On Inter-view Redundancy-aware Cluster Based Coding Structure Decision on MV-HEVC for MPEG Immersive Video

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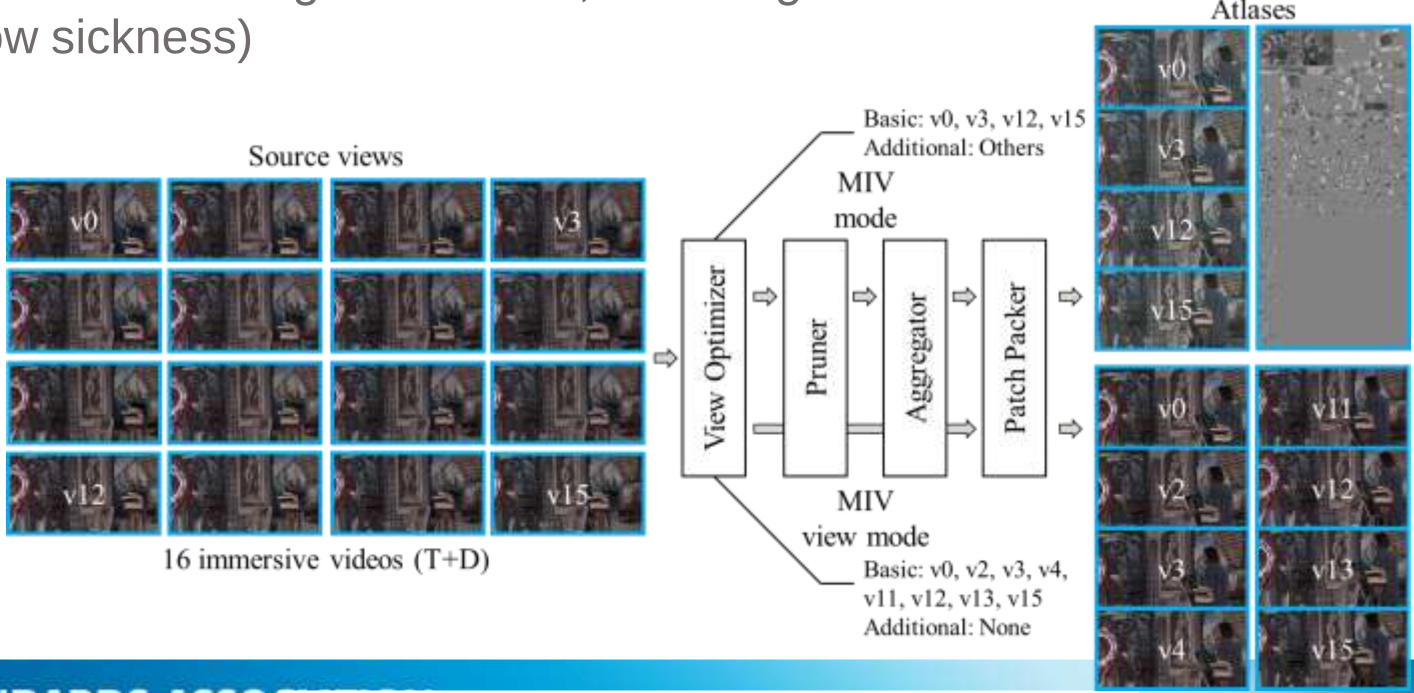
MPEG Immersive Video (MIV)

