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Author(s) or Contact(s):	Yo-Sung Ho, Kwan-Jung Oh Cheon Lee, Gwangju Institute of Science and Technology (GIST) 1 Oryong-dong, Buk-gu, Gwangju, 500-712, Republic of Korea	Tel: Email:	hoyo@gist.ac.kr kjoh81@gist.ac.kr leecheon@gist.ac.kr
	*Byeongho Choi and *Ji Ho Park *Korea Electronics and Technology Institute (KETI) #68 Yatap-dong, Bundang-gu, Seongnam-si, Gyeonggi-do, 463-816, Republic of Korea		bhchoi@keti.re.kr scottie@keti.re.kr
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Abstract

This document describes geometrical compensation for multi-view video coding (MVC). For multi-view video, the adjacent views have geometrical distortion such as the vertical and horizontal displacements [1], different size for the same object, and image warping [2]. In inter-view prediction, we should use large search range for motion estimation to be free from the geometrical distortion. The coding efficiency of the inter-view prediction is degraded because a image to be coded and its reference image are less correlated because of the geometrical distortion. To improve the coding efficiency of MVC, the geometrical distortion between the frame to be coded and its reference frame is compensated by 2D warping scheme. 'Breakdancers' and 'Race1' sequences and search range 8 are used for experiments. The maximum 0.32dB PSNR gain is obtained from 'Race1'. By the preliminary experiments, we demonstrate that the proposed algorithm achieves better results and we can reduce the search range size for MVC without much quality sacrifice.

1. Introduction

Unlike the existing single view video coding, multi-view video coding includes the inter-view prediction. However, since the multi-view video captured by the multiple cameras at different positions, the successive views have geometrical distortion. In general, the geometrical distortion caused by the camera arrangements, radial distortion of camera lens, and so on. In the inter-view prediction, the geometrical distortion causes the degradation of coding efficiency and the motion estimation process needs to large search range to find the right matching position. The proposed scheme compensates the geometrical distortion by using the existing 2D warping technique.

2. Geometrical Distortions

In multi-view video, geometrical distortion means the difference of two images which belong to different adjacent views respectively. Fig.1 and Fig 2 show the successive adjacent images.

Fig. 1 Adjacent Images for 'Race1' (left: view0, right: view2)

Fig. 2 Images for 'Breakdancers' (left: view0, right: view2)

In MVC, the left image in the view0 is used as reference frame to encode the right image in the view2. Fig.3 shows the difference images for images in Fig.1 and Fig.2. As you can see, many objects are not overlapped at the collocated positions. It decreases the coding efficiency, especially for the small search range.

Fig. 3 Difference Images (left: 'Breakdancers', right: 'Race1')

3. Geometrical Compensation

We described the geometrical distortion in previous section. In this section, we propose the geometrical compensation scheme. 2D warping technique [2] is widely used for an image warping and an image rectification. It warps the target image by 3x3 warping matrix and it regards that all pixels in the target image have the same depth value. We manually find the proper 3x3 warping matrixes for each sequence and used them for the geometrical compensation. Fig. 4 and Fig. 5 show the geometrically compensated image for the view0 (left images in Fig. 1 and Fig. 2) and difference image with image in the view0 (right images in Fig.1 and Fig.2). In other words, we generate the geometrical compensated images by using the image in the view0 and 3x3 warping matrixes. In this document, the values of 3x3 warping matrixes for 'Breakdancers' and 'Race1' are [0.99 0 -25; 0 095 25; 0 0 1] and [0.995 -0.01 -10; 0.01 1 -27; 0 0.00005 1] respectively.

