Real-Time HDR Video Tone Mapping Using High Efficiency Video Coding

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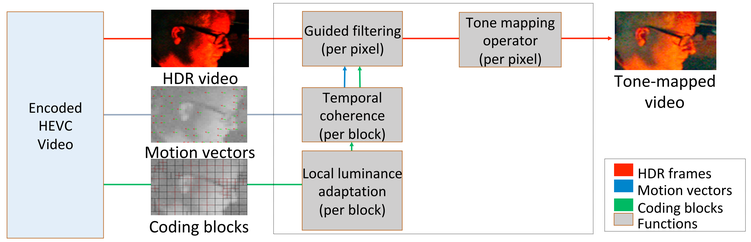
Abstract

High-dynamic-range (HDR) video streams have been delivered through high efficiency video coding (HEVC). HDR video tone mapping is required additionally but is operated separately to adjust the content's dynamic range for each display device. HDR video tone mapping and HEVC encoding share common computational processes for spatial and temporal coherence in a video stream; however, they have been developed and implemented independently with their own computational budgets. In this work, we propose a practical HDR video tone-mapping method that combines two overlapping computational blocks in HDR video tone-mapping and HEVC compression frameworks with an objective to achieve real-time HDR video tone mapping. We utilize precomputed coding blocks and motion vectors so as to achieve spatial and temporal coherence of HDR video tone-mapping in the decoding stage, even without introducing substantial computational cost. Results demonstrate that our method can achieve real-time performance without compromising the video quality, which is highly comparable to state-of-the-art video tone-mapping methods.

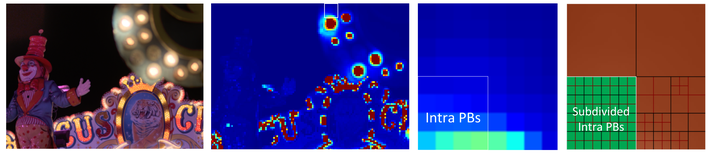
Motivation

- HDR video encoded with HEVC codec consists of motion vector and coding blocks
  - Motion vectors provide temporal coherence information
  - Coding blocks account local similarity of image structures
- We provide a HDR video tone mapping with two goals
  - To achieve real-time performance of tone-mapping
  - To achieve both spatial and temporal coherence
- We utilize the precomputed information in HEVC video without introducing substantial computational cost

Our Approach

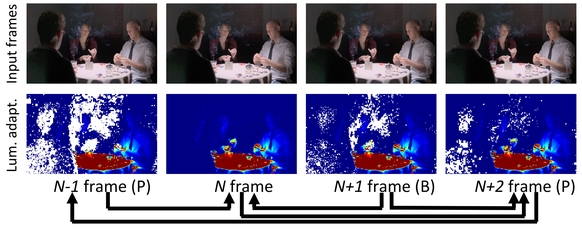


- Local luminance adaptation
  - Ensure spatial consistency
  - Estimate luminance adaptation parameters for each HEVC coding block
  - Intra-PBs are subdivided to provide local smoothness in the adaptation map

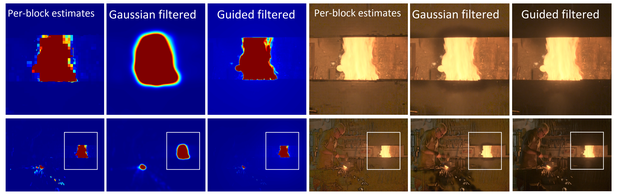


Input frame | Luminance adaptation map | Luminance map (Close-up) | Block structure (Close-up)

- Temporal coherence
  - Update adaptation parameters via motion vectors



- Guided filtering
  - Avoid blocking artifacts in the luminance adaptation parameter map



(a) Local luminance adaptation parameter maps (b) Tone-mapping results

Results

- Performance comparison

(a) Aydin et al. (time: 7545.00 ms) | (b) Eilertsen et al. (time: 19.11 ms) | (c) Croci et al. (time: 24.00 ms) | (d) Ours (time: 14.20 ms)

Real-time TMOs	Eilertsen	Croci	Ours
Temporal filtering	0.08	1.00	3.00
Spatial filtering	15.60	22.00	10.20
Tone mapping	3.43	1.00	1.00
Total time (ms)	19.11	24.00	14.20
Frame rate (fps)	52.33	41.67	70.42

- Image quality evaluation