Tencent 腾讯 | Tencent Media Lab

Enhanced Intra Coding Beyond AV1

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Outline

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- Cross-Component Mode Coding (Chroma)
- Context-Adaptive Mode Coding (Luma)

Summary

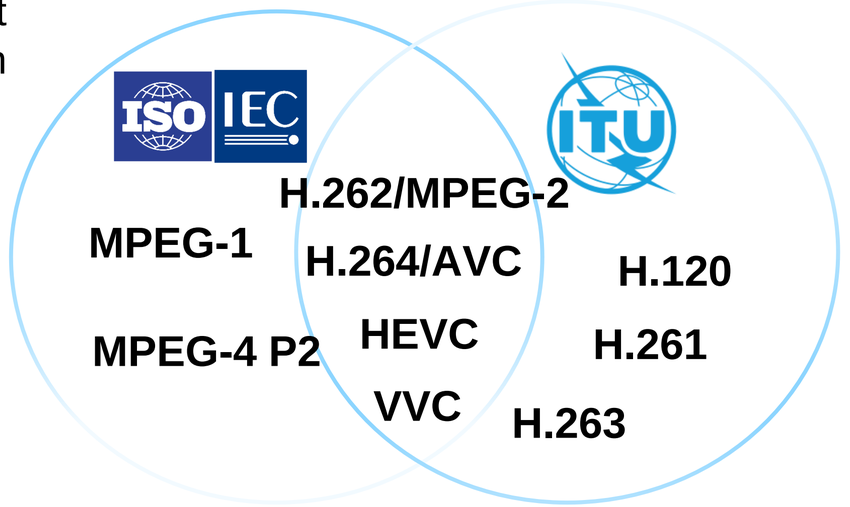
Introduction

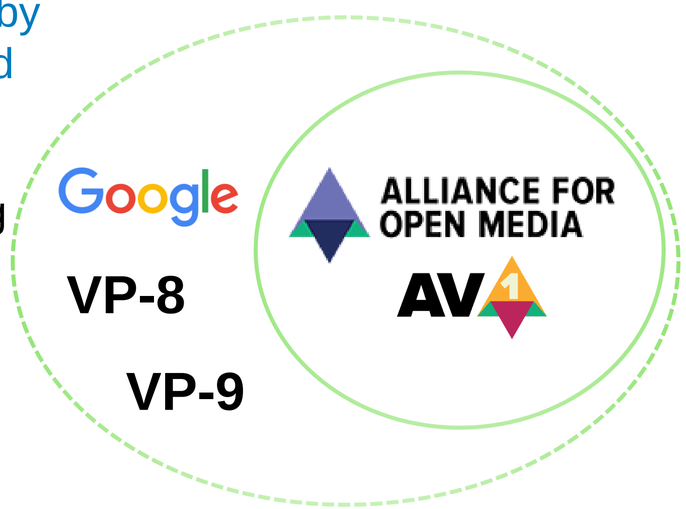
The **Moving Picture Experts Group (MPEG)** is a working group of authorities that was formed by ISO/IEC JCT1 to set standards for audio and video compression and transmission

The **Video Coding Experts Group** (VCEG, also known as Question 6) is a working group of the ITU Telecommunication Standardization Sector (ITU-T) concerned with video coding standards

The **Alliance for Open Media (AOM)** was a non-profit organization created in September 2015 for developing open, royalty-free technologies. The first video codec developed by AOM is AV1 (AOMedia Video 1), which finalized in March, 2018. The predecessor of AV1 is VP9 developed by Google, who also contributed heavily for the development of AV1 and reference codes and some coding tools are inherited from VP9

The **AVS** Workgroup, as known as the digital audio and video coding standard workgroup of China, was founded in June 2002. This workgroup has successfully developed several video coding standards, such as AVS1, AVS2 and AVS3. The latest standard developed by AVS is AVS3 phase 1, finalized in March, 2019





