from fig. 3, if we increase the filtering strength from sigma 10 to sigma 30, it will not reduce the bitrate.

Results for the second video sequence are shown in Fig. 4. The bitrate of the original video sequence is 1.238Mbps. Low-pass filtering reduces the required bitrate while the overall quality remains close to the original video. This is based on the fact that human visual system perceives high quality 3D even if only one of the views is of high quality. Sharp edges in the high quality image mask the blur in the low quality view and overall impression is close to the sharper view.

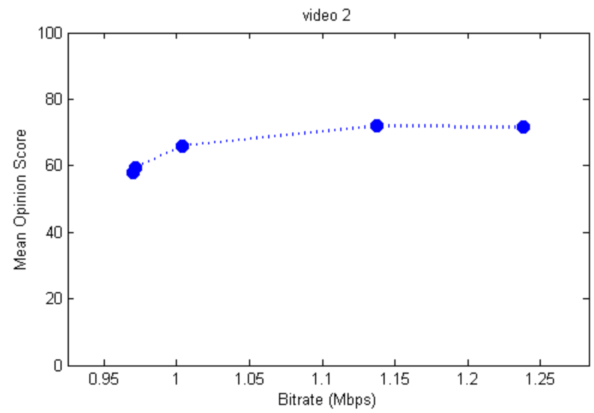

Fig. 4. Mean Score Opinion of the second stereoscopic video sequence versus the required bitrate with H.264 compression

IV. CONCLUSION

In this study, we measured the bitrate reduction in our new asymmetric stereoscopic video coding. We had applied low-pass filtering to horizontal slices of each view while the corresponding slice in the other view is of the original quality and measured the bitrate reduction in H.264 compression. Our results showed that significant bitrate reduction can be achieved with video quality close to the original video. We concluded that low-pass filtering horizontal slices in the stereoscopic video is an effective technique to reduce the transmission bandwidth and storage memory required for the stereoscopic videos, while preserving the quality of the original stereoscopic video.

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