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# **Result of CE2 on Multi-view Video Coding**

## **Sejong Univ./ETRI**

**ISO/IEC JTC1/SC29/WG11**

**JVT-T110**

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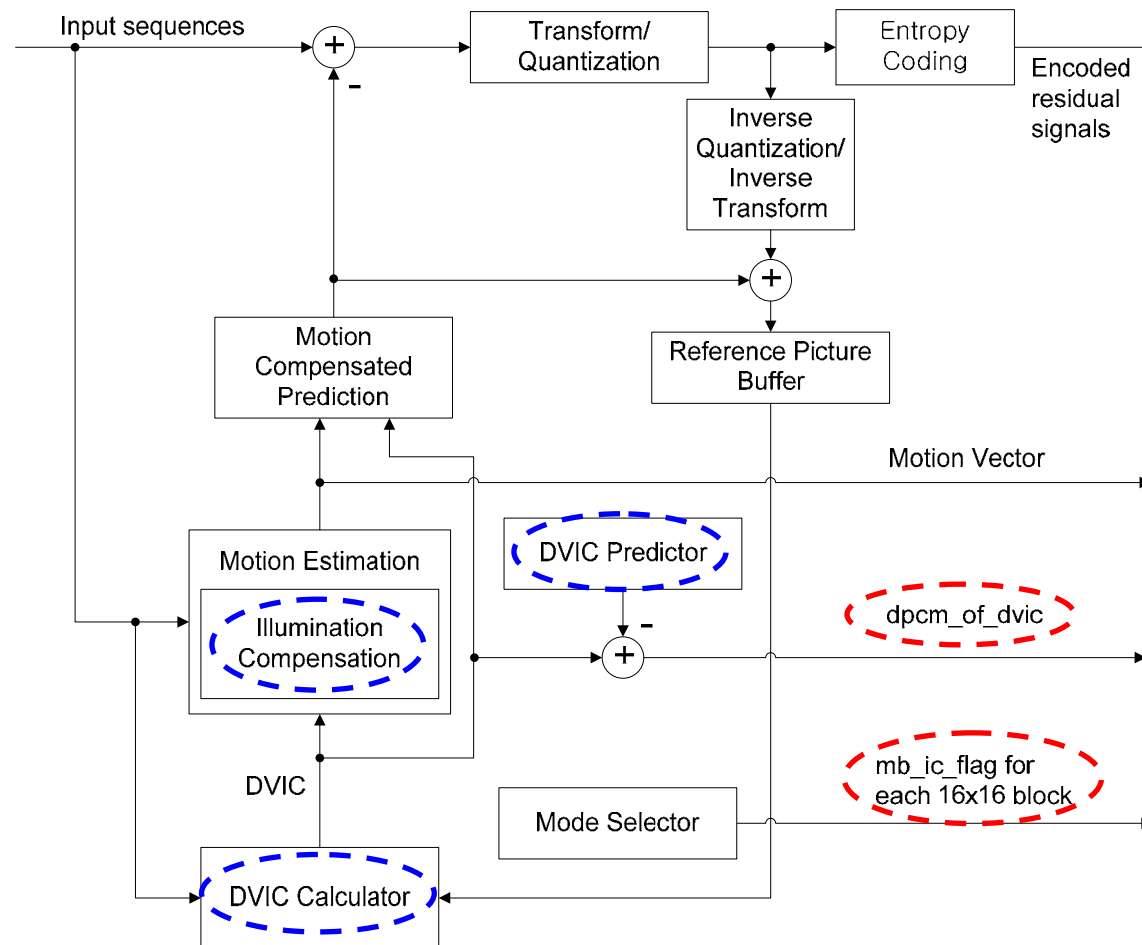
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# 1. Introduction

- ✦ This proposal is based on the proposal proposed in April at Montreux.
- ✦ The prediction process of Difference Value of Illumination Change (DVIC) was slightly modified to simplify the prediction process.
- ✦ To compensate the illumination change in multi-view video coding, we propose an *MB-based illumination change-adaptive (ICA) ME/MC* technique.
- ✦ MB-based ICA ME/MC is performed for Luma component on the spatio-temporal direction.

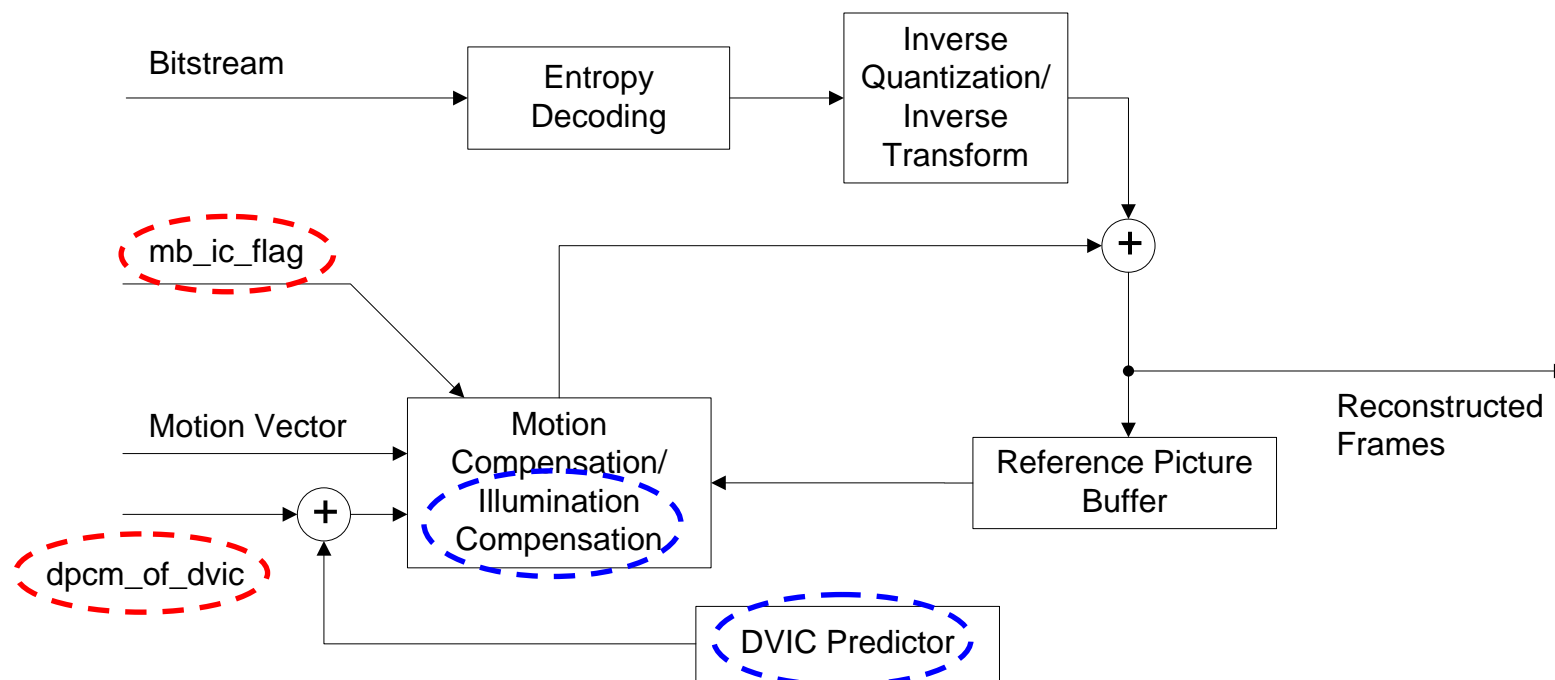
## 2. ICA ME/MC for Luma Component for MVC

## ✦ Encoding Structure of the Proposed Method



## 2. ICA ME/MC for Luma Component for MVC

### ✦ Decoding Structure of the Proposed Method



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## 2. ICA ME/MC for Luma Component for MVC

### ✦ Encoding Structure of the Proposed Method consists of

- ICA ME/MC
- Prediction of the **difference value of illumination change** (DVIC)
- Entropy coding of **mb\_ic\_flag** and **dpcm\_of\_dvic**

### ✦ Decoding Structure of the Proposed Method consists of

- ICA MC
- Reconstruction of a DVIC
- Entropy decoding of **mb\_ic\_flag** and **dpcm\_of\_dvic**

### ✦ Target MBs for IC

- IC-Inter  $16 \times 16$  (when `mb_type==Inter  $16 \times 16$  && mb_ic_flag==1`)
- IC-Direct  $16 \times 16$  (when `mb_type==Direct  $16 \times 16$  && mb_ic_flag==1`)

## 2. ICA ME/MC for Luma Component for MVC

### ✦ 1) MB-based ICA ME/MC for Inter 16×16 mode

- **IC-Inter 16×16** is used for P or B slice.
- The conventional *SAD* calculation :  $S \times T$  block based ME

$$SAD(x, y) = \sum_{i=m}^{m+S-1} \sum_{j=n}^{n+T-1} |f(i, j) - r(i+x, j+y)|$$

- The *NewSAD* calculation for ICA ME

$$M_{cur} = \frac{1}{S \times T} \sum_{i=m}^{m+S-1} \sum_{j=n}^{n+T-1} f(i, j)$$

$$M_{ref}(p, q) = \frac{1}{S \times T} \sum_{i=p}^{p+S-1} \sum_{j=q}^{q+T-1} r(i, j)$$

$$NewSAD(x, y) = \sum_{i=m}^{m+S-1} \sum_{j=n}^{n+T-1} \left| \{f(i, j) - M_{cur}\} - \{r(i+x, j+y) - M_{ref}(m+x, n+y)\} \right|$$

- In the proposed method,  $S$  and  $T$  are set to 16.

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## Cont.

- The Difference Value of Illumination Change (DVIC)

$$DVIC = M_{cur} - M_{ref}(p, q)$$

- ICA MC

$$\begin{aligned} NewR(i, j) &= \{f(i, j) - M_{cur}\} - \{r(i + x', j + y') - M_{ref}(m + x', n + y')\} \\ &= \{f(i, j) - r(i + x', j + y')\} - \{M_{cur} - M_{ref}(m + x', n + y')\} \\ &= \{f(i, j) - r(i + x', j + y')\} - DVIC \end{aligned}$$

in which  $(x', y')$  : determined motion vector

- Reconstruction

$$\begin{aligned} f'(i, j) &= \{NewR(x', y', i, j) + r(i + x', j + y')\} + \{M_{cur} - M_{ref}(m + x', n + y')\} \\ &= \{NewR(x', y', i, j) + r(i + x', j + y')\} + DVIC \end{aligned}$$

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## Cont.