Introduction

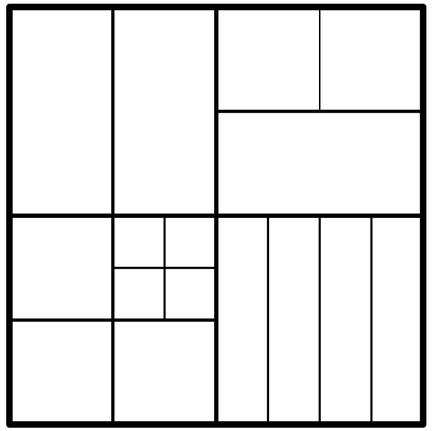
AV2 Project

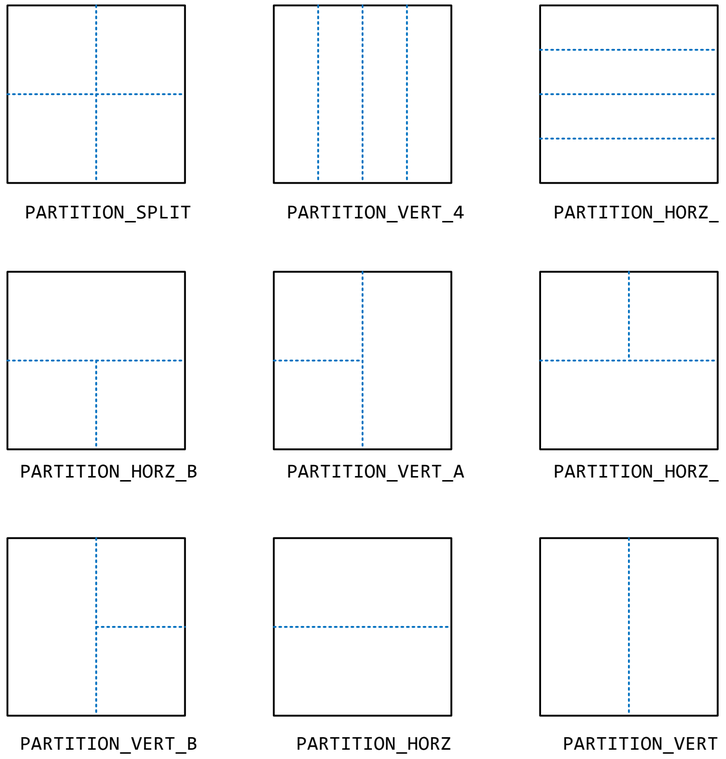
- AOM is current organizing next-generation video technology exploration beyond AV1, namely AV2
- Technical discussion is being organized as Incubator Subgroup meeting
- Codebase: libaom
- Existing technical contributions including: Partitioning, **Intra**, Transform, SCC, Quantization

Review of AV1 Coding Tools

Block Partitioning

- Up to 10 partition types are supported in AV1
- Only PARTITION_SPLIT is allowed to further split





