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*Title:* **CE10: Multi-view Video Coding using View Interpolation Method**

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*Source:* GIST and KETI

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# Abstract

In this document, an additional picture coding method named 'VIP P-picture' coding is described based on the proposed view interpolation by GIST and KETI for multi-view video coding. The proposed view interpolation method can improve quality of interpolated images using initial disparity estimation, variable block-based disparity estimation, and pixel-level disparity estimation using adjusted search range. The interpolated intermediate images are used as reference frames for multi-view video coding. 'VIP P-picture' coding has been included and motion vector prediction has been modified in order to exploit the interpolated image.


# 1. Introduction

Multi-view video sequences are captured by two or more adjacent cameras simultaneously. Therefore, there is high spatial correlation among adjacent view images. Most prediction structures are trying to exploit this inter-view correlation. In the prediction structure proposed by Fraunhofer-HHI, shown in Fig. 1, each picture in S1, S3 and S5 have four reference frames: two temporal frames and two adjacent view frames [1]. Since these three views can be considered as inter-view, we 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 describe briefly the proposed view interpolation scheme for multi-view video coding, and we propose 'VIP P-picture' coding scheme to use the interpolated image.

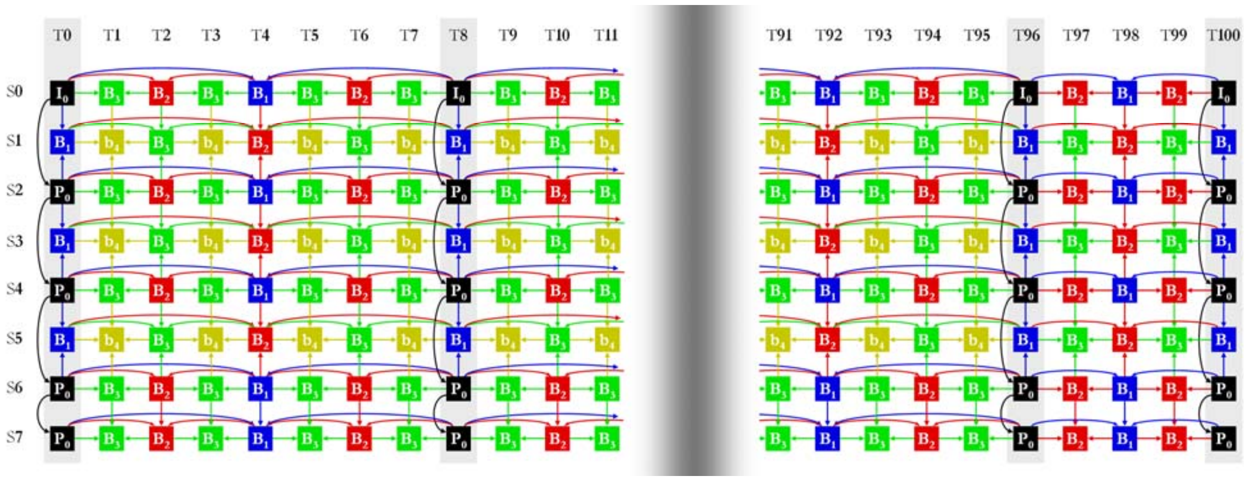



Fig. 1: Inter-view-temporal Prediction Structure

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

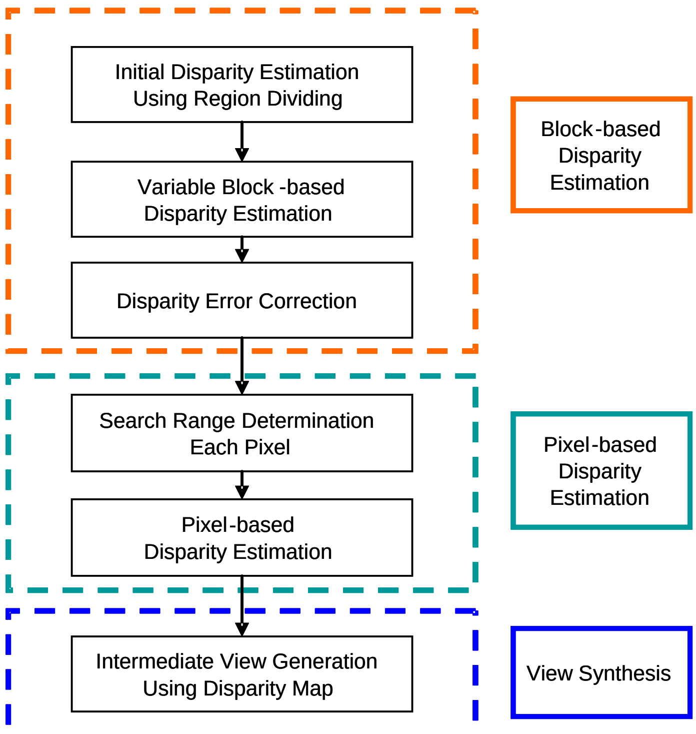



Fig. 2. Proposed View Interpolation Method

Previous interpolation methods have several weaknesses: (a) it is difficult to set the maximum search range before the disparity estimation operation, and (b) the accuracy of disparity estimation is poor 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 because it is a region dividing method. We also use variable block sizes for disparity estimation, which is more effective in 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 disparity information. 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 inter views such as S1, S3, and S5 in Fig. 1 because it is possible when adjacent views are already coded. After generating the intermediate image, it can be used as an additional reference frame. One of advantages of the intermediate image is that it is mostly overlapped with the image to be coded. We propose the view interpolated prediction P-picture (VIP P-picture) coding scheme and It performs like as 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 the co-located block in the intermediate image and it does not need a motion vector prediction. Figure 3 shows the overall coding structure using the VIP image.

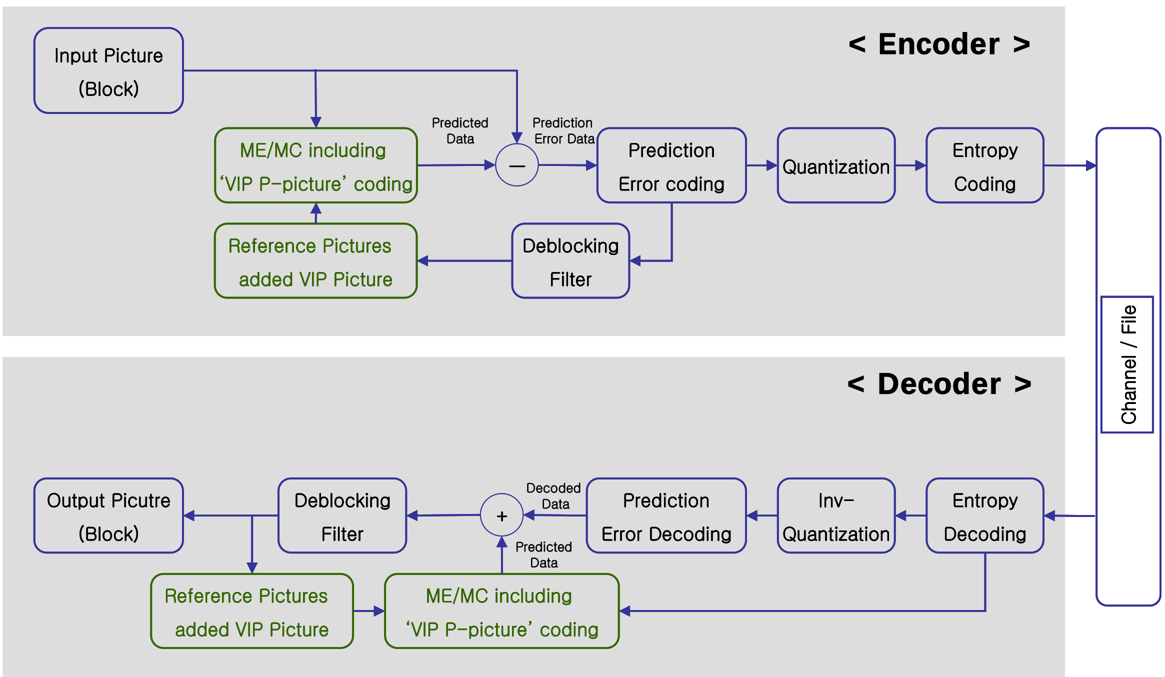
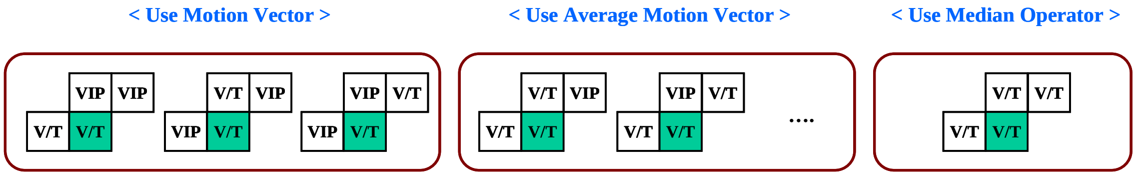