### ✦ 2) MB-based ICA ME/MC for Direct $16 \times 16$ mode

- **IC-Direct  $16 \times 16$**  is used only for B slices and does not need the ICA ME.
- The MV that is derived by the existing derivation process of MV in spatial Direct mode is used.
- The DVIC is only calculated by  $(M_{cur} - M_{ref})$  pointed by the derived MV.
- The remaining part of the process is the same as the case **IC-Inter  $16 \times 16$  mode**.
- Although a current macroblock is determined as “Direct Skip”, the **mb\_ic\_flag** and **dpcm\_of\_dvic** (only when mb\_ic\_flag is 1) is needed in the bitstream.



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## Cont.

### ✦ 3) New Syntax Elements

- **mb\_ic\_flag** : To signal to the decoder whether the ICA ME/MC is used and the DPCM value of DVIC (**dpcm\_of\_dvic**) is included in bitstream. This information is only included in case of Inter  $16 \times 16$  or Direct  $16 \times 16$ .

```
If (mb_ic_flag == 1) {  
    The current MB is regarded as IC-Inter  $16 \times 16$  or IC-Direct  $16 \times 16$ .  
    and includes dpcm_of_dvic.  
} else {  
    The current MB is regarded as conventional Inter  $16 \times 16$  or Direct  $16 \times 16$ .  
    Not include dpcm_of_dvic.  
}
```

- **dpcm\_of\_dvic** : DPCM value of the DVIC is calculated by using the neighboring blocks of a current block.

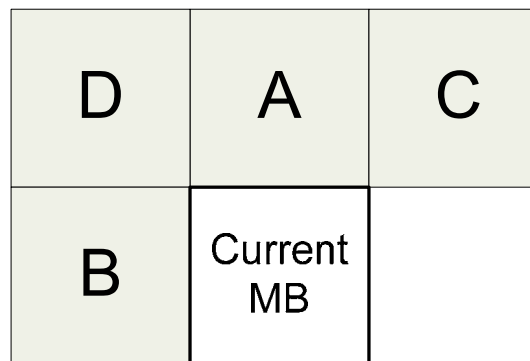
$$\text{dpcm\_of\_dvic} = DVIC - \text{pred}_{DVIC}$$

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## 2. ICA ME/MC for Luma Component for MVC

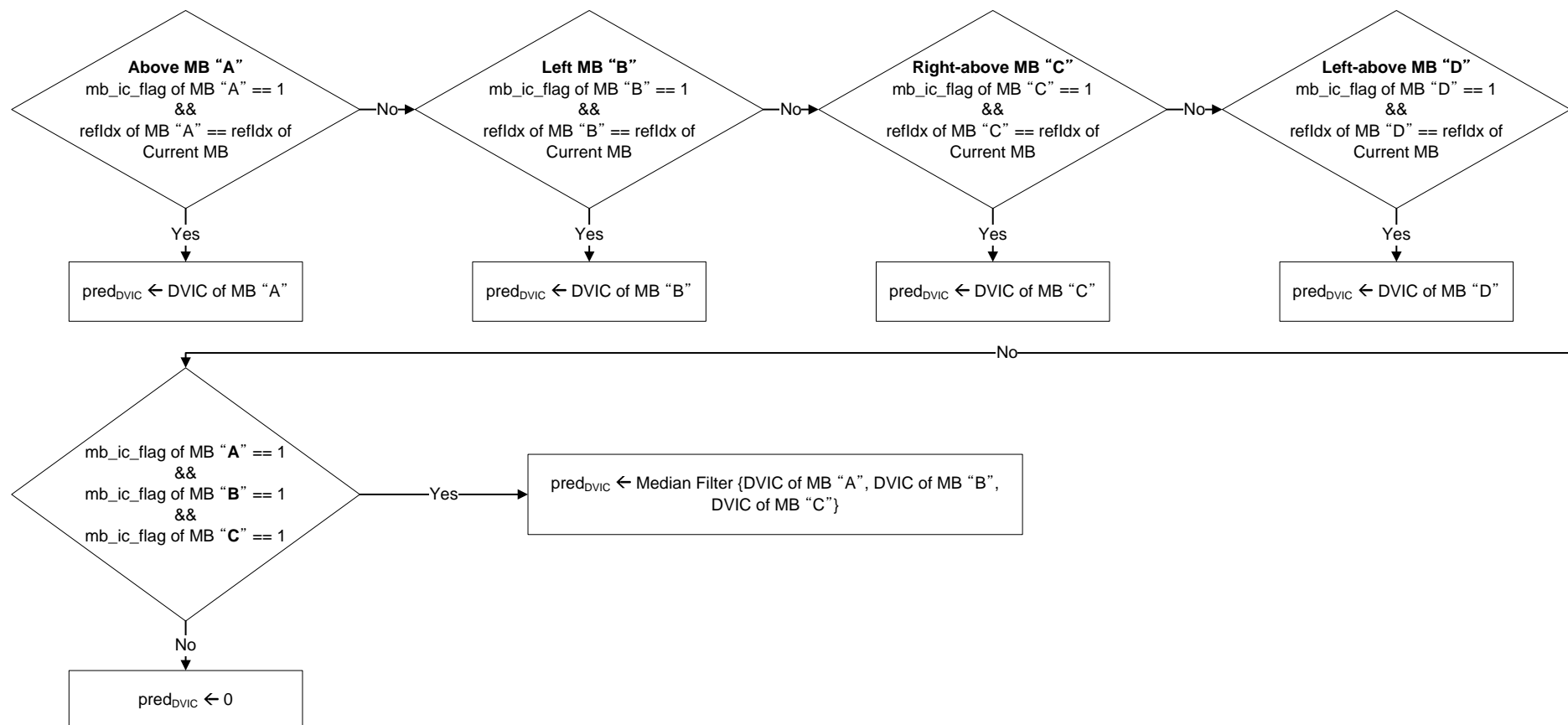
### ✦ Prediction Process of a DVIC

- The meaning of DVIC is the local illumination change in each MB.
- The DVIC of the current MB may have a high correlation with that of *neighboring* MBs.
- The predictor ( $\text{pred}_{\text{DVIC}}$ ) of a DVIC of a current MB is used for reducing bits more.



## 2. ICA ME/MC for Luma Component for MVC

### ✦ Prediction Process of a DVIC.



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## 2. ICA ME/MC for Luma Component for MVC

### ✦ Prediction Process of a DVIC

- Step 1) If the above MB “A” of the current MB was encoded by using MB-based ICA MC and its reference index is equal to a reference index of the current MB,  $\text{pred}_{\text{DVIC}}$  is set to the DVIC of MB “A” and the process is finalized. Otherwise, go to next step.
- Step 2) If the left MB “B” of the current MB was encoded by using MB-based ICA MC and its reference index is equal to a reference index of the current MB,  $\text{pred}_{\text{DVIC}}$  is set to the DVIC of MB “B” and the process is finalized. Otherwise, go to next step.
- Step 3) If the right-above MB “C” of the current MB was encoded by using MB-based ICA MC and its reference index is equal to a reference index of the current MB,  $\text{pred}_{\text{DVIC}}$  is set to the DVIC of MB “C” and the process is finalized. Otherwise, go to next step.
- Step 4) If the left-above MB “D” of the current MB was encoded by using MB-based ICA MC and its reference index is equal to a reference index of the current MB,  $\text{pred}_{\text{DVIC}}$  is set to the DVIC of MB “D” and the process is finalized. Otherwise, go to next step.
- Step 5) If the neighboring MB “A”, “B”, and “C” were encoded by using MB-based ICA MC, these three DVICs are median-filtered.  $\text{pred}_{\text{DVIC}}$  is set to the result of median-filtering and the process is finalized. Otherwise, go to next step.
- Step 6)  $\text{pred}_{\text{DVIC}}$  is set to zero and the process is ended.

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## 2. ICA ME/MC for Luma Component for MVC

### ✦ Entropy Coding for `mb_ic_flag` and `dpcm_of_dvic` using CABAC

- `mb_ic_flag` : three context models similar to those of `mb_skip_flag`

Let the variable `condTermFlagN` (with `N` being either `A` or `B`) be derived as follows.

- If `mbAddrN` is available or `mb_ic_flag` for the macroblock `mbAddrN` is equal to 1, `condTermFlagN` is set equal to 0.
- Otherwise (`mbAddrN` is not available and `mb_ic_flag` for the macroblock `mbAddrN` is equal to 0), `condTermFlagN` is set equal to 1.

The variable `ctxIdxInc` is derived by

`ctxIdxInc = condTermFlagA + condTermFlagB`

## 2. ICA ME/MC for Luma Component for MVC

### ✦ Entropy Coding for mb\_ic\_flag and dpcm\_of\_dvic using CABAC

- dpcm\_of\_dvic : UEG0, two context models similar to those of transform coefficient levels coding.

Abs.	Bin string																			
value	TU prefix														EGO suffix					
1	0																			
2	1	0																		
3	1	1	0																	
4	1	1	1	0																
5	1	1	1	1	0															
...	.	.	.	.	.	.														
...	.	.	.	.	.	.	.	.	.	.	.	.	.	.						
13	1	1	1	1	1	1	1	1	1	1	1	1	1	0						
14	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0					
15	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0					
16	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0			
17	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1			
18	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	
19	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	
20	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	
...	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
bin	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	...