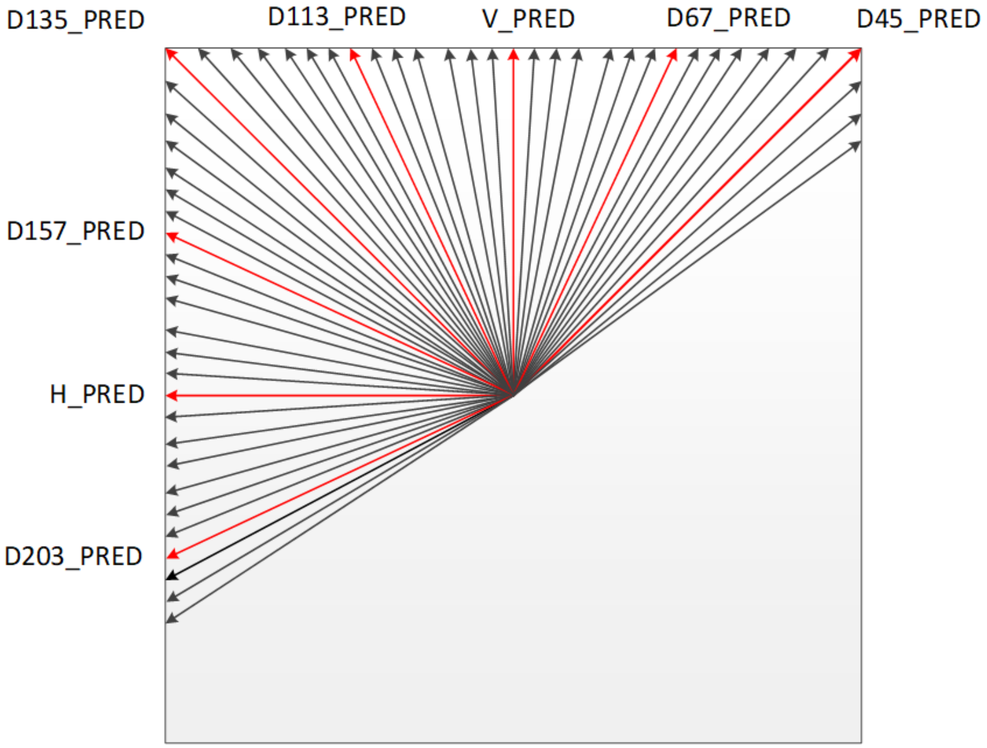
Review of AV1 Coding Tools

Intra Prediction

Angular intra prediction modes

- 56 angles (8 nominal modes with 7 delta angles)
- Nominal mode and delta angle are signaled as separate syntax

```
intra_block_mode_info( ) {
        RefFrame[ 0 ] = INTRA_FRAME
        RefFrame[ 1 ] = NONE
        y_mode
        if ( is_directional_mode( y_mode )  &&  MiSize >= BLOCK_8X8) {
            angle_delta_y
        }
        if ( HasChroma ) {
            uv_mode
            if ( UVMode == UV_CFL_PRED ) {
                read_cfl_alphas( )
            }
            if ( is_directional_mode( uv_mode )  &&  MiSize >= BLOCK_8X8) {
                angle_delta_uv
            }
        }
```



