JCTVC-L0077

Additional VUI and SEI for chroma sampling filter

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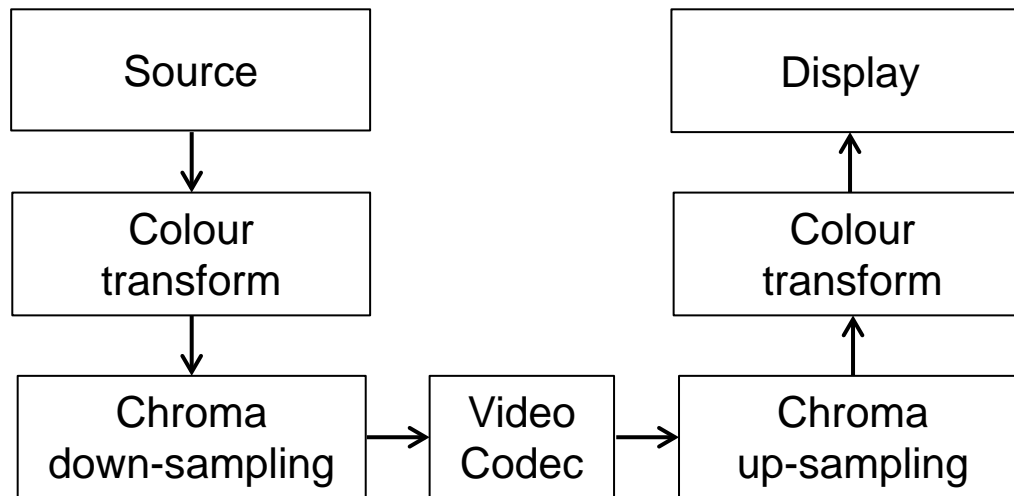
Pankaj Topiwala   FastVDO LLC.
Wei Dai
Madhu Krishnan

Marta Mrak   BBC
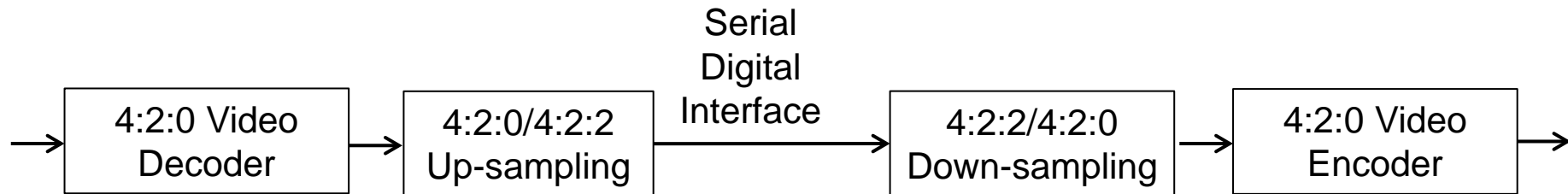Andrea Gabriellini

Background 1

- **In VUI, video signal specifies only chroma sample locations.**
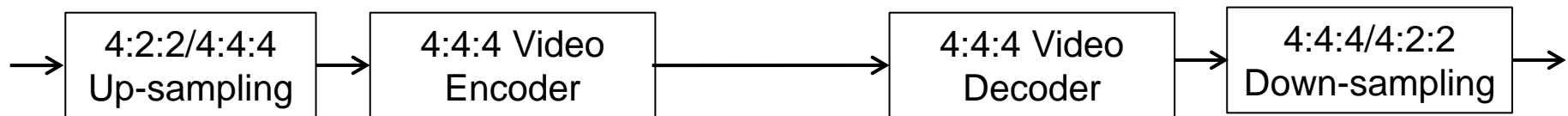 - Consistency of chroma sampling filters is needed..

  - JCTVC-K0211(FastVDO) discusses several filters which are designed to minimize loss in a single 4:2:2/4:2:0/4:2:2 (or 4:4:4/4:2:0/4:4:4) conversion.

Background 2

- **A problem of chroma shift when two or more codecs are concatenated is known.**

Serial Digital Interface

| → | 4:2:0 Video Decoder | → | 4:2:0/4:2:2 Up-sampling | → | 4:2:2/4:2:0 Down-sampling | → | 4:2:0 Video Encoder | → |

– SMPTE 2050-1:2012 defines perfect reconstruction filter set.