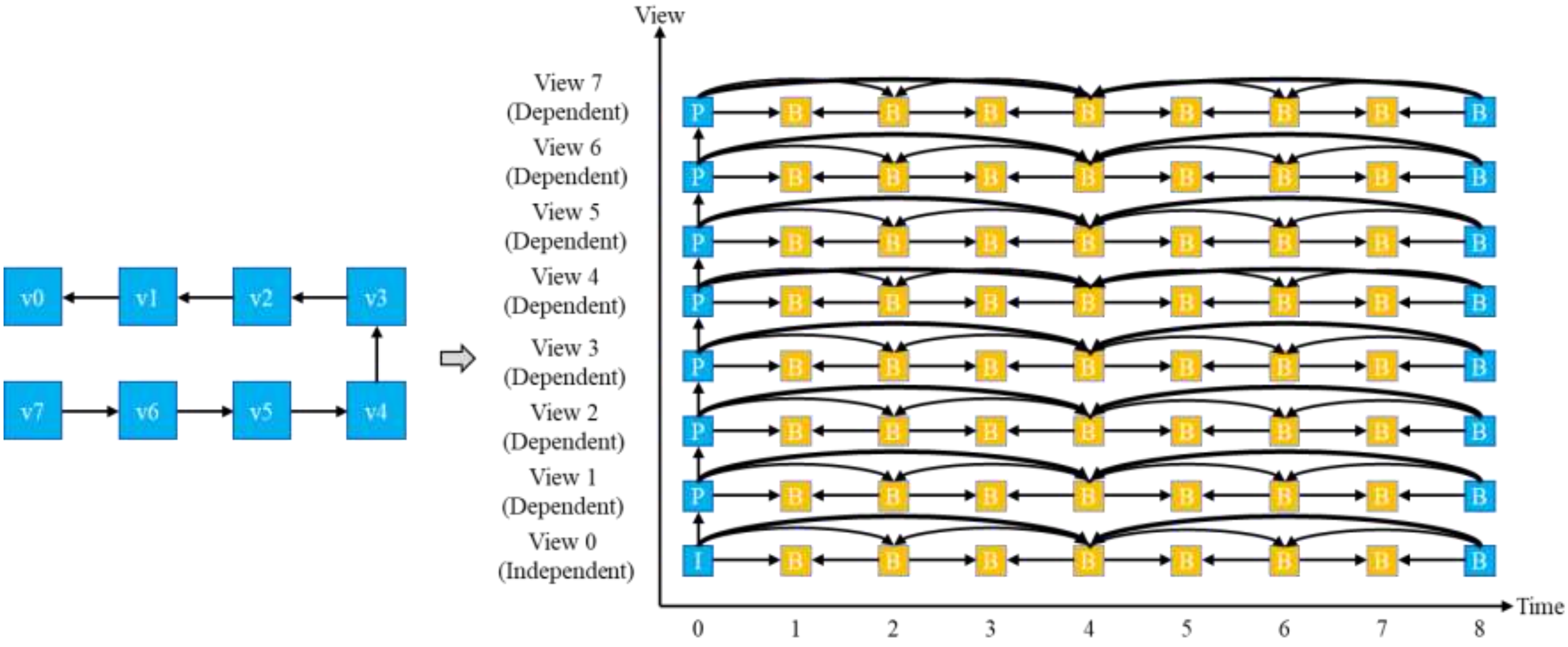
- Challenges of multi-view videos processing to provide immersion:
  - high bandwidth, high computational complexity, high latency
- MIV for immersive video pre- and post-processing
  - Test model for immersive video (TMIV) as a reference software
  - MIV mode: removes redundancy from the source views (+HEVC, VVC)
    → efficient on low bandwidth
  - MIV view mode: selects subset of views (+MV-HEVC)
    → efficient on high bandwidth, advantageous for multi-view color consistency (low sickness)



MIV pre-processing for immersive video (version 8.0)