Ctx\_1
Ctx\_2
bypass

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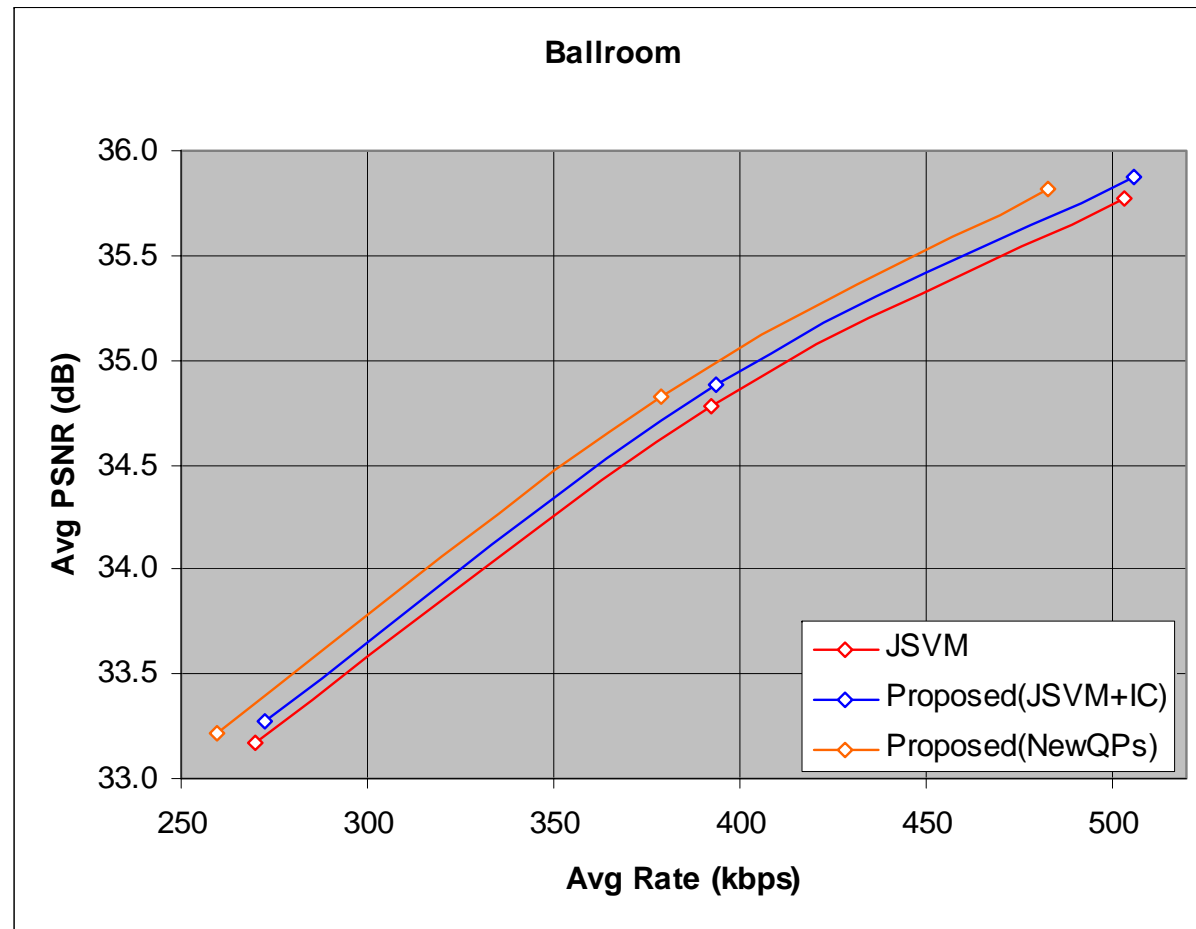
## 3. Experimental Results

### ✦ Three types of experimental results

- 1) The first results using the existing configuration.
- 2) The second results using the modified QP values.  
BaseQP  $\rightarrow$  BaseQP  
BaseQP + 3  $\rightarrow$  BaseQP + 2  
BaseQP + 4  $\rightarrow$  BaseQP + 4  
BaseQP + 5  $\rightarrow$  BaseQP + 6  
BaseQP + 6  $\rightarrow$  BaseQP + 7  
BaseQP + 7  $\rightarrow$  BaseQP + 8
- 3) The third results according to each picture set.

