

JCTVC-E069

# CE6.f: LUT-based adaptive filtering on intra prediction samples

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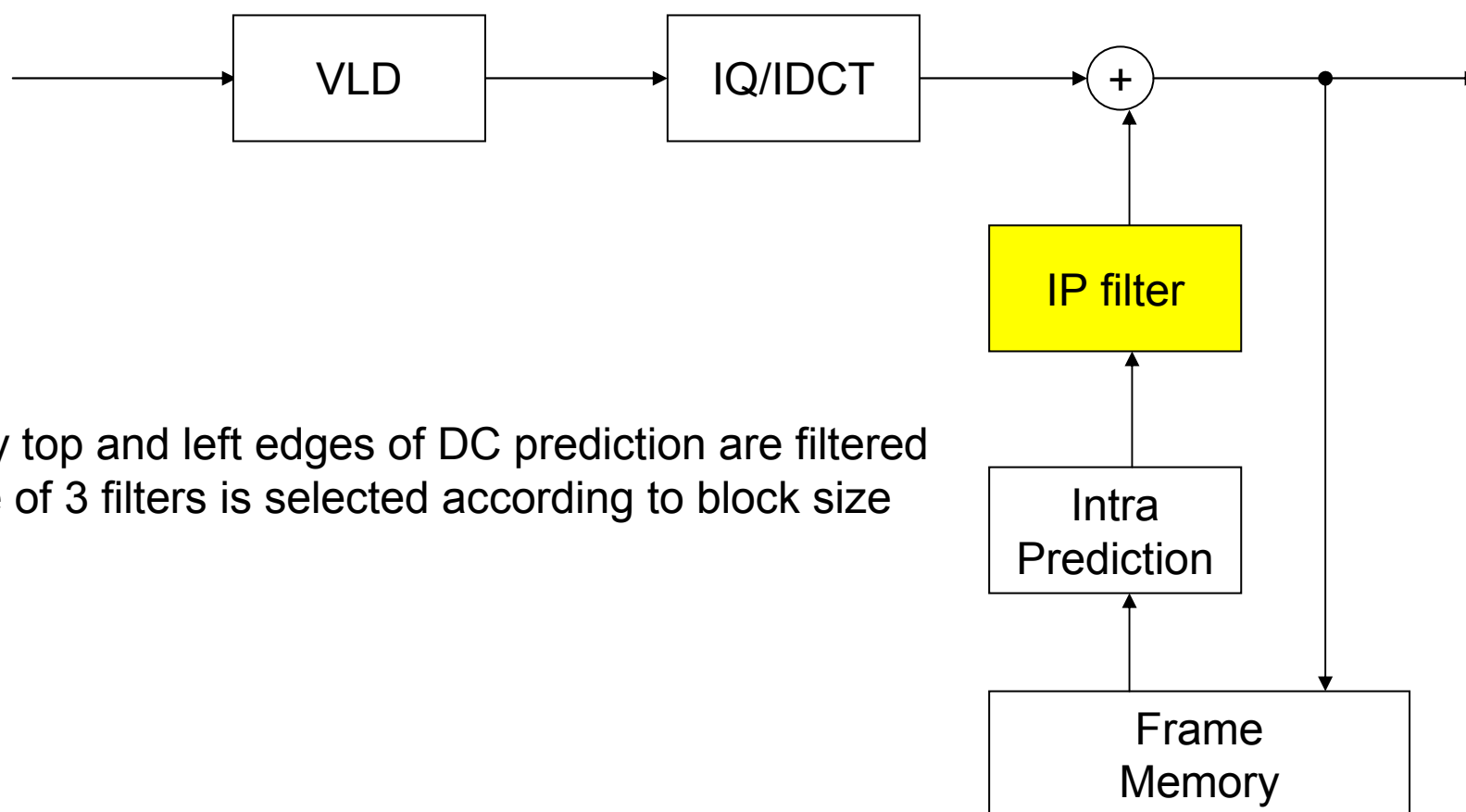
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# Introduction

- In JCTVC-D109, LUT-based adaptive filtering on intra prediction samples is proposed.
  - 2 tap filter for top and left edge of DC prediction less than 32x32
  - Replace filter option “2” in MDIS with “1”
- Verification results compared to the anchor
  - BD-rate gain are 0.2%(AI/HE) and 0.4%(AI/LC)
  - Encoding times are 99%(AI/HE and AI/LC)
  - Decoding times are 99%(AI/HE) and 98%(AI/LC)
- Proposal: adopt this technology to HM-3