Background

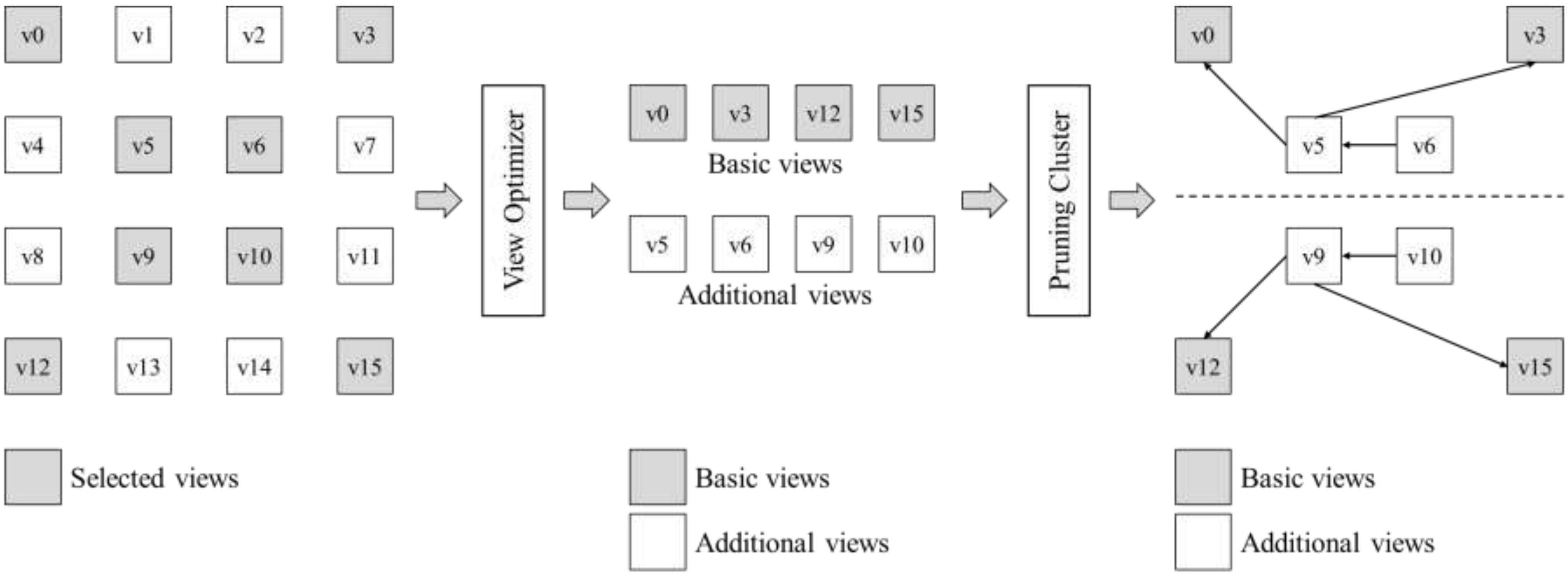
- MV-HEVC as an extension of HEVC to:
  - Efficient compression of multi-view videos by exploiting inter-view redundancy
  - Highly efficient for structured (rectangular) camera coordination
  - Inter-view coding structure needs to be defined
  - How to decide the optimal coding structure?



