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*Title:* **CE6: View Interpolation Prediction for Multi-view Video Coding**

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*Purpose:* Proposal

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# Abstract

This contribution describes a ‘VIP P-picture’ coding which uses the synthesized image as the additional reference frame. The proposed view interpolation method can make an intermediate image by using initial disparity estimation, variable block-based disparity estimation, and pixel-level disparity estimation based on the adjusted search range. In addition, motion vector prediction scheme is modified and vertical displacement is compensated to maximize the efficiency of ‘VIP P-picture’ coding.

# 1. Introduction

Multi-view video simultaneously capture the several scenes from two or more adjacent cameras. Most prediction structures are trying to exploit inter-view correlation of multi-view video. Since S1, S3, and S5 views in the prediction structure in Fig. 1 have two inter-view frames [1], these three B views can generate intermediate view images using adjacent view images. The generated intermediate view images can be used as reference frames in the disparity and motion compensation process. It is obvious that a high-quality intermediate image guarantees improvement of coding efficiency. In this document, we briefly describe the proposed view interpolation scheme for multi-view video coding, and we propose ‘VIP P-picture’ coding scheme to use the interpolated image.

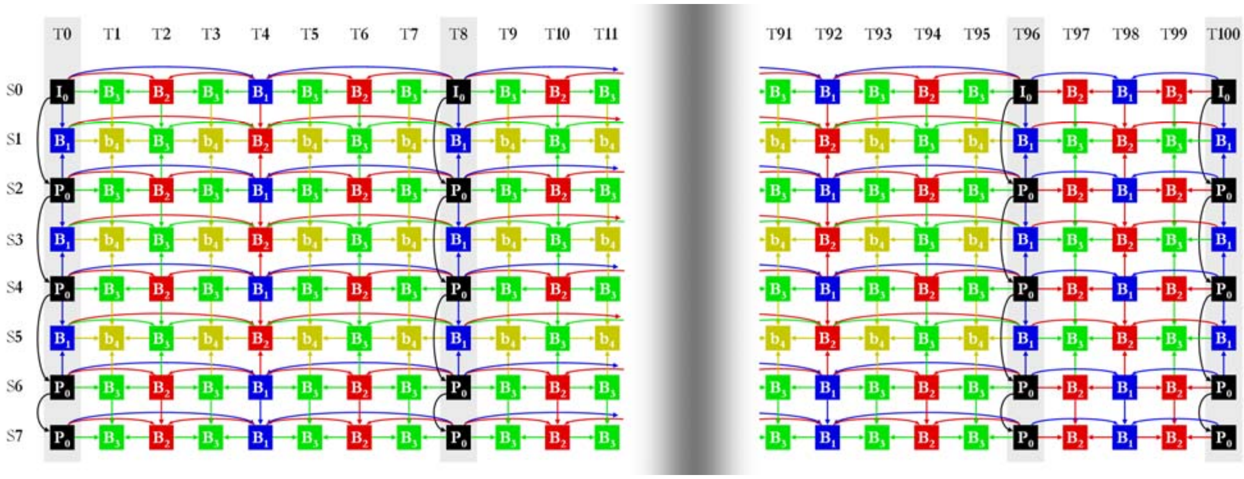



Fig. 1: Inter-view-temporal Prediction Structure

## 2. Efficient View Interpolation Method for Multi-view Coding

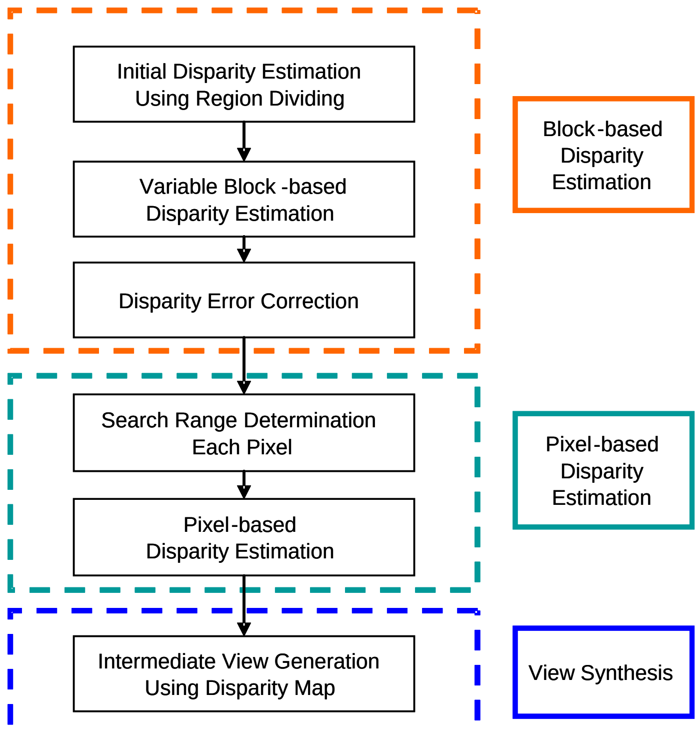



Fig. 2. Proposed View Interpolation Method

