A REAL-TIME AVS3 8K-UHD ENCODING AND DECODING SYSTEM

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ABSTRACT

In this demo, a real-time AVS3 8K ultra-high-definition (UHD) encoding and decoding system is presented. The high-speed encoder and decoder in this system, namely SVT-AVS3 and DAVS3 respectively, are delicately developed based on efficient parallel architectures, e.g. the Intel® Scalable Video Technology (SVT). The proposed system is implemented on the X86 platform. It can achieve 8K-UHD real-time encoding and decoding at 10-bit depth with bit rate up to 100Mbps.

Index Terms— AVS3, Ultra High Definition, Real-time

1. INTRODUCTION

With the development of video industry, ultra-high-definition (UHD) videos such as 4k/8K videos and 360 degree panoramic videos nowadays are omnipresent in our lives. These videos provide people a better visual experience. However, the massive contents are also leading to an explosion of video traffic. A more efficient 8K-UHD real-time encoding and decoding system is strongly demanded.

Specifically designed for the emerging UHD video contents, the third generation of audio video coding standard (AVS3) finalized its first phase in March, 2019. It is stated that AVS3 adopted a series of new coding tools for more efficient compression and achieved almost 30% performance better than AVS2 and HEVC on UHD sequences [1].

However, the adopted new tools greatly increase the encoding and decoding complexity, which make it hard to satisfy the ubiquitous time-sensitive applications. As shown in the maintenance report for the reference software of AVS3, i.e. HPM [2], AVS3 has almost ten times encoding complexity and 1.1 times decoding complexity than that of HEVC. For better utilizing the advantages of AVS3, we developed a novel system on x86 platform, which highly optimized AVS3 encoder and decoder. The proposed system is supposed to stably achieve a real-time encoding and decoding support for 8K-UHD videos.

The rest of this paper is organized as follows. In section II, we will introduce the high-speed encoder, namely SVT-AVS3. The high-speed decoder, namely DAVS3, will be introduced in Section III. The remaining design and configurations of this demonstration system will be described in Section IV.

2. SVT-AVS3: A HIGH-SPEED ENCODER FOR AVS3

Intel® Scalable Video Technology (SVT) architecture is specifically designed for multi-core platforms and highly optimized for Intel® Xeon® Scalable processors. This architecture will split the whole encoding process into numbers of independent algorithm cores, and each of which will handle a part of encoding process and work in parallel [3]. Until now, SVT is still the best architecture that maximize the use of Intel® multi-core processors for parallel encoding.

Combining AVS3 features with Intel® SVT architecture, we developed a highly paralleled AVS3 encoder, namely SVT-AVS3, which has been specifically designed for various encoding conditions from Video On Demand (VOD) usage to live streaming. Almost all optional parts in SVT-AVS3 are parameterized to make the encoder more flexible to match different usages. After careful analyzing AVS3 encoding logic, we divided SVT-AVS3 coding process into different coding loops: an open loop and a closed loop. In this way, SVT-AVS3 could adjust some of its own computing resources to achieve a better scheduling strategy than the conventional CPU strategies. Besides, based on Human Visual System (HVS) theory, SVT-AVS3 also adds some adjustable bytes for structured features. Through that, SVT-AVS3 could provide a comfortable subjective quality even with extremely low bitrate.

Tests on the Intel® Xeon® Platinum 8180 platform shows that SVT-AVS3 has achieved tens of thousands of times acceleration than HPM. For 8K-UHD 10-bit videos, the encoding speed can be up to 40 frames per second with a single 8180 processor. If with dual 8180 processors and GOP-level parallelism, SVT-AVS3 could provide an encoding speed with 75 frames per second.

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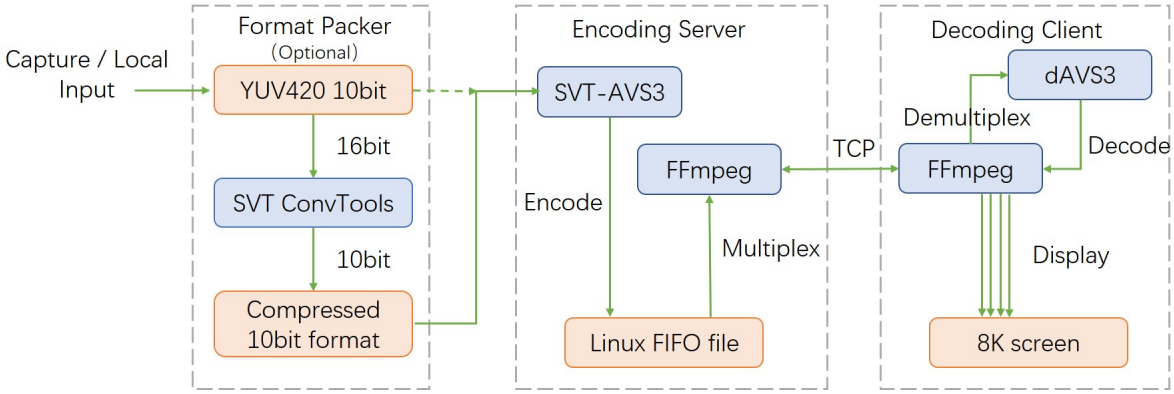

Fig. 1. Architecture of the proposed system

3. DAVS3: A HIGH-SPEED DECODER FOR AVS3

On the decoding side, a high-speed decoder named DAVS3 is developed based on the reference decoder. DAVS3 adopted multiple parallel granularity, which is configurable for users, to improve the decoding speed. The parallel granularity covers from frame-level parallelism to the Largest Coding Unit (LCU) level parallelism. These flexible configurations allow users to control decoder performance based on their actual running environment.

Furthermore, most of data structures in the decoder are redesigned to reduce the frequency of memory access. Simultaneously, these newly designed structures are also well considered for the use of Single Instruction Multiple Data (SIMD) instruction set [4]. Besides SIMD optimization, a series of algorithms are customized to enhance the utilization of computing resources and use more efficient approaches to prevent scheduling problems like cache-missing.

Tested on the Intel® Core™ i9-9980XE platform, DAVS3 could stably decode 8K-UHD AVS3 streams at a speed of 60 fps, which is more than one hundred times faster than HPM.

4. DEMONSTRATION SETUP

The whole architecture of the proposed system is shown in Fig. 1. It mainly consists of a SDI signal simulator, an encoding server equipped with dual Intel® Xeon® Platinum 8180 processors and 24×16G DDR4 2666MHz RAM, a decoding client equipped with an Intel® Core™ i9-9980XE CPU and 64G DDR4 2666MHz RAM, and a television supporting 8K-UHD 10-bit depth.

The proposed system has been implemented into the FFmpeg [5]. Considering that the size of 8K-10bit data could also be a great challenge for hard-disk reading, we recommend to use a new packed-10bit format as mentioned in [6]. With YUV420 input, SVT-AVS3 would encode them into AVS3 format and output the stream into a Linux FIFO file. Then, FFmpeg will packet the pipe-stream into a MPEG-TS format and broadcast them out through TCP protocol in a gigabit Ethernet. Finally, the client is able to use ffmpeg and DAVS3 to receive, decode and display that stream.

5. CONCLUSION

In this demo, a real-time AVS3 8K-UHD encoding and decoding system is presented. The proposed system is implemented on the X86 platform. With its highly parallel architectures and carefully designed fast algorithms, The proposed system can achieve 8K-UHD real-time encoding and decoding at 10-bit depth with bit rate up to 100Mbps.

6. REFERENCES

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