

# JCTVC-G374: Improving the Intra Prediction Based on a Uniform Probability Model

Lingzhi Liu

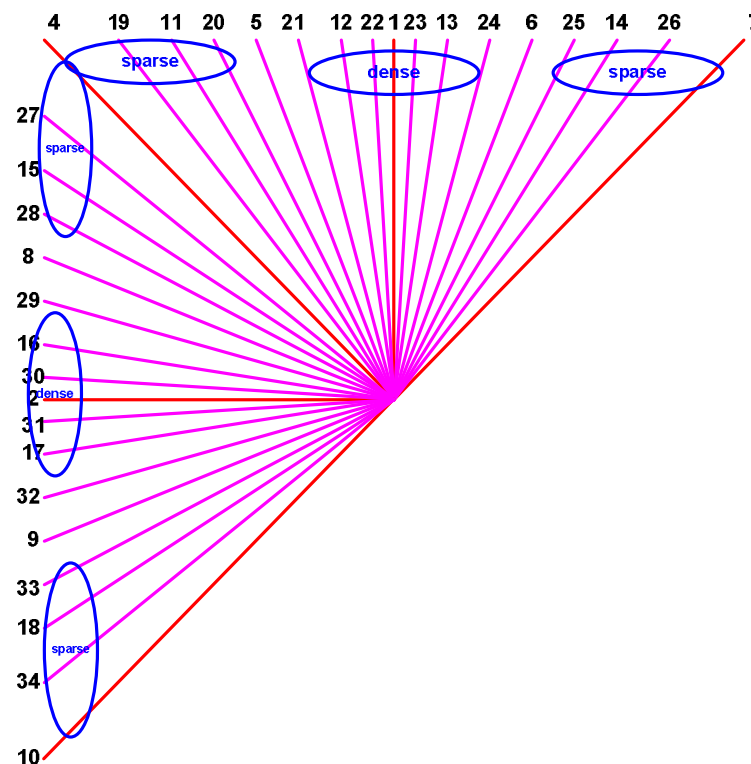
[www.hisilicon.com](http://www.hisilicon.com)

HISILICON TECHNOLOGIES CO., LTD.



# Introduction

- **Unified Intra Prediction (UIP) in HM has up to 33 directional modes**
- **According to the symmetric feature, a 9-entry angTable table is defined to performance the calculation of the prediction values**
  - $\text{angTable}[9] = \{0, 2, 5, 9, 13, 17, 21, 26, 32\}$
- **Problem remaining:**
  - It is not clear how the entries in the table are obtained.
  - The distribution of intra prediction modes show the highest priorities for Horizontal, Vertical and a certain higher priorities for Diagonal modes, but the table is more sparse for diagonal angles. Thus a performance decreasing is observed for the sequences with varied diagonal textures.
- **A New Angular Table is proposed in this contribution:**
  - $\text{angTable2}[9] = \{0, 2, 5, 9, 13, 18, 23, 28, 32\}$



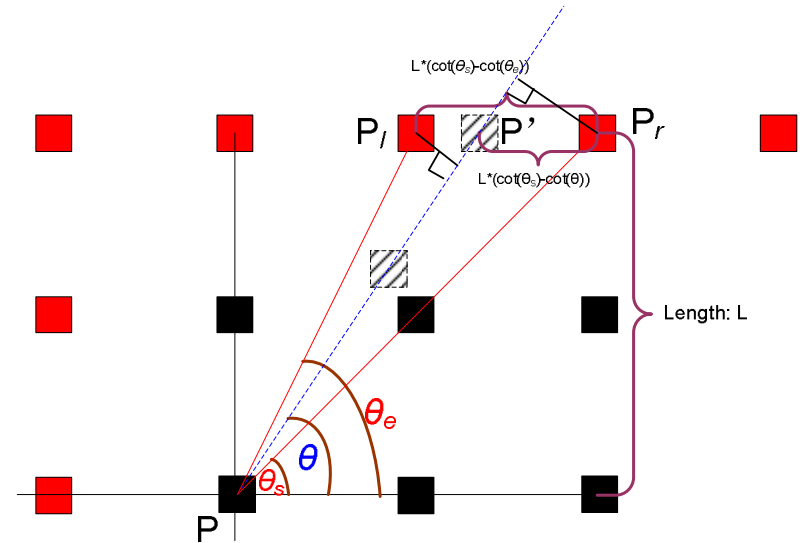
# Prediction Method and Angles in UIP

- **UIP method**

$$\begin{cases} w_l = \frac{\cot(\theta_s) - \cot(\theta)}{\cot(\theta_s) - \cot(\theta_e)} \\ w_r = 1 - w_l \end{cases}$$