### 3. Experimental Results

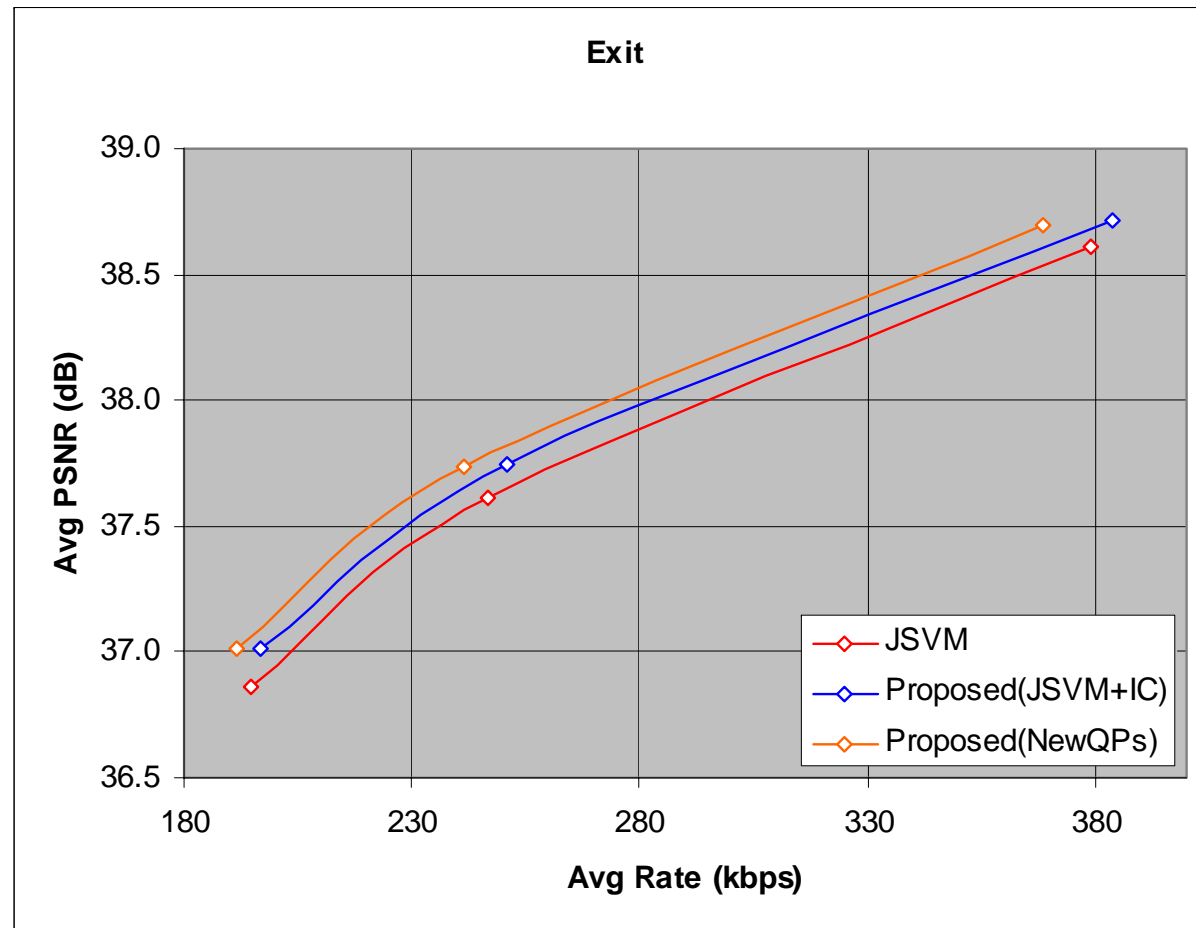
#### ✦ Ballroom





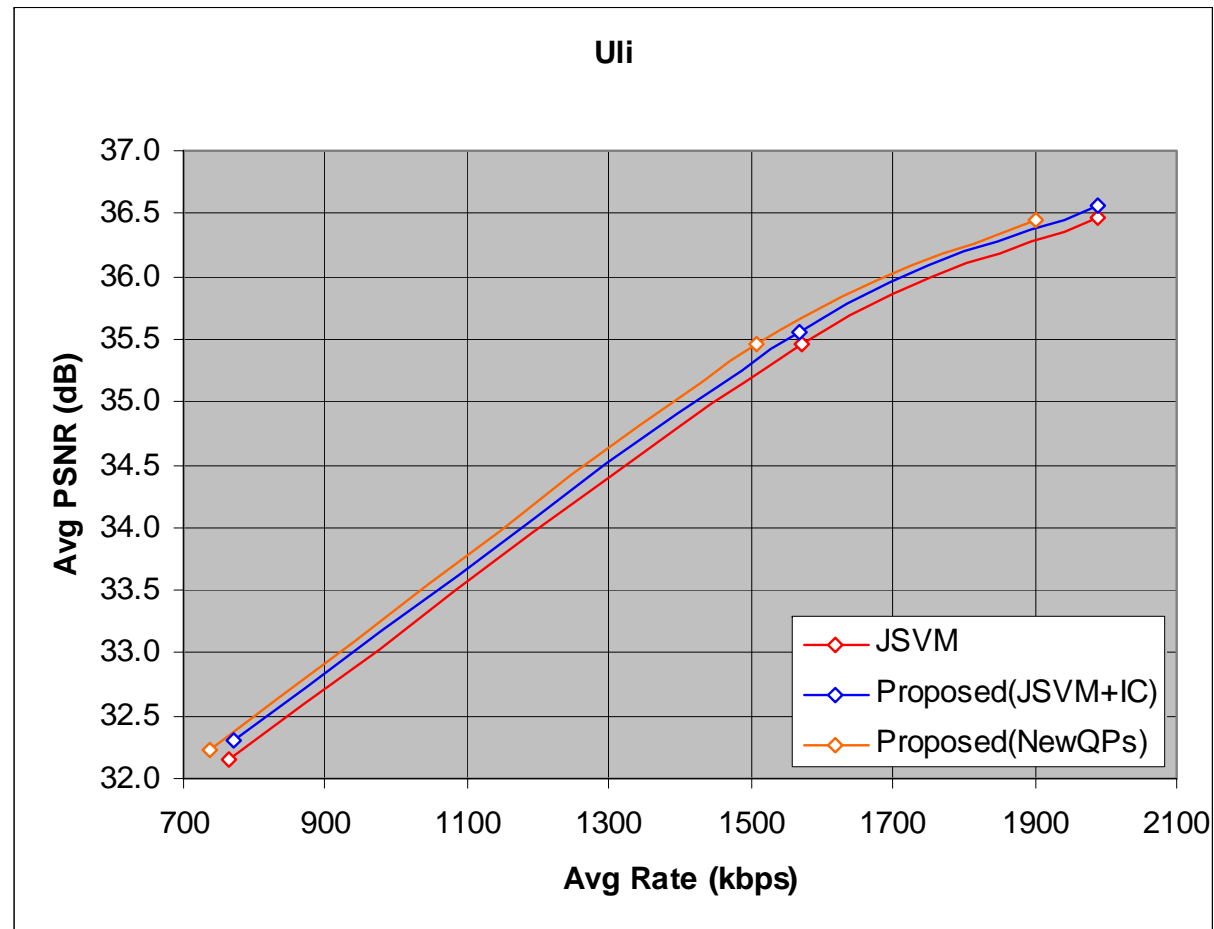
### 3. Experimental Results

✦ Exit



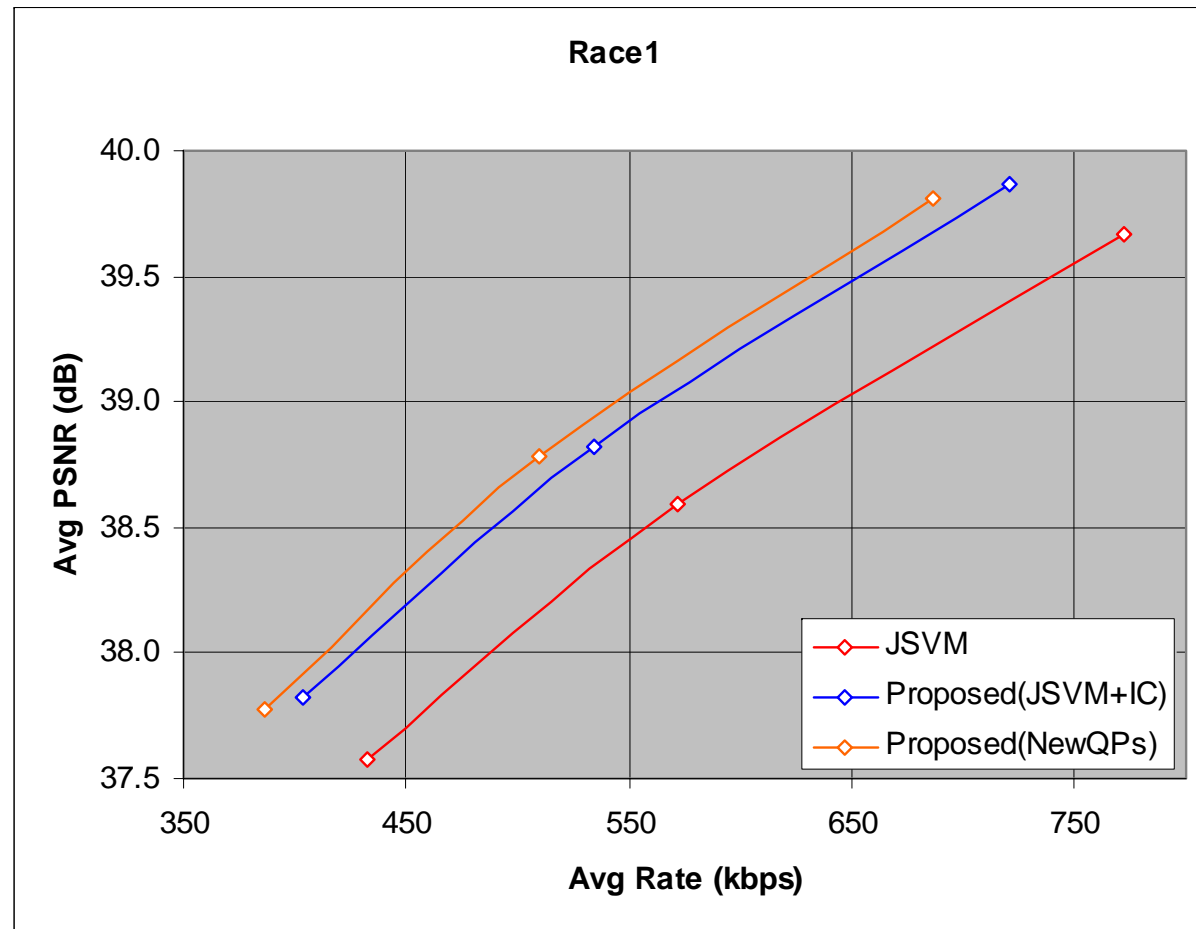
### 3. Experimental Results

✦ Uli



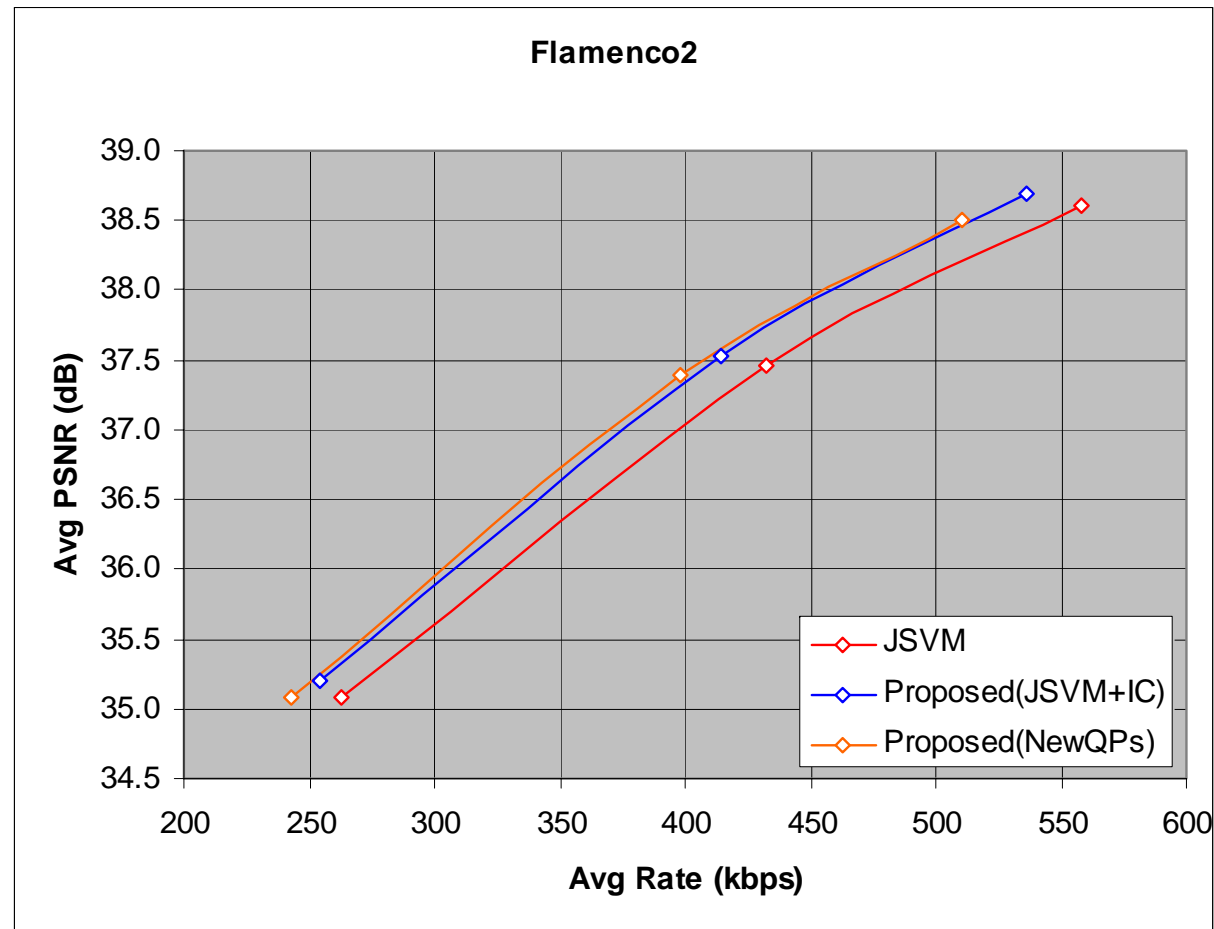
### 3. Experimental Results

#### ✦ Race1



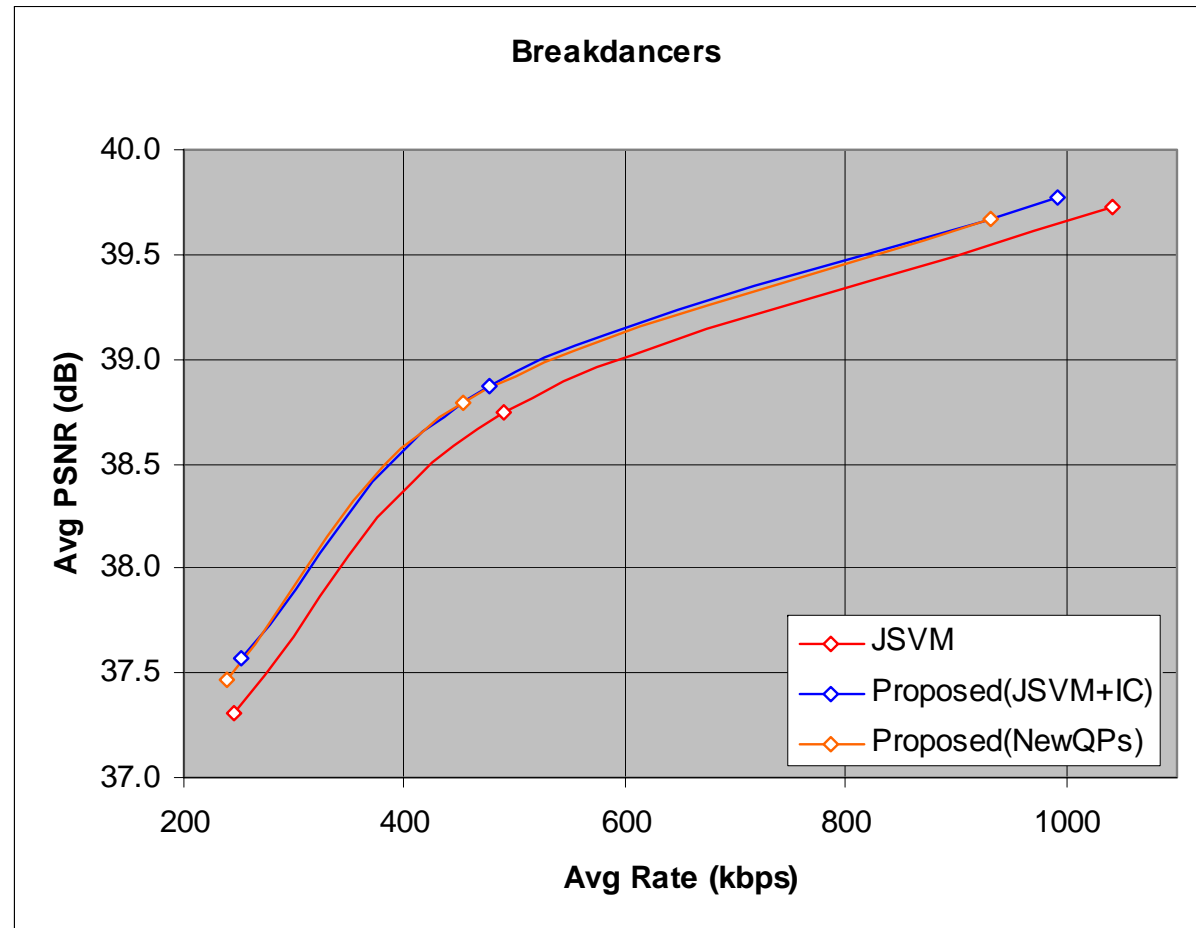
### 3. Experimental Results

#### ✦ Flamenco2



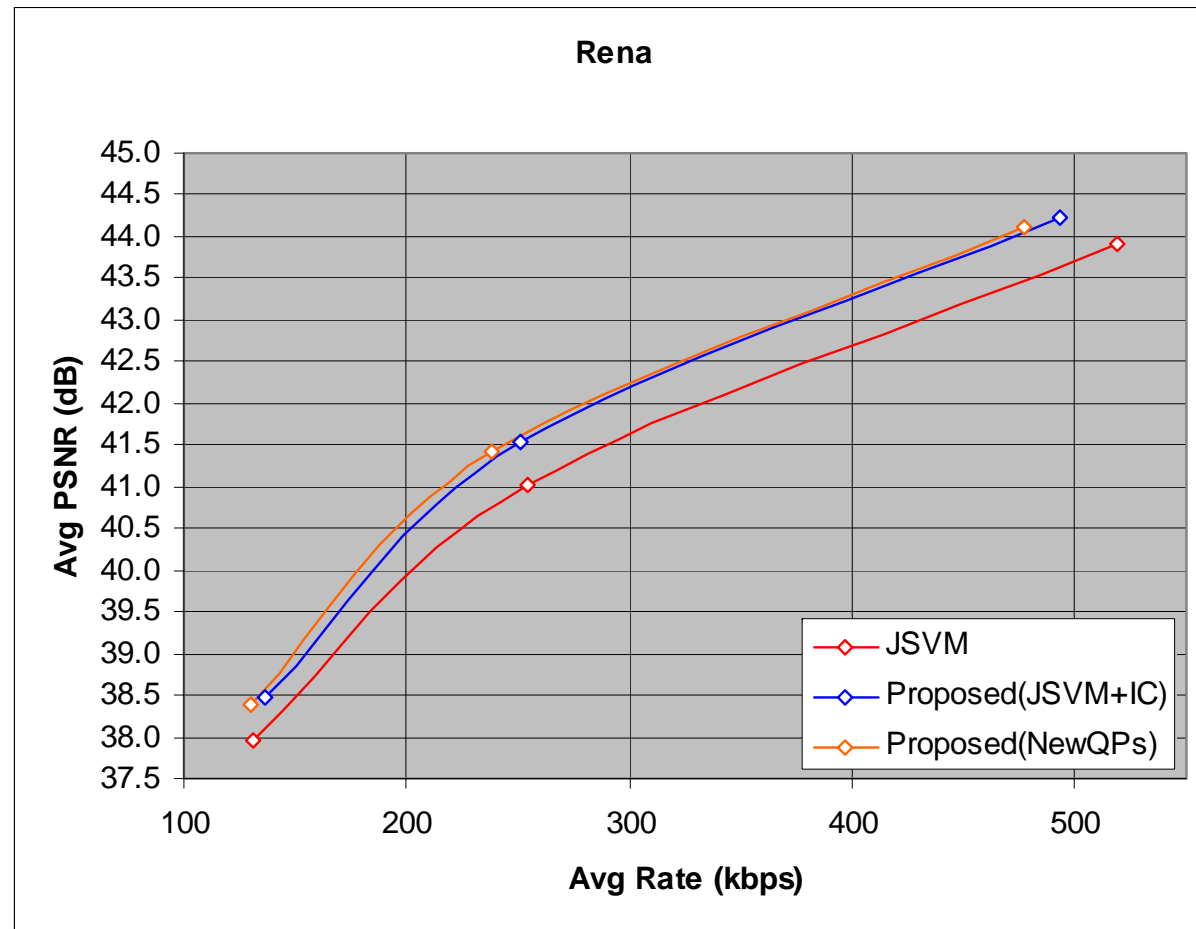