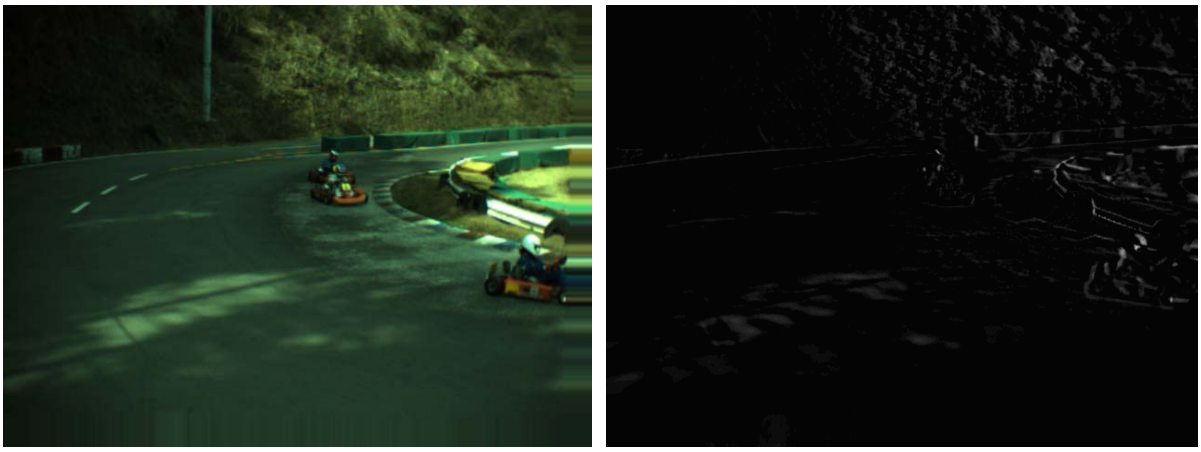

Fig. 4 Geometrical Compensated Images and Its Difference Image for 'Race1

Fig. 5 Geometrical Compensated Images and Its Difference Image for 'Breakdancers'

4. Experimental Results

According to the description in [3], four QPs (22, 27, 32, and 37) have been used for 'Race1' and 'Breakdancers'. The proposed geometrical compensation scheme is implemented on JMVM 4.0 software [4]. The average PSNR and bitrate for each basic QP are presented, and the gain and bit saving of the proposed method are compared with the anchor software. We use a search range 8 for the experiments. These results are preliminary results that are obtained from only three views (view0, 1, and 2) and anchor frames. Table 1 to 2 show the experimental results compared to the JMVM 4.0 and Fig. 6 to 7 show the RD curves for the experimental results.

Table 1. Preliminary Results for 'Race1'

Target	Basis QP	Avg. PSNR (dB)		Avg. Bitrate (kbps)		Gain	
		JMVM1.0	Proposed	JMVM1.0	Proposed	PSNR	Bit saving
Total	22	40.86	40.85	1678.65	1647.12	0.32dB	-6.16%
	27	37.91	38.00	943.07	887.49		
	32	35.10	35.08	510.73	476.68		
	37	32.22	32.23	311.38	295.10		
P & B views	22	40.86	40.94	1595.38	1548.08	0.33dB	-6.17%
	27	37.84	37.93	891.85	888.32		
	32	35.08	35.04	471.18	420.11		
	37	32.19	32.21	288.15	263.72		

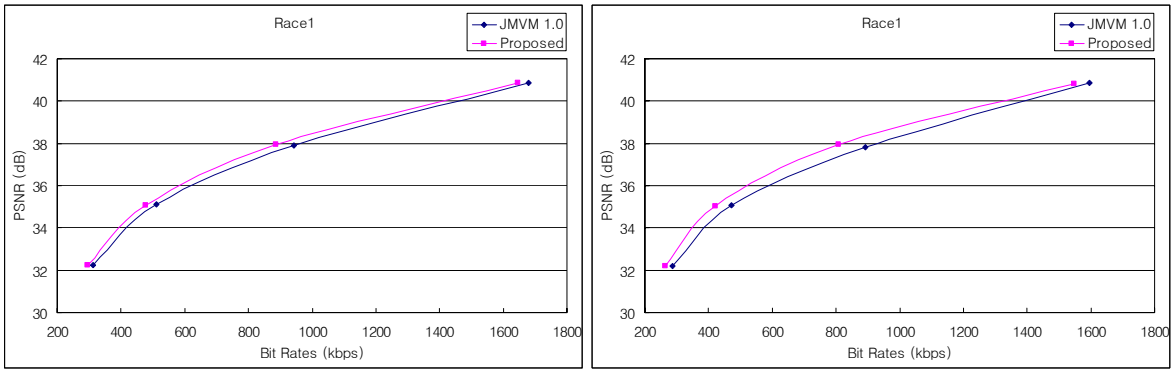

Fig. 6 Rate-Distortion Curves for 'Race1' (left: Total, right: P and B views)

