Software-Based Encoder for UHD Digital Signage System

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***Abstract*— With the rapid growth of the digital signage industry, high resolution video contents are used for digital signage. In this situation, advertisers want to use UHD video contents to advertise their product. In this paper, we propose a software-based encoder for UHD digital signage contents which can divide frames into appropriate form for the layout of a digital signage display system and manage quality of divided frames.**

***Keywords*— Digital Signage, Software-Based Encoder, Ultra High Definition**

I. INTRODUCTION

Since the digital signage industry has been widely propagated, advertisers want to use high resolution video contents to advertise their products. [1]-[4] For this reason, advertising producers need an encoder for Ultra High Definition(UHD) video contents to make UHD digital video signage. In general, hardware-based encoders are used to encode high resolution video contents. However, hardware-based encoders are expensive and hard to customize. Furthermore, it is difficult to improve the performance of a hardware-based encoder without changing the machine. To solve these problems, we propose a software-based encoder for UHD digital signage system.[5]-[6]

To reduce the price of digital signage display system, multi-panel based devices are used to display digital signage. Figure 1 shows the multi-panel based device which can display UHD video contents by using four full-HD panels. This means that an encoder for digital signage contents should convert the digital signage content to suit with multi-panel signage device.[7]-[9]

Figure 1. Multi-panel based device for digital signage

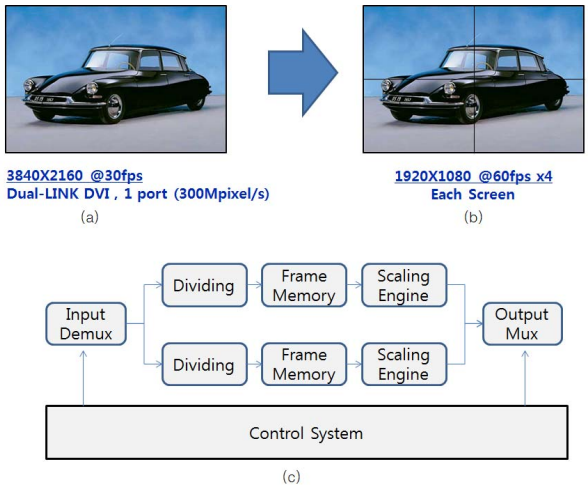

Figure 2. Concept design of Multi-panel based device for digital signage

In this paper, we propose an encoder which can divide a digital signage content and encode each content in parallel. If the encoded UHD digital signage content's quality is low, customers do not feel attractive from the digital signage contents whether the content's resolution is high or not.[5]-[7] The proposed encoder can encode UHD digital video signage contents with high quality and low bitrate.

The proposed method divides an UHD digital signage contents into pieces then divides each piece into slices. By using parallel encoding, we can encode the digital signage content appropriately for the layout of multi-panel device in short time. We can manage the quality of each piece of the digital signage content because we can set each piece's parameter individually.

This paper is organized as follows. We explain the proposed software-based digital signage encoder in section II. Experimental results are given in section III and concluding remarks are given in section IV.

II. PROPOSED SOFTWARE-BASED ENCODER

A. Software-based Encoder Design

Figure 3 shows the encoding processes of the proposed soft-ware based UHD digital video signage encoder. First, each frame of digital video signage contents is divided into

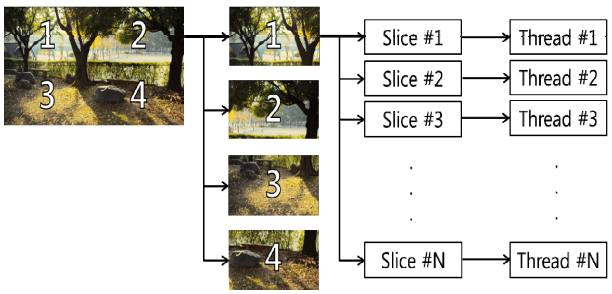

Figure 3. Design of the digital signage encoder

pieces to suit for the layout of digital signage display device. Each piece is also divided into slices which are encoded in parallel. A thread is given for a slice, so we can manage the number of slices which are used to encode a frame. Because of pieces in same frame are encoded in parallel, the proposed encoder can control parameters for each piece. If a piece's encoding quality is lower than other pieces, the encoder will enhance the quality of the piece. By using this method, we can normalize the quality of the target UHD digital video signage content.

