

MEDIATEK

CONFIDENTIAL B

P40 NR1

Introduction & Usage



Outline

- P23 → P40 Change List
- Modifying items
 - Multiscale NR Filter Tuning – Content Aware
 - Contour Tuning

P23 NR1 → P40 NR1

P23

NBC NBC2

Global

☒ ANR1 ENY

☒ ANR1 ENC

☐ TABLE EN

1 Scale Mode

☐ ITUNE ANR

Luma LUT

CPX1-3	CPY0-3	SP0-3
40	16	0
100	16	0
160	16	-9
0-255	12	-2

Range Filters

0	PTY GN TH
16	PTC GN TH

LSC/LCE Link

☒ LCE LINK

X1-3	GAIN0-3	SP0-3
64	16	0
128	16	0
192	16	0
	16	0
0	SCL GN	
4	C GAIN	

YANR Mods

0	K RAT
3	K LO TH
3	K HI TH
2	K LPF
1	K HPF
0	K LMT
0	CENGAINLO
0	CENGAINHI
0	CENGAINLO LPF
0	CENGAINHI LPF
32	CEN OFT
0	CEN GAIN
32	CEN TH

CANR Mods

40	C L DIFF TH
1	C SM EDGE
2	C SM EDGE TH
8	K TH C

Range Filters

0	PTY GAIN TH
0	PTC GAIN TH

PTC/Y Auto Tune

PTY	PTC	LPF	COEF
1	2	1	2
2	3	2	3
3	4	3	4
4	6	4	6
24	GainL	32	GainH

Act Map [Y 0/64 = BLF/Ori]

HH	HL	H	L	
0	0	0	0	TH Y
20	20	16	20	BLDBASEY
20	20	48	20	BLD TH Y
8	8	0	0	SLANT Y
200	160	128		Luma TH Y
0	0	0		LUMA BLDBASEY
64	64	64		LUMA BLD TH Y
4	4	4		LUMA SLANT Y
0	TH C	64		BLD BASE C
64	BLD TH C	0		SLANT C
8	DITH U	8		DITH V

Median Filter

☐ MEDIAN EN

3	VAR	4	LM WT
10	13	16	19
22			

COR

TH	5	16	8	0
SL	4	3		
LV	12			
OFT	0			

Multi-L LMT

0	HI LMT1	CPY0-3	SP0-3
255	HI LMT2	0	0
0	LO LMT1	0	0
255	LO LMT2	0	0
		0	0

Act gain/thres

8	ACT LCE GAIN
16	ACT SCALE OFT
0	ACT SCALE GAIN
0	ACT DIF GAIN
16	ACT DIF LO TH
16	ACT DIF HI TH
0	ACT SIZE GAIN
16	ACT SIZE LO TH

Table LUT

CPX1-3	CPY0-3	SP0-3
40	8	0
120	8	0
160	8	0
8	0	0-255

Chroma LUT

CPX1-3	CPY0-3	SP0-3
40	16	0
100	16	0
160	16	0
0-255		

Contour Tuning

P40

NBC NBCBlend FW NBC Link FWNBC

Global

☐ TBL PRC

TABLE CNR Strength

☒ LTM LINK

☒ ANR ENY

☒ ANR ENC

NR Debug

☐ ITUNE ANR

☐ ITUNE WEIGHT ANR

☐ ITUNE LTM ANR

Luma LUT

Y CPX1	64
Y CPX2	128
Y CