Cloud-based Real-Time Streaming Service for UHD Contents

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Abstract: Digital broadcasting technology has been to equip the environment that can service UHD contents. At this time video streaming service is a very popular technology in which these services strive continuously transmit video content from the server to the client. Video delivery technology to deliver the best quality to the user automatically has become a very important challenge at this point. By using the Hypertext Transfer Protocol (HTTP) which is the de facto protocol of the Internet service at this time, a new streaming method has been carried out research and development.

Keywords— **UHD, MPEG-DASH, Cloud**

1. Introduction

Development of digital broadcasting technology has provided an environment that the high-quality UHD broadcast contents can be maden and serviced which is superior to HD contents. Recently, such as the national broadcasting service, the cable TV, IPTV accomplished the UHD trial broadcasts service beyond the HD contents successfully. From the changes of the pattern of broadcasting consumption which is using computers and smartphones based on the internet then traditional media such as TV viewing experience, the real time streaming contents has been needed, without downloading the contents.

The various streaming service systems on the market that support this consumption patterns. However, the FullHD contents has been supported and developed but the other contents not. The success of the pilot broadcast UHD contents also means success in an ideal environment, you can configure each broadcast environment and to the practical commercialization of services must address a variety of issues.

UHD contents data has a more than four times as compared to Full HD contents in this Super quantitative characteristics by existing video encoding techniques and network resources in a level is a seamless streaming service is not possible. Therefore, the analysis and research and development of related technologies are needed to stream the UHD content in real-time in the existing Internet.

In this paper, we build a system that can through the research and development of trans-coding of UHD content, content lifecycle management, real-time streaming services and video player, streaming service portal uses the existing internet network to service the real-time streaming of UHD content to be tested.

This paper is organized as follows. First, in chapter two introduces the core part of the system for real-time streaming of UHD contents. In chapter 3, we describe the test results from the chapter two and the additional research areas for the future.

2. The system for the UHD contents using the real-time streaming service

In this paper, we suggested the system to correspond to the variety of network environments such as, the 3G, LTE and the wired and wireless LAN systems and response to the veriety of the user terminals such as, the TV, desktop, laptop, tablet and the smartphone environments with a variety of performances.

The system we suggested combined with the transcoding and the scalable encoding and decoding technology which is based on the HEVC, the life-cycle management of the UHD contents and techniques for the efficient management of the network resources and consists of a server technology for streaming content of UHD.

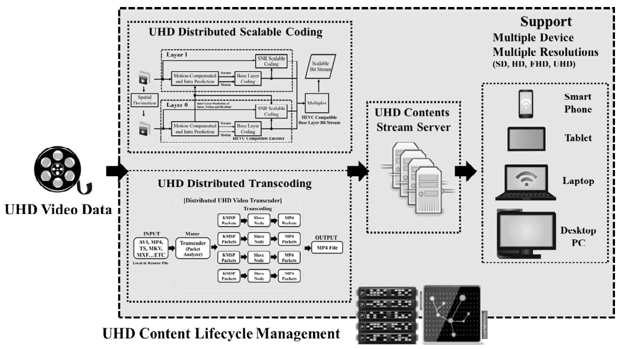

Figure 1. The Proposed UHD broadcasts contents streaming service based on the cloud

2.1 The Distriduted Transcoding for the real-time UHD contents

2. 1. 1 HEVC

HEVC (High Efficiency Video Coding) scheme has increased over 50% compared to the conventional techniques as a next-generation of the H.264 video compression technology, the H.264 technology after the latest compression techniques. HEVC video compression technology is considered a variety of ultra-high resolution, and the video compression technology for high-definition, wide screen resolution, color depth, lossless codec, and the Scalable Video Coding techniques for the preparation of the UHDTV broadcasting.

