TE 3 subtest 1
Adaptive warped reference
(JCTVC-C033)

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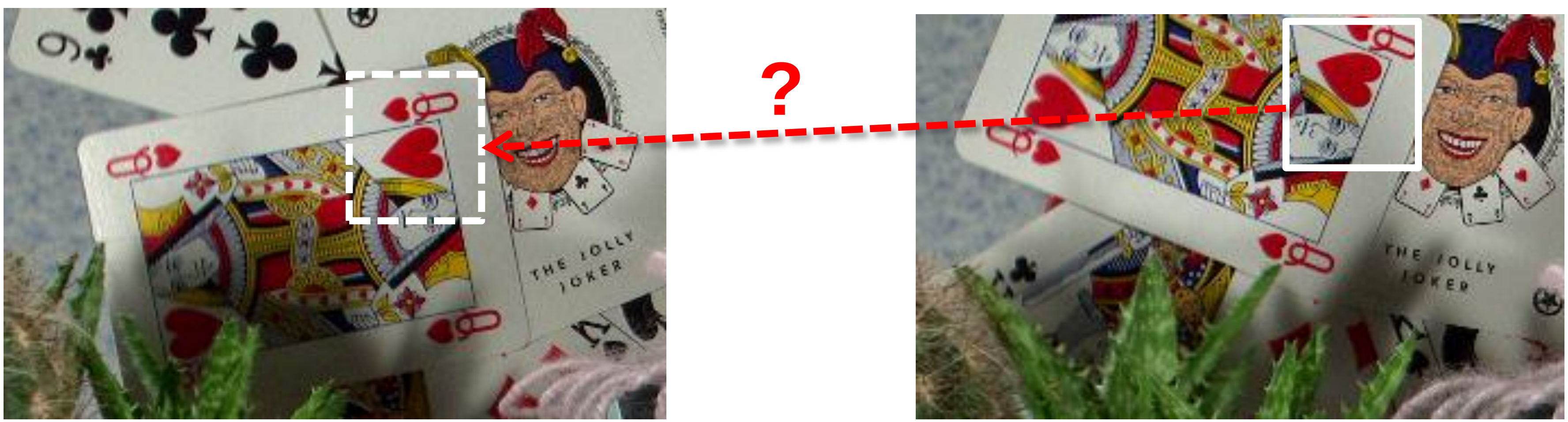
Summery

- **On TMuC 0.7.3**
- **Avg 3.3 % bitrate saving (up to 41.1%)**
  - 3.1% in low-delay & high efficiency case
  - 3.5% in random-access & high efficiency case
- **Enc/Dec complexity : 33.6% / 20.8%**
- **Simple picture level tool**
  - No decoding process & syntax change in CU/PU/partition level
  - Temporal ref pic added in the ref pic list
- **Cross-verified by TUB (JCTVC-C282)**

Problem statement

- **Conventional motion compensation**
  - Support only translational motion
  - Not efficient for complex motion like zooming, rotation, etc.

Reference picture **Current picture**



- **Adaptive warped reference**
  - Enhance temporal prediction performance
  - Support zooming, rotation, affine motion and etc.