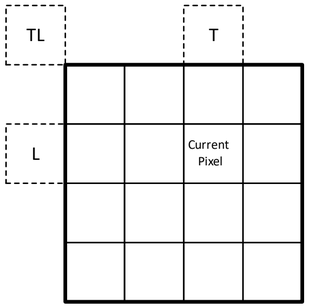
Review of Coding Tools

Intra Prediction

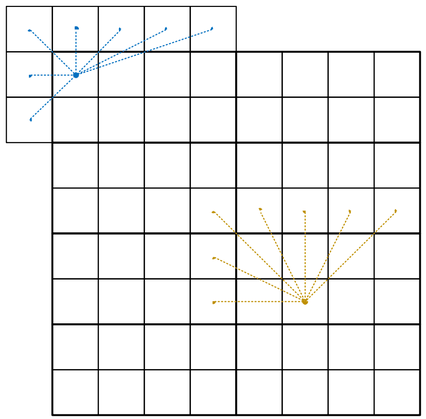
Non-Angular intra prediction modes

- DC, SMOOTH, SMOOTH_H, SMOOTH_V

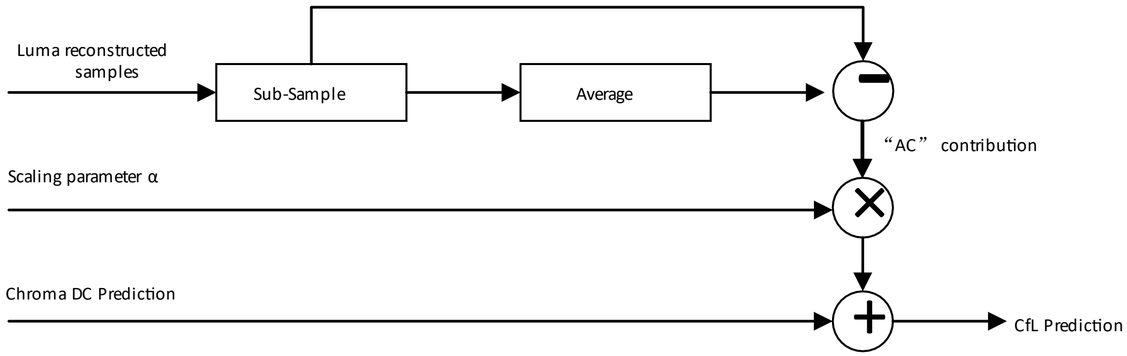
- Paeth Predictor



- Recursive filtering modes

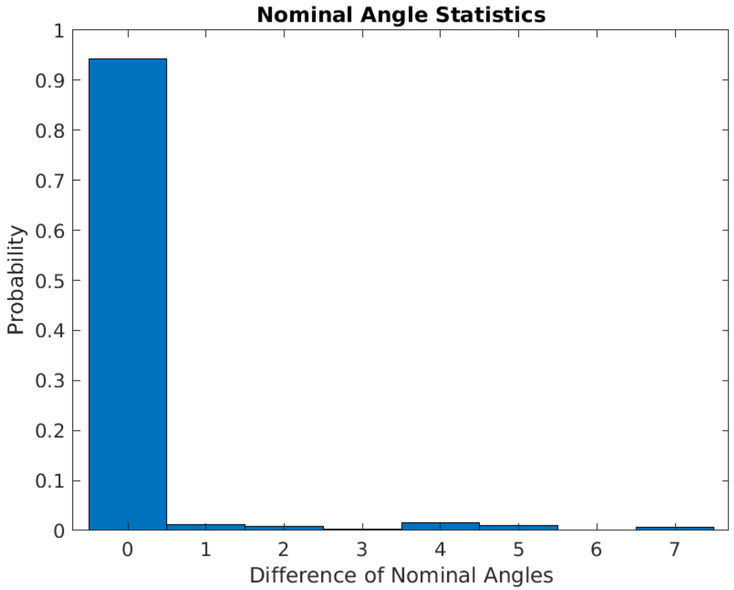


- Chroma from Luma (CfL)

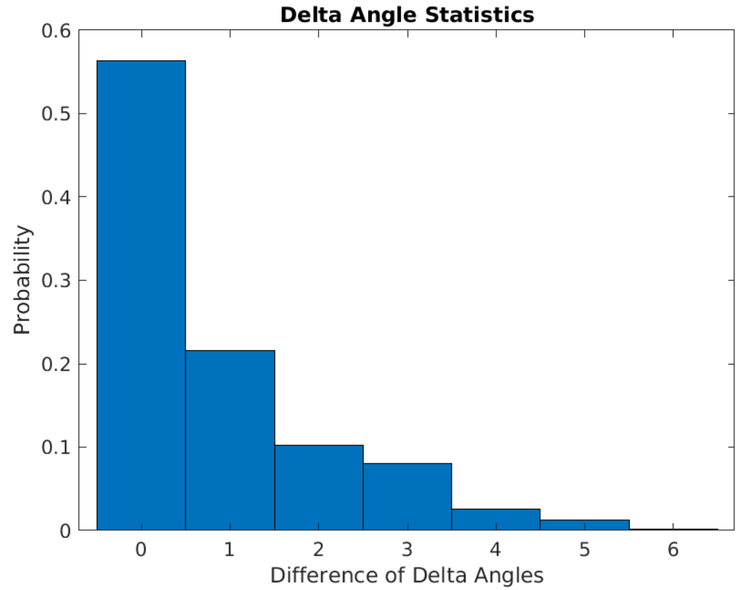


Problem Statements

- AV1 Intra Coding Analysis



Distribution of absolute difference between luma and chroma nominal mode



Distribution of absolute difference between luma and chroma delta angle

Proposed Method

Cross-Component Mode Coding (Chroma)

- The delta angles of chroma blocks are highly correlated with col-located luma delta angles
- Instead of signaling chroma delta angles, they are derived from luma delta angles
  - Set chroma delta angle to 0 if chroma and luma nominal angle are different
  - Use luma delta angle for chroma if the nominal angles are equal.

	All Intra					
	Over AV1					
	Y	U	V	EncT	DecT	YUV
Class A1	-1.04%	1.52%	1.65%	95%	100%	-0.18%
Class A2	-1.04%	1.41%	1.23%	94%	99%	-0.50%
Class B	-1.04%	2.46%	2.43%	96%	104%	-0.31%
Class C	-0.86%	2.79%	2.98%	97%	100%	-0.15%
Class E	-1.22%	2.44%	1.98%	96%	95%	-0.49%
Overall	-1.03%	2.20%	2.15%	96%	100%	-0.32%
Class D	-0.63%	1.82%	2.41%	97%	101%	-0.09%
Class F	-0.84%	2.13%	1.78%	97%	100%	-0.24%

Proposed Method

Cross-Component Mode Coding (Chroma)

- To reduce the chroma loss: luma delta angle is used as the context for chroma delta angles.
- All the delta angles are allowed when luma and chroma nominal angles are equal (Method #1); all the delta angles are allowed regardless of whether luma and chroma nominal angles are equal (Method #2);

Table 2: Summary of coding performance of cross-component mode coding methods.