2. 1. 2 The Distributed HEVC Transcoding

In the case of using the codec to compress the images, we use the various algorithms. Using an image compression codec makes the higher and the more complexity of the algorithm. HEVC required more than five times computation than H.264, so the encoding an the decoding performance is slow because of the CPU is slow operation alone. In the N-Screen environment such as the mobile, TV increase the consumption patterns, so it should be able to support the various resolution as well as UHD resolution and the SD, HD and the Full HD resolution at the same time.

Therefore, transcoder technology is considered as essential to convert to a multi-resolution compression formats such as the HEVC-based SD, HD, FHD, UHD from the image of the low efficiency of the existing compression format such as the H.264, VC-1, ProRes, etc.

We studied the technology of the video packet analyzer, the video time and space division optimization algorithm, the parallel structure transcoder and the stream syncing combine for the cloud-based distributed transcoding techniques. Those study of the technology needed for the characteristic of the large capacity of the UHD content and to support the various resolutions.

2.1. 3 The Distrubuted Transcoding System of Cloud

The UHD distributed transcoding system of the content is the same as [Fig 2]. We developed the transcoder based on the FFMPEG and KETI HEVC encoder and constructed in the distributed processing system based Hadoop developing. The distributed transcoding system is the mixing the analyzes the packet of the inputted compressed image, and dividing the stream at a predetermined time interval by a distributed parallel transcoding, the newly compressed video stream and an audio stream functions to create a new image format.

The overall configuration of a distributed transcoding system is combination of the Master Transcoder UI (Packet Analyzer) dividing the picture and analyzing the input image and the Slave Nodes (Transcoder) make the divide transcode of the input video.

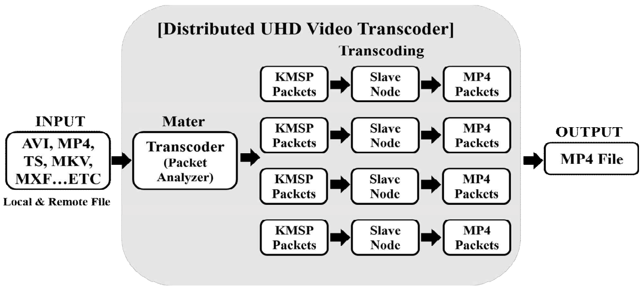

Figure 1. The Real-time Transcoding UHD contents

2. 1. 4 The Distributed Transcoding Speed Testing

Various [Table 1] to measure the speed of a distributed transcoding system implemented in this section were tested by constructing the content and execution environment such as [Table 2].

We took the distributed transcoding with respect to one content to the median of the three velocity value after continuous running three times to a final velocity time reading the file in order to minimize the effects on the input and output files were excluded from the calculation speed.

[Table 3] is transcoding rate for the 4K UHD image and [Table 4] shows the value of the compression rate and the image quality after the transcoding. As the result, the average rate of the transcoded image of 4K UHD exhibited 35.44 fps @ 42.75 dB.

Table 1. System Environment

OS	Windows 7 SP1 64bit
CPU	Intel Xeon E5-2687W v2 (8-core, 3.4GHz)
RAM	32GB
Hadoop Cluster	Master1, Slave7
Contents	4K(3840x2160) MP4 (H.264/AVC)

Table 2. 4K UHD Contents

Contents Name	Total Frame	Bitrate(Kbps)
Jack	3877	43584
City	2706	39215
Sport	4286	41380
Nature	6237	40910
YoungDay	6963	40660
FIFA	53949	24501
Average	13003	38375

Table 3. 4K UHD Video Transcoding Speed

Contents Name	Transcoding processing speed (fps)
Jack	33.80
City	31.58
Sport	28.69
Nature	44.26
YoungDay	44.84
FIFA	29.44
Average	35.44

Table 4. 4K UHD Video Transcoding Quality and Compression Ratios

Contents Name	Output Bitrate	Output Video Quality (dB)
Jack	3503.88	44.94
City	3219.36	40.61
Sport	7759.64	40.22
Nature	5921.36	38.36
YoungDay	1653.70	51.80
FIFA	9403.10	40.58
Average	5243.51	42.75

3. The Real-time Distributed SHVC Encoding, Decoding by Could System

3.1 SHVC

By the Scalable Video Coding is encoded in a hierarchical manner to support various resolutions, frame rates, and quality in a single bitstream, the consumer terminal is how to extract only a portion of the bitstream to decode the image for the user environment.