- Filter coefficients for 4:2:0/4:2:2 and 4:2:2/4:2:0 conversions.

| → | 4:2:2/4:4:4 Up-sampling | → | 4:4:4 Video Encoder | → | 4:4:4 Video Decoder | → | 4:4:4/4:2:2 Down-sampling | → |

– JCTVC-L0162 and JCTVC-K0302 (BBC) discuss this case.

- JPEG2000 5/3 filter is used.

Examples

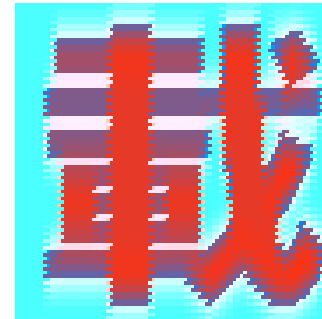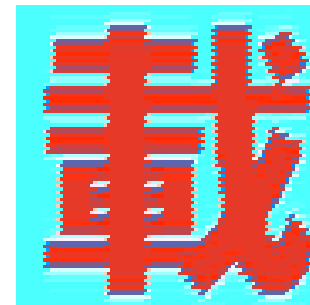- **Degradation of repeat between down and up sampling process.**

1 time   4 times   16 times

Perfect reconstruction filter

Down-Sampling Filter   Up-Sampling Filter
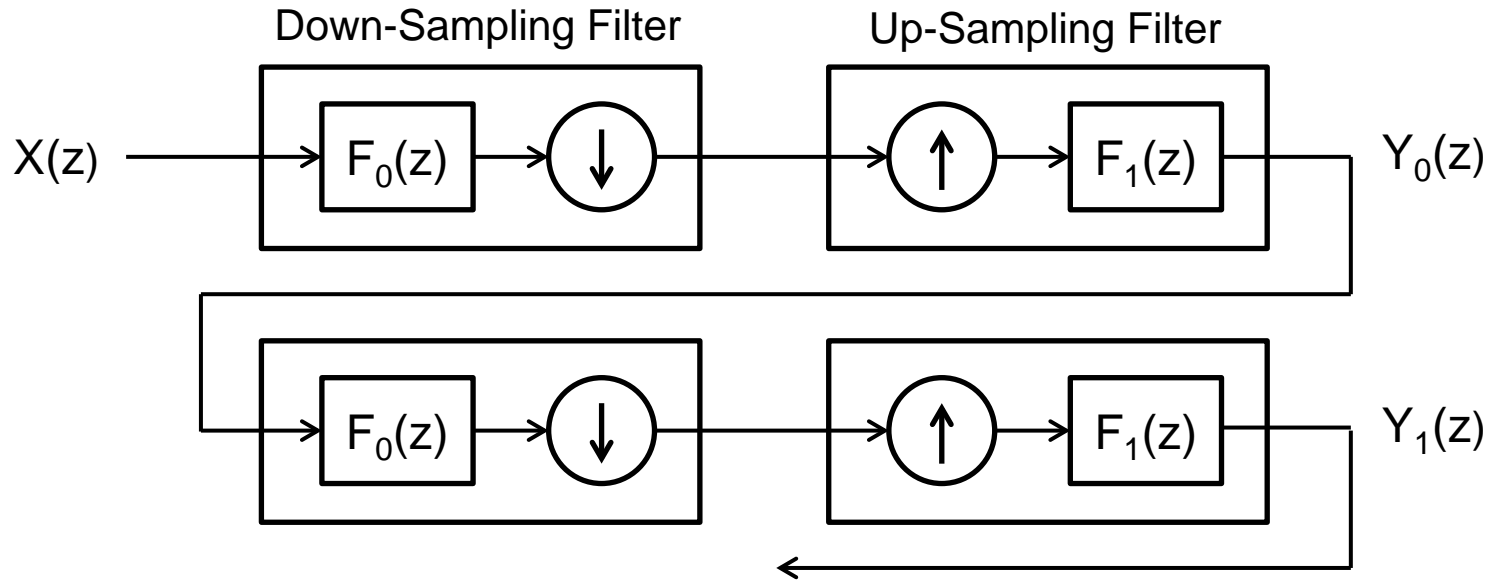
$$\text{If } F_0(z) \, F_1(z) + F_0(z) F_1(z) = 2 \text{ then } Y_0(z) = Y_1(z)$$