### 3. Experimental Results

#### ✦ Breakdancers



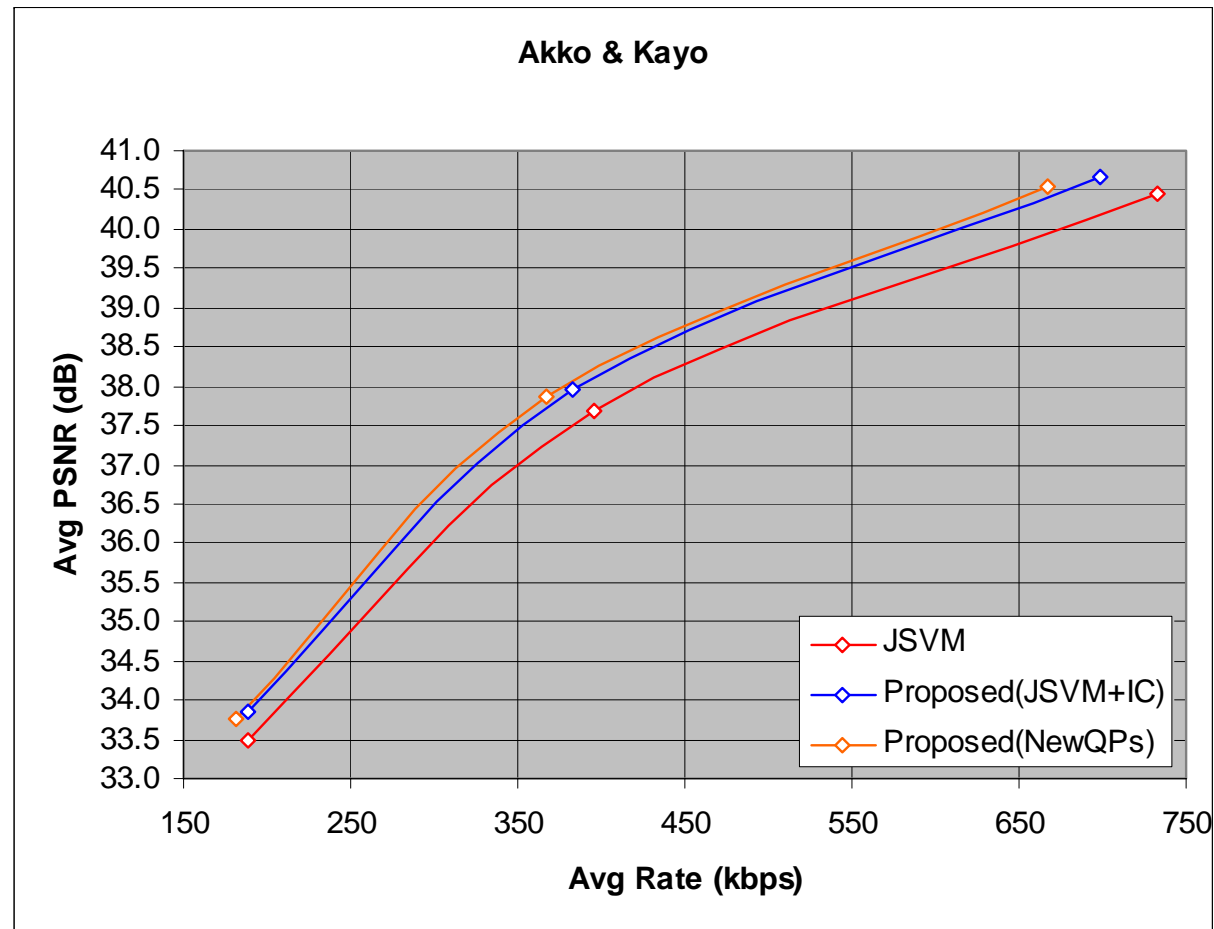
### 3. Experimental Results

#### ✦ Rena



### 3. Experimental Results

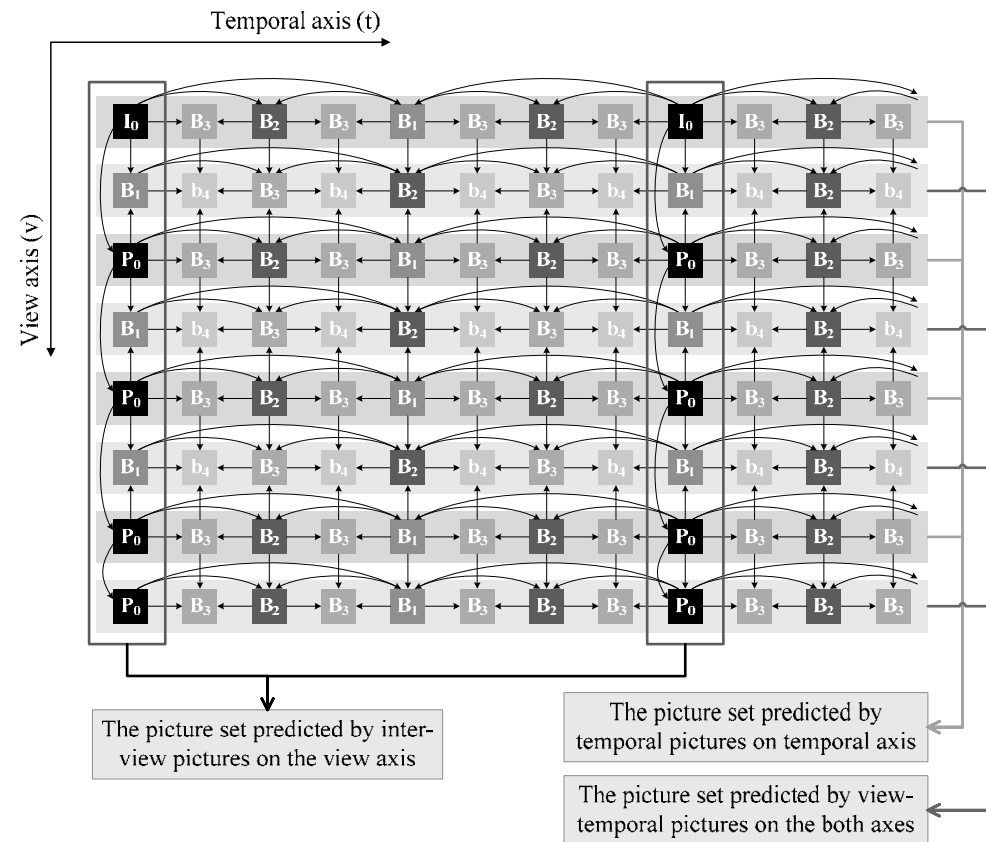
#### ✦ Akko&Kayo



### 3. Experimental Results

#### ✦ The third results

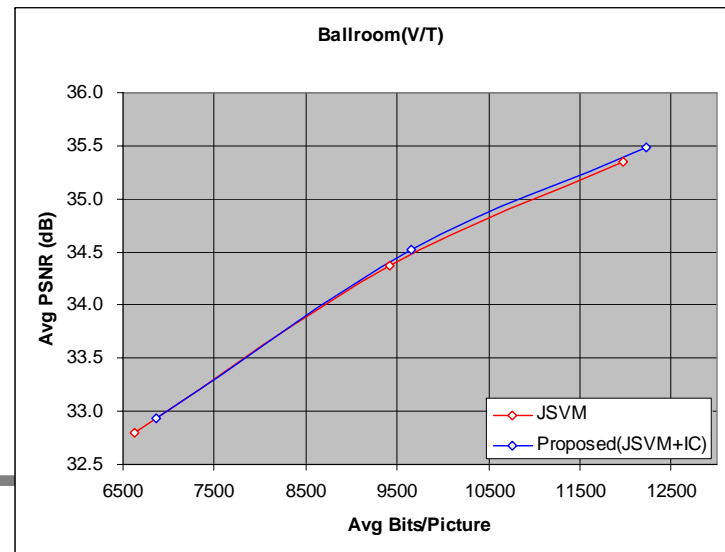
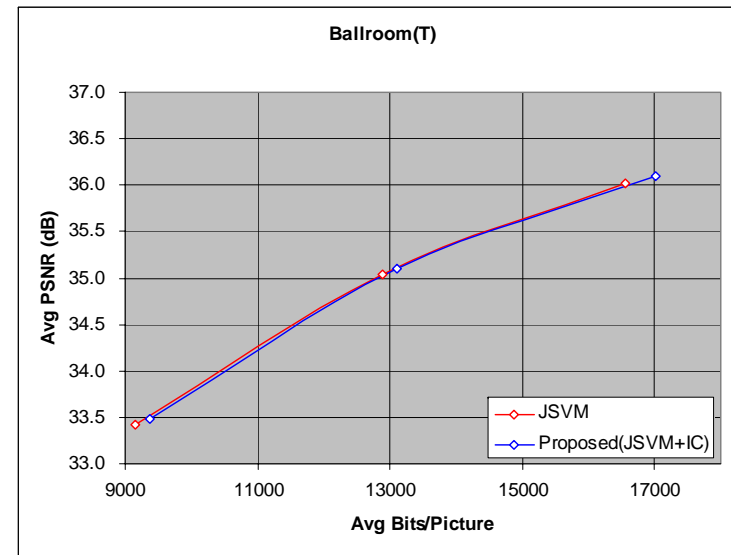
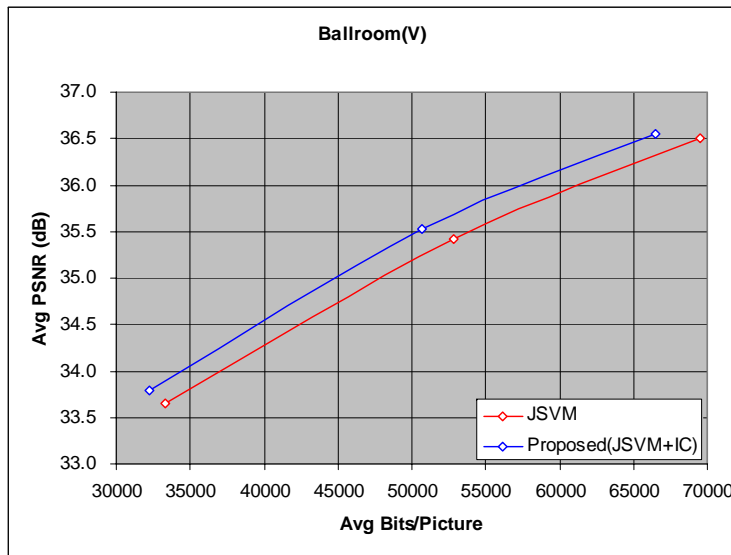