The extraction method, and outputs only the basic unit having a layer identifier to be extracted by analyzing the layer identifiers included in the encoded bit stream. The Scalable Encoding method has the disadvantages of the higher encoding and decoding complexity, but has the advantage that it can support a variety of consumer environment through a single encoding and simple extraction.

For example, the Scalable Encoding scheme based on the HEVC is the SHVC (Scalable HEVC) techniques used to UHD original video image of compressing performed to the [Fig 3] and as the Base Layer and the Enhancement Layer to get two kinds of video data. The additional Enhancement Layer is the UHD video data and the Base Layer is the video data of the HD quality. If the Base Layer using a decoding technique SHVC can not play back the image using only while the Enhancement Layer that fully reproduce the video of HD class.

In the case of play the UHD, we found that we have to use all the Enhancement Layer data that compressed to SHVC and the Base Layer data.

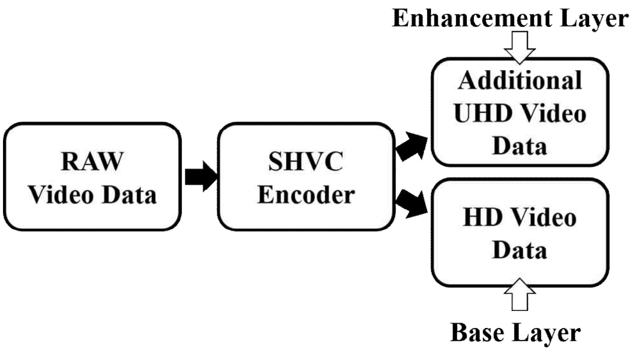

Figure 2. SHVC Compression Technique

The Enhancement Layers of the current CTU (coding tree unit) block encoding as in the current CTU around the CTU block and the corresponding is the base layer (Base layer) CTU block of encoded similarities based on the current encoding to the CTU block of a fast encoding method for limiting the maximum block size CU.

We improved the speed to reduce the procces of calculate the cost distortion value about the size of the CU block. As the [Fig 4], limiting the maximum CU size of the encoded CTU as a compensation a layer between the resolution in the CU block size of the base layer block that corresponds to the current CTU size.

Also, the improvement rised when the Enhancement Layer of a current neighboring block of the completed encoding CTU AL, A, AR, L correspond AL, A, AR, L CTU of the Base Layer blocks, and in that case it is determined that there is a respective similarity.

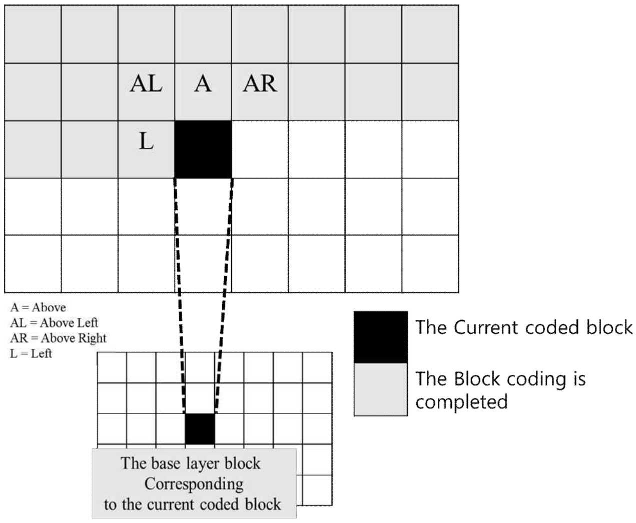

Figure 3. Base Layer Block, Enhancement Layser Block

The Enhancement Layer of the rate for all modes encoding available for the PU (Prediction Unit) block to be currently encoded - without going through the prediction process by the distortion cost value calculation, a base layer (Base Layer) corresponding to the PU high-speed encoding method using the time hierarchy of the picture (Temporal sub-layer) information to be PU current encoding and the encoding mode of determining a candidate prediction mode, through the prediction process only on the determined candidate prediction mode determining the best PU mode to be.

