Hierarchical Parallel Processing of HEVC Encoder

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HEVC/H.265

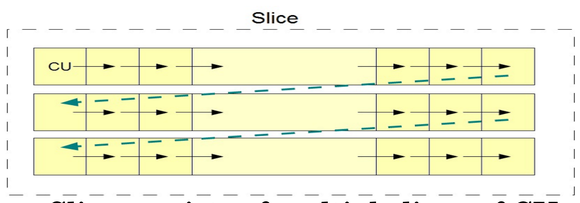
HEVC is the latest video coding standard and support emerging 4K and 8K videos
Its compression ratio is twice as high as H.264/AVC. However, the computational complexity is ten times higher
This paper proposes parallel processing to accelerate an HEVC encoder

Parallel Processing of HEVC Encoder

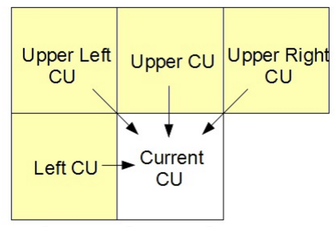
Slice layer parallel processing (assign one slice to one thread)
- Pros: Each slices are completely independent, scalability is good
- Cons: BD-Rate is rapidly increasing or compression quality rapidly goes down

CU layer parallel processing (assign one CU lines to one thread)
- Pros: Degradation of compression quality is relatively low
- Cons: Parallelism of CU layer is limited by number of CU lines
- wave-front parallel processing is needed to satisfy data dependency between CUs
- To minimize synchronize overhead, threads are binded inside one processor package

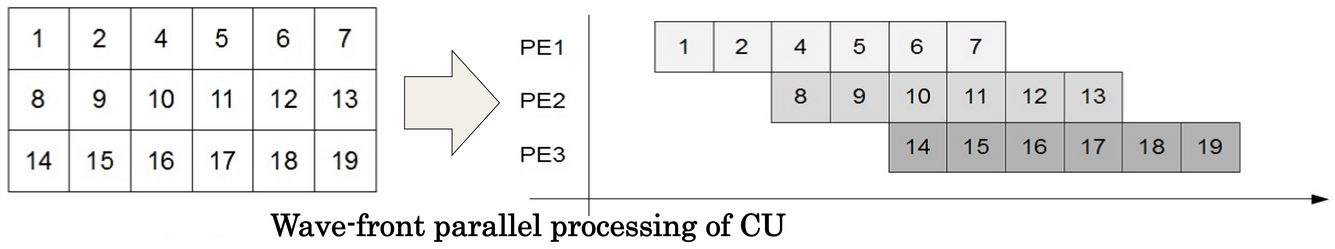
Complete each weakness by combines CU layer wave-front parallel processing and slice layer parallel processing hierarchically to keep balance between scalability and compression quality



