Title   **[MIV] Patch constellations**

Source   **PUT, ETRI**

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Abstract

The document presents a proposal of adding a third type of transmitted views, resulting in basic views, semi-basic views (additional views, but not split into clusters/patches, so a patch constellation with preserved relative arrangement is packed into an atlas), and typical additional views (packed as a mosaic of patches). Proposed approach decreases number of patches and increases temporal consistency of the video. The recommendation is to include the proposal into TMIV 17.

1   Proposal

We propose to modify a TMIV encoder (MIV Main anchor) by changing two steps: view labeling and patch packing. In TMIV 16, there are two types of views: basic and additional. By default, in TMIV 16 there are as many basic views (blue in Fig. 1B), as fit in the first atlas, while the second one contains patches from additional views (green and orange in Fig. 1B). In the proposal, we do not change the first atlas (Fig. 1A), but the second one is filled with proposed semi-basic views (as many as fit there, green in Fig. 1A). Semi-basic views are partially-occupied (occupied areas in Fig. 1A – darker green). Patches from additional views (orange in Fig. 1A) are packed into non-occupied areas of semi-basic views (pale green, Fig. 1A).
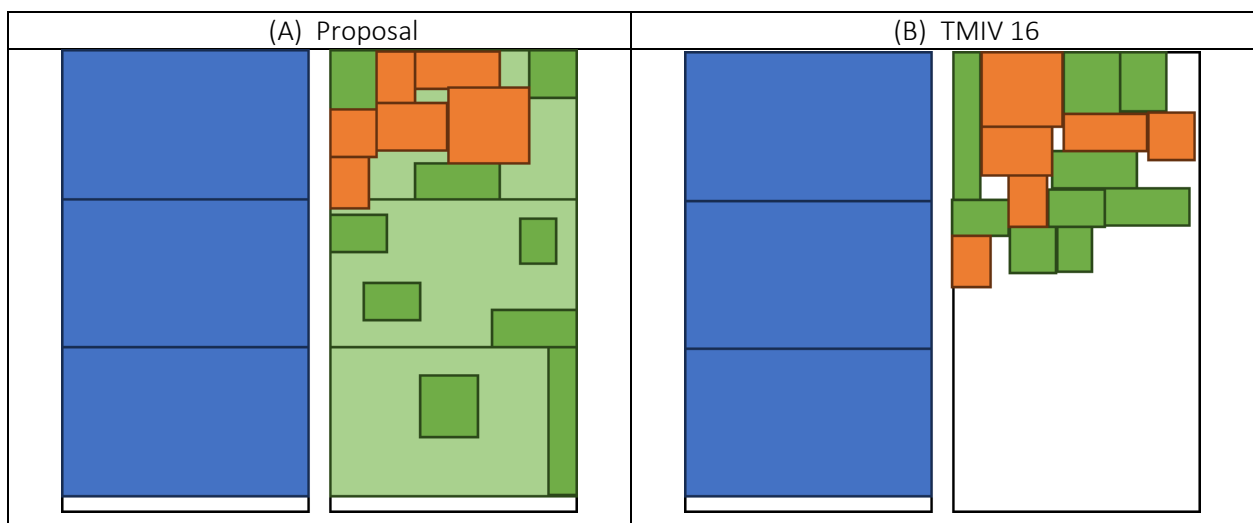

Fig. 1. Atlases in the proposed approach and A65 anchor.

The decision regarding labeling the view as semi-basic or additional is performed based on the pruning graphs, and non-basic views which are higher in the graphs become semi-basic views.