Previous interpolation methods have several weaknesses: (a) the quality of the synthesized image depends on the maximum disparity search range, and (b) the accuracy of disparity estimation is unstable in boundary regions. We have proposed an improved view interpolation scheme, as shown in Fig. 2. The first step is block-based disparity estimation which does not consider the maximum disparity search range based on the region dividing scheme. We also use variable block sizes for disparity estimation, which is more effective in complex region such as object boundary regions. The last step for disparity estimation is pixel-level estimation using adjusted search ranges. After these three steps, we interpolate inter-view images using the estimated disparities. During the whole processes, the disparity errors are corrected using the median filtering. For more details, see the reference document [2].

# 3. Multi-view Video Coding Method using Interpolated Image

## 3.1 View Interpolated Prediction P-picture Coding

View interpolation prediction is applied to B views such as S1, S3, and S5 in Fig. 1 because these views have already coded adjacent views. After generating the intermediate image, it can be used as an additional reference frame. The intermediate image mostly overlaps with the image to be coded. We propose the view interpolated prediction P-picture (VIP P-picture) coding scheme and it performs like P-picture coding. VIP P-picture coding is composed of additional macroblock modes: 'VIP_SKIP', 'VIP_16x16', 'VIP_8x16', 'VIP_16x8', and 'VIP_P8x8'. VIP_SKIP mode refers to the co-located block in the intermediate image and it does not need motion vector prediction. Figure 3 shows the overall coding structure using the VIP scheme.

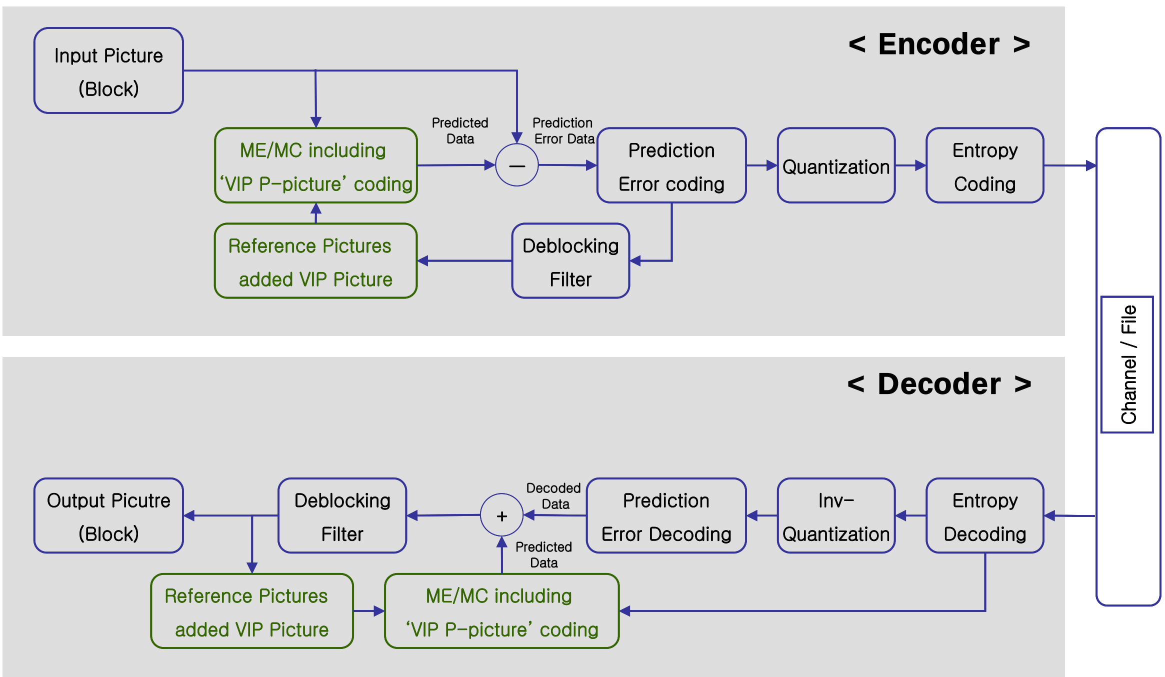
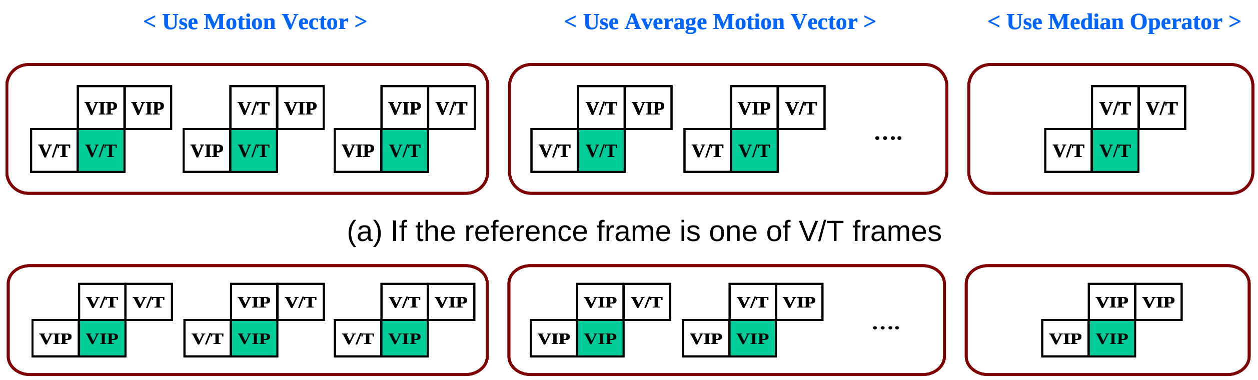