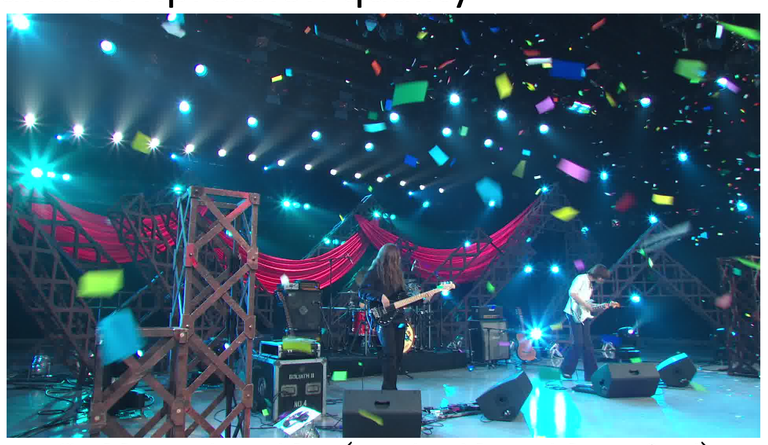
Slice consists of multiple lines of CU

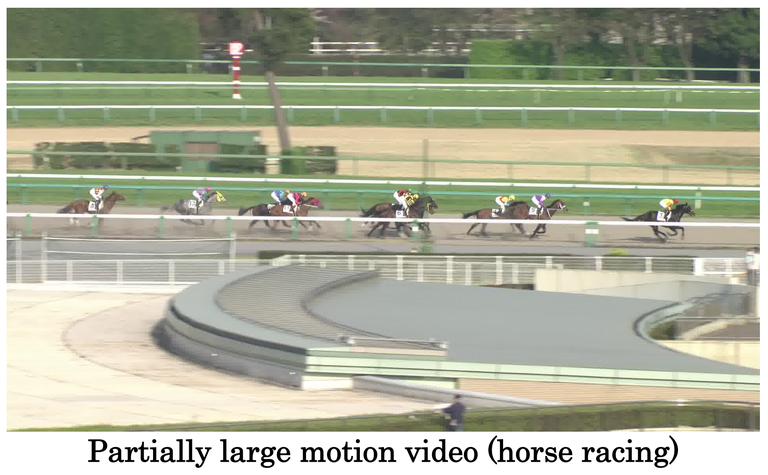


Data dependency between CUs



Wave-front parallel processing of CU


Stable motion video (music video with confetti)

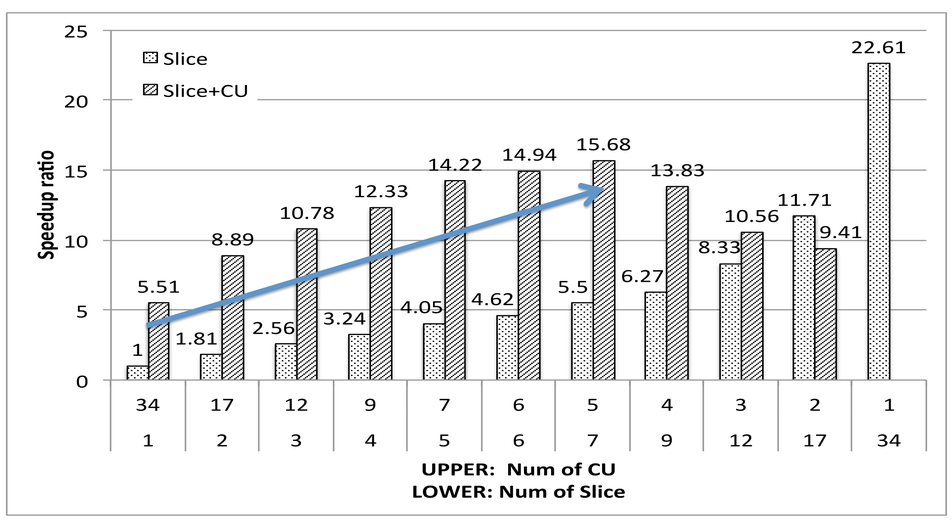

Partially large motion video (horse racing)

Evaluation Environment

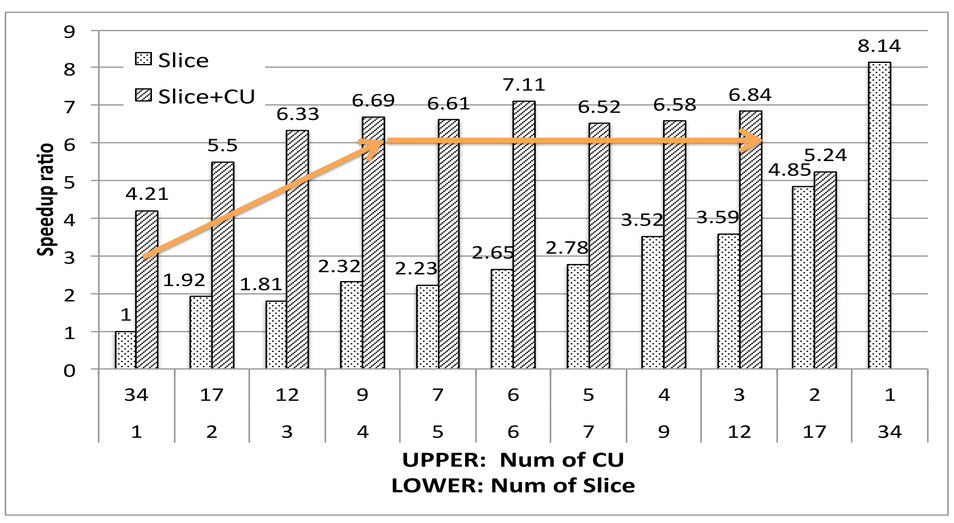
Hitachi BS2000 (Blade-based SMP Server)
- Intel Octa-core Xeon E7-8830 x 8 (total 64 cores)
- Linux 2.6.32, GCC 4.4.7
- Clustering 4 blades as a SMP by special interconnect

