

JCTVC-U0102
ON CONSTRAINED INTRA
PREDICTION FOR THE
UNIFICATION FRAMEWORK
OF INTRA BLOCK COPY

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Introduction

- In HEVC SCC draft 3, IBC mode is signaled as normal inter mode
- The specification text is ambiguous and SCM-4.0 software is broken when constrained intra prediction (CIP) is enabled

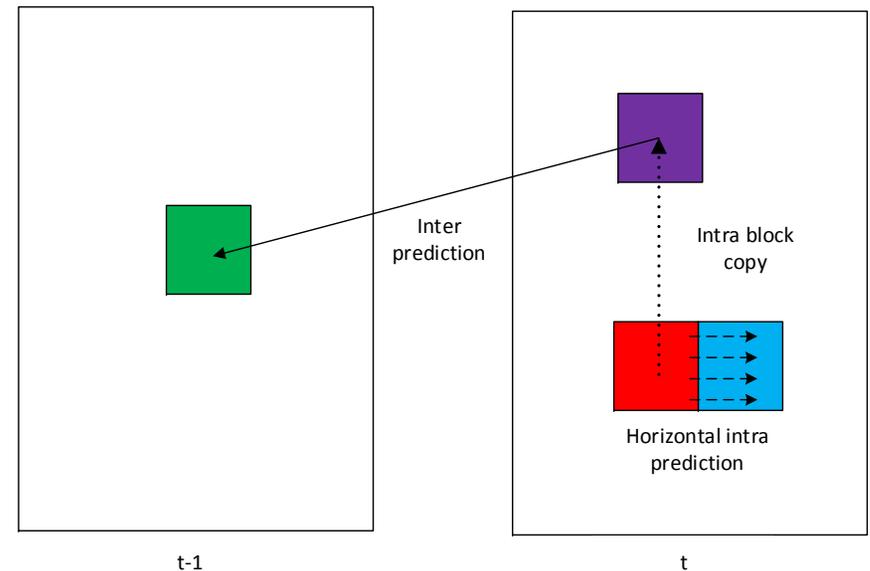
`constrained_intra_pred_flag` equal to 0 specifies that intra prediction allows usage of residual data and decoded samples of neighboring coding blocks coded with or without using a reference picture that is not the current picture. `constrained_intra_pred_flag` equal to 1 specifies constrained intra prediction, in which case the **general intra prediction process** only uses residual data and decoded samples from neighboring coding blocks coded without using a reference picture that is not the current picture.

- How to interpret “general intra prediction process”?
 - **Interpretation #1**: it only refers to intra prediction
 - **Interpretation #2**: it refers to both intra prediction and IBC prediction
- Both two interpretations are problematic when CIP is enabled

Introduction

■ Interpretation #1

- “general intra prediction” refers to **only intra prediction**
- Intra samples can be predicted from intra samples and IBC samples
- The IBC reference samples could be predicted from inter samples
- **The CIP functionality is broken**



■ Interpretation #2

- “general intra prediction” refers to **intra prediction and IBC prediction**
- The CIP solution during the development of HEVC Rext
- IBC samples can only be predicted from intra samples rather than inter samples
- **The IBC coding efficiency is significantly reduced**

The proposed method

- When CIP is enabled, it is proposed to only use the samples of intra CUs as reference for intra prediction
- The proposed CIP constraint is only applied to **P/B slices** that use at least **one temporal reference picture**; otherwise, the CIP constraint is disabled
- Benefits
 - **Enabled CIP functionality:** IBC and inter samples are not allowed to predict intra samples
 - **Improve IBC coding efficiency:** inter samples are allowed to be used as reference for IBC prediction
 - **Unified design:** IBC and inter samples are treated identically, i.e., disabled, for intra prediction when the CIP constraint is applied

Proposed spec changes

7.4.3.3.1 General picture parameter set RBSP semantics

constrained_intra_pred_flag equal to 0 specifies that intra prediction allows usage of residual data and decoded samples of neighbouring coding blocks coded **using either intra or inter prediction modes** ~~with or without using a reference picture that is not the current picture~~. **constrained_intra_pred_flag** equal to 1 specifies constrained intra prediction, in which case ~~the general~~ intra prediction process **for slices that use at least one reference picture that is not the current picture** only uses residual data and decoded samples from neighbouring coding blocks coded ~~without using intra prediction mode~~ ~~a reference picture that is not the current picture~~.

8.4.4.2.1 General intra sample prediction

- Each sample $p[x][y]$ is derived as follows:
- If one or more of the following conditions are true, the sample $p[x][y]$ is marked as "not available for intra prediction":
 - The variable `availableN` is equal to `FALSE`.
 - ~~Samples of the block at the neighbouring luma location $(xNbY, yNbY)$ are coded from a reference picture which is not the current picture~~ **`CuPredMode[xNbY][yNbY]` is not equal to `MODE_INTRA`, `DiffPicOrderCnt(aPic, CurrPic)` is not equal to 0 for at least one picture `aPic` in `RefPicList0` and `RefPicList1` of the current slice,** and `constrained_intra_pred_flag` is equal to 1.
- Otherwise, the sample $p[x][y]$ is marked as "available for intra prediction" and the sample at the location $(xNbCmp, yNbCmp)$ is assigned to $p[x][y]$.

