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SHVC 및 MVC 통합 기반의 스케일러블 다시점 비디오 부호화 설계 및 구현

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Design and Implementation of Scalable Multi-view Video Coding Based on Integration of SHVC and MVC

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요 약

다시점 이미지의 뷰포인트 간에 높은 유사도가 존재함을 바탕으로 MV-HEVC는 뷰포인트 내에서 전통적인 시간적 방향 예측 뿐만 아니라 뷰포인트 간에 예측을 수행함으로써 높은 부호화 효율을 얻는다. 본 논문에서는 HEVC를 기본 계층으로 사용하는 스케일러블 다시점 비디오 부호화를 구현하기 위해 SHVC와 MVC를 통합 구현함을 제안한다. 실험결과에 의해 BD-PSNR 개선이 1.5dB에 이르고 동시에 BD-Bitrate를 50~60% 가량 줄일 수 있음을 확인하였다.

Abstract

Based on the fact that high similarities exist between viewpoints of multi-view images, MV-HEVC achieves high encoding efficiency by performing conventional temporal direction prediction in a single viewpoint as well as inter-view prediction between viewpoints. In this paper, we propose to integrate SHVC and MVC (Multi-view Video Coding) to implement scalable multi-view video encoder using HEVC as a base layer. According to experimental results, it is verified that the BD-PSNR improvement reaches up to 1.5dB while reducing the BD-Bitrate by around 50~60%.

Keywords : Scalable Multi-view video coding, HEVC, SHVC, MV-HEVC

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Ⅰ. Introduction

To provide optimum quality multi-view video service under heterogeneous network environments and mobile equipment, it is needed to encode multi-view video in a layered format based on scalability [1], [2]. So it is important to develop a scalable multi-view video coding structure which combines multi-view video coding technology, MV-HEVC, and layered video coding technology, SHVC [1]. But there must be an update in the reference picture management when we combine the two separate codecs to develop a scalable multi-view encoder. Reference picture is generally managed by reference picture list. To perform picture-to-picture prediction efficiently in the process of video encoding and decoding, many reference pictures should be stored in the memory. And the DPB (Decoded Picture Buffer) also needs to be changed to accommodate the developed scalable multi-view coding structure [3].

In this paper, we propose an efficient design and implementation of scalable multi-view video coding based on integration of SHVC and MVC. The proposed design mainly consists of three parts: 1) reference picture reordering part which reorganize the sequence of the reference pictures, 2) marking process part which stores and dispatches reference pictures to and from the DPB memory, and 3) reference picture list reconstruction part which composes the two conventional reference picture lists, each one used for SHVC and MV-HEVC. With the proposed reference picture list design, the predictive coding of the developed scalable multi-view video coding can be performed efficiently in terms of advanced prediction accuracy in motion estimation, systematic DPB management, and improved coding efficiency.

Ⅱ. Design Of Reference Picture List and Prediction Mechanism

Fig. 1 shows the system architecture of the proposed scalable multi-view video coding based on integration of SHVC and MVC for dual-views video, where major coding structures and mechanisms of SHVC and MV-HEVC are integrated. Each view is basically processed by applying the layered coding mechanism of SHVC to generate the base and enhancement layers in a scalable way. To achieve inter-view prediction effect, the reconstructed picture of view0 is used as an additional reference frame for coding view1.