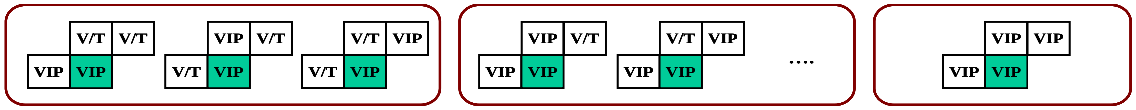

Fig. 3 Coding Structure added 'VIP P-picture' coding

## 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 has 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 VIP frame, motion vector predictor only considers neighboring blocks referring VIP frame, 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

## 4. Experimental Results

According to the description in [3], four QPs (22, 27, 32, 37) have been used for four sequences which are good enough to generate the intermediate image. We have implemented the proposed view interpolation scheme and 'VIP P-picture' coding method using JMVM 1.0 software. We have experimented four sequences only 1 second because of the lack of time. 'Rena' and 'Akko&Kayo' sequences are encoded for 31 frames, and 'Exit' and 'Ballroom' sequences are encoded for 25 frames. The search range for VIP is 48. Following 6 figures show the rate-distortion curves.

Fig. 5 and Fig. 6 show the coding results for the views adopted 'VIP P-picture' coding. According to Fig. 5 and Fig. 6, the coding efficiency has improved about 1dB in low bits rate, but it has little improved in high bits rate. The average PSNR for 'Rena' and 'Akko&Kayo' in low bits rate has improved about 0.3 dB as shown in Fig. 7 and Fig. 8. The average PSNR of interpolated images of 'Rena' and 'Akko&Kayo' are around 32 dB. 'VIP_SKIP' mode is chosen in these sequences over 30%. The results of 'Ballroom' and 'Exit' are similar to the results of the reference software because the PSNR of the interpolated image is not so good. More detail experimental results are provided in the attached Excel file.

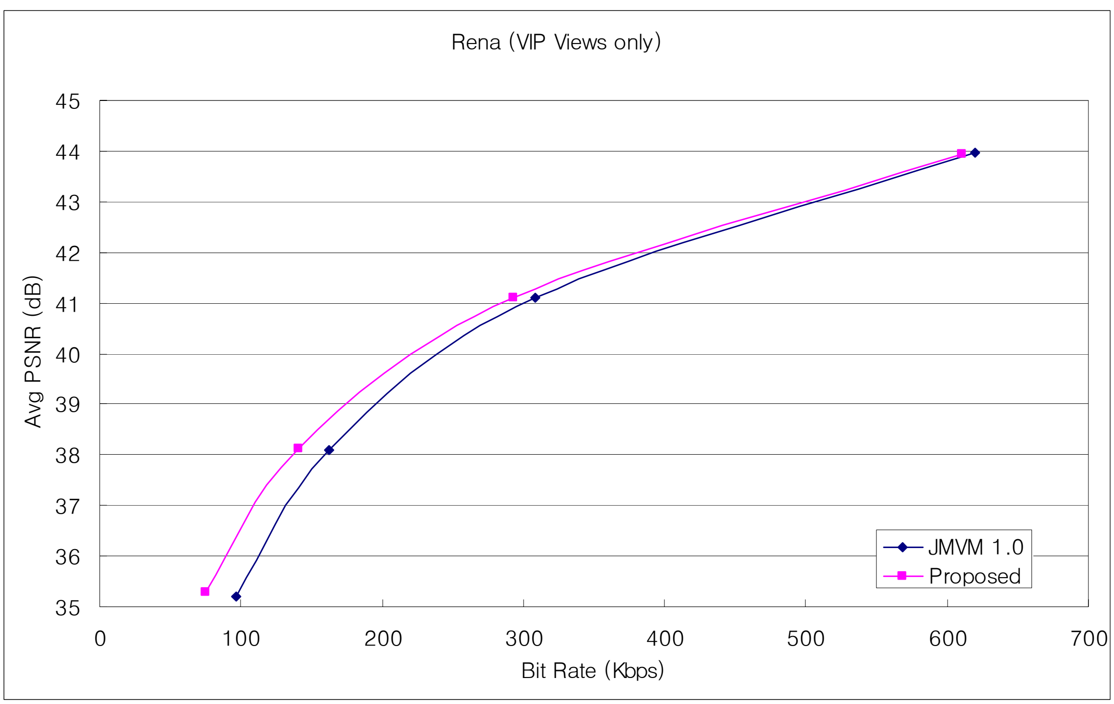



Fig. 5. Rate-Distortion Curve for Rena (only VIP views)

