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| *Title:* | **Real time SHVC software decoding with multi-threaded parallel processing** | | |
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| *Author(s) or*  *Contact(s):* | Srinivas Gudumasu  Yuwen He  Yan Ye  Yong He  Interdigital Communications LLC  9710, Scranton Road,  Suite#250, San Diego, CA - 92121 | Tel: Email: | 1.858.210-4819  yuwen.he@ InterDigital.com |
| *Source:* | InterDigital Communications, Inc. | | |

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# Abstract

This contribution provides a parallel decoding framework for SHVC. Various optimization technologies are implemented on the basis of SHM-2.0 software to achieve real time decoding speed. Multi-threading and SIMD optimizations are applied to accelerate the decoding process.

Experiments on a desktop with Intel i7 processor 2600 running at 3.4 GHz show that the parallel SHVC software decoder is able to decode 1080p spatial 2x up to 60 fps (frame per second) and 1080p spatial 1.5x up to 50 fps. The bitstreams are generated with SHVC common test conditions.

# Introduction

At the 14th JCTVC meeting, a real-time SHVC decoding method was proposed in [4], which relies on picture level parallel decoding and WPP for decoding acceleration. In this contribution, we present a real-time parallel SHVC decoder based on SHM-2.0 software [2]. All test bitstreams are generated under the SHVC common test condition (CTC) [3]; that is, parallel coding tools such as wavefront or tile are not enabled.

From the profiling data of SHM-2.0 decoder for 1.5x and 2x cases, the following observations are made:

1. Base layer decoding takes around 20-26% of total decoding time
2. Enhancement layer decoding takes around 47-55% of the total decoding time
3. Base layer decoded picture up-sampling and motion vectors up-sampling takes around 24-27% of the total decoding time.

Figure 1 shows the decoding time, in percentages, of BL decoding, EL decoding, and upsampling for 1080p spatial 2x and 1.5x bitstreams coded with random access configuration.

**Figure 1. Processing time at various stages of SHVC decoding with SHM-2.0**

The proposed implementation scheme uses multi-threading at different layers and SIMD optimizations to achieve real-time decoding.

# Decoder performance analysis

The SHM-2.0 [2] reference software is used to encode using the random access configuration in SHVC CTC [3]. Three 1080p test sequences with spatial scalability 2x and 1.5x are used for analysis. The simulation platform is the desktop with Intel Core i7 2600 processor running at 3.4 GHz.

Table 1 illustrates the decoding performance of our optimized SHVC decoder for spatial 2x scalability configuration. The decoding speed exceeds 35 fps and could reach 60 fps. The decoding speed of the spatial 1.5x configuration is provided in Table 2. For 1.5x, the proposed solution could achieve decoding speed up to 50 fps.

Table 1. Performance of our optimized SHVC decoder for 1080p 2x bitstreams

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Test Sequence** | **BL QP** | **EL QP** | **Bite Rate (Mbps)** | **Decoding Speed (FPS)** | |
| **Optimized decoder** | **SHM-2.0 decoder** |
| Basketball Drive 25 fps | 26 | 26 | 5.302 | 37.8 | 6.5 |
| 30 | 30 | 2.878 | 47.41 | 7.24 |
| 30 | 32 | 2.077 | 56.5 | 7.87 |
| Kimono 24 fps | 26 | 26 | 2.733 | 52.2 | 7.16 |
| 30 | 30 | 1.528 | 60.33 | 7.8 |
| Park Scene 24 fps | 26 | 26 | 4.508 | 43.65 | 6.9 |
| 26 | 28 | 3.023 | 50.24 | 7.2 |
| 30 | 32 | 1.561 | 59.76 | 8.1 |

Table 2. Performance of our optimized SHVC decoder for 1080p 1.5x bitstreams

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Test Sequence** | **BL QP** | **EL QP** | **Bite Rate (Mbps)** | **Decoding Speed (FPS)** | |
| **Optimized decoder** | **SHM-2.0 decoder** |
| Basketball Drive 25 fps | 28 | 26 | 5.268 | 35.58 | 5.6 |
| 30 | 28 | 3.843 | 40.92 | 5.84 |
| 32 | 32 | 2.058 | 49.24 | 6.57 |
| Kimono 24 fps | 26 | 26 | 2.75 | 48.48 | 6.23 |
| 30 | 30 | 1.54 | 54.55 | 6.65 |
| Park Scene 24 fps | 26 | 24 | 6.25 | 35.8 | 5.6 |
| 26 | 26 | 4.518 | 40.79 | 5.87 |
| 30 | 32 | 1.681 | 53.05 | 6.99 |

The decoding speed vs. bit-rate of two sequences (baseketball-drive and park-scene) for 1080p 2x and 1.5x are shown in Figure 4 and Figure 5. The decoding speed decreases when bit-rate increases because of two reasons: 1) entropy decoding is done using single thread in our implementation, and entropy decoding throughput will slow down at higher bit-rates; 2) there are more no-zero coding blocks at higher bit-rates so inverse quantization and inverse transform operations are performed more frequently.

Figure 4. Decoding speed vs. bit-rate for 1080p 2x bitstreams (BB: baseketball drive, PS: park scene)

Figure 5. Decoding speed vs. bit-rate for 1080p 1.5x bitstreams (BB: baseketball drive, PS: park scene)

# Conclusion

This proposal discusses a real-time software based SHVC decoder using parallel decoding. The optimized SHVC decoder achieves decoding speed of up to 60 fps for 1080p 2x and 50 fps for 1080p 1.5x.

1. **References**
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# Patent rights declaration(s)

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