Since the proposed encoder divides a frame into pieces, we can set each piece's encoding parameters like bitrate, framerate, size and motion estimation method individually. If an advertiser has different priority of digital signage contents, the advertiser can allocate more bitrate for important digital signage contents. When the encoding is finished, each slice is combined to reconstruct original frame. Because of the frame is combined after dividing process, blocking artifacts can be shown at the edge of slices. We use deblocking algorithm to remove blocking effect and get clear frame.

The proposed encoder which uses dividing encoding method is faster than a simple whole frame encoder. UHD video frames are bigger than cache memory. If we encode whole frame without dividing process, the frame data overflow cache memory and violate the memory which should be used for next frame. Since each divided slice's size is small, memory violation problem is solved by using dividing encoding process.

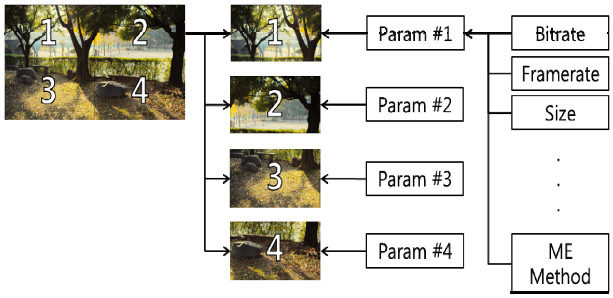

Figure 4. Encoding parameters of the digital signage content

TABLE 1. COMPARISON BETWEEN THE PROPOSED METHOD AND A SIMPLE IPP H.264 ENCODER

	Proposed Method	**IPP encoder**
Speed (fps)	15.48	9.30
CPU usage (%)	96.58	99.27

B. Encoder Implementation

We use H.264 codec for UHD digital signage contents. The H.264 format is the most popular codec for high resolution video contents and has high compression ratio. The H.264 standard also considers dividing frames into slices. We support main profile which is appropriate to generate high compressed video contents.[10]

The proposed encoder encodes target UHD digital video signage contents as follows. First, read a raw UHD digital video signage content with encoding parameters. We use YUV stream format for raw UHD digital video signage contents. The proposed encoder is created and initialized with given encoding parameters. Next, the input YUV stream is divided into pieces logically and each piece is divided into slices by considering number of thread. Each slice is encoded by single thread in parallel. After a frame is encoded, the proposed encoder gets QP of each piece to control next frame's quality. If specific piece's quality is too high or low, it will be adjusted in next frame.

Since digital signage contents can be transferred in online, the UHD digital signage video content's bitrate should be less than 30Mbps. It means that the compression ratio of the target UHD digital video signage content should be very high. The proposed method can compress the raw YUV stream to 30Mbps H.264 video without degrading the resolution of digital signage contents.

III. EXPERIMENTAL RESULTS

We used two Intel Xeon X5680 processors to encode UHD digital video signage contents to evaluate the proposed method. The proposed method uses OpenMP technology for parallel processing. The resolution of videos which are used to