Fig. 3 Coding Structure added 'VIP P-picture' coding

## 3.2 Modified Motion Vector Prediction

The H.264/AVC encodes the difference value between the motion vector value of the current macroblock and predicted motion vector value using the motion vectors of neighboring macroblocks. The reason why this approach is efficient is that all reference frames have the similar correlation with the frame to be coded in H.264/AVC. On the other hand, the proposed coding scheme employs three types of reference frames: temporal frame (T frame), spatial frame (V frame), and VIP frame. Since three types of reference frames have different disparity values, the current motion vector prediction scheme can not improve the coding gain efficiently. We propose a modified motion vector prediction method which predicts a motion vector more using division of motion vectors between VIP frame and V/T frames. Fig. 4 shows the modified motion vector prediction methods. If a reference frame is one of V/T frames, the motion vector predictor considers only blocks referring those of V/T frames as shown in Fig. 4 (a). Similarly, if a reference frame is a VIP frame, motion vector predictor only considers neighboring blocks referring VIP frame as shown in Fig. 4. (b). If the number of neighboring blocks having the same kinds of reference frame is one, motion vector predictor uses its motion vectors directly. In case of two, the average value of motion vectors is used. In case of three, the median value of motion vectors is used.




(a) If the reference frame is one of V/T frames

(b) If the reference frame is VIP frame

Fig. 4 Modified Motion Vector Prediction Method

### 3.3 Compensation of Vertical and Unequal Horizontal Displacements

Some test sequences show vertical displacement and unequal horizontal displacements which decrease the accuracy of stereo matching. We compensate these displacements by handling them manually. Figure 5 shows the example of the compensation of vertical displacement. We attached the excel file related to vertical and unequal horizontal displacement. For the vertical displacement, we calculated pixel based disparity. We represent the unequal horizontal displacement by using the disparity rates between the center view and its left and right views.