Example (B01):

```
info  Pruning graph:
info  ( v8 v19 ) <- v2 <- v12 <- v1 <- v23 <- v14 <- v7 <- v5 <- v21 <- v3 <- v18 <- v10 <-
v17 <- v11 <- v16 <- v0 <- v22 <- v4 <- v20 <- v6 <- v13 <- v9 <- v15
info  Inter period: [0, 32)
info  Loading multiview frame 0 with start frame offset 0 (= 0).
info  View types:
info  ( B B ) <- S <- S <- A <- A <- A <- A <- A <- A <- A <- A <- A <- A <- A <- A <- A
<- A <- A <- A <- A <- A <- A
```

Another example (J01):

```
info  Pruning graph:
info  ( v20 v24 ) <- v10 <- v11 <- v23 <- v15 <- v19 <- v12 <- v22 <- v16 <- v18 <- v21 <- v17
info  ( v0  v4  ) <- v14 <- v1  <- v13 <- v5  <- v9  <- v2  <- v3  <- v6  <- v8  <- v7
info  Inter period: [0, 32)
info  Loading multiview frame 0 with start frame offset 0 (= 0).
info  View types:
info  ( B B ) <- S <- S <- A <- A <- A <- A <- A <- A <- A <- A <- A
info  ( B B ) <- S <- S <- A <- A <- A <- A <- A <- A <- A <- A
```

Proposed approach allows for:
- decreasing the total number of patches,
- increasing temporal consistency of the video, incl. transitions between consecutive GOPs (Fig. 2).

Limitations:
- the proposal preserves all small clusters of semi-basic views (which would be skipped during packing in TMIV16), so it requires to change the minimum block size for natural content: 128 -> 64,
- efficiency of the proposal depends on proper ordering of views in the pruning graphs (which is the case for almost all the content, except for L02).

Fig. 2	Frame 0	Frame 32	Frame 64
Anchor			
Proposal			
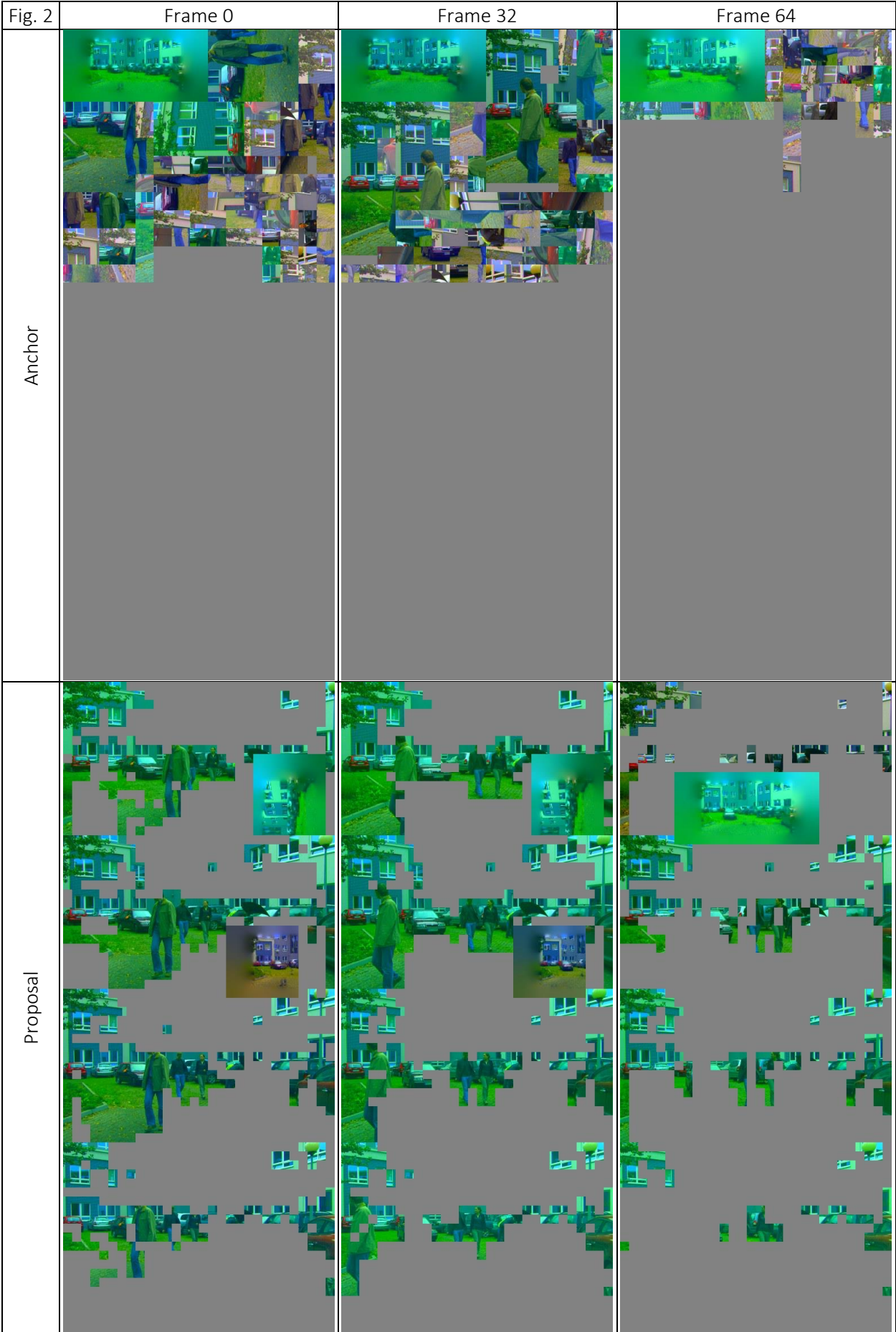
2   Results (A65)