Table 2. Preliminary Results for 'Breakdancers'

Target	Basis QP	Avg. PSNR (dB)		Avg. Bitrate (kbps)		Gain	
		JMVM1.0	Proposed	JMVM1.0	Proposed	PSNR	Bit saving
Total	22	40.22	40.23	2627.90	2606.39	0.03	-1.38%
	27	38.98	38.98	1075.87	1062.05		
	32	37.47	37.46	545.15	536.90		
	37	35.51	35.49	318.55	310.72		
P & B views	22	40.36	40.36	2469.19	2436.92	0.22	-9.17
	27	39.09	39.09	1120.62	991.74		
	32	37.53	37.52	570.91	501.48		
	37	35.49	35.46	301.13	289.38		

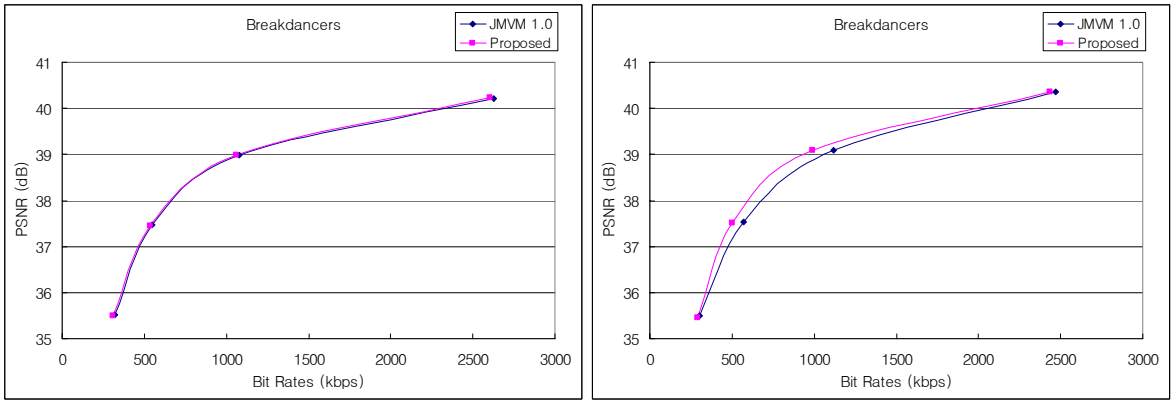

Fig. 7 Rate-Distortion Curves for 'Breakdancers' (left: Total, right: P and B views)

As you can see, the proposed geometrical compensation scheme achieves better results and we can reduce the search range for MVC without much quality sacrifice. The maximum xxxdB PSNR gain is obtained from 'Race1' and its search range is '8'.

5. Conclusion

In this document, the geometrical compensation scheme was proposed to improve the coding efficiency of MVC and to reduce the search range used in MVC without quality sacrifice. The proposed method compensated the geometrical distortion for the reference frame and the geometrically compensated image is more correlated with the frame to be coded compared to the original one. By the preliminary experiments, we demonstrate the proposed method improve the coding efficiency, especially for the small search range. From this demonstration, we expect that the geometrical compensation scheme efficiently improves the current MVC and reduce the search range and encoding time. We strongly recommend the CE establishment for geometrical compensation scheme.

6. Acknowledgements

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7. References

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[4] P. Pandit, A. Vetro, and Y. Chen, “JMVM 4 software,” ITU-T and ISO/IEC JTC1, JVT-W208, San Jose, California, USA, April 2007.

(Append for Proposal Documents)

JVT Patent Disclosure Form

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Organization name	Gwangju Institute of Science and Technology (GIST) Korea Electronics and Technology Institute (KETI)
Mailing address	C-404, Department of Information and Communications 1 Oryong-dong, Buk-gu, Gwangju 500-712
Country	Republic of Korea
Contact person	Yo-Sung Ho
Telephone	+82-62-970-2211
Fax	+82-62-970-2247
Email	hoyo@gist.ac.kr
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Title	Geometrical Compensation for MVC
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