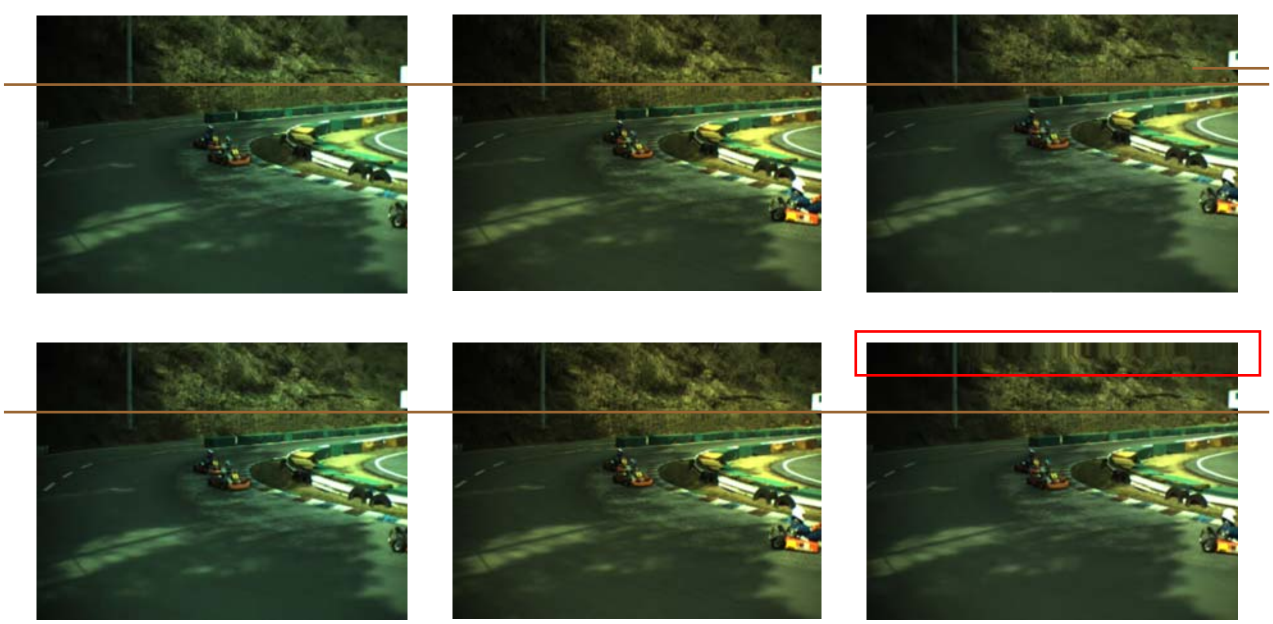


Fig. 5 Compensation of the Vertical Displacement

## 4. Experimental Results

According to the description in [3], four QPs (22, 27, 32, 37) have been used for seven sequences. We have implemented the proposed view interpolation scheme and 'VIP P-picture' coding method using JMVM 1.0 software following the CE description [4]. VIP scheme shows interesting results for dense sequences such as 'Akko&Kayo', 'Rena', and 'Breakdancers'. However it does not show gains for the other sequences. Whole experimental results are contained in the attached excel file.

Table 1. Performance Evaluation for '*Akko&Kayo'* Sequence

| Basic QP | Avg. PSNR (dB) | | Avg. Bitrate (kbps) | | Gain | Bit saving |
|---|---|---|---|---|---|---|
| | JMVM | Proposed | JMVM | Proposed | | |
| 37 | 32.85 | 32.84 | 167.56 | 153.89 | 0.16dB | 3.12% |
| 32 | 35.84 | 35.82 | 276.78 | 264.94 | | |
| 27 | 38.79 | 38.77 | 494.75 | 485.64 | | |
| 22 | 41.46 | 41.44 | 942.11 | 937.35 | | |

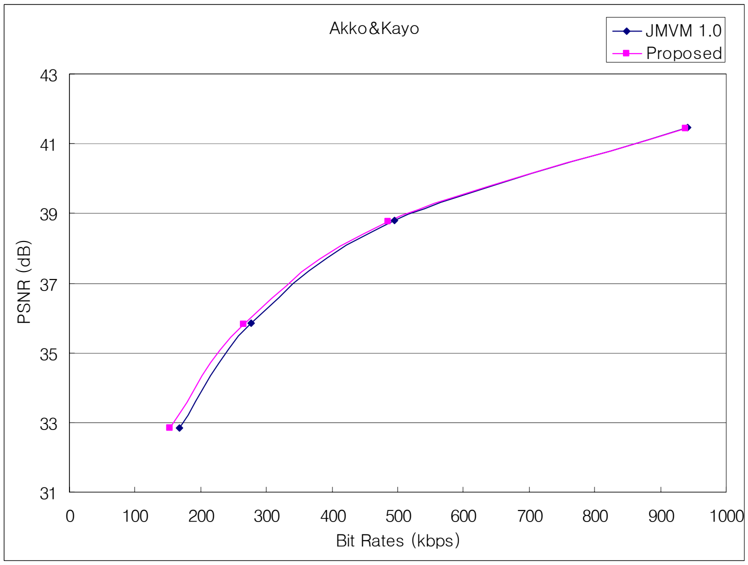



Fig. 5 Rate-Distortion Curves for '*Akko&Kayo'* Sequence

Table 2. Performance Evaluation for '*Akko&Kayo'* Sequence (VIP views only)