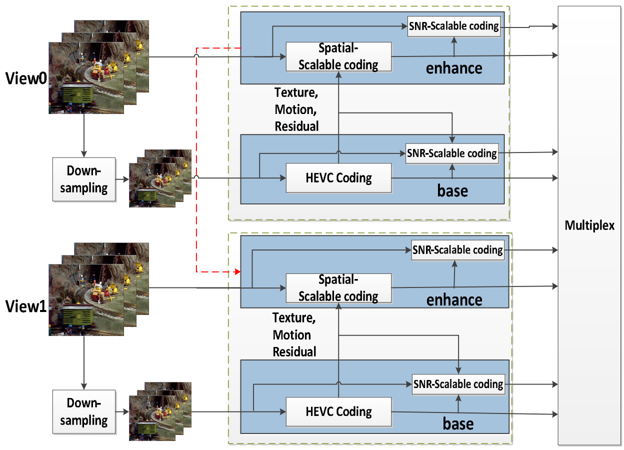

그림 1. SHVC 및 MVC 결합 기반의 제안된 스케일러블 다시점 비디오 부호화 구조

Fig. 1. System architecture of the proposed scalable multi-view video coding based on integration of SHVC and MVC

Fig. 2 shows the overall architecture of the designed reference picture list for the proposed scalable multi-view video coding based on integration of SHVC and MVC employing inter-view prediction. In this architecture, predictive coding efficiency can be improved by using enhancement layer picture of view0 (B0_2) as an additional reference picture for coding the picture of view1 (B1_2).

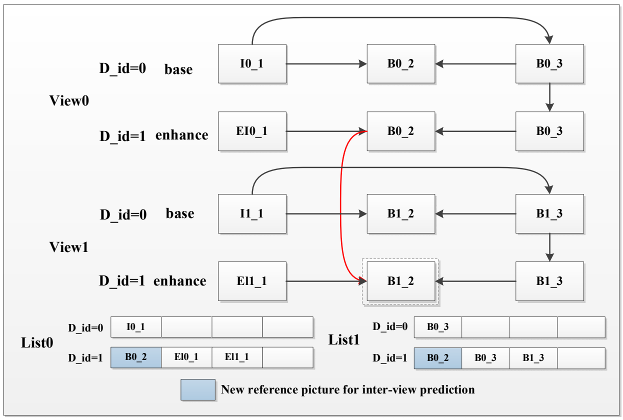

그림 2. 시점 간 예측을 지원하기 위해 설계된 참조화면리스트의 전체 구조
Fig. 2. Overall architecture of the designed reference picture list supporting inter-view prediction

Fig. 3 shows prediction structures between layers. Each of them is denoted as follows: 1) simulcast case: all layers are coded independently with HM (HEVC test model) software, 2) MV-HEVC simulcast case: layers are coded with HTM (MV-HEVC reference software) where D1 and D0 are coded independently, 3) SHVC simulcast case: layers with spatial dependency are coded with SHM (scalable HEVC reference

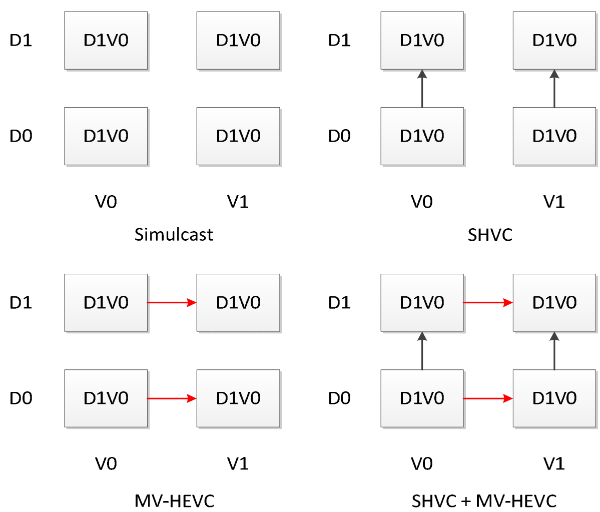

그림 3. 계층 간 다양한 예측 구조
Fig. 3. Prediction Structures between layers

software) where V0 and V1 are coded independently. 4) MV-HEVC+SHVC case: In addition to inter-view prediction predicted from D0 at the same view using inter-layer prediction, D1 is predicted from D0 at the same view using inter-layer prediction. In this implementation, we adopted the prediction mechanism of 4) MV-HEVC+SHVC case.