- **The angles defined in angTable are**

- $\theta_i = \text{arccot}(\text{angTable}[i/32])$

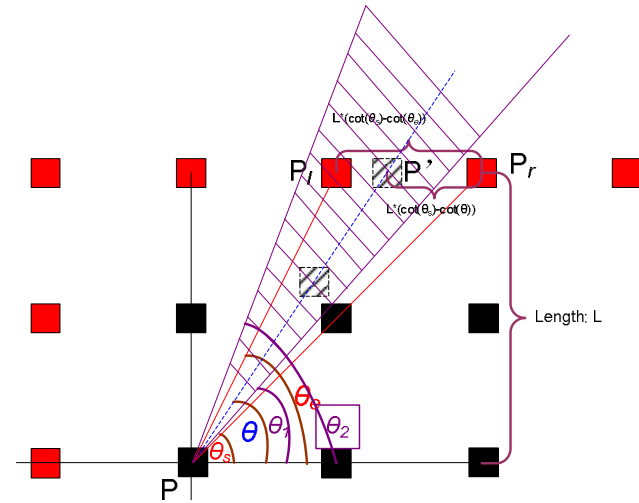


# Uniform Distribution of Predicting Angles and Equivalent Averaging Prediction Angle

- A predicting  $\theta$  is in the angular interval  $[\theta_0, \theta_1]$ , and it corresponds to the uniform distribution between  $\theta_0$  and  $\theta_1$
- Computing the averaging weighting factor  $W$  through definite integral
- Equivalent Averaging Prediction Angle (EAPA)

$$\theta_{equ} = \arccot \cot \left( \frac{\ln(\sin(\theta_1)) - \ln(\sin(\theta_0))}{\theta_1 - \theta_0} \right)$$

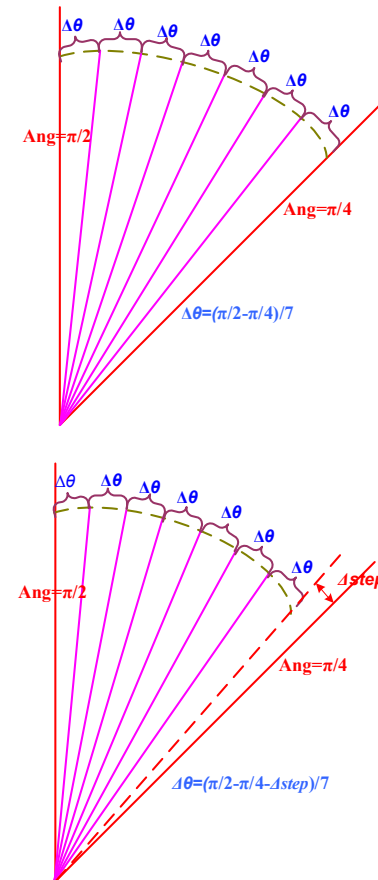
- New AngTable enties:
  - $\text{angTable2}[i] = \text{round}(\cot(\theta_{equ}[i]) * 32)$



$$\begin{aligned} W_l &= \lim_{N \rightarrow \infty} \sum_{n=1}^N \left( \frac{1}{N} * \frac{\cot(\theta_s) - \cot(\theta_0 + n * \Delta\theta)}{\cot(\theta_s) - \cot(\theta_e)} \right) \\ &= \lim_{N \rightarrow \infty} \sum_{n=0}^N \left( \frac{\Delta\theta}{\theta_1 - \theta_0} * \frac{\cot(\theta_s) - \cot(\theta_0 + n * \Delta\theta)}{\cot(\theta_s) - \cot(\theta_e)} \right) \\ &= \int_{\theta_0}^{\theta_1} \left( \frac{1}{\theta_1 - \theta_0} * \frac{\cot(\theta_s) - \cot(\theta)}{\cot(\theta_s) - \cot(\theta_e)} \right) d\theta \\ &= \frac{1}{\cot(\theta_s) - \cot(\theta_e)} * \left( \cot(\theta_s) - \frac{\ln(\sin(\theta_1)) - \ln(\sin(\theta_0))}{\theta_1 - \theta_0} \right) \end{aligned}$$

# Derive the New angTable entries

- The fan-shape of  $\pi/4$  is divided into 7 equal intervals.
  - $\Delta\theta = (\pi/2 - \pi/4)/7$
  - the  $i$ th angular intervals is  $[\pi/4 + i * \Delta\theta, \pi/4 + (i+1) * \Delta\theta]$  ( $i=0..6$ )
- Calculate the EAPA  $\theta_{equ,i}$  of the  $i$ th angular interval
  - $\theta[9] = (\pi/2, \theta_{equ,6}, \theta_{equ,5}, \dots, \theta_{equ,0}, \pi/4)$
  - $angTable2[9] = \{0, 2, 5, 9, 13, 18, 23, 29, 32\}$
- Because the priority of angle  $\pi/4$  is weaker,  $\Delta\theta$  is adjusted to  $(\pi/2 - (\pi/4 + \Delta step))/7$ .
  - Generate several tables to verify and pick the best one
  - $angTable2[9] = \{0, 2, 5, 9, 13, 18, 23, 28, 32\}$



# Testing Case1: using the new angTable2 only

- The overall performances are the same.
- Noticeable coding gain is obtained for the sequences of **BasketballDrill832x480**
  - implies that the original angTable has performance decreasing when there are varying diagonal textures.