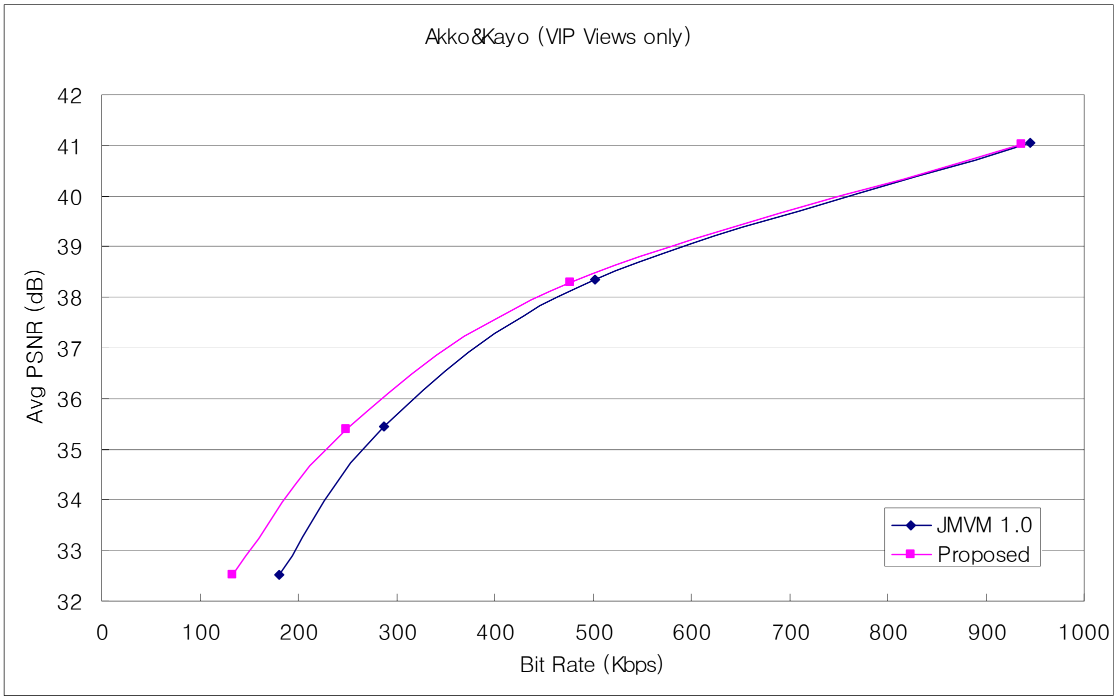



Fig. 6. Rate-Distortion Curve for Akko&Kayo (only VIP views)

