

Intra prediction based on repetitive pixel replenishment (JCTVC-F617)

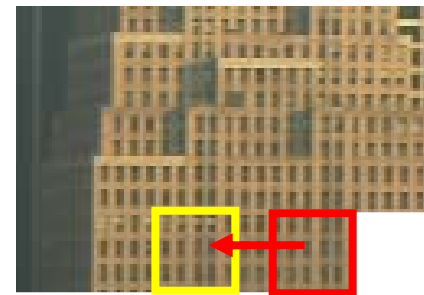
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**Renesas Electronics Corporation
Kenichi Iwata, Seiji Mochizuki, Ryoji Hashimoto**

Summary

■ Intra RPR (Repetitive Pixel Replenishment)

- **New** intra prediction mode for HEVC
- Applying **2-D template matching** to intra prediction
 - Suitable for repeat of complicated pattern
- Intra RPR parameter condition
 - Block size : **4x4, 8x8, 16x16**
 - Pixel precision : **half pixel**
 - simple average of integer pixel
 - Reference Area : **H [-16, 16], V[-16, 0]**
- Performance on HM3.0rc2 Intra
 - BD-rate Y : **-0.3 % and up to -2.0%**
 - Complexity : 118% encoding
98% decoding



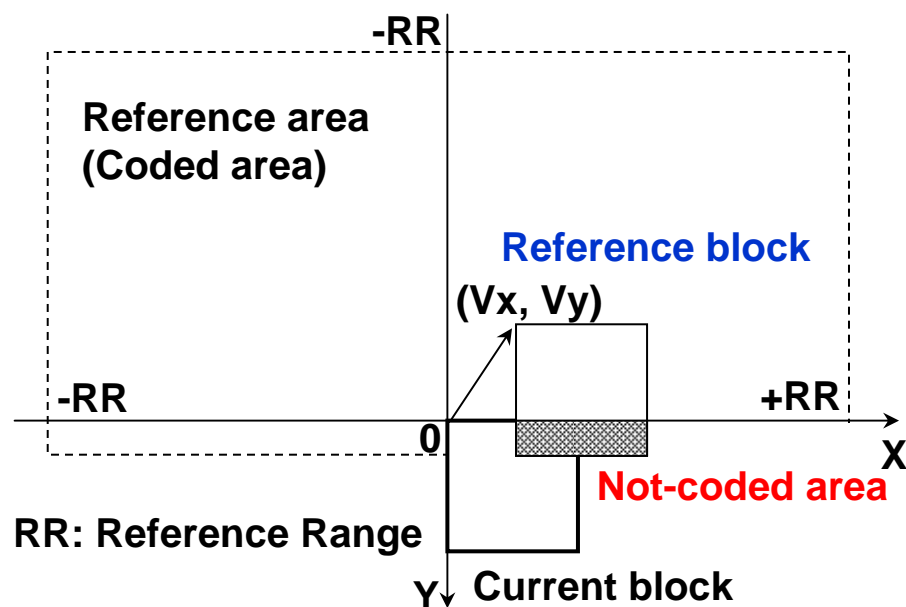
Intra repetitive pixel replenishment(1)

■ Vector multiplication

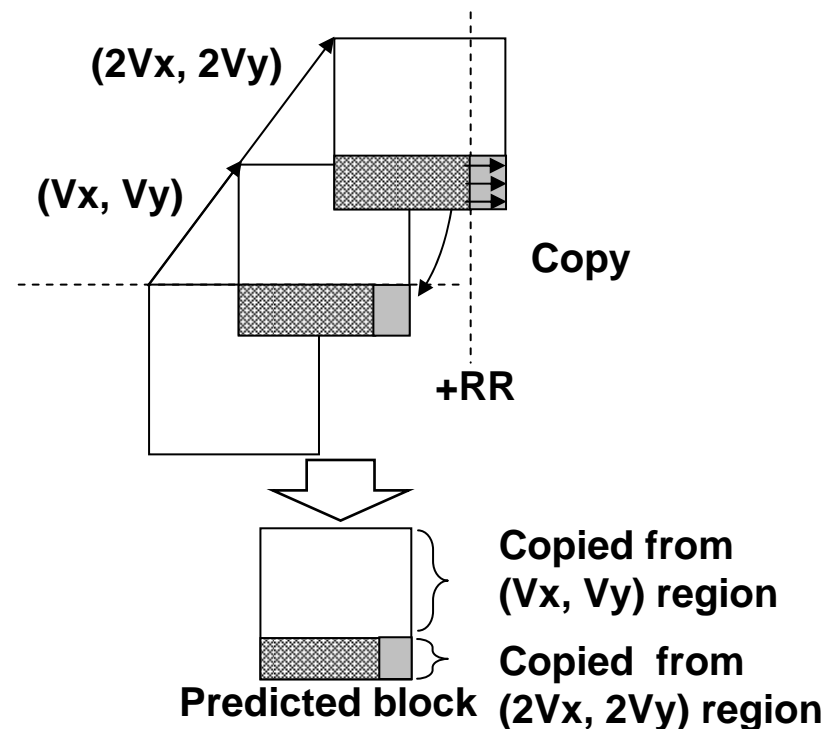
- If **reference block** includes **not-coded area** as shown in Fig. (a), intra vector is multiplied as $(2Vx, 2Vy)$, and padding such region by using new reference pixel as shown in Fig. (b).