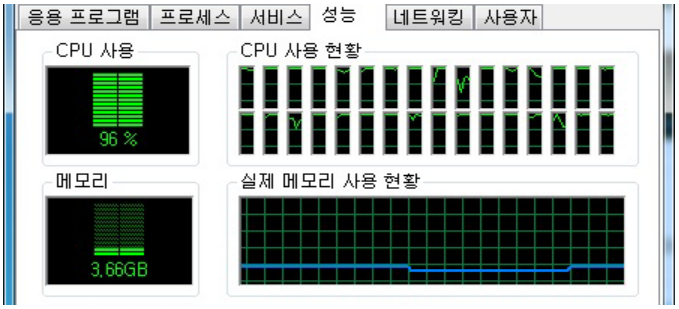

Figure 5. CPU usage of UHD digital signage encoder

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Summary:
Num frames encoded = 990
Encoding Time = 63.96 sec, 15.48 fps
Average CPU usage = 96.58%
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Summary:
Num frames encoded = 990
Encoding Time = 106.43 sec, 9.30 fps
Average CPU usage = 99.27%
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Figure 6. Comparison between the proposed method(top) and a simple IPP H.264 encoder(bottom)

evaluate the proposed has 3840x2160. We divided the target UHD digital video signage into four pieces and same initial encoding parameter is given for every piece. In this paper, we compare the simple H.264 encoder in IPP sample with the proposed software-based UHD digital signage encoder.

Table 1 and Figure 6 shows that the proposed method is 60 percentage faster than existing simple IPP H.264 encoder despite IPP encoder also supports multi thread processing. The proposed method is faster than existing method because the two-level parallel processing need less time to pipeline threads which encode slices.

Figure 7 shows that encoded UHD digital video signage contents which are encoded by using the proposed method have high fidelity after encoding. The average peak signal to noise ratio(PSNR) of encoded contents is over 45dB and even the minimum value is over 35dB while encoded contents are compressed to 30Mbps H.264 video.

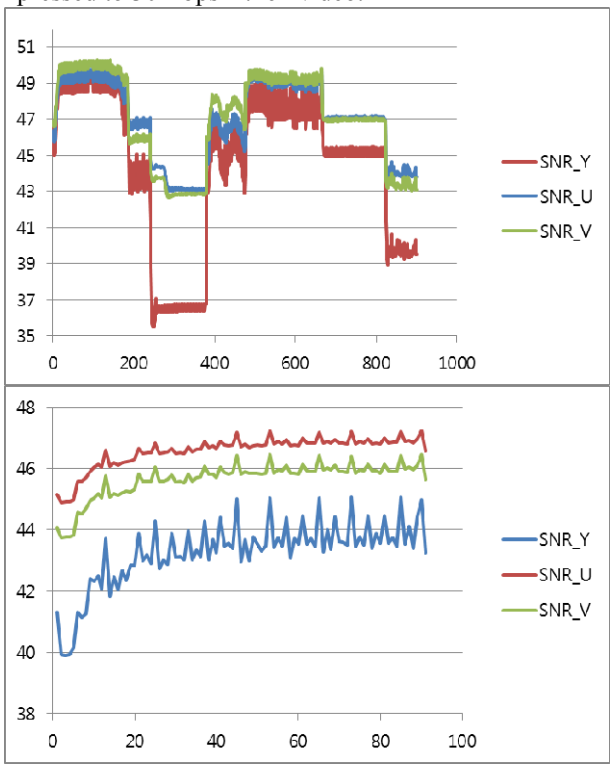

Figure 7. PSNR of encoded UHD digital video signage contents

Figure 8. Multi-panel based digital signage display device

We also checked the fidelity based on human visual system by using multi-panel based digital signage display device with experts. The encoded UHD digital signage contents have no blocking artifact and have high fidelity. Since the encoder control each piece's quality, every panel's content have similar quality.

IV. Conclusions

In this paper, we proposed a software-based UHD digital signage encoder which can encode UHD digital video contents with high fidelity in short time by using parallel encoding technology. Our experimental results show that the proposed encoder guarantees better speed than an existing encoder on same system. In future research, we will try to use HEVC codec to reduce the bitrate of digital signage contents and encode 3D UHD video contents with the proposed encoder.

Acknowledgment

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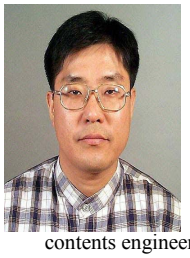

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