| Basic QP | Avg. PSNR (dB) | | Avg. Bitrate (kbps) | | Gain | Bit saving |
|---|---|---|---|---|---|---|
| | JMVM | Proposed | JMVM | Proposed | | |
| 37 | 32.61 | 32.59 | 120.35 | 86.18 | 0.74dB | 11.93% |
| 32 | 35.50 | 35.45 | 189.58 | 159.97 | | |
| 27 | 38.36 | 38.31 | 335.68 | 312.92 | | |
| 22 | 41.02 | 40.99 | 649.01 | 637.09 | | |

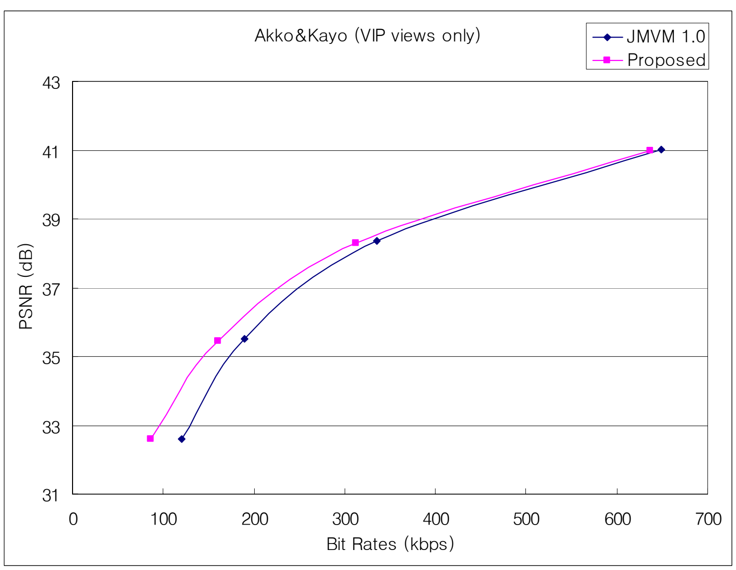



Fig. 6 Rate-Distortion Curves for '*Akko&Kayo'* Sequence (VIP views only)

Table 3. Performance Evaluation for '*Rena'* Sequence

| Basic QP | Avg. PSNR (dB) | | Avg. Bitrate (kbps) | | Gain | Bit saving |
|---|---|---|---|---|---|---|
| | JMVM | Proposed | JMVM | Proposed | | |
| 37 | 35.47 | 35.49 | 77.51 | 72.65 | 0.24dB | 5.16% |
| 32 | 38.48 | 38.47 | 137.12 | 129.29 | | |
| 27 | 41.57 | 41.55 | 273.93 | 256.91 | | |
| 22 | 44.40 | 44.39 | 571.48 | 566.72 | | |

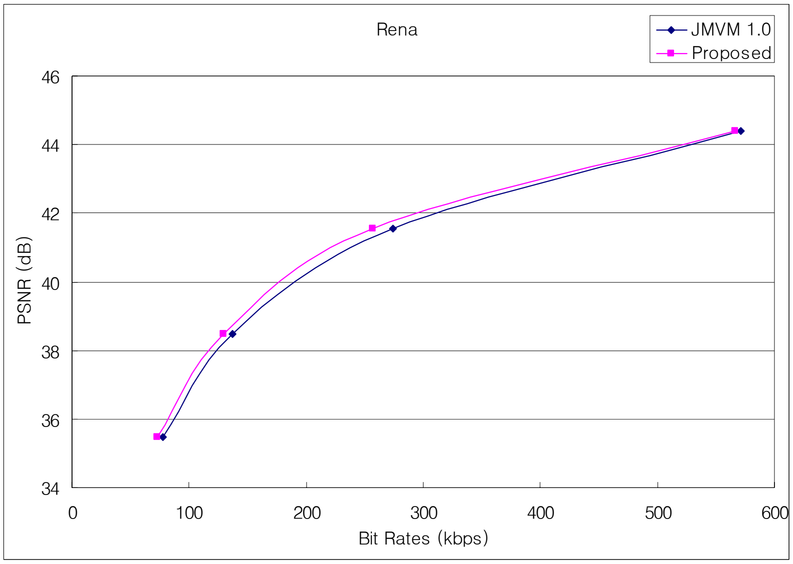



Fig. 7 Rate-Distortion Curves for '*Rena* Sequence

Table 4. Performance Evaluation for '*Rena'* Sequence (VIP views only)