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  – Support only translational motion
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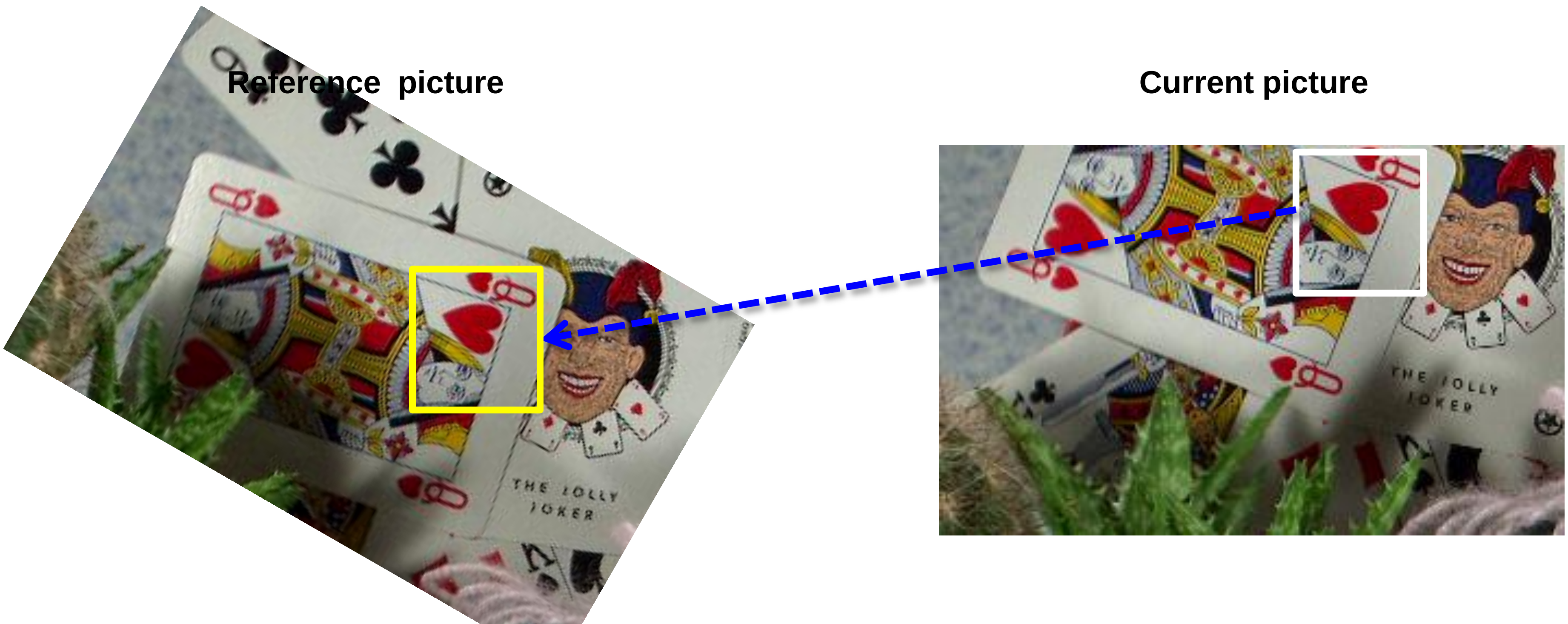