# Intra prediction samples filtering

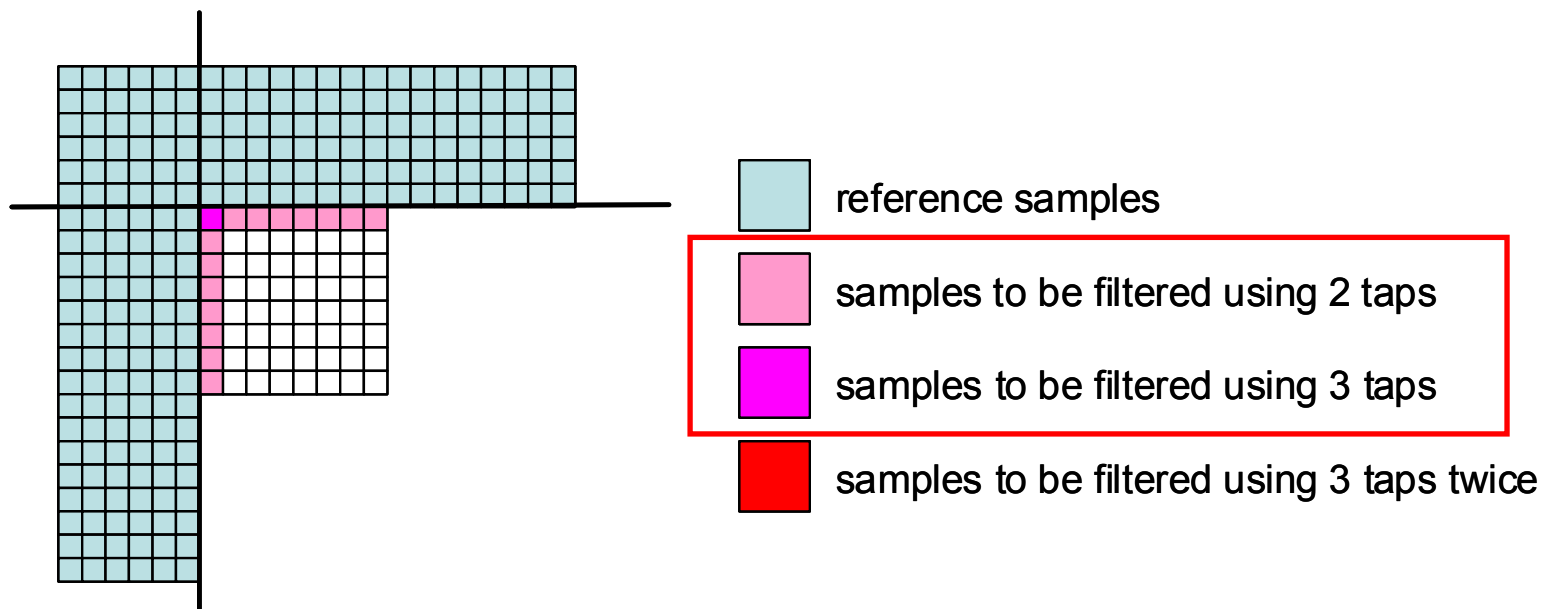
- Decoding process



- only top and left edges of DC prediction are filtered
- one of 3 filters is selected according to block size