Example of MV-HEVC coding structure

Cluster-based Pruning in MIV

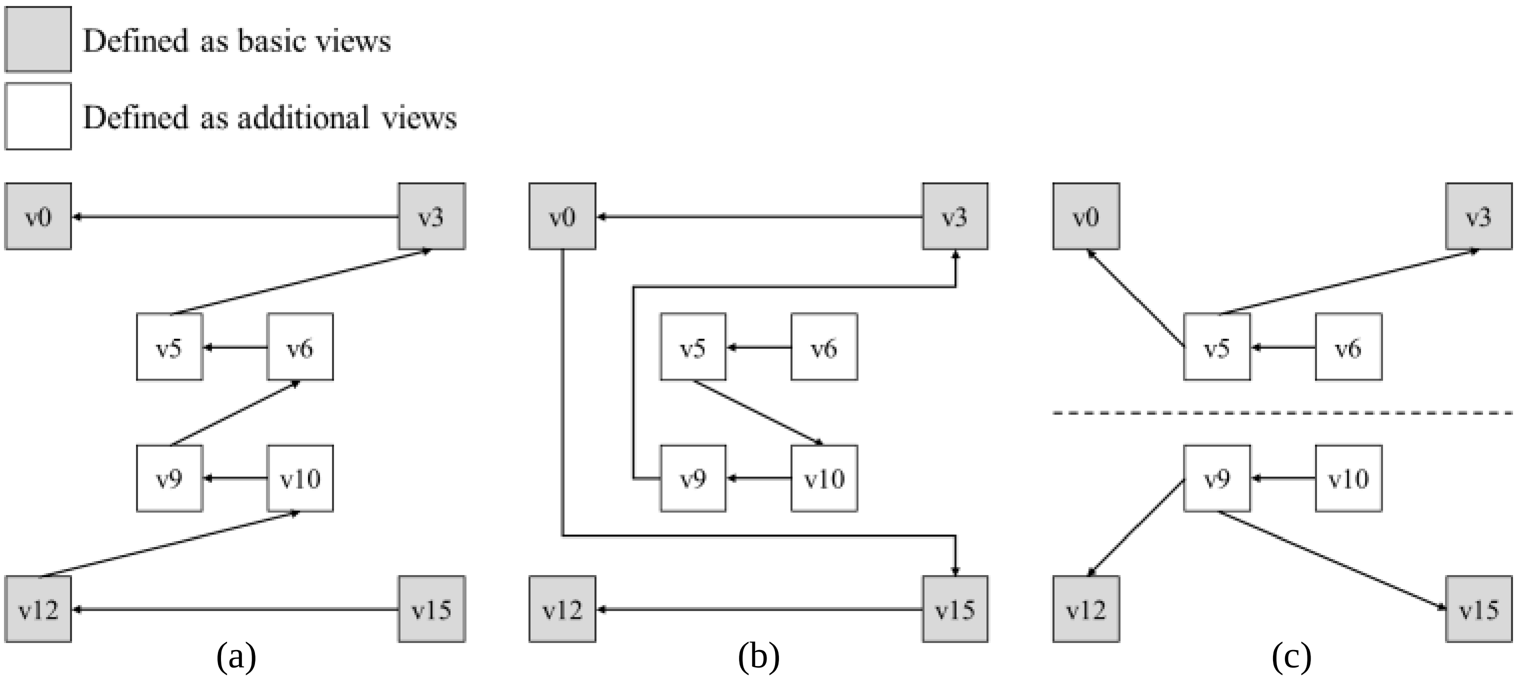
- Redundancies are removed by pruning process
- View optimizer: divides basic views (BVs) and additional views (AVs)
  - ➢ Redundancies are removed from AVs
- Pruning cluster generates cluster graph to:
  - ➢ Reduce the computational complexity
  - ➢ Remove the redundancies more efficiently



Example of pruning cluster generation by TMIV (version 8.0)

