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A FAST INTRA-PREDICTION DECISION ALGORITHM IN INTER-FRAME BASED ON A NOVEL FEATURE OF HEVC

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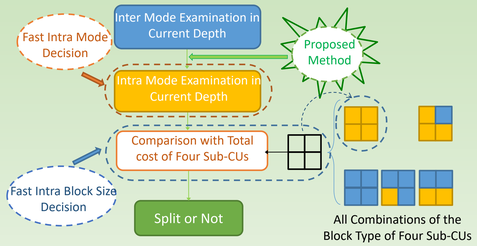
Problem

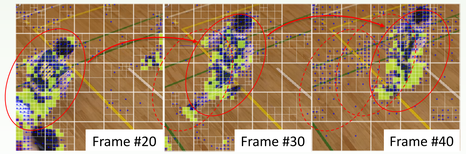
The impact of Intra-prediction for Inter-frames

- Important for coding performance – **5.29%** BD-rate saving
- Percentage of Intra-coded blocks is low – **5.84%**
- But costs a lot of time – **21.49%** of total coding time



Mode Decision Process in Inter-frames and all kinds of fast Intra-prediction algorithms

Observations



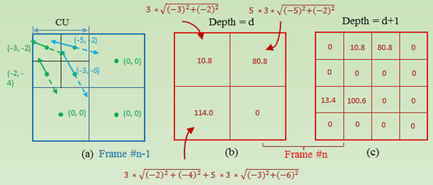
Intra-coded blocks (colored in yellow) come along with the moving objects in contiguous frames

- Non-rigid motion
- New contents

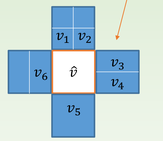
A Novel Feature: Motion Strength Count (MSC)

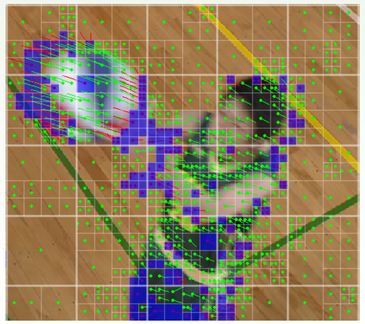
$$MSC = \sum_{i\in\beta}\left(d_i * \left\|MV_i^{n-1}\right\|\right) + \omega * \sum_{j\in\alpha}\left(d_j * \left\|MV_j^{n-1}\right\|\right)$$

Depth of MV_i^{n-1} | Inter-MVs of frame #n-1 | Depth of MV_j^{n-1} | Intra-MVs of frame #n-1



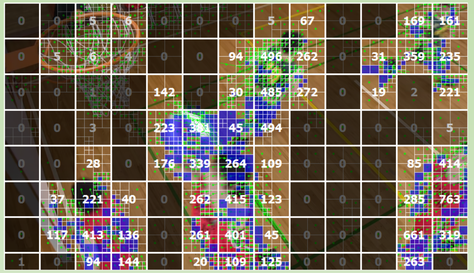
$$\measuredangle\hat{v} = \text{median}(\measuredangle v_{i\in V})$$
$$\|\hat{v}\|_2 = \text{median}(\|v_{i\in V}\|_2)$$





Red Arrows: Intra MV Green Arrows: Inter MV

MSC MAP of the First CU Depth



High MSC value, high possibility to show intra-coded blocks(colored in blue)

Decision Algorithm

- **In depth 1**

  if $MSC_i^{d=1} >= TA$
  go to check smaller blocks;
  else
  finish further checking;
  return;
  end

- **In depth 2**

  if $MSC_i^{d=2} >= TA$ or $\frac{1}{8}\sum_{j\in N8(i)} MSC_j^{d=2} >= TB$
  examine intra-mode in current depth;
  check smaller blocks;
  else
  finish further checking;
  return;
  end

- **In depth 3-4**

  examine intra-mode in current depth.

Coding Performance on HM15.0

Class	Sequences	BD-rate	ΔITS	ΔTTS
A	Traffic	0.066%	69.1%	13.6%
	PeopleOnStreet	0.091%	32.9%	11.9%
B	Kimono	0.456%	53.4%	15.0%
	ParkScene	0.290%	57.0%	15.0%
	Catus	0.576%	54.0%	14.1%
	BasketballDrive	0.375%	31.0%	4.2%
	BQTerrace	0.296%	67.0%	12.1%
C	BasketballDrill	0.386%	45.3%	8.0%
	BQMall	0.236%	44.5%	7.9%
	PartyScene	0.052%	47.2%	10.8%
	RaceHorses	0.013%	20.2%	3.7%
D	BasketballPass	-0.201%	54.3%	7.6%
	BQSquare	-0.244%	61.3%	12.0%
	BlowingBubbles	0.432%	44.9%	7.7%
	RaceHorses	-0.124%	15.6%	2.5%
E	FourPeople	0.433%	86.3%	8.3%
	Johnny	0.237%	96.1%	8.6%
	KristenAndSara	0.192%	92.8%	8.3%
Ave.		**0.198%**	**62.9%**	**9.6%**

More than 60% Intra-coding time saving with negligible performance loss

Comparisons with [1] and [2]

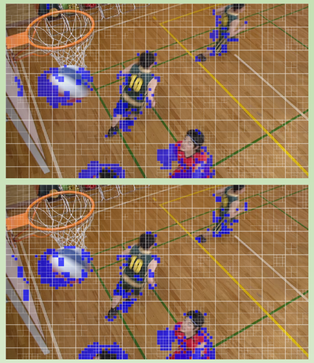
Class	Proposed		[1]		[2]	
	BD-rate	ΔITS	BD-rate	ΔITS	BD-rate	ΔITS
B	0.4%	53%	0.5%	50%	0.7%	61%
C	0.2%	39%	0.4%	48%	1.0%	57%
D	0.0%	44%	0.3%	44%	0.8%	54%
E	0.3%	92%	0.8%	63%	1.1%	65%
Ave.	**0.2%**	**57%**	0.5%	51%	0.9%	59%

The proposed method is compatible with [1](fast block size decision) and [2](combination of fast intra-mode and block size decision)

Hit Rate of Prediction Type in QP 22-37

QP / Class	22	27	32	37
A	92.7%	95.7%	96.9%	97.5%
B	88.6%	96.1%	97.0%	97.1%
C	94.5%	95.8%	95.9%	95.9%
D	99.1%	98.7%	98.1%	97.7%
E	98.6%	99.7%	99.8%	99.9%
Ave.	**94.7%**	**97.2%**	**97.5%**	**97.6%**

Accuracy of the prediction type is high



Conclusions

- Proposed a new feature **Motion Strength Count**, MSC, to predict the possibilities of examining Intra-prediction in Inter-frames.
- Designed **a Fast Intra-prediction Decision** algorithm based on MSC to fast determine whether a CU needs to be checked intra-prediction.
- **Compatible** with current fast Intra-mode decision and fast intra-block size decision algorithms for further speedup.

Future Extensions

- Extending the calculation of MSC from P frames to B frames.
- Selecting the two thresholds adaptively according to the video's contents.

Reference

[1] Biao Min and R. C. C. Cheung, "A Fast CU Size Decision Algorithm for the HEVC Intra Encoder," *IEEE Trans. Circuits Syst. Video Technol.*, vol. 25, no. 5, pp. 892–896, May 2015.

[2] H. Zhang and Z. Ma, "Fast Intra Mode Decision for High Efficiency Video Coding (HEVC)," *IEEE Trans. Circuits Syst. Video Technol.*, vol. 24, no. 4, pp. 660–668, 2014.