	All Intra HE			All Intra LC		
	Y	U	V	Y	U	V
Class A	0.1%	0.0%	0.1%	0.1%	0.1%	0.1%
Class B	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
Class C	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.3%
Class D	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Class E	0.1%	0.0%	0.1%	0.1%	0.1%	0.1%
Overall	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Enc Time[%]	100%			99%		
Dec Time[%]	100%			98%		

	All Intra HE			All Intra LC		
	Y	U	V	Y	U	V
Class A	0.1%	0.0%	0.1%	0.1%	0.1%	0.1%
Class B	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
Class C	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.3%
Class D	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Class E	0.1%	0.0%	0.1%	0.1%	0.1%	0.1%
Class F	-0.2%	-0.2%	-0.1%	-0.2%	-0.1%	-0.2%
Overall	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%
	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%
Enc Time[%]	100%			100%		
Dec Time[%]	100%			98%		

BasketballDrill832x480					
AI HE			AI LC		
Y	U	V	Y	U	V
-1.02%	-0.80%	-0.90%	-0.90%	-0.77%	-0.98%

# Testing Case2: alternatively using the original or the new angTable

- **The condition for using the new angTable:**
  - when both the intra prediction mode of left and above are not available or inter blocks
  - or one of the modes is 4, 7, 10, 11, 14, 15, 18, 19, 26, 27 or 34
    - one of the neighboring modes is close to the diagonal direction
- **only the new table is used for intra chroma prediction.**
- **Most of the coding gain is kept for BasketballDrill.**
- **Others are kept the same performance as the anchor.**

	All Intra HE			All Intra LC		
	Y	U	V	Y	U	V
Class A	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Class B	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Class C	-0.2%	-0.1%	-0.2%	-0.2%	-0.2%	-0.2%
Class D	0.0%	-0.1%	-0.1%	0.0%	0.0%	0.0%
Class E	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%
Overall	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%
	0.0%	-0.1%	-0.1%	0.0%	0.0%	0.0%
Enc Time[%]	100%			101%		
Dec Time[%]	100%			99%		

	All Intra HE			All Intra LC		
	Y	U	V	Y	U	V
Class A	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Class B	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Class C	-0.2%	-0.1%	-0.2%	-0.2%	-0.2%	-0.2%
Class D	0.0%	-0.1%	-0.1%	0.0%	0.0%	0.0%
Class E	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%
Class F	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%
Overall	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%
	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%
Enc Time[%]	100%			101%		
Dec Time[%]	100%			99%		

BasketballDrill832x480					
AI_HE			AI_LC		
Y	U	V	Y	U	V
-0.92%	-0.55%	-0.73%	-0.82%	-0.57%	-0.79%

# Testing Case3: the same as Case2 except that the original table is used for chroma

- **Case2 is generally better**
  - Also supports that the new table has some advantages for prediction.

	All Intra HE			All Intra LC		
	Y	U	V	Y	U	V
Class A	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%
Class B	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%
Class C	-0.2%	-0.1%	-0.1%	-0.2%	-0.1%	-0.1%
Class D	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%
Class E	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
<b>Overall</b>	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Enc Time[%]	101%			102%		
Dec Time[%]	100%			99%		

	All Intra HE			All Intra LC		
	Y	U	V	Y	U	V
Class A	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%
Class B	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%
Class C	-0.2%	-0.1%	-0.1%	-0.2%	-0.1%	-0.1%
Class D	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%
Class E	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Class F	-0.2%	-0.1%	0.0%	-0.2%	-0.2%	-0.1%
<b>Overall</b>	-0.1%	0.0%	0.0%	-0.1%	0.0%	0.0%
	-0.1%	0.0%	0.0%	-0.1%	0.0%	0.0%
Enc Time[%]	101%			102%		
Dec Time[%]	100%			99%		

BasketballDrill832x480					
AI_HE			AI_LC		
Y	U	V	Y	U	V
-0.82%	-0.52%	-0.47%	-0.73%	-0.46%	-0.40%



# Thank you

[www.hisilicon.com](http://www.hisilicon.com)