Redundancy-aware Coding Structure Decision

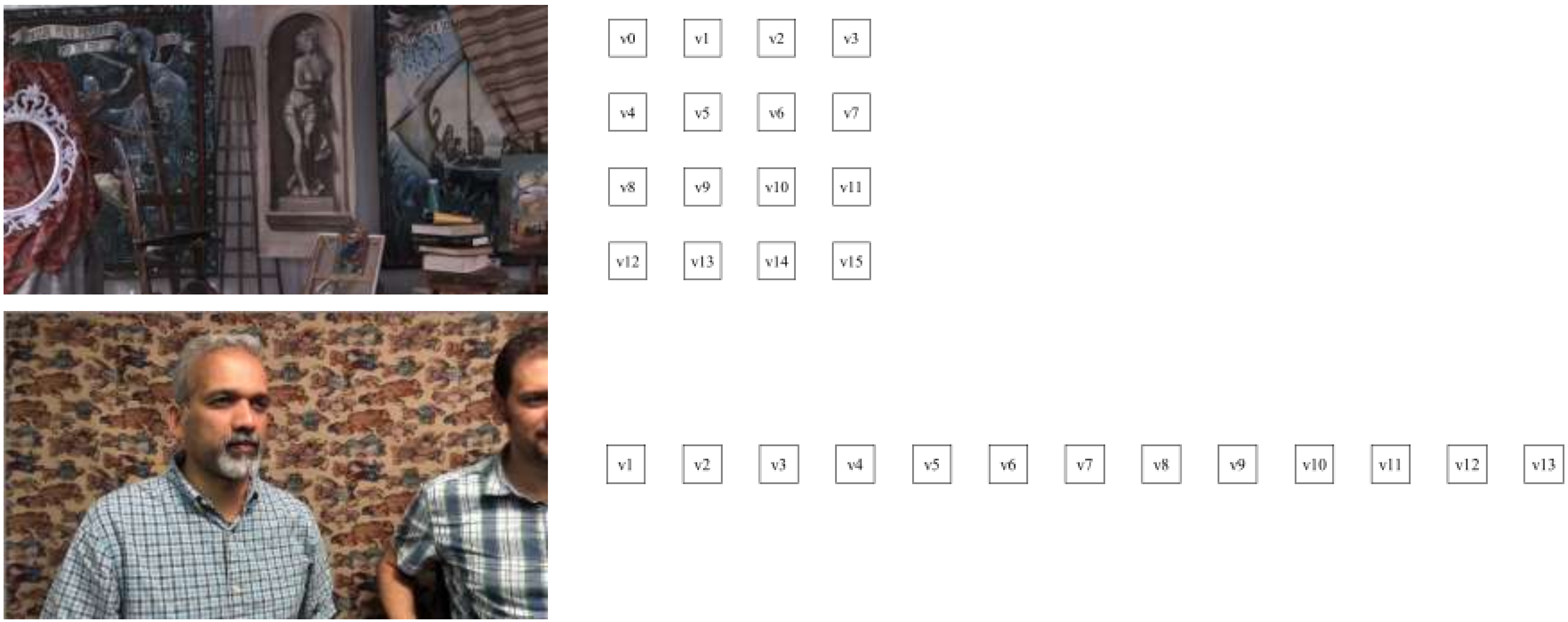
- Method 1: view index based ordering
  - Decides coding structure by view index (ascending order)
- Method 2: pruning based ordering
  - Coding structure mode decision by pruning order (no group)
- Method 3: cluster based ordering
  - Uses cluster-based approach for 1) increased coding efficiency, 2) parallel decoding → low sickness and low latency



Coding structure decision modes.
(a) view index based ordering, (b) pruning based ordering, (c) cluster based ordering

Experimental Setup

- MV-HEVC test model (HTM) v13.0, TMIV v3.0
  - TMIV v8.0 was used to decide the pruning graph
  - TMIV v3.0 is better when using MV-HEVC
- Two MIV test sequences were used
  - Painter(2048 × 1088) – 16 views, Frog(1920 × 1080) – 13 views



