

**A JOINT JND MODEL BASED ON LUMINANCE AND  
FREQUENCY MASKING FOR HEVC  
- JCTVC-I0163, 9<sup>TH</sup> JCT-VC MEETING -**

2012. 4. 30.

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# Summary

- ❖ The proposed joint JND model combines a luminance JND model and the quantization matrix of HM 6.1.

$$\begin{array}{cc} \text{<JCTVC-H477>} & \text{<JCTVC-G880>} \\ Qstep^{JND} = Qstep \cdot JND_L(\mu) & Qstep^{QM}(i, j) = Qstep \cdot QM(i, j) \end{array}$$

<Proposed method>

$$Qstep^{JND\ with\ QM}(i, j) = Qstep \cdot JND_L(\mu) \cdot QM(i, j)$$

- Consider both the luminance masking JND model [1] and the frequency masking JND model with the default frequency weighting matrices [2] of HM 6.1

- ❖ Performance

- the average 6% and maximum 30% reductions in bitrates at similar subjective quality levels of HM 6.1.

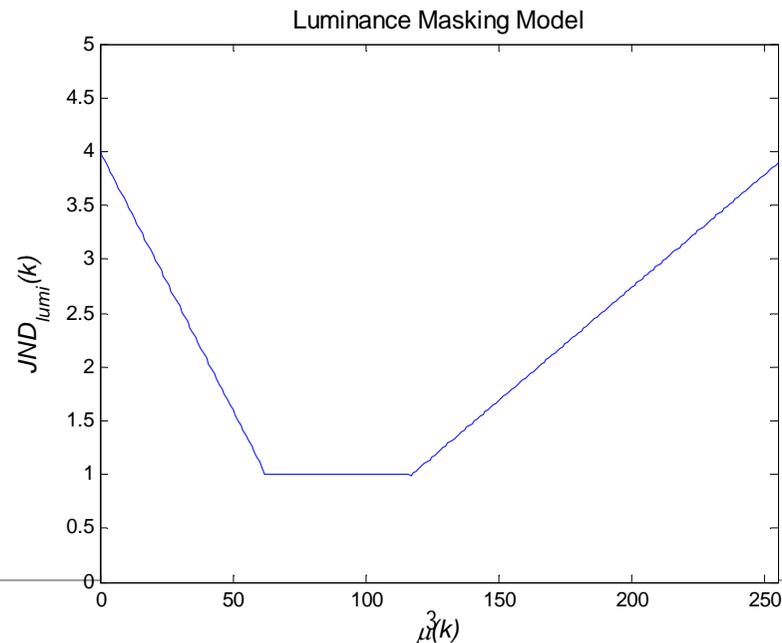
## The related work

- ❖ A Just Noticeable Distortion (JND) based quantization method [H0477]

$$Qstep^{JND} = Qstep \cdot JND_L(\mu)$$

- $JND_L(\mu)$  : a luminance masking threshold for the average pixel value  $\mu$  of a prediction for the current TU block with  $JND_A = 4$ ,  $\mu_B = 62$ ,  $\mu_C = 115$ ,  $JND_D = 4$ .

$$JND_L(\mu) = \begin{cases} -\mu(JND_A - 1)/\mu_B + A & \mu \leq \mu_B \\ 1 & \mu_B < \mu < \mu_C \\ (\mu - \mu_C)(JND_D - 1)/((2^{bit-depth} - 1) - \mu_C) + 1 & \mu \geq \mu_C \end{cases}$$



## The proposed method

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- ❖ Luminance and frequency masking effects into quantization in HM 6.1

$$Qstep^{JND}(i, j) = Qstep(i, j) \cdot JND(i, j)$$

- $JND(i, j)$ :  $(i, j)$ -th quantization weighting factor for TU block

$$JND(i, j) = JND_L(\mu)QM(i, j)$$

- $JND_L(\mu)$  : a luminance masking threshold for the average pixel value  $\mu$  of a prediction for the current TU block
- $QM(i, j)$  :  $(i, j)$ -th quantization weighting factor of HM 6.1
- with  $JND_A = 3$ ,  $\mu_B = 82$ ,  $\mu_C = 95$ ,  $JND_D = 3$ .

$$\Delta PSNR = PSNR_{proposed} - PSNR_{original}$$

$$\Delta Bitrate = \frac{Bitrate_{proposed} - PSNR_{original}}{PSNR_{original}} \times 100$$

## Objective Quality

### ❖ HM6.1 vs HM 6.1 with the proposed joint JND Model

Configuration	Sequence	QP	$\Delta$ PSNR-Y[dB]	$\Delta$ Bitrate[%]
ra_main	SteamLocomotiveTrain	22	-0.202	-9.529
ra_main	SteamLocomotiveTrain	27	-0.112	-7.038
ra_main	Traffic	22	-0.428	-9.773
ra_main	Traffic	27	-0.252	-5.589
ra_main	BQTerrace	22	-0.954	-30.612
ra_main	BQTerrace	27	-0.301	-23.468
ra_main	Cactus	22	-0.336	-18.622
ra_main	Cactus	27	-0.220	-6.079
ra_main	BasketballDrive	22	-0.283	-16.585
ra_main	BasketballDrive	27	-0.136	-4.801
ra_main	BasketballDrill	22	-0.663	-7.039
ra_main	BasketballDrill	27	-0.418	-4.512
ra_main	RaceHorsesC	22	-0.773	-10.370
ra_main	RaceHorsesC	27	-0.400	-6.037

# Subjective Quality

$\Delta$ Bitrate	$\Delta$ PSNR-Y
-30.612	-0.954

## ❖ BQTerrace QP22, 30<sup>th</sup> frame

- HM



- JND in HM (Frequency band masking model + Luminance variance masking model)



# Subjective Quality

$\Delta$ Bitrate	$\Delta$ PSNR-Y
-23.468	-0.301

## ❖ BQTerrace QP27, 30<sup>th</sup> frame

- HM



- JND in HM (Frequency band masking model + Luminance variance masking model)



# Subjective Quality

$\Delta$ Bitrate	$\Delta$ PSNR-Y
-16.585	-0.283

## ❖ BasketballDrive QP22, 200th frame

- HM



- JND in HM (Frequency band masking model + Luminance variance masking model)



# Subjective Quality

$\Delta$ Bitrate	$\Delta$ PSNR-Y
-18.622	-0.336

## ❖ Cactus QP22, 100th frame

- HM



- JND in HM (Frequency band masking model + Luminance variance masking model)



# Conclusion

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## ❖ Conclusion

- propose joint JND model harmonized with the luminance making JND and the default frequency weighting matrices of HM 6.1
- the average 6% and maximum 30% reductions in bitrates at similar subjective quality levels of HM 6.1 (flat quantization)
- It is recommended that the joint JND based quantization be adopted in HM for further development

## ❖ References

1. M. Naccari, M. Mrak, "On Just Noticeable Distortion Quantization in the HEVC Codec", JCTVC-H0477, 8th meeting, San José, CA, USA, 1–10 February, 2012.
2. M. Haque, A. Tabatabai and Y. Morigami, "HVS model based default quantization matrices", JCTVC-G880, 7th meeting, Geneva, Switzerland, November 2011.