	Method #1					Method #2					Method #2 (High QP)				
	BDR-Y	BDR-U	BDR-V	YUV	ΔT_{Enc}	BDR-Y	BDR-U	BDR-V	YUV	ΔT_{Enc}	BDR-Y	BDR-U	BDR-V	YUV	ΔT_{Enc}
Class A1 (4K)	-1.04%	1.17%	1.24%	-0.30%	96%	-1.02%	0.88%	1.08%	-0.37%	100%	-1.53%	0.42%	1.05%	-0.89%	101%
Class A2 (4K)	-1.05%	1.14%	0.96%	-0.57%	94%	-1.02%	0.83%	0.66%	-0.61%	100%	-1.24%	0.96%	0.75%	-0.81%	100%
Class B (1080P)	-1.03%	2.10%	2.18%	-0.37%	96%	-1.01%	2.00%	1.89%	-0.40%	100%	-1.30%	2.22%	1.93%	-0.63%	100%
Class C (480p)	-0.87%	2.31%	2.40%	-0.26%	97%	-0.84%	1.92%	1.83%	-0.31%	100%	-1.31%	2.83%	2.33%	-0.48%	100%
Class E (720P)	-1.19%	2.02%	1.42%	-0.58%	96%	-1.18%	1.16%	1.05%	-0.70%	100%	-1.54%	1.21%	1.22%	-0.94%	100%
Class D (240p)	-0.63%	1.62%	2.06%	-0.14%	97%	-0.66%	1.07%	1.42%	-0.29%	99%	-1.11%	2.48%	1.81%	-0.45%	100%
Class F (Synthetic)	-0.82%	1.86%	1.41%	-0.30%	97%	-0.78%	1.59%	1.34%	-0.30%	100%	-1.10%	0.46%	0.96%	-0.64%	100%
Average*	**-1.03%**	**1.82%**	**1.74%**	**-0.40%**	**96%**	**-1.00%**	**1.46%**	**1.40%**	**-0.46%**	**100%**	**-1.37%**	**1.68%**	**1.56%**	**-0.72%**	**100%**

*Average does not include Class D and F.

Proposed Method

Context-Adaptive Mode Coding (Luma)

- Using neighboring luma delta angles as context for the current luma delta angle.
- Using a separate CDF when nominal angles are different
- Enabling full rd for luma delta angles

Table 3: Summary of coding performance of context-adaptive coding methods.

	Method #3					Method #4				
	BDR-Y	BDR-U	BDR-V	YUV	ΔT_{Enc}	BDR-Y	BDR-U	BDR-V	YUV	ΔT_{Enc}
Class A1 (4K)	-1.10%	-0.62%	-0.64%	-0.94%	151%	-2.05%	0.31%	0.30%	-1.27%	148%
Class A2 (4K)	-1.05%	-0.06%	-0.15%	-0.82%	156%	-1.88%	0.56%	0.34%	-1.35%	152%
Class B (1080P)	-0.99%	0.09%	-0.18%	-0.79%	159%	-1.80%	1.67%	1.72%	-1.07%	157%
Class C (480p)	-0.65%	-0.29%	-0.27%	-0.58%	162%	-1.46%	1.78%	1.93%	-0.83%	162%
Class E (720P)	-1.33%	-0.40%	-0.82%	-1.18%	161%	-2.29%	0.75%	0.21%	-1.71%	160%
Class D (240P)	-0.49%	-0.15%	-0.34%	-0.45%	160%	-1.15%	1.27%	1.89%	-0.62%	159%
Class F (Synthetic)	-0.57%	-0.22%	-0.57%	-0.54%	158%	-1.43%	1.21%	1.05%	-0.89%	157%
Average*	**-1.00%**	**-0.22%**	**-0.38%**	**-0.84%**	**158%**	**-1.86%**	**1.13%**	**1.05%**	**-1.20%**	**156%**

*Average does not include Class D and F.

Experiments Setup

Test Condition

- Platform
- libaom (master, hash tag 299b96d3836e8fa9b6ee85646175e1dce2a4dd74)
- Configurations
    - All intra
    - Cpu-used-0
    - 49 frames
    - JVET sequences
    - QP: 28, 35, 42, 49

Summary

- Cross-component mode coding

1. Chroma delta angles are only allowed when the luma and chroma nominal angle are same, and the chroma delta angle depends on luma delta angle
2. All chroma delta angles are allowed regardless of whether the luma and chroma nominal angle are same or not.

- Context-adaptive mode coding

two different CDF derivation processes are designed, based on whether the nominal angle of the current block is the same as the nominal angle of one of its neighbors.

Conclusion:

- In this paper, a cross-component mode coding algorithm is proposed to exploit dependencies between luma and chroma delta angles, and a context-adaptive mode coding algorithm is proposed to exploit dependencies between neighboring luma delta angles. By combining these two proposed methods, 1.20% BD-rate reduction is achieved with 156% of encoding time as compared to AV1.

Thanks!
Q&A