■ Restriction of reference area

- Reference pixel must locate in reference range as shown Fig. (b)
 - Outside of reference area is copied from boundary pixel



(a) Intra vector prediction



(b) Adaptive padding

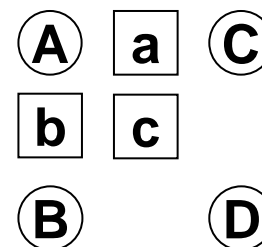
Intra repetitive pixel replenishment(2)

■ Encoding condition for Intra RPR

- Both luma and chroma are predicted by Intra RPR
- Block size : 4x4, 8x8, 16x16
 - Large size of complicated pattern **hardly** repeats
- Reference area : H [-16, 16] V[-12(for 4x4)/-16(otherwise), 0]
 - All pixels in area is searched

- Half-pel prediction : simple average

- $a = (A + C + 1) / 2$
- $b = (A + B + 1) / 2$
- $c = (A + B + C + D + 2) / 4$



- Skip search of Intra RPR

- If following condition is true
 - Intra prediction mode of current PU is
 - Horizontal
 - Vertical
 - DC



} These PU do **not** have **complicated pattern**

Intra repetitive pixel replenishment(3)

■ Transform and scanning order

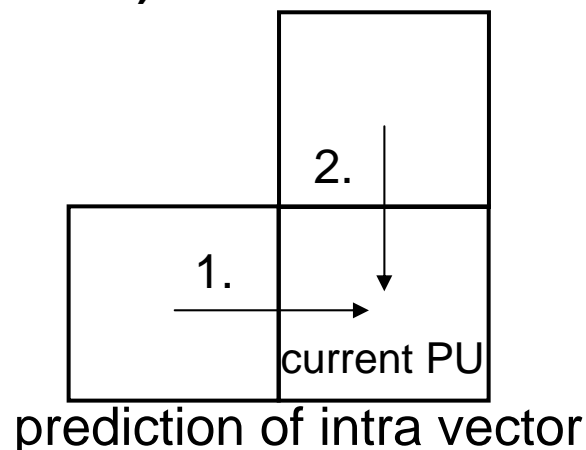
- Use DCT and zig-zag scan in blocks coded intra vector
 - As same as inter prediction

■ Representation of intra vector in bitstream

- Difference (mvd) between intra vector and its predictor (mvp)
 - Intra vector = mvd + mvp

■ How to get the predictor of intra vector

- 1. Left PU is intra vector
 - mvp = intra vector of left PU
- 2. Up PU is intra vector (left PU is not intra vector)
 - mvp = intra vector of up PU
- 3. Neither left nor up PU is intra vector
 - mvp = default value (-1, -1)



Bitstream syntax (1)

■ CABAC

- 1 bit flag *intra vector flag* is added after intra part mode
 - Add as a **new** intra prediction mode
- If *intra vector flag* is equal to 1
 - 1 (2Nx2N) or 4 (NxN) *intra vector difference* is coded as follows for each component x, y
 - $\text{abs}(\text{mvd}) == 0$: 1
 - $\text{abs}(\text{mvd}) < 4$: 01 + XX + sign
 - otherwise : $\underbrace{00}_{\text{normal mode}} + \underbrace{\text{XXXXXX}}_{\text{bypass mode}} + \underbrace{\text{sign}}_{\text{mode}}$

intra_part_mode
<i>intra_vector_flag</i>
if (intra_vector_flag) {
<i>intra_vecrtor_difference</i> [x/y]
} else {
prev_intra_mode_pred_flag/rem_intra_pred_mode
chroma_pred_mode
}

Bitstream syntax (2)

■ CAVLC

- Use intra RPR instead of IntraPredMode == 15(4x4)/27(otherwise)
 - Replace a one of intra prediction mode
 - **After IntraPredMode, intra vector difference of each component is coded with se(v)**

intra_part_mode
prev_intra_mode_pred_flag
if (prev_intra_mode_pred_flag == 0)
rem_intra_pred_mode
if (IntraPredMode == 15/27) {
intra vector difference [x/y]
} else {
intra_chroma_pred_mode
}

Performance evaluation of Intra RPR on HM3.0rc2

■ BD - rate reduction [%]

	Intra			Intra LoCo		
	Y	U	V	Y	U	V
Class A	-0.02	-0.01	-0.02	-0.11	-0.03	-0.06
Class B	-0.33	-0.32	-0.35	-0.48	-0.45	-0.45
Class C	-0.62	0.56	0.53	-0.97	0.41	0.36
Class D	-0.18	0.58	0.56	-0.32	0.64	0.54
Class E	-0.26	-0.20	-0.17	-0.49	-0.10	-0.25
All	-0.29	0.12	0.10	-0.47	-0.08	0.02

■ Complexity [%]

	Intra	Intra LoCo
Encode	118	133
Decode	98	96

■ Experimental condition

- As described in E-700

Conclusion

- Renesas proposed **new** intra prediction based on repetitive pixel replenishment (**Intra RPR**).
 - Adaptive template block size
 - Half-pel precision
 - Difference of motion vector is coded in bitstream

- Performance on HM3.0rc2
 - BD-rate (Intra) : **-0.3 % and up to -2.0%**
 - Encoding/Decoding time : **118% / 98%**



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