- The separated results according to each picture set.
  - Picture Set “V”
  - Picture Set “T”
  - Picture Set “V/T”





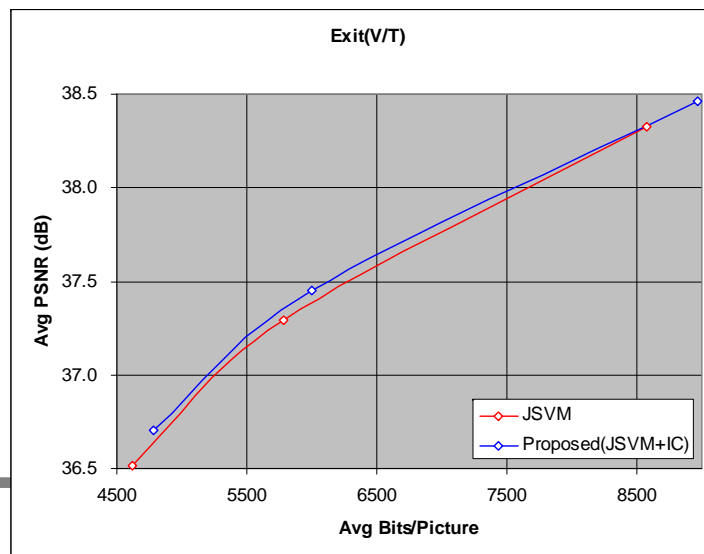
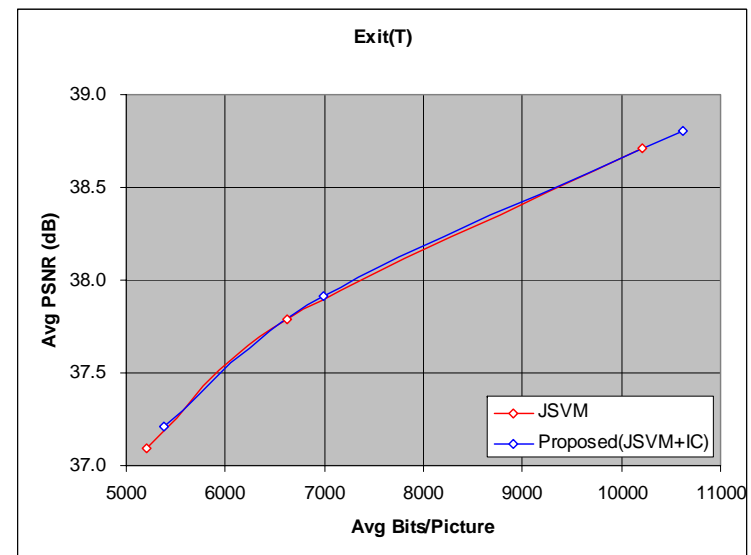
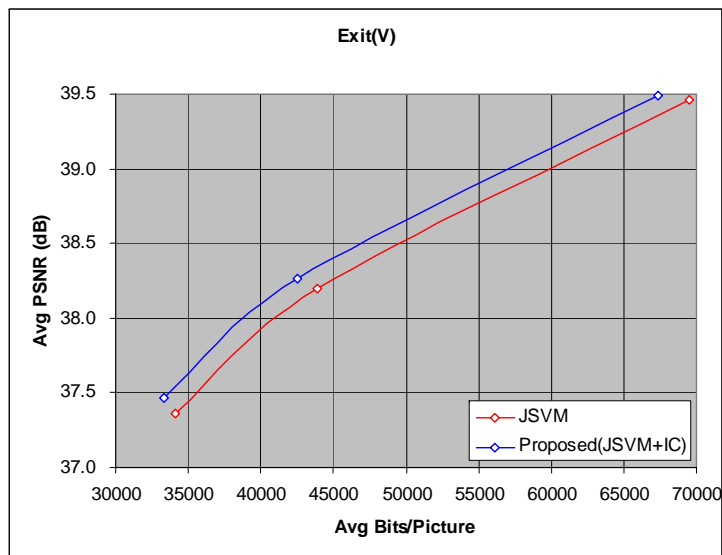
### 3. Experimental Results

#### ✦ Ballroom



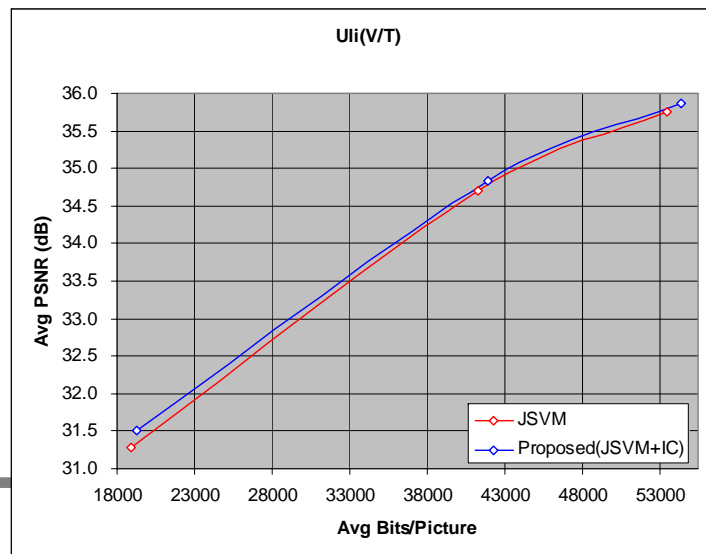
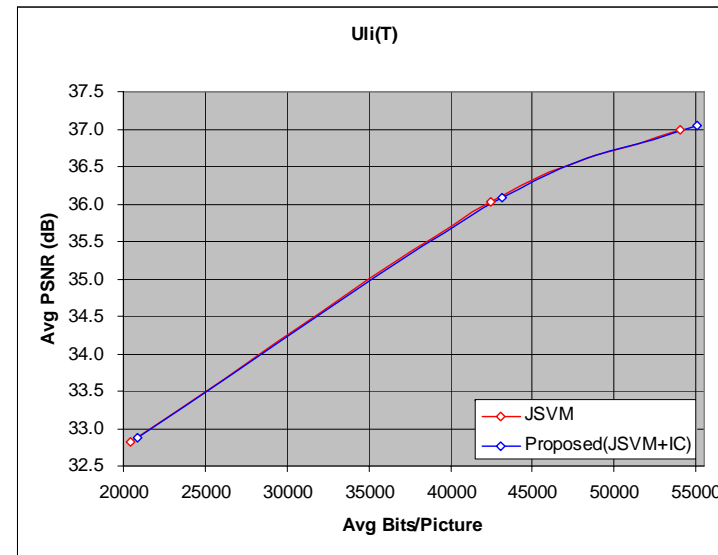
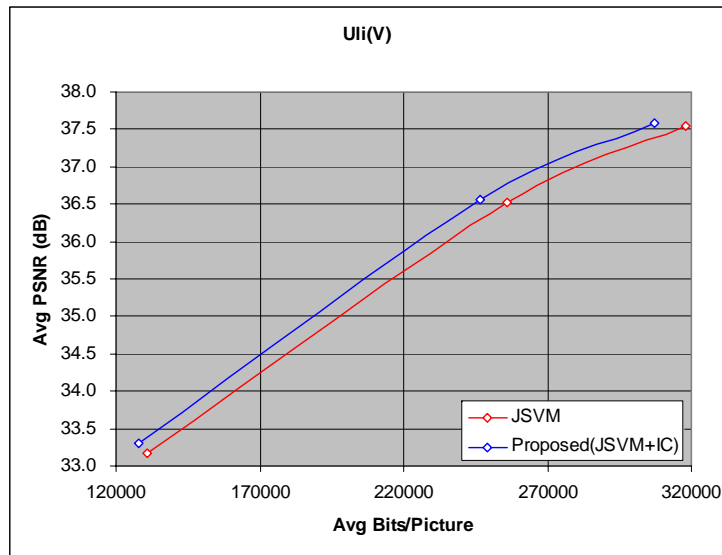
### 3. Experimental Results