- **Adaptive warped reference**
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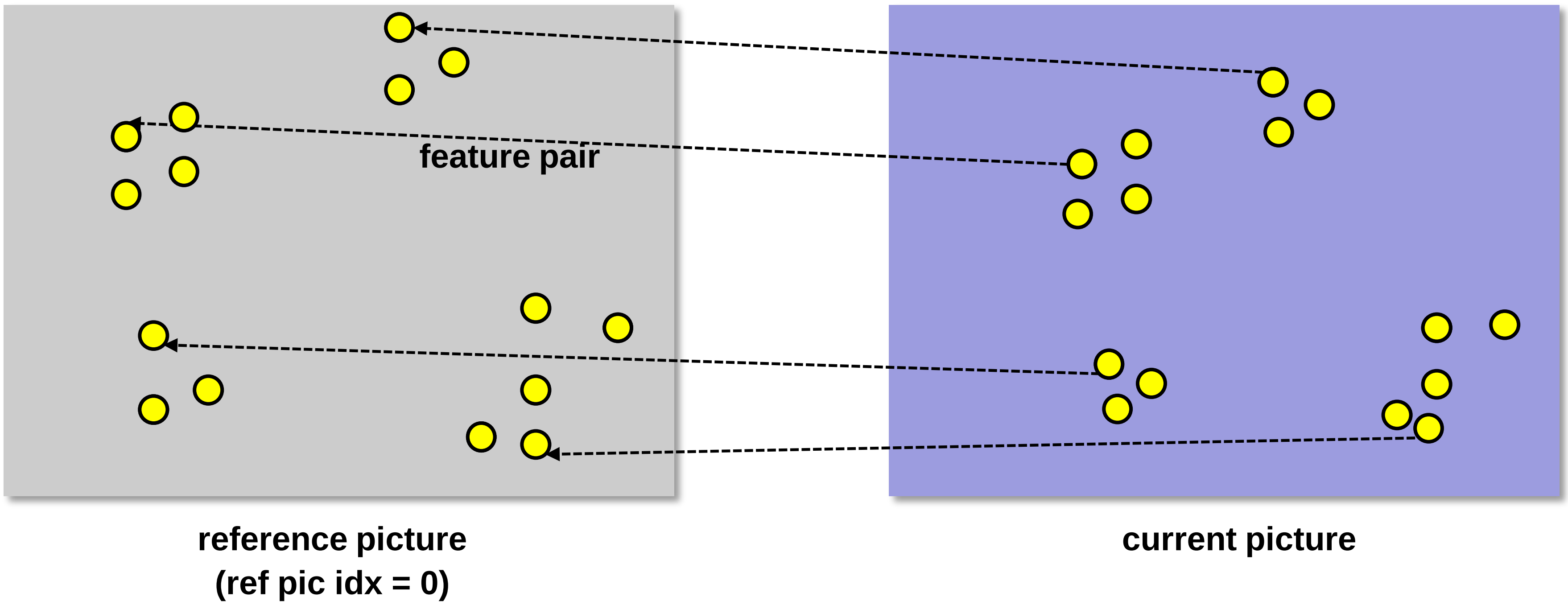
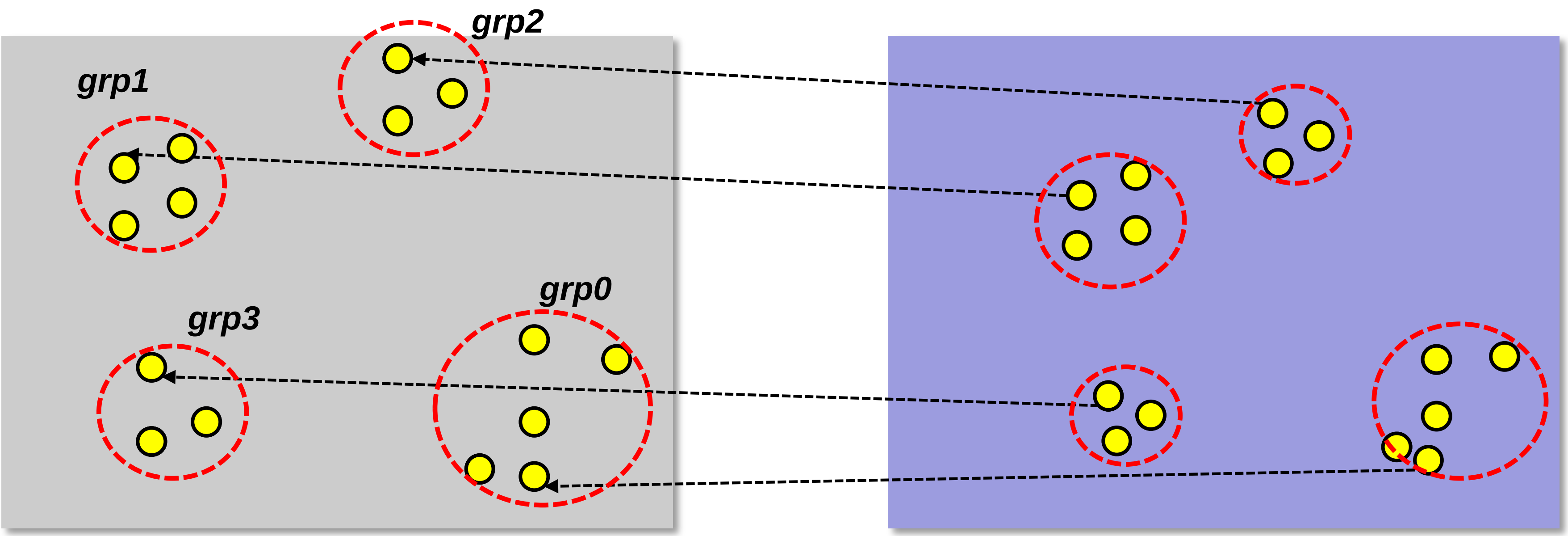
Proposed method

- **Step 1 : Deriving warping parameters**
  - Apply KLT (Kanade-Lucas-Tomasi) feature tracker



Proposed method

- **Step 1 : Deriving warping parameters**
  - Apply KLT (Kanade-Lucas-Tomasi) feature tracker
  - Feature pairs segmented into several groups by motion segmentation