| Basic QP | Avg. PSNR (dB) | | Avg. Bitrate (kbps) | | Gain | Bit saving |
|---|---|---|---|---|---|---|
| | JMVM | Proposed | JMVM | Proposed | | |
| 37 | 35.21 | 35.26 | 61.81 | 50.70 | 0.57dB | 11.99% |
| 32 | 38.14 | 38.13 | 104.75 | 86.85 | | |
| 27 | 41.13 | 41.09 | 204.58 | 187.31 | | |
| 22 | 43.96 | 43.94 | 425.95 | 415.08 | | |

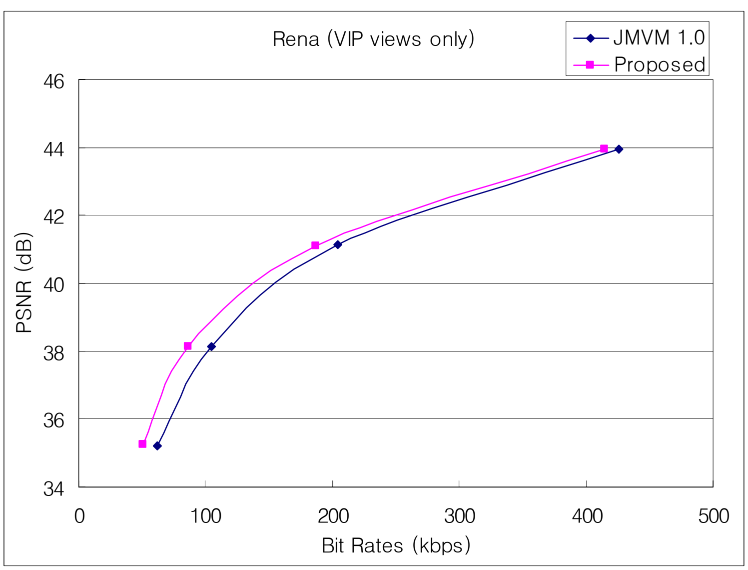



Fig. 8 Rate-Distortion Curves for '*Rena'* Sequence (VIP views only)

Table 5. Performance Evaluation for '*Breakdancers'* Sequence

| Basic QP | Avg. PSNR (dB) | | Avg. Bitrate (kbps) | | Gain | Bit saving |
|---|---|---|---|---|---|---|
| | JMVM | Proposed | JMVM | Proposed | | |
| 37 | 35.01 | 35.03 | 117.42 | 118.80 | 0.03dB | 1.25% |
| 32 | 37.08 | 37.11 | 203.20 | 204.39 | | |
| 27 | 38.67 | 38.71 | 399.72 | 398.99 | | |
| 22 | 39.88 | 39.92 | 989.92 | 974.54 | | |

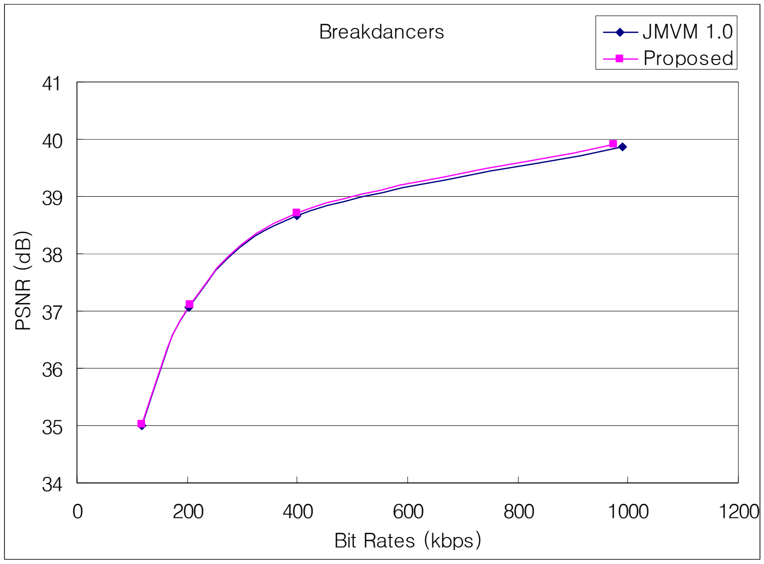



Fig. 9 Rate-Distortion Curves for '*Breakdancers'* Sequence

Table 6. Performance Evaluation for '*Breakdancers'* Sequence (VIP views only)