#### ✦ Exit



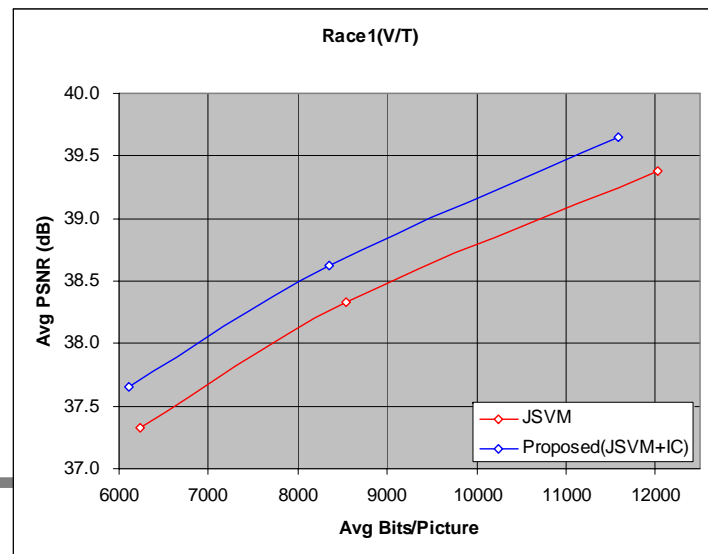
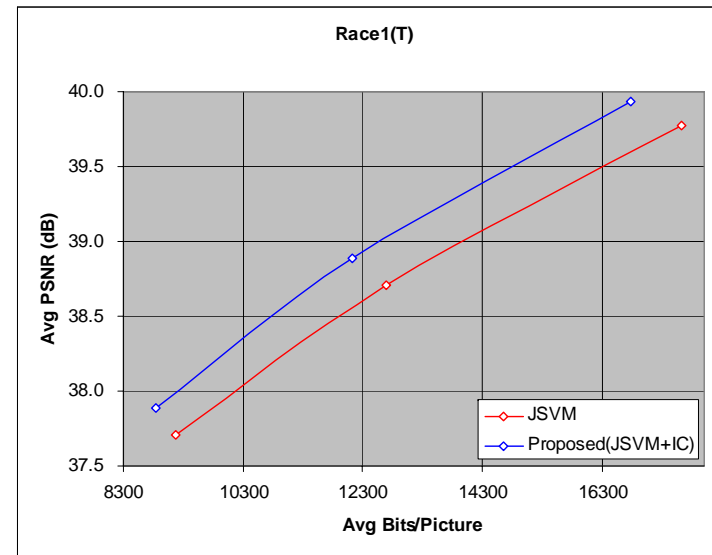
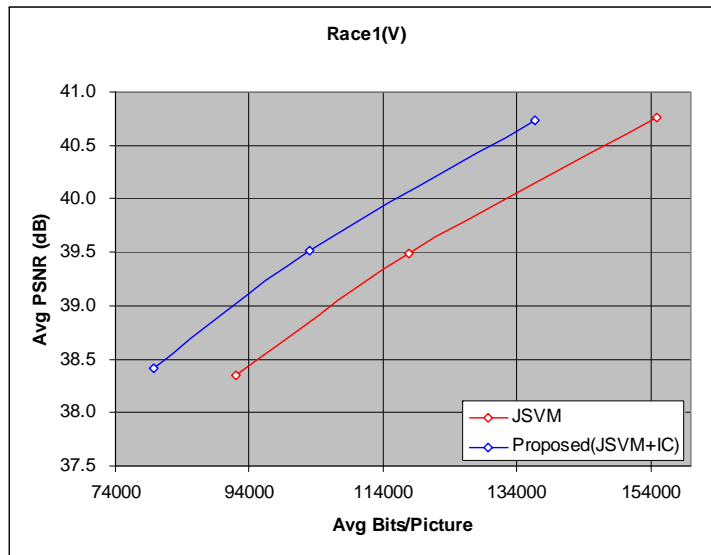
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✦ Uli



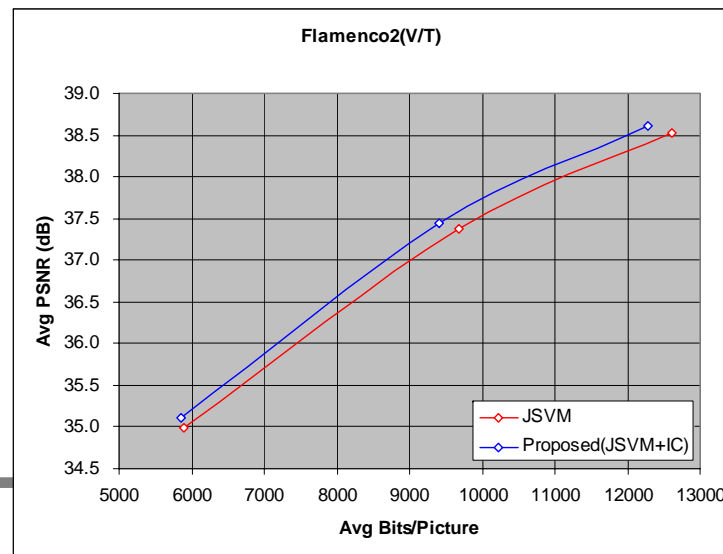
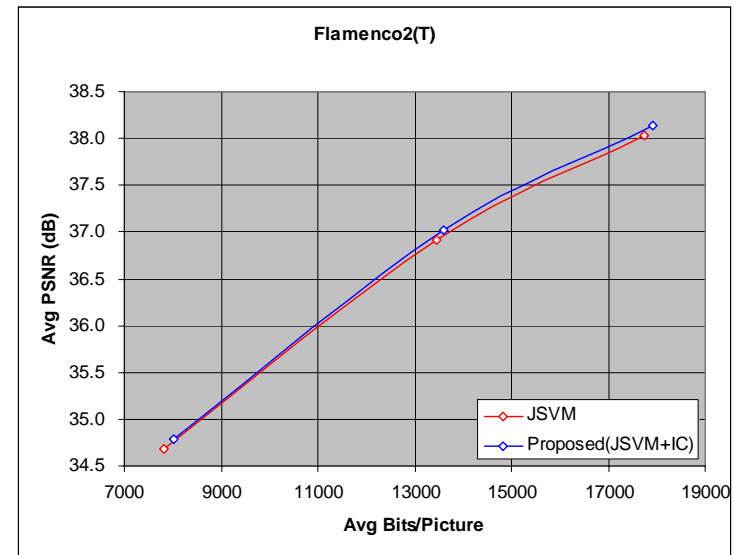
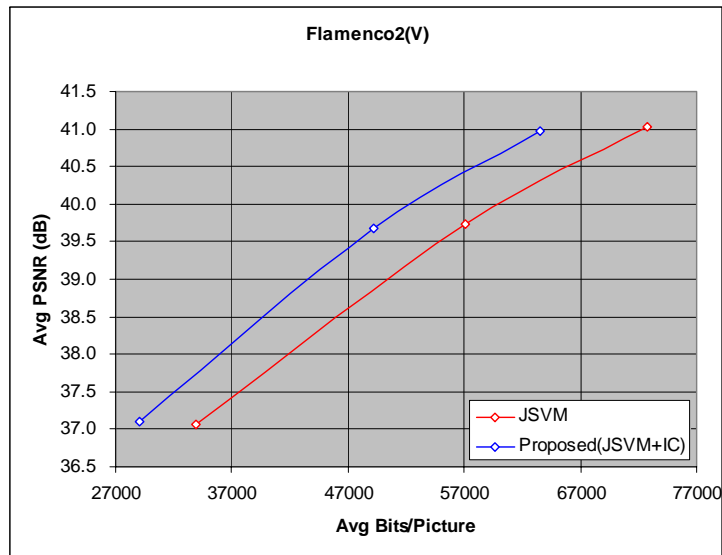
### 3. Experimental Results