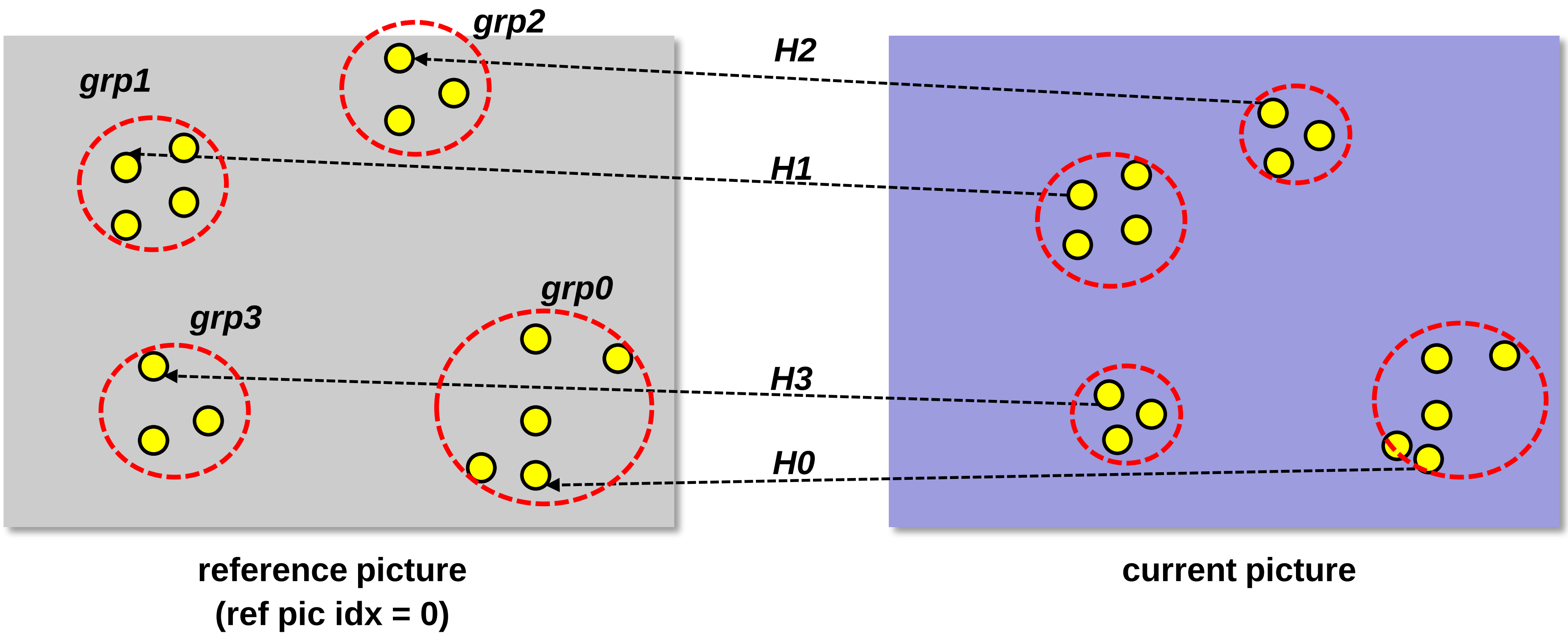


reference picture
(ref pic idx = 0)