HM-8.0 HEVC Reference Encoder
- Resolution: 1920 x 1080
- QP: 37, Random Access, CU: 32x32, Search Range: 128

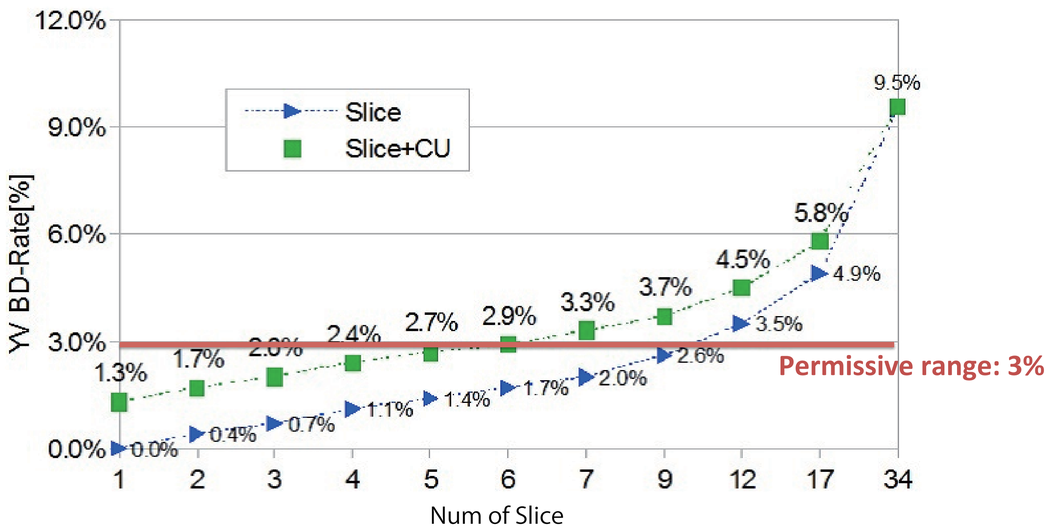
Evaluation



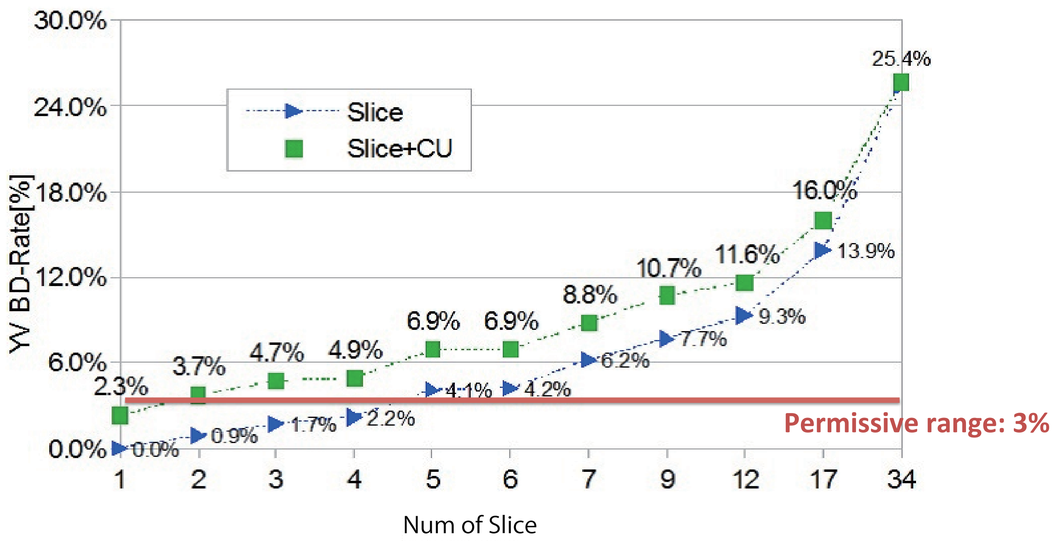
Speedup ratio of HEVC encoder with stable motion video



Speedup ratio of HEVC encoder with partially large motion video



BD-Rate of stable motion video



BD-Rate of partially large motion video

- Computation load of processor cores is become imbalance and speedup ratio saturated at small number of processor cores if motion of video is partially large
- Speedup ratio shows good scalability and impact for quality is relatively small if the motion of video is stable
- Multi-layer parallel processing is important to accelerate encoder with keeping coding efficiency and characteristics of video is effective to scalability of parallel processing