Ⅲ. Experimental Results

In order to evaluate the compression efficiency and video quality after applying the proposed mechanism in actual coding process, we developed a scalable multi-view video coding system which integrates SHM-10.0 [4] and HTM-13.1 [5] together. Test condition for the performance evaluation was set to GOP_size=8, Intra_period=16, and frame_rate=25 frames per second. We used Poznan Hall HD sequences which are composed of dual views, one for the left-view and the other for the right-view. The maximum number of reference frames for motion estimation was set to 6. We compare the performance in terms of compression efficiency and average PSNR between the bitstreams generated by the conventional SVC+MVC predictive coding mechanism and by the proposed predictive coding mechanism integrating SHVC and MVC. The test is performed using four different values of QP (quantization parameter) values such as 27, 30, 33, and 35.

Table 1 shows the test results for coding the left-view video of the Poznan Hall sequences with HD resolution. “SVC prediction” in Table 1 denotes the results of coding for the left-view video by using MVC+SVC predictive coding architecture. “Proposed prediction” denotes the results obtained by using the proposed predictive coding architecture. The experimental results in Table 1 show that we could achieve

표 1. HD급 해상도의 Poznan Hall 시퀀스에 대한 다양한 QP 값 변동에 따른 BD-PSNR 및 BD-Bitrate 비교
Table 1. Comparison of BD-PSNR and BD-Bitrate for various QP values for the Poznan Hall video sequences of HD resolution

		Encoding test sequence data					
		SVC+MVC		Proposed prediction		BD-PSNR	BD-Bitrate
		(bits)	(PSNR)	(bits)	(PSNR)	(dB)	(%)
Poznan Hall	QP=27	302880	41.67	158224	41.84	1.47	-57.56
	QP=30	196728	40.86	100505	41.22		
	QP=33	158496	40.45	68093	40.44		
	QP=35	143872	40.20	53612	39.87		

1.4697 dB increase in BD-PSNR and 57.5634% decrease in BD-Bitrate at the same time by employing the proposed prediction mechanism. Fig. 4 shows the comparison of PSNR performance by plotting RD (rate-distortion) curve for the Poznan Hall test sequences.

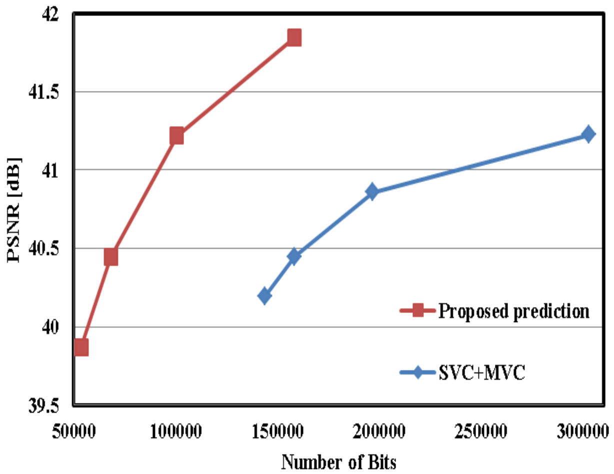

그림 4. Poznan Hall 시퀀스에 대한 PSNR 성능 비교
Fig. 4. Comparison of PSNR performance for the Poznan Hall sequence.

Overall, the application of the proposed prediction architecture results in not only decrease in compressed data size measured in bit-rate, but also quality improvement measured in average PSNR, when compared to the SVC's conventional prediction architecture, and this performance improvement is proportional to the size of QP values. For other test sequences, we could observe similar improved results in terms of BD-PSNR and BD-Bitrate.

Ⅳ. Conclusions

In this paper, we proposed an efficient design and implementation of scalable multi-view video coding based on integrating SHVC and MVC mechanism. Experimental results showed the superiority of the proposed scalable multi-view video coding compared to the conventional implementation in terms of compression efficiency and video quality.

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