current picture

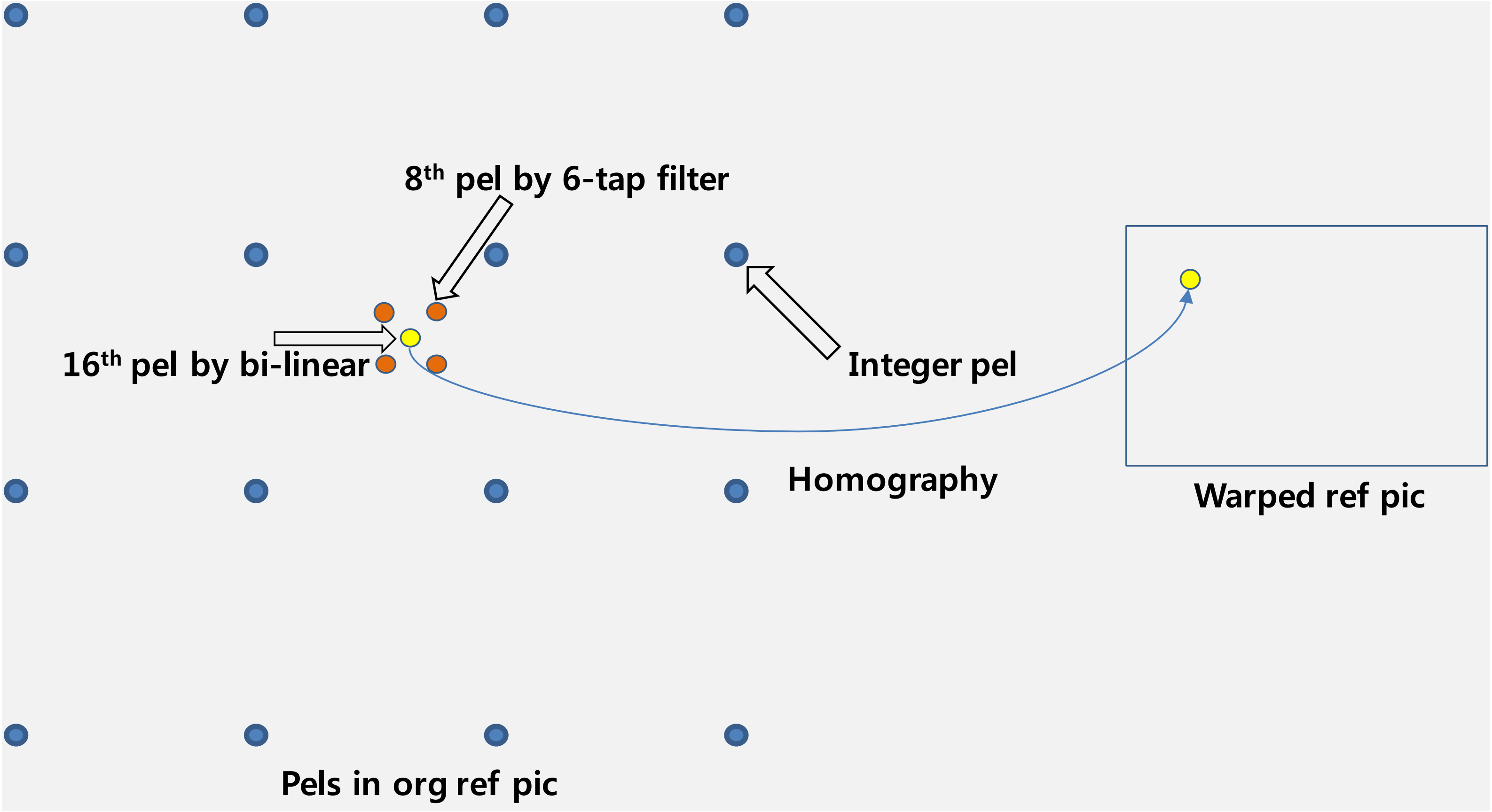
Proposed method

- **Step 1 : Finding warping parameters**
  - Apply KLT (Kanade-Lucas-Tomasi) feature tracker
  - Feature pairs segmented into several groups by motion segmentation
  - Achieving four warping matrix by DLT (direct linear transform) to each feature group