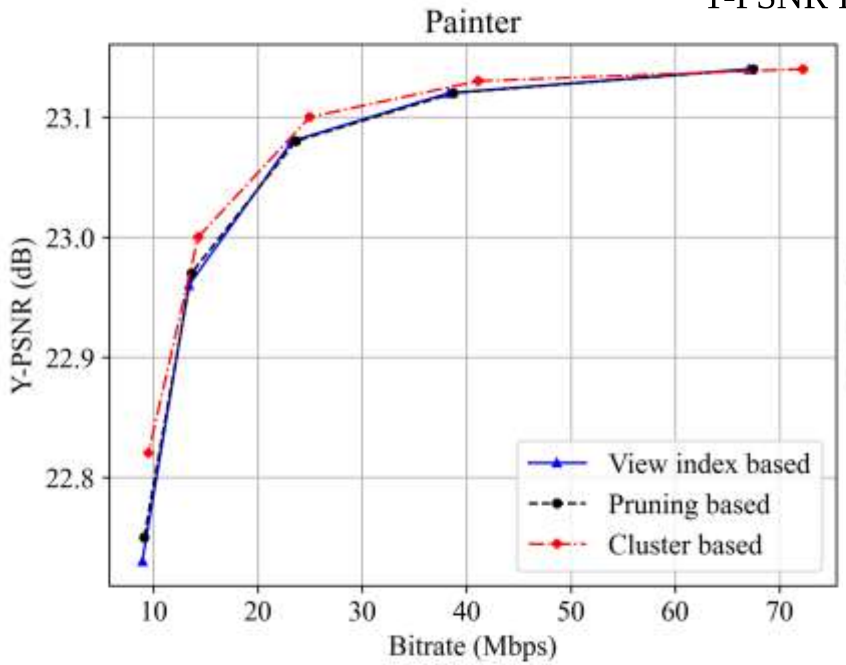
View representations and camera coordinations.
Upper: Painter, Lower: Frog.

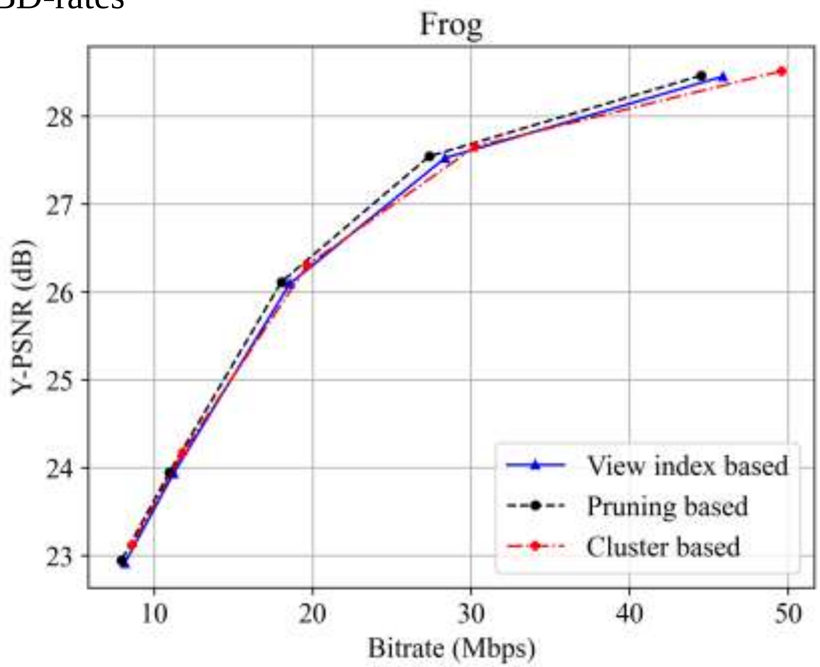
Experimental Results: Coding Efficiency

- Y-PSNR BD-rate gains compared to the anchor (view index based)
- In average, the cluster-based method showed the best bandwidth saving

Sequences	View index based	Pruning based	Cluster based
Painter	0.00%	-0.78%	-8.33%
Frog	0.00%	-3.36%	0.56%
Average	**0.00%**	**-2.07%**	**-3.88%**