# prediction samples to be filtered

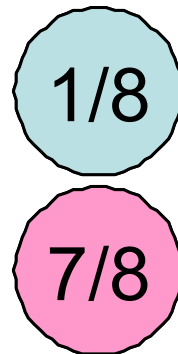
- Example: 8x8 DC prediction



# Filters

- 2 tap filters except the top-left corner sample

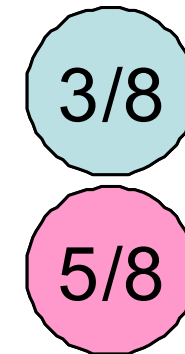
Filter #A



Filter #B



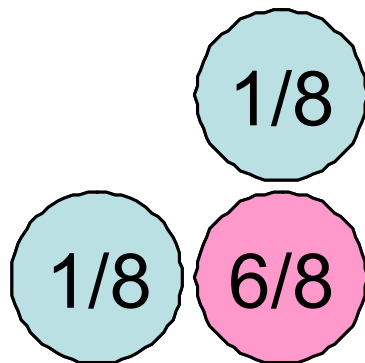
Filter #C



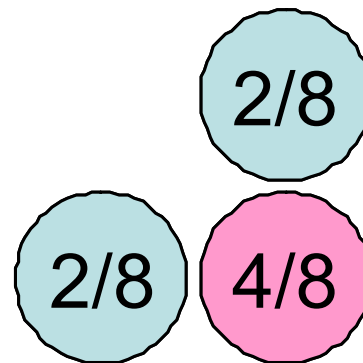
# Filters

- 3 tap filters for the top-left corner sample

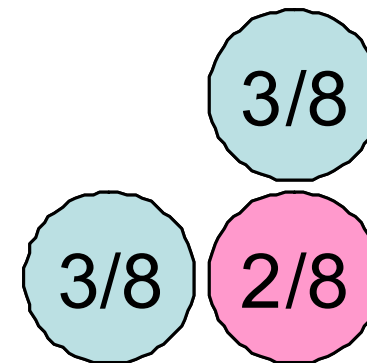
Filter #A



Filter #B



Filter #C



# Look-up table

Replace filter option “2” in MDIS with “1”

- MDIS

{0, 0, 0, 1, 0, 0, 1, 0, 0, 1, 0}, //4x4

{0, 0, 0, 1, 1, 2, 2, 2, 1, 1, 0}, //8x8

{0, 0, 0, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0}, //16x16

{0, 0, 0, 2, 0, 0, 0, 0}, //32x32

{0, 0, 0, 2, 2, 0}, //64x64

- Proposed scheme

{0, 0, **A**, 1, 0, 0, 1, 0, 0, 1, 0}, //4x4

{0, 0, **B**, 1, 1, 1, 1, 1, 1, 1, 0}, //8x8

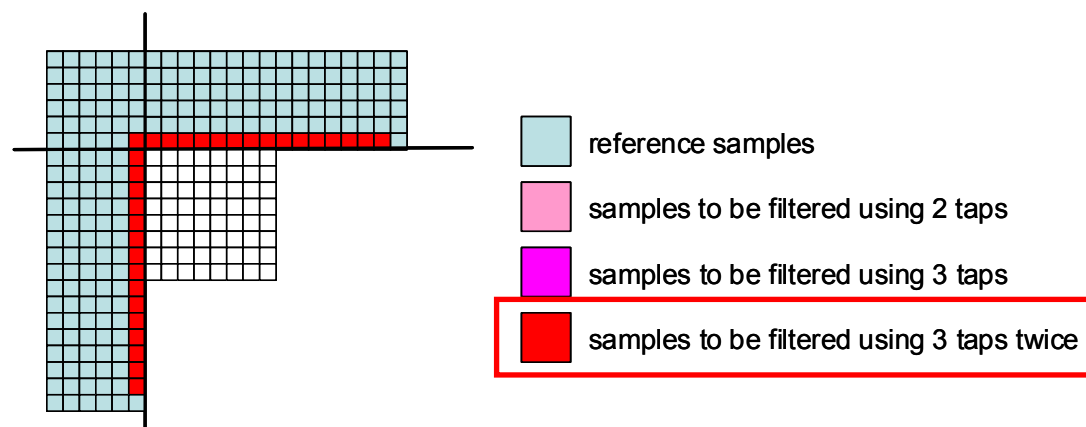
{0, 0, **C**, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0}, //16x16