Proposed method

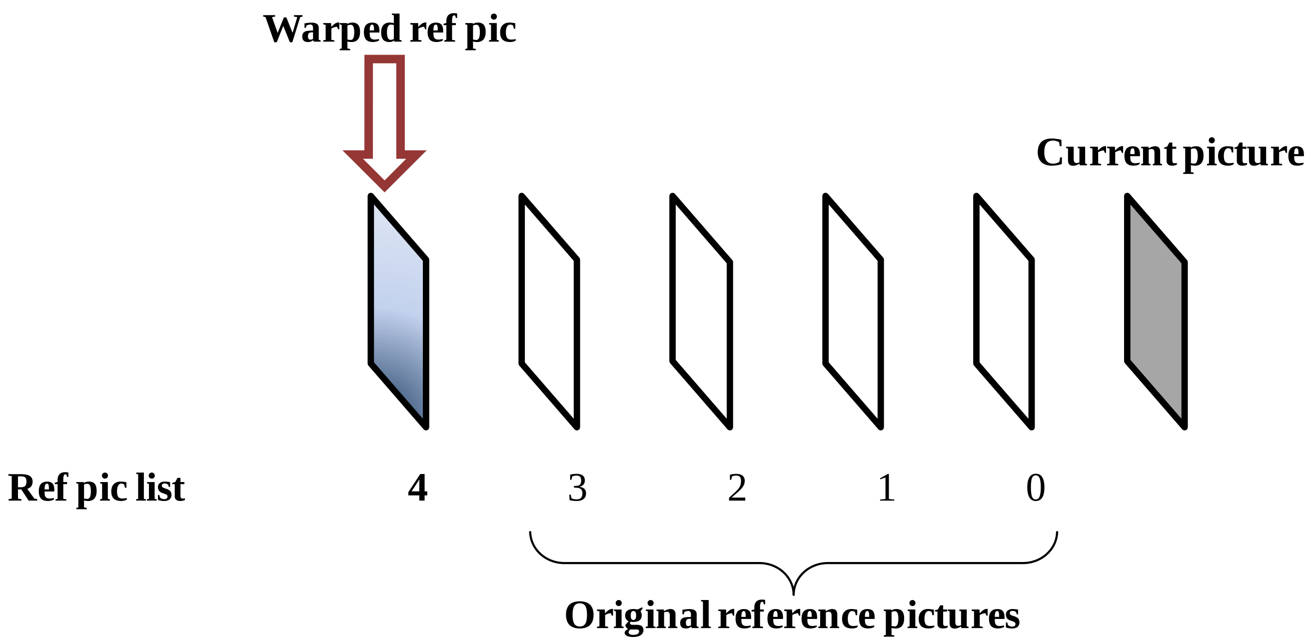
- **Step 2 : Selection of the best warped reference picture**
  - 4 warping matrix → 4 warped reference pictures



  - Select best one having the smallest SAD among four candidates.

Proposed method

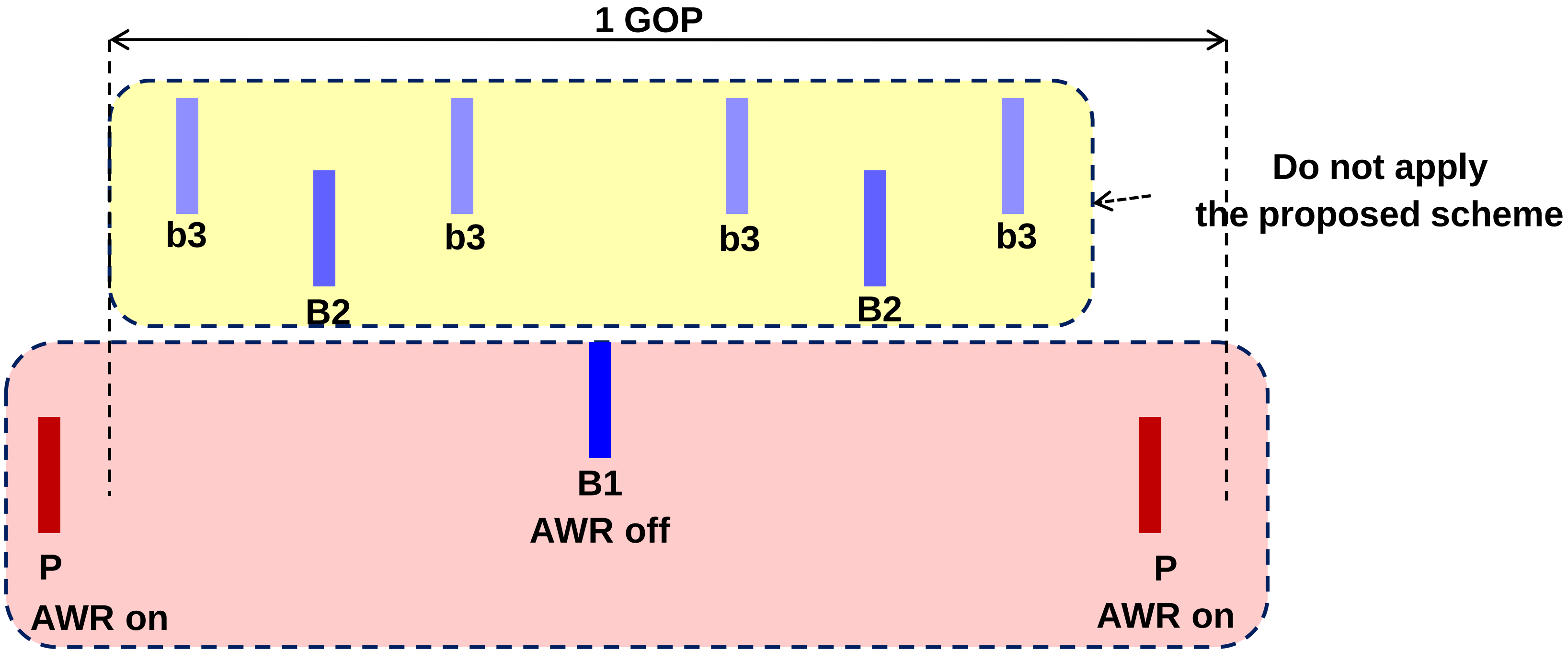
- **Step 3 : Adding to the reference picture list**
  - Best warped reference picture inserted at the last slot temporally