Proposed spec changes

8.5.3.2.8 Derivation process for temporal luma motion vector prediction

The variables `mvLXCol` and `availableFlagLXCol` are derived as follows:

- If `slice_temporal_mv_enabled_flag` is equal to 0, both components of `mvLXCol` are set equal to 0 and `availableFlagLXCol` is set equal to 0.
- ~~– Otherwise, if the reference picture is the current picture and `constrained_intra_pred_flag` is equal to 1, both components of `mvLXCol` are set equal to 0 and `availableFlagLXCol` is set equal to 0.~~
- Otherwise, the following ordered steps apply:

Simulation

- Three settings for simulation
 - **Setting #1** is based on interpretation #1
 - TMVP is disabled for IBC CUs
 - The CIP functionality is broken
 - **Setting #2** is based on interpretation #2
 - TMVP is disabled for IBC CUs
 - The CIP functionality is guaranteed
 - **Setting #3** is the proposed method
 - The CIP functionality is guaranteed

Thanks to Sharp for the cross-check!

Comparison of Interpretation #1 V.S. Proposed

- Lossy 444 results using **full frame IBC search**
- Minor BD-rate increase to enable the CIP functionality
 - RA: {0.2%, 0.2%, 0.2%}
 - LB: {0.1%, 0.1%, 0.1%}

	Random Access			Low delay B		
	G/Y	B/U	R/V	G/Y	B/U	R/V
RGB, text & graphics with motion, 1080p & 720p	0.2%	0.1%	0.2%	0.2%	0.1%	0.1%
RGB, mixed content, 1440p & 1080p	0.4%	0.4%	0.4%	0.3%	0.2%	0.2%
RGB, Animation, 720p	0.1%	0.2%	0.2%	0.1%	0.3%	0.3%
RGB, camera captured, 1080p	0.0%	0.0%	0.1%	0.1%	0.0%	0.0%
YUV, text & graphics with motion, 1080p & 720p	0.1%	0.0%	0.0%	0.0%	0.1%	-0.2%
YUV, mixed content, 1440p & 1080p	0.4%	0.2%	0.2%	0.2%	0.0%	-0.1%
YUV, Animation, 720p	0.2%	0.3%	0.4%	0.1%	0.3%	0.4%
YUV, camera captured, 1080p	0.0%	0.1%	0.1%	0.0%	-0.1%	0.1%
Enc Time[%]	101%			99%		
Dec Time[%]	95%			91%		

Comparison of Interpretation #1 V.S. Proposed

- Lossy 420 results
- Minor BD-rate increase to enable the CIP functionality
 - RA: {0.3%, 0.3%, 0.1%}
 - LB: {0.2%, 0.0%, 0.1%}

	Random Access			Low delay B		
	G/Y	B/U	R/V	G/Y	B/U	R/V
YUV, text & graphics with motion, 1080p & 720p	0.3%	0.3%	0.1%	0.3%	0.1%	0.1%
YUV, mixed content, 1440p & 1080p	0.5%	0.3%	0.1%	0.2%	0.1%	-0.1%
YUV, Animation, 720p	0.3%	0.4%	0.2%	0.1%	0.0%	0.4%
Enc Time[%]		100%			100%	
Dec Time[%]		100%			98%	

Comparison of Interpretation #2 V.S. Proposed

- Lossy 444 results using **full frame IBC search**
- Average BD-rate savings
 - RA: {2.2%, 2.3%, 2.3%}
 - LB: {3.3%, 3.4%, 3.4%}

	Random Access			Low delay B		
	G/Y	B/U	R/V	G/Y	B/U	R/V
RGB, text & graphics with motion, 1080p & 720p	-6.4%	-6.4%	-6.3%	-8.1%	-8.4%	-8.4%
RGB, mixed content, 1440p & 1080p	-2.8%	-2.9%	-2.9%	-4.9%	-5.0%	-5.1%
RGB, Animation, 720p	-0.1%	-0.2%	-0.2%	-0.2%	-0.4%	-0.3%
RGB, camera captured, 1080p	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
YUV, text & graphics with motion, 1080p & 720p	-5.8%	-5.8%	-5.9%	-7.6%	-7.6%	-7.5%
YUV, mixed content, 1440p & 1080p	-2.7%	-2.9%	-2.9%	-5.1%	-5.3%	-5.2%
YUV, Animation, 720p	-0.1%	-0.2%	-0.1%	-0.2%	-0.6%	-0.3%
YUV, camera captured, 1080p	0.0%	-0.1%	-0.1%	0.0%	-0.1%	0.0%
Enc Time[%]	99%			101%		
Dec Time[%]	101%			99%		

Comparison of Interpretation #2 V.S. Proposed

- Lossy 420 results
- Average BD-rate savings
 - RA: {3.3%, 3.4%, 3.4%}
 - LB: {4.6%, 4.5%, 4.7%}

	Random Access			Low delay B		
	G/Y	B/U	R/V	G/Y	B/U	R/V
YUV, text & graphics with motion, 1080p & 720p	-6.8%	-6.7%	-6.8%	-8.7%	-8.8%	-9.0%
YUV, mixed content, 1440p & 1080p	-2.9%	-3.3%	-3.1%	-4.7%	-4.0%	-4.5%
YUV, Animation, 720p	-0.3%	-0.3%	-0.3%	-0.4%	-0.6%	-0.5%
Enc Time[%]		98%			100%	
Dec Time[%]		98%			98%	

Closing remarks

- Propose one CIP solution to the current IBC unification framework
- Benefits
 - The CIP functionality is guaranteed
 - Improved IBC coding efficiency
 - Being consistent with the unification framework of IBC and inter modes
- Suggest to adopt into SCC