It encodes the candidate prediction mode of the PU block of an Enhancement Layer to be currently encoded at a high speed through the algorithm of Figure 5.

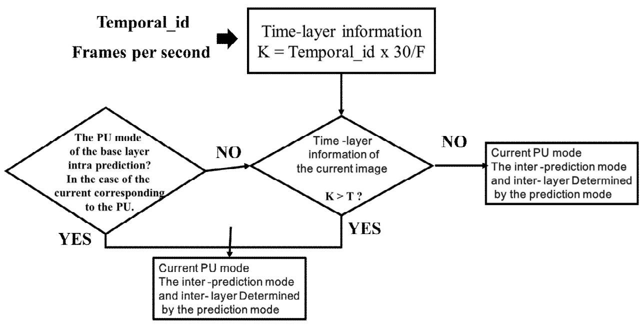

Figure 4. Prediction encoding mode determination method of improvements

3.2 Real-time Distributed SHVC Encoding Testing by Cloud System

Environment configured in this test is the same as [Table 5]. Experimental method was getting an encoding rate of the average value of the encoding rate after five continuously running the encodre fiv times. As the [Table 6], between the UHD bitstream decoding of video encoded by the UHD / HD and the original image shows the 7.81 frames per second in the average PSNR value in the 38.7dB.

Table 5. System Environment

OS	Windows 7 SP1 64bit
CPU	Intel Xeon E5-2687W v2 (8-core, 3.4GHz)
RAM	32GB
Hadoop Cluster	Master1, Slave7
Contents	4K(3840x2160) MP4 (H.264/AVC)

Table 6. Encoding Speed Test Result

Encoding Times	1	2	3	4	5
Encoding Time(sec)	105	114	106	118	110
Frame Number (frames)	864	864	864	864	864
Encoding Speed (fps)	8.23	7.58	8.15	7.32	7.85
PSNR (dB)	38.7	38.7	38.7	38.7	38.7
Average Encoding speed (fps)	7.81				

3.3 Real-time Distributed SHVC Decoding Testing by Cloud System

Environment configured in this test is the same as Table 7. The target UHD content is encoded using a single bit stream to the cloud-based distributed to 864 frames encoder to measure the speed of decoding.

As the Table 8, we measured the speed by repeating the decoding 5 times. The decoding rate of the encoded bitstream to UHD / HD was measured by 11.6fps. The PSNR values of the decoded image and the original image was 38.7dB.

Table 7. System Environment

OS	Windows 7 SP1 64bit
CPU	Intel Core i7-4960X (3.6GHz)
RAM	62GB

Table 8. Decoding Speed Test Result

Decoding Times	1	2	3	4	5
Decoding Time(sec)	105	114	106	118	110
Frame Number (frames)	864	864	864	864	864
Decoding Speed (fps)	8.23	7.58	8.15	7.32	7.85
PSNR (dB)	38.7	38.7	38.7	38.7	38.7
Average Decoding speed (fps)	7.81				

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4. Conclusion

In this paper, we analyzing the skills what needed in the system to provide real-time streaming of the UHD contents. We conducted a test of a real-time streaming of the UHD contents. The test range was the total content management processing, the transcoding, the SHVC encoding system , a streaming server in a single integrated environment, to the end user terminal.

We used a test terminal PC, Android smartphone, utilizing QoS capabilities of the network router was set up unlimited bandwidth, 5Mbps, 2Mbps. The MPD files generated as a result of the transcoding and encoding of the SHVC automatically save to the server via the integrated management system.

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