

JVT 20th Meeting Klagenfurt, Austria

JVT-T082

Improved prediction and transform for spatial scalability

G. Rath, C. Guillemot, W. Yang, **V. Bottreau**

- **Spatial Scalability**

- Prediction

- Prediction involves normative up-sampling
 - Offline design of current up-sampling filters independent of down-sampling filters
 - Up-sampling filters are not biorthogonal to down-sampling filters
 - Inherent redundancy of the Laplacian pyramid

- Transform

- Enhancement layer signal presents orientations of energy

- Better compression of two spatial layers needs better prediction and better spatial transform
- Better prediction involves the design of an up-sampling filter dependent on the down-sampling filter, QP, sequence, etc
- Why not use the existing filters but improve the prediction based on both the up-sampling and the down-sampling existing filters?
- The enhancement layer signal depends on both the down-sampling and the up-sampling filters
- Why not use a better transform derived from these filters?

- **Laplacian pyramid structure**

- EL : x
- BL : $c = HxH'$ (H decimation filter matrix, down-sampling filter coefficients)
- $d = x - GcG'$ (G interpolation matrix, up-sampling filter coefficients)
- Down-sampling and up-sampling filters are non-biorthogonal -> BL signal c and the EL signal d are correlated : **$HdH' = c - HGcG'H'$**
- **Correlation can be reduced through a improved prediction -> modified d**

- Energy in EL is aligned along certain directions (dependant of the down-sampling and up-sampling filters)
- Directions may be found using eigen-decomposition of an operator made of the decimation and interpolation filter matrices
- Orthogonal transform matrix better suited to the EL coding
- Leads to better compaction of energy, and hence better compression efficiency for EL

Macroblock Modes and Syntax

- EL MBs using ILP >> MBs using spatial intra modes
- spatial intra modes replaced by:
 - I slice

JSVM	Spatial-intra: Intra_4x4, Intra_8x8
	Inter-layer texture: IntraBL(d +DCT)_4x4, IntraBL(d +DCT)_8x8
Proposed	Inter-layer texture: IntraBL(d +DCT)_4x4, IntraBL(d +DCT)_8x8
	IntraBL(d + Transform)_4x4, IntraBL(d +Transform)_8x8
	IntraBL(mod d +DCT)_4x4, IntraBL(mod d +DCT)_8x8
	IntraBL(mod d +Transform)_4x4, IntraBL(mod d +Transform)_8x8

Macroblock Modes and Syntax

— P slice

JSVM	Spatial-Intra:	Intra_4x4, Intra_8x8
	Temporal	Skip, Inter_16x16, Inter_16x8, Inter_8x16, Inter_8x8
	Inter-layer texture	IntraBL(d +DCT)_4x4, IntraBL(d +DCT)_8x8
	Inter-layer MV and residual	IntraBLSkip, Inter_4, Inter_8, Inter_16
Proposed	Temporal:	Skip, Inter_16x16, Inter_16x8, Inter_8x16, Inter_8x8
	Inter-layer texture	IntraBL(d +DCT)_4x4, IntraBL(d +DCT)_8x8
		IntraBL(d +Transform)_4x4, IntraBL(d +Transform)_8x8
		IntraBL(mod d +DCT)_4x4, IntraBL(mod d +DCT)_8x8
		IntraBL(mod d +Transform)_4x4, IntraBL(mod d +Transform)_8x8
	Inter_layer MV and residual	IntraBLSkip, Inter_4, Inter_8, Inter16

- **Improved Prediction**

- decimation + interpolation in addition to the existing interpolation operation

- **Transform**

- Luma : 16x16 transform
- Chroma : 8x8 transform
- Complexity similar to 4x4 transform
- floating-point additions and multiplications

- GOPSize equal to 1
- IntraPeriod equal to 1
- CABAC turned ON
- ClosedLoop activated
- Layer 0 is CIF@30Hz encoded using QP equal to {18, 22, 26}
- Layer 1 is 4CIF@30Hz encoded using QP equal to {20, 24, 28, 32}
- FExt OFF for Layer 0
- FExt ON for Layer 1

- Improved prediction taking into account the inherent correlation between BL and EL signal (Laplacian pyramid)
- Modified transform better suited to the orientation of the energy inside EL
- Applied over existing down-sampling and up-sampling filters
- Up to 4% average bit-rate reduction in dyadic spatial scalability for INTRA-only coding
- Benefits coming from a better BL coding (->Open Loop case)
- Some losses due to the removal of spatial intra modes
- May be extended to inter-layer residual prediction
- Propose to further investigate solutions within AHG on Spatial Scalability Resampling