#### ✦ Race1



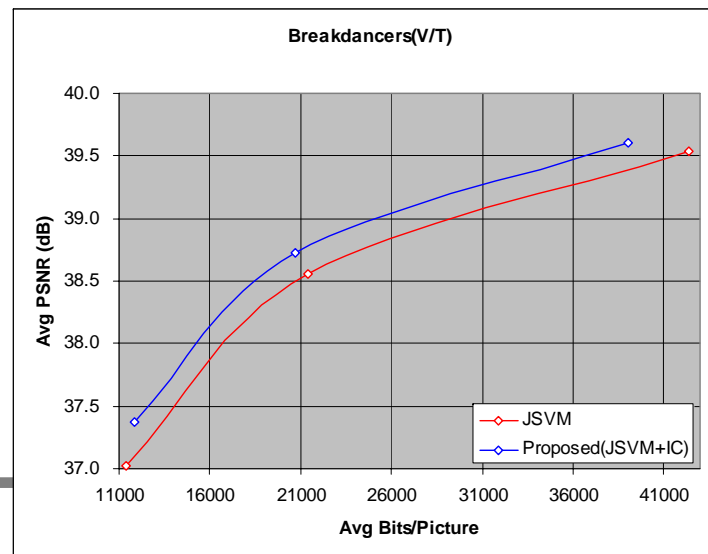
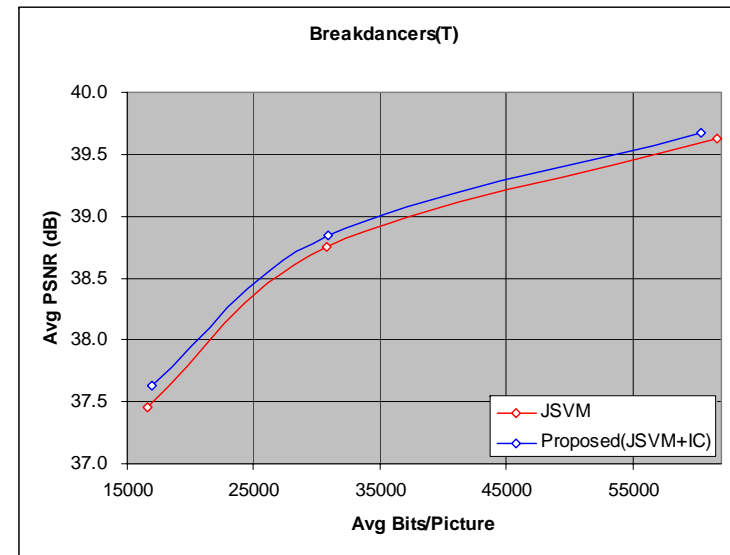
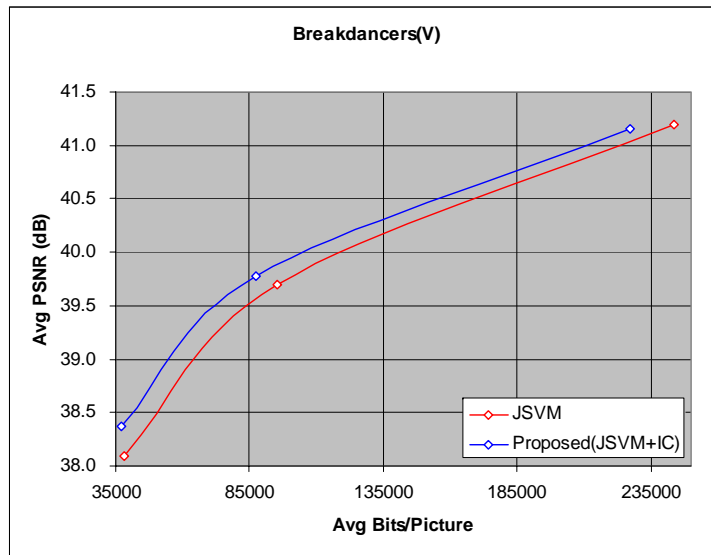
### 3. Experimental Results

#### ✦ Flamenco2



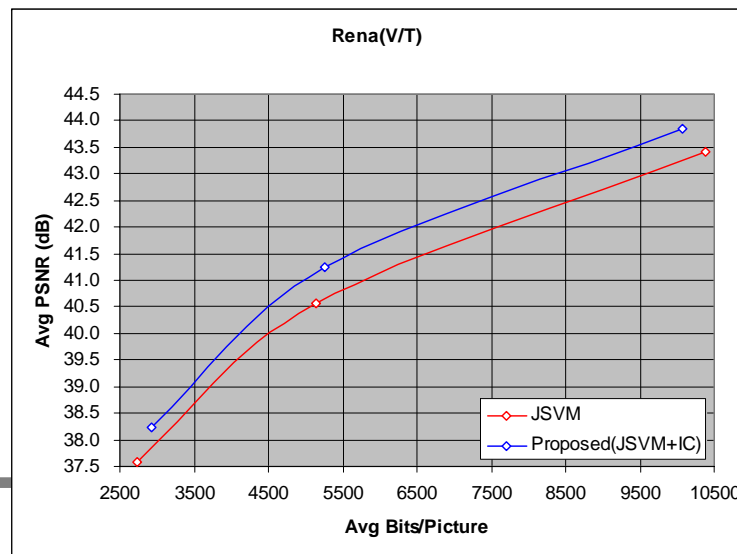
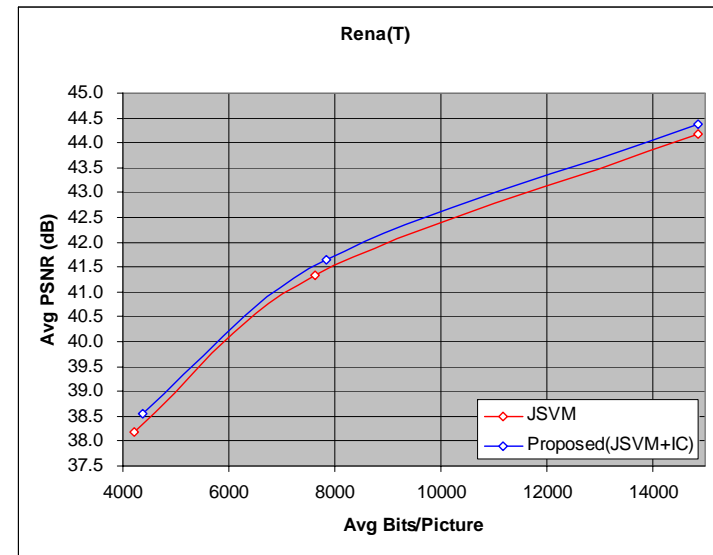
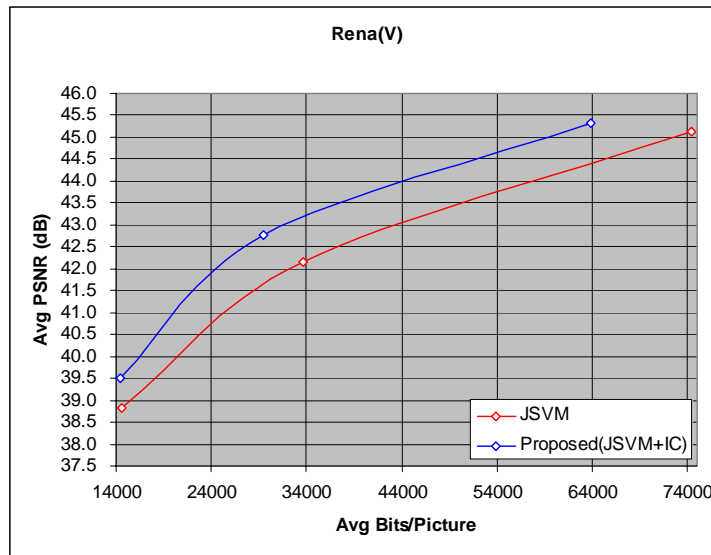
### 3. Experimental Results

#### ✦ Breakdancers



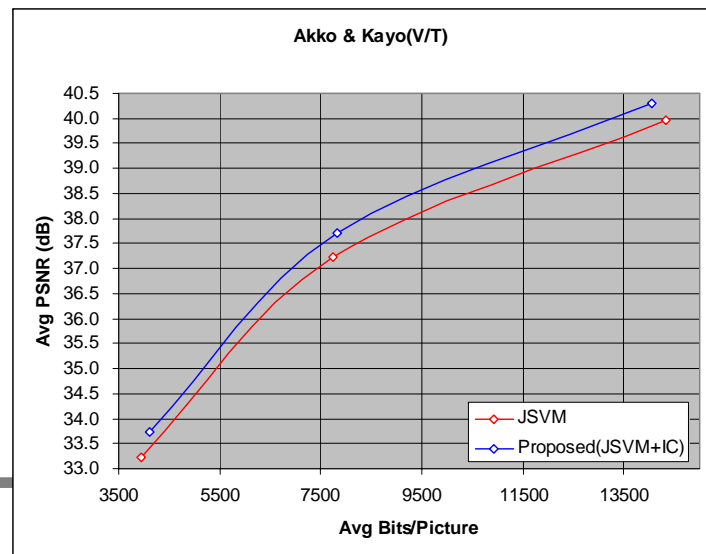
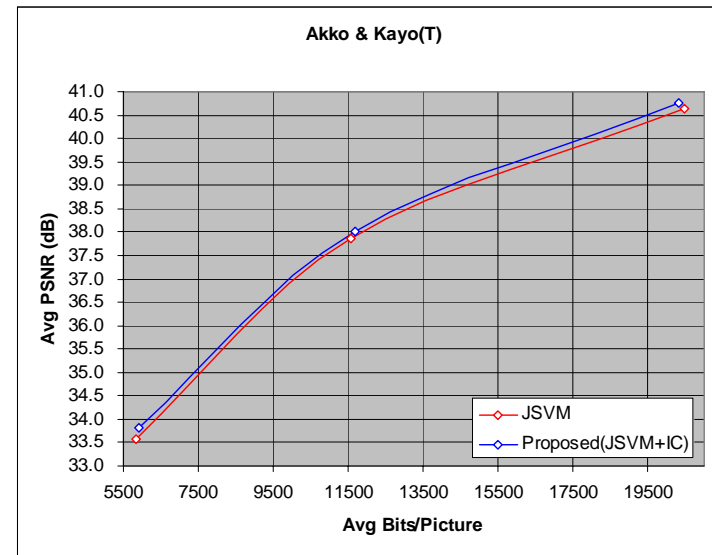
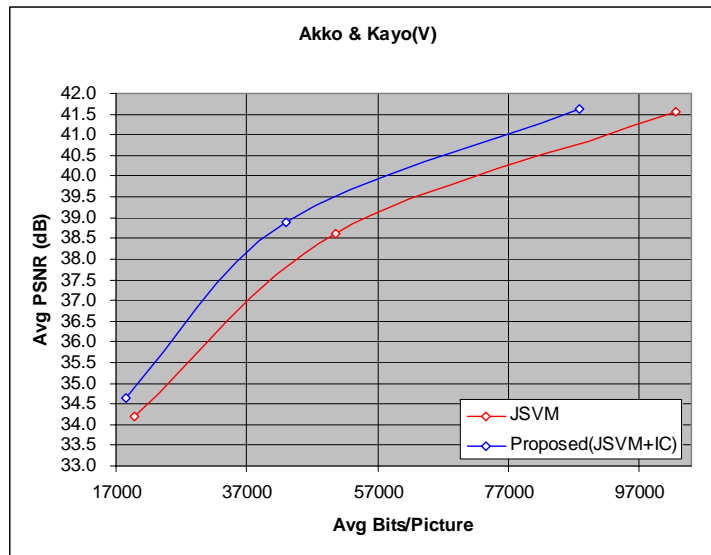
### 3. Experimental Results

#### ✦ Rena



### 3. Experimental Results

#### ✦ Akko&Kayo





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## 4. Conclusions

- ✦ MB modes are added for ICA ME/MC by using **mb\_ic\_flag**
  - IC-Inter  $16 \times 16$  mode, IC-Direct  $16 \times 16$  mode
- ✦ Syntax addition
  - **mb\_ic\_flag**, **dpcm\_of\_dvic**
- ✦ Very Simple to implement
- ✦ We propose to adopt the proposed IC in MVC standard
  - PSRN gains : 0.1~0.6dB