Y-PSNR BD-rates





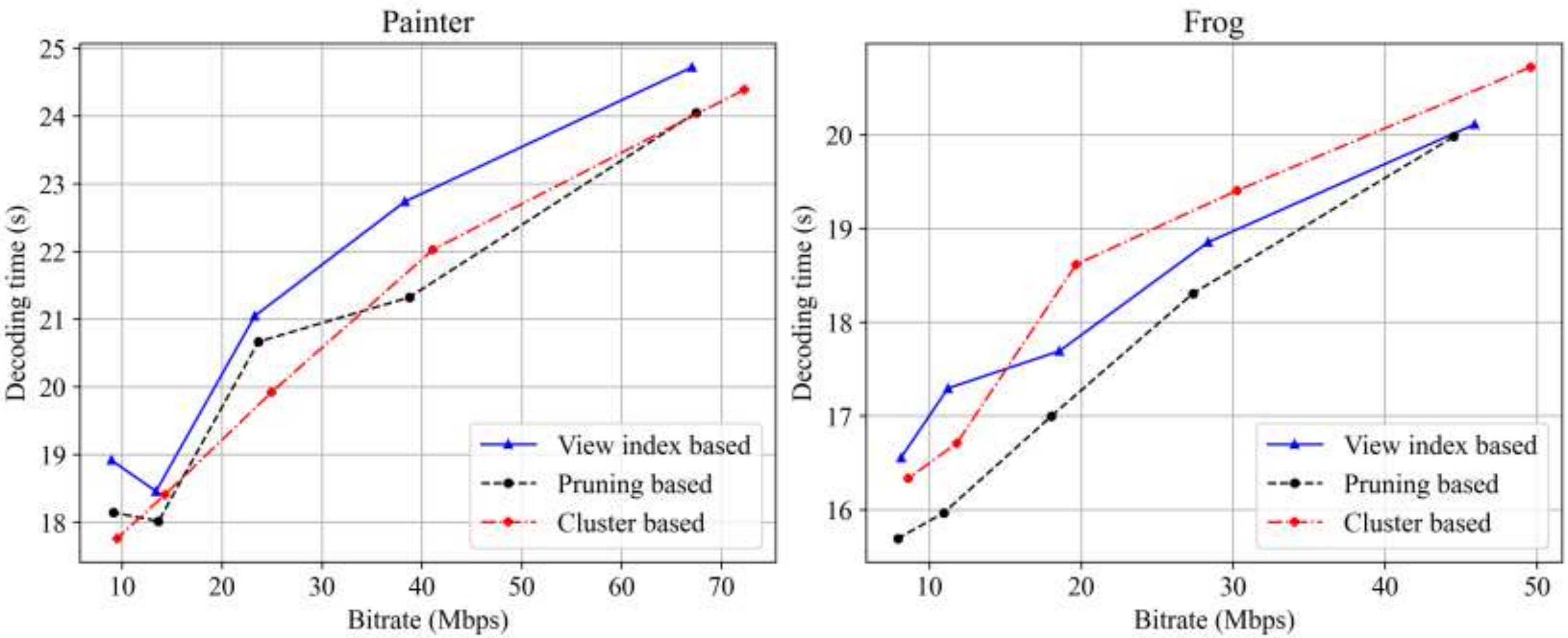
Rate-distortion curves of Painter (left), Frog (right)

Experimental Results: Decoding runtime

- Decoding runtime savings compared to the anchor (view index based)
- If parallel decoding is available, cluster-based method can halve the runtime

Sequences	View index based	Pruning based	Cluster based
Painter	100.00%	96.53%	96.81%
Frog	100.00%	96.06%	101.41%
Average	**100.00%**	**96.30%**	**99.11%**

Decoding runtime ratio



Decoding runtime curves

Conclusion

- Motivation
  - High BW & computing time for multi-view videos streaming: MIV & MV-HEVC can be used
  - View clustering and ordering is needed to:
    - Increased coding efficiency (better quality) and decreased latency
- Proposed Methods and Insights
  - Coding structure decision considering: 1) pruning order and 2) clustering by MIV
  - BD-rate, decoding time savings compared to the anchor
  - 2× faster decoding runtime when using parallel processing to the cluster-based method
- Conclusion and Future Work
  - Inter-view redundancy-aware cluster based coding structure decision for immersive video leads to the decreases of bitrate and latency
  - Experiments on parallel processing / selective group streaming needs to be conducted