- **Step 4 : Encoding warping parameters**
  - Encode four motion vectors in the slice header (instead of homography)
  - Each vector quantized by 3 bit quantizer

Proposed method

- **Single pass encoding structure**
  - Check the quality of the warped reference and decide to add / remove it in the ref pic list
  - Early skip mode based on the temporal level criterion



Test conditions

- **Implemented on TMuC 0.7.3**

- **Common test conditions (JCTVC-B300 & JCTVC-B303)**
  - Low delay, high efficiency
  - Random access, high efficiency

- **Test sequences**
  - Common sequences + extra sequences

Sequence name	Resolution
Flowervase_WQVGA	416x240
Flowervase_WVGA	832x480
City_720p	1280x720
Jets_720p	1280x720
Bluesky_1080p	1920x1080
Station2_1080p	1920x1080

Experimental results – BD bitrates

Class	Sequences	BD-rate(%)
A	Traffic	0.0
	PeopleOnStreet	0.0
B	BasketballDrive	-0.2
	BQTerrace	0.1
	Cactus	**-8.4**
	Kimono	0.0
	ParkScene	0.1
	Bluesky	**-14.2**
	Station2	**-28.9**
C	BasketballDrill	0.0
	BQMall	0.1
	PartyScene	-0.2
	RaceHorses	0.0
	Flowervase	-0.4
D	BasketballPass	0.1
	BlowingBubbles	0.1
	BQSquare	-0.2
	RaceHorses	0.1
	Flowervase	**-2.3**
E	**City**	**-3.6**
	Jets	**-16.4**
Avg. (RA_HE)		**-3.5**

Class	Sequences	BD-rate(%)
B	BasketballDrive	0.1
	BQTerrace	0.7
	Cactus	**-3.1**
	Kimono	0.2
	ParkScene	0.1
	Bluesky	**-8.4**
	Station2	**-41.1**
C	BasketballDrill	-0.2
	BQMall	0.6
	PartyScene	-0.1
	RaceHorses	0.5
	Flowervase	-0.7
D	BasketballPass	0.6
	BlowingBubbles	0.2
	BQSquare	0.3
	RaceHorses	0.8
	Flowervase	**-6.1**
E	Vidyo1	0.0
	Vidyo3	-0.9
	Vidyo4	-0.1
	City	-0.2
	Jets	**-12.4**
Avg. (LD_HE)		**-3.1**

Experimental results – Complexity comparison

Test condition	Encoding complexity	Decoding complexity
Low delay	130.4%	117.3%
Random access	136.8%	124.3%
Avg	**133.6%**	**120.8%**

- **Main reason of encoder complexity**
  - Additional process for warping parameter generation
  - Additional motion estimation for warped ref pic
- **Main reason of decoder complexity**
  - Additional interpolation process for generating warped reference predictors

Conclusion

- **Avg 3.3 % saving on TMuC (up to 41.1%)**
- **Reasonable complexity increase**
- **Simple picture level tool**

- **Recommend adopt into TMuC to guarantee high performance in any sequences having complex motion**