- **SMPTE RP 2050-1 and JPEG2000 5/3 filter are satisfied this condition.**

- **There is no degradation of repeat between down and up sampling process.**

Proposal

- **A framework of VUI and SEI is introduced.**

- **VUI indicates predefined chroma sampling filter set information**
  - Vertical and horizontal filter indicators
  - Vertical filtering process flag for field picture

- **Chroma sampling filtering hint SEI can specify explicit filter set information**

Proposed VUI syntax

vui_parameters( ) {	Descriptor
chroma_loc_info_present_flag	u(1)
if(chroma_loc_info_present_flag) {	
chroma_sample_loc_type_top_field	ue(v)
chroma_sample_loc_type_bottom_field	ue(v)
chroma_filter_info_present_flag	u(1)
if(chroma_filter_info_present_flag) {	
ver_chroma_filter_idc	u(8)
hor_chroma_filter_idc	u(8)
ver_filtering_process_flag	u(1)
}	
}	
}	

Chroma filter index in vertical direction

Value	Vertical chroma sampling filter	Informative Remark
0	Unspecified	Chroma filter is unknown or is determined by the application.
1	User-defined	Filter coefficients are specified in the chroma sampling filter hint SEI message
2	$F_V[0][0] = \{-3, -19, 34, 500, 500, 34, -19. 3\}$ $F_V[0][1] = \{19, 103, 1037, -135\}$ $F_V[1][0] = \{-8, -26, 115, 586, 409, -48, -4, 0\}$ $F_V[1][1] = \{24, -41, 1169, -128\}$ $F_V[1][2] = \{-76, 783, 330, -13\}$	SMPTE RP 2050-1:2012 Chroma sample type should be 0.
3	$F_V[0][0] = \{1,0,-3,0,10,16,10,0-1,0,1\}$ $F_V[0][1] = \{1\}$ $F_V[0][2] = \{-1,5,5,-1\}$	Chroma sample type should be 2,3,4 or 5 and DistinctParityFlag should be equal to 0.
4 … 255	Reserved	For future use by ITU-T | ISO/IEC

Chroma filter index in Horizontal direction

Value	Horizontal chroma sampling filter	Informative Remark
0	Unspecified	Chroma filter is unknown or is determined by the application.
1	User-defined	Filter coefficients are specified in the chroma sampling filter hint SEI message
2	$F_H[0][0] = \{-1, 2, 6, 2, -1\}$ $F_H[0][1] = \{1\}$ $F_H[0][2] = \{1, 1\}$	ITU-T Rec. T.800 | ISO/IEC15444-1, 5/3 filter
3	$F_H[0][0] = \{1, 0, -3, 0, 10, 16, 10,0, -3, 0, 1\}$ $F_H[0][1] = \{1\}$ $F_H[0][2] = \{-1, 5, 5, -1\}$	Chroma sample type should be 0, 2 or 4.
4 … 255	Reserved	For future use by ITU-T | ISO/IEC

Proposed SEI syntax

chroma_sampling_filter_hint(payloadSize) {	Descriptor
target_format_idc	ue(v)
perfect_reconstruction_flag	u(1)
if(ver_chroma_filter_idc == 1) {	
num_vertical_filters	ue(v)
NumVerFilters = num_vertical_filters	
if(NumVerFilters > 0)	
for(i=0; i < NumVerFilters; i++) {	
ver_tap_length_minus1[i]	ue(v)
for(j=0; j <= ver_tap_length_minus1[i]; j++) {	
ver_filter_coeff[i][j]	se(v)
}	
}	
}	
if(hor_chroma_filter_idc == 1) {	
num_horizontal_filters	ue(v)
NumHorFilters = num_horizontal_filters	
if(NumHorFilters > 0)	
for(i=0; i < NumHorFilters; i++) {	
hor_tap_length_minus1[i]	ue(v)
for(j=0; j <= hor_tap_length_minus1[i]; j++) {	
hor_filter_coeff[i][j]	se(v)
}	
}	
}	
}	

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Conclusion

- **Additional VUI and SEI message for chroma sampling filter has been proposed.**
  - Any conversion of 4:4:4, 4:2:2 and 4:2:0

- **Reduction of conversion losses of chroma format**

- **Joint four company proposal.**
  - Toshiba, Fujitsu Lab., FastVDO and BBC.

Example of PSNR degradation suppression

Character