Mandatory content - Proposal vs. Low/High-bitrate Anchors

Sequence		BD-rate Y-PSNR	BD-rate IV-PSNR	BD-PSNR Y-PSNR	BD-PSNR IV-PSNR
Chess	B02	-19.1%	-32.1%	1.0%	2.1%
Guitarist	B03	65.2%	65.4%	-0.3%	-0.5%
Cadillac	J02	-3.6%	3.4%	0.4%	0.0%
Fan	J04	-0.3%	-0.9%	0.1%	0.2%
Group	W01	-10.5%	-11.0%	0.5%	0.8%
Painter	D01	-4.5%	-4.4%	0.6%	0.5%
Frog	E01	4.9%	4.2%	-0.3%	-0.2%
CBABasketball	L02	114.2%	174.8%	-2.5%	-3.6%
Average		**18.3%**	**24.9%**	**-0.1%**	**-0.1%**

The solution was tested on all CTC content:

Class A

Sequence		BD-rate Y-PSNR	BD-rate IV-PSNR	BD-PSNR Y-PSNR	BD-PSNR IV-PSNR
ClassroomVideo	A01	-0.9%	5.2%	0.5%	0.0%
Average		**-0.9%**	**5.2%**	**0.5%**	**0.0%**

Class B

Sequence		BD-rate Y-PSNR	BD-rate IV-PSNR	BD-PSNR Y-PSNR	BD-PSNR IV-PSNR
Museum	B01	-0.7%	0.0%	0.1%	0.1%
Chess	B02	-19.1%	-32.1%	1.0%	2.1%
Guitarist	B03	65.2%	65.4%	-0.3%	-0.5%
Average		**15.2%**	**11.1%**	**0.2%**	**0.5%**

Class C

Sequence		BD-rate Y-PSNR	BD-rate IV-PSNR	BD-PSNR Y-PSNR	BD-PSNR IV-PSNR
Hijack	C01	-4.6%	-3.3%	0.1%	0.0%
Cyberpunk	C02	-50.8%	-26.9%	1.5%	1.1%
Average		**-27.7%**	**-15.1%**	**0.8%**	**0.6%**

Class J

Sequence		BD-rate Y-PSNR	BD-rate IV-PSNR	BD-PSNR Y-PSNR	BD-PSNR IV-PSNR
Kitchen	J01	-23.4%	-16.1%	1.5%	1.1%
Cadillac	J02	-3.6%	3.4%	0.4%	0.0%
Mirror	J03	-7.9%	-12.8%	1.1%	1.5%
Fan	J04	-0.3%	-0.9%	0.1%	0.2%
Average		**-8.8%**	**-6.6%**	**0.8%**	**0.7%**