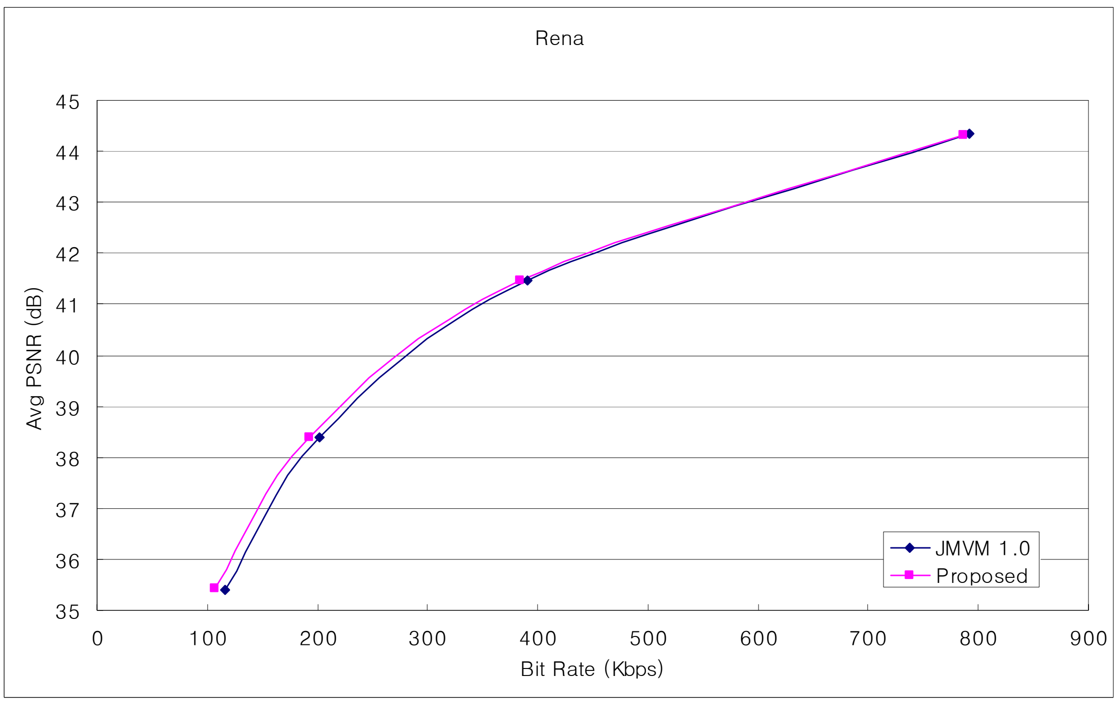



Fig. 7. Rate-Distortion Curve for Rena (for 16 views)

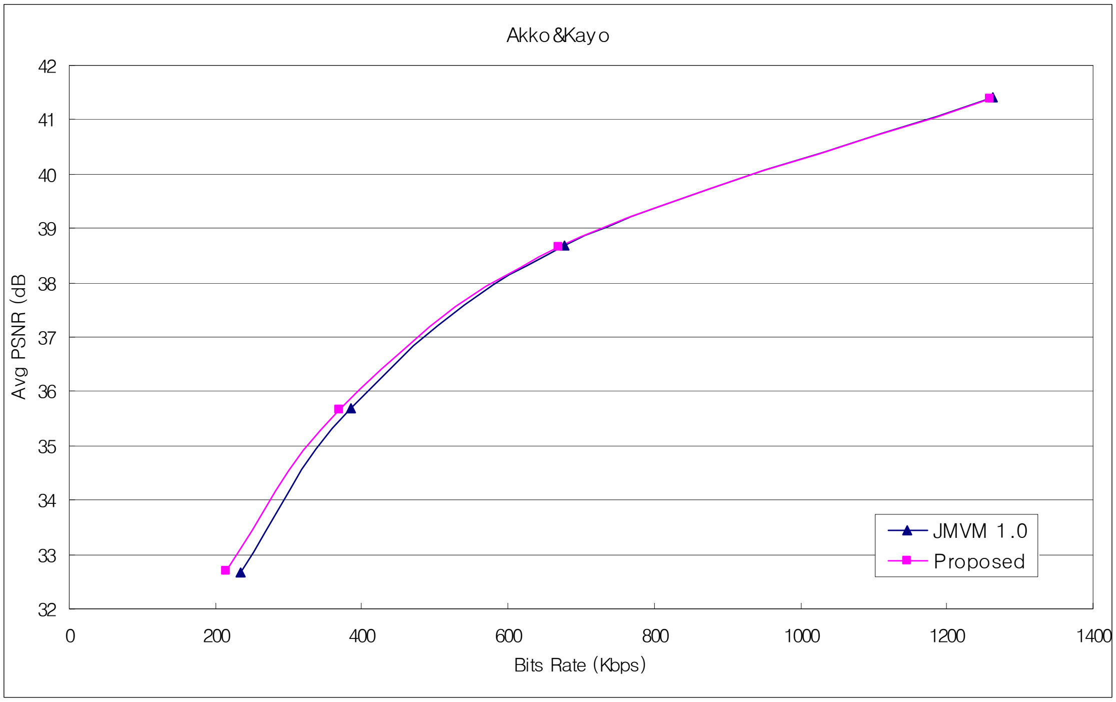



Fig. 8. Rate-Distortion Curve for Akko&Kayo (for 15 views)

# 5. Conclusion

'VIP P-picture' coding method is proposed to use an interpolated image for MVC. It is composed of additional macroblock modes for VIP coding scheme and modified motion vector prediction scheme. The experimental results show the PSNR of VIP adopted views has improved over 0.5 dB for 'Rena' and 'Akko&Kayo', and the average PSNR has improved over 0.15 dB for those sequences. Rest two 'Ballroom' and 'Exit' sequences were almost the same efficiency comparing with reference software.

# 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"

(Append for Proposal Documents)

# JVT Patent Disclosure Form

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| Place and date of submission | Klagenfurt, July 17-21, 2006 |

**Relevant Recommendation | Standard and, if applicable, Contribution:**

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