{0, 0, 0, 1, 0, 0, 0, 0}, //32x32

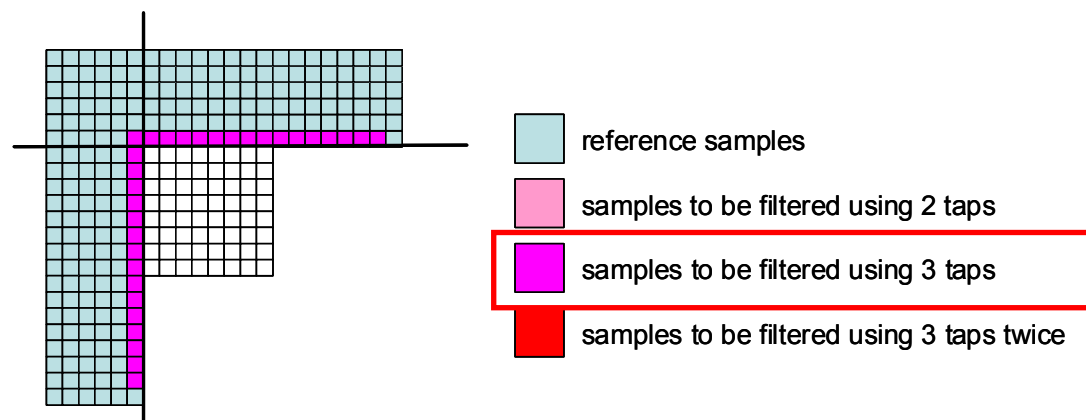
{0, 0, 0, 1, 1, 0}, //64x64

# Reference samples to be filtered

- MDIS



- Proposed





# Simulation Results (1)

- Anchor: HM2.0 Intra Only default conditions
- Tested: Proposed scheme implemented on HM2.0

|             | Intra     |           |           | Intra LoCo |           |           |
|-------------|-----------|-----------|-----------|------------|-----------|-----------|
|             | Y BD-rate | U BD-rate | V BD-rate | Y BD-rate  | U BD-rate | V BD-rate |
| Class A     | -0.1      | -0.2      | -0.1      | -0.4       | -0.2      | -0.2      |
| Class B     | -0.3      | -0.2      | -0.2      | -0.4       | -0.4      | -0.4      |
| Class C     | -0.3      | -0.2      | -0.2      | -0.4       | -0.3      | -0.3      |
| Class D     | -0.2      | -0.2      | -0.2      | -0.3       | -0.3      | -0.3      |
| Class E     | -0.2      | -0.1      | -0.2      | -0.3       | -0.3      | -0.3      |
| All         | -0.2      | -0.2      | -0.2      | -0.4       | -0.3      | -0.3      |
| Enc Time[%] | 99%       |           |           | 99%        |           |           |
| Dec Time[%] | 99%       |           |           | 98%        |           |           |

0.2% and 0.4% gain with complexity reduction compared to the anchor

# Simulation Results (2)

- Anchor: HM2.0 Intra Only default conditions
- Tested: CE6.e Planar+DST software

|             | Intra     |           |           | Intra LoCo |           |           |
|-------------|-----------|-----------|-----------|------------|-----------|-----------|
|             | Y BD-rate | U BD-rate | V BD-rate | Y BD-rate  | U BD-rate | V BD-rate |
| Class A     | -1.0      | 0.1       | 0.5       | -1.6       | -2.3      | -1.9      |
| Class B     | -1.3      | -0.6      | -0.1      | -1.4       | -2.4      | -2.1      |
| Class C     | -1.0      | -0.2      | 0.0       | -1.3       | -2.0      | -2.1      |
| Class D     | -1.0      | -0.4      | -0.3      | -1.3       | -2.1      | -2.2      |
| Class E     | -1.2      | 1.0       | 1.1       | -1.3       | -1.8      | -2.0      |
| All         | -1.1      | -0.1      | 0.2       | -1.4       | -2.2      | -2.0      |
| Enc Time[%] | 105%      |           |           | 108%       |           |           |
| Dec Time[%] | 101%      |           |           | 102%       |           |           |

# Macro settings of CE6.e software

```
#define REPLACE_DC_MODE_WITH_PLANAR 1
#define CODE_PREDERROR_DIFFERENTLY 1
#define ADD_PLANAR_MODE 1
#if REPLACE_DC_MODE_WITH_PLANAR || ADD_PLANAR_MODE
#define D326_PREDICTION 0
#define D083_PREDICTION 0
#define D235_PREDICTION 1
#endif
```

```
#if CODE_PREDERROR_DIFFERENTLY
#define DST_FOR_PLANAR 1
#endif
```

```
#if ADD_PLANAR_MODE
#define D235_MODE_SIGNALING 1 // Set to 1 for test CE6.e.3.b
#endif
```

```
#if DST_FOR_PLANAR
#define D235_TRANSFORM 1
#endif
```

```
#if ADD_PLANAR_MODE
#define NUM_INTRA_MODE 35
#define PLANAR_IDX (NUM_INTRA_MODE-1)
#endif
```