Class W

Sequence		BD-rate Y-PSNR	BD-rate IV-PSNR	BD-PSNR Y-PSNR	BD-PSNR IV-PSNR
Group	W01	-10.5%	-11.0%	0.5%	0.8%
Dancing	W02	-29.3%	-22.6%	1.4%	1.2%
Average		**-19.9%**	**-16.8%**	**0.9%**	**1.0%**

Class D

Sequence		BD-rate Y-PSNR	BD-rate IV-PSNR	BD-PSNR Y-PSNR	BD-PSNR IV-PSNR
Painter	D01	-4.5%	-4.4%	0.6%	0.5%
Breakfast	D02	-21.6%	-19.4%	1.5%	1.2%
Barn	D03	-25.9%	-27.4%	1.5%	1.3%
Average		**-17.3%**	**-17.1%**	**1.2%**	**1.0%**

Class E

Sequence		BD-rate Y-PSNR	BD-rate IV-PSNR	BD-PSNR Y-PSNR	BD-PSNR IV-PSNR
Frog	E01	4.9%	4.2%	-0.3%	-0.2%
Carpark	E02	-13.1%	-13.2%	1.2%	0.8%
Street	E03	-20.6%	-13.8%	0.7%	0.3%
Average		**-9.6%**	**-7.6%**	**0.5%**	**0.3%**

Class L

Sequence		BD-rate Y-PSNR	BD-rate IV-PSNR	BD-PSNR Y-PSNR	BD-PSNR IV-PSNR
Fencing	L01	-16.8%	-17.8%	3.1%	2.5%
CBABasketball	L02	114.2%	174.8%	-2.5%	-3.6%
MartialArts	L03	-61.1%	---	2.6%	2.6%
Average		**12.1%**	**---**	**1.1%**	**0.5%**

Remarks:

- RD-curves for B03 are almost flat, and the quality difference should be considered negligible:

%	B03				
	IV-PSNR				
	Anchor B03	Proposal B03	Delta		BD-rate
-0.5%	38.46	38.26	-0.20		65.4%
-0.8%	38.44	38.24	-0.20		
-1.1%	38.36	38.16	-0.20		BD-PSNR
-0.3%	37.82	37.62	-0.19		-0.5%
	38.50	38.30	-0.20		
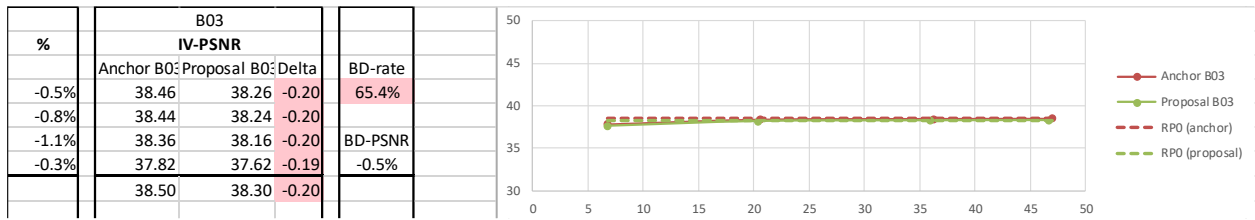
- efficiency decrease for L02 is caused by weird ordering of views in the pruning graphs, where neighboring views (v5, v6, v7, and v8) are selected to be semi-basic views:

```
000062.260868  info      Pruning graph:
000062.260883  info      ( v9 v14 ) <- v7 <- v8 <- v13 <- v12 <- v11 <- v10
000062.260885  info      ( v0 v4  ) <- v6 <- v5 <- v1  <- v2  <- v3
```

3 Recommendation

We recommend including the proposed modification in TMIV17.

4 Acknowledgement