| Basic QP | Avg. PSNR (dB) | | Avg. Bitrate (kbps) | | Gain | Bit saving |
|---|---|---|---|---|---|---|
| | JMVM | Proposed | JMVM | Proposed | | |
| 37 | 34.48 | 34.54 | 92.86 | 96.55 | 0.08dB | 3.09% |
| 32 | 36.62 | 36.70 | 157.96 | 161.11 | | |
| 27 | 38.37 | 38.49 | 298.89 | 296.96 | | |
| 22 | 39.71 | 39.83 | 689.40 | 648.40 | | |

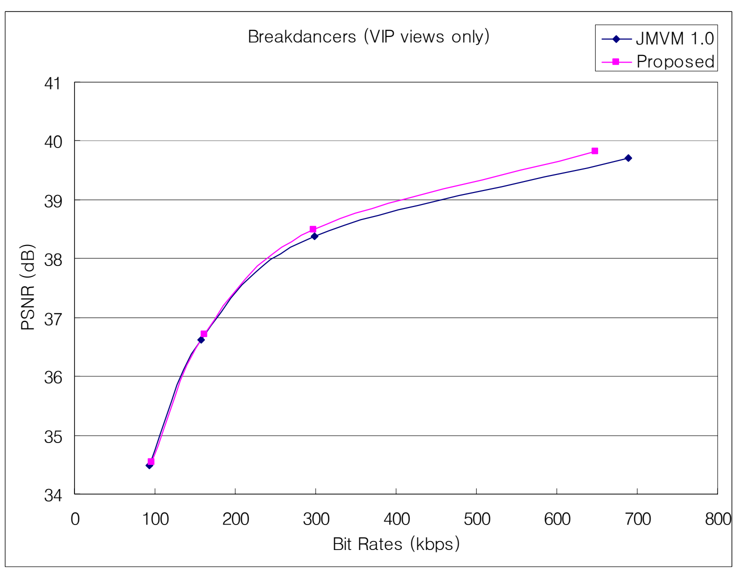



Fig. 10 Rate-Distortion Curves for '*Breakdancers'* Sequence (VIP views only)

# 5. Conclusion

'VIP P-picture' coding method has proposed to use interpolated images for MVC. It is composed of additional macroblock modes for VIP coding scheme and modified motion vector prediction scheme. Unequal horizontal displacements are compensated to maximize the quality of the synthesized image. This scheme shows average 0.66dB gain for B-views and average 0.2dB gain for whole views for dense sequences: 'Akko&Kayo' and 'Rena'. It also shows 0.03dB gain for B-views and 0.08dB gain for whole views for 'Breakdancers'. However, 'VIP P-picture' coding dose not show any gains for other sequences. We think these results are caused by sparse camera arrangement and some problems [5] of test sequences.

# 6. Acknowledgements

This work was supported in part by the Information Technology Research Center (ITRC) through the Realistic Broadcasting Research Center (RBRC) at Gwangju Institute of Science and Technology (GIST), and in part by the Ministry of Education (MOE) through the Brain Korea 21 (BK21) project.

# 7. References

[1] ISO/IEC JTC1/SC29/WG11 W8019, "Description of Core Experiments in MVC"
[2] ISO/IEC JTC1/SC29/WG11 JVT-U102, "View Interpolation for Multi-view Video Coding"
[3] ISO/IEC JTC1/SC29/WG11 JVT-U211, "Common Test Conditions for Multiview Video coding"
[4] ISO/IEC JTC1/SC29/WG11 JVT-V306, "CE6: View Interpolation Prediction for MVC"
[5] ISO/IEC JTC1/SC29/WG11 JVT-W084, "Observations of Multi-view Test Sequences"

(Append for Proposal Documents)

# JVT Patent Disclosure Form

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| Place and date of submission | San Jose, California, 21-27 April, 2007 |

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