# Simulation Results (3)

- Anchor: HM2.0 Intra Only default conditions
- Tested: Proposed scheme implemented on CE6.e Planar+DST software

|             | Intra     |           |           | Intra LoCo |           |           |
|-------------|-----------|-----------|-----------|------------|-----------|-----------|
|             | Y BD-rate | U BD-rate | V BD-rate | Y BD-rate  | U BD-rate | V BD-rate |
| Class A     | -1.1      | 0.1       | 0.5       | -1.9       | -2.4      | -2.0      |
| Class B     | -1.5      | -0.7      | -0.3      | -1.6       | -2.7      | -2.4      |
| Class C     | -1.3      | -0.3      | -0.2      | -1.6       | -2.3      | -2.3      |
| Class D     | -1.2      | -0.5      | -0.4      | -1.5       | -2.3      | -2.4      |
| Class E     | -1.3      | 0.9       | 1.0       | -1.6       | -2.0      | -2.2      |
| All         | -1.3      | -0.2      | 0.1       | -1.6       | -2.4      | -2.3      |
| Enc Time[%] | 104%      |           |           | 108%       |           |           |
| Dec Time[%] | 101%      |           |           | 101%       |           |           |

Additional 0.2% gain with complexity reduction on top of Planar+DST

# Conclusions

- The proposed scheme improves coding efficiency
  - 0.2% and 0.4% for Intra HE and LC respectively
  - ENC time reductions are 1% and 1% for HE and LC
  - DEC time reductions are 1% and 2% for HE and LC
- The proposed scheme improves coding efficiency even used with planar mode.
- Propose the scheme to be adopted to HM-3



# Additional Results

- Clarify the performance of MDIS simplification
  - replace 2-pass filtering of MDIS to 1-pass filtering
- Clarify the performance of DC prediction filtering
- Anchor: HM2.0

# Additional Results (1)

- Anchor: HM2.0 Intra Only default conditions
- Tested: Simplified MDIS

|             | Intra     |           |           | Intra LoCo |           |           |
|-------------|-----------|-----------|-----------|------------|-----------|-----------|
|             | Y BD-rate | U BD-rate | V BD-rate | Y BD-rate  | U BD-rate | V BD-rate |
| Class A     | 0.2       | 0.2       | 0.2       | 0.3        | 0.3       | 0.2       |
| Class B     | 0.1       | 0.1       | 0.1       | 0.1        | 0.0       | 0.0       |
| Class C     | 0.0       | 0.0       | 0.1       | 0.0        | 0.0       | 0.0       |
| Class D     | 0.0       | 0.1       | 0.1       | 0.0        | 0.1       | 0.0       |
| Class E     | 0.1       | 0.0       | 0.0       | 0.1        | -0.1      | -0.1      |
| All         | 0.1       | 0.1       | 0.1       | 0.1        | 0.1       | 0.0       |
| Enc Time[%] | 100%      |           |           | 98%        |           |           |
| Dec Time[%] | 99%       |           |           | 99%        |           |           |

- 0.1% loss of coding efficiency
- 1-2% complexity reduction



# Additional Results (2)

- Anchor: HM2.0 Intra Only default conditions
- Tested: DC prediction samples filter with default MDIS

|             | Intra     |           |           | Intra LoCo |           |           |
|-------------|-----------|-----------|-----------|------------|-----------|-----------|
|             | Y BD-rate | U BD-rate | V BD-rate | Y BD-rate  | U BD-rate | V BD-rate |
| Class A     | -0.3      | -0.3      | -0.3      | -0.7       | -0.4      | -0.3      |
| Class B     | -0.3      | -0.3      | -0.2      | -0.5       | -0.4      | -0.4      |
| Class C     | -0.3      | -0.2      | -0.2      | -0.4       | -0.3      | -0.3      |
| Class D     | -0.3      | -0.3      | -0.3      | -0.4       | -0.3      | -0.2      |
| Class E     | -0.2      | -0.1      | -0.1      | -0.4       | -0.2      | -0.2      |
| All         | -0.3      | -0.2      | -0.2      | -0.5       | -0.3      | -0.3      |
| Enc Time[%] | 100%      |           |           | 100%       |           |           |
| Dec Time[%] | 100%      |           |           | 100%       |           |           |

- 0.3% and 0.5% gain compared to the original HM2.0
- Additional enc/dec complexity is negligible

# Observations

- Slight loss of coding efficiency but achieve a bit of complexity reduction to simplify the reference samples filter
- The DC filtering scheme improves coding efficiency
  - 0.3% and 0.5% for Intra HE and LC respectively
  - Additional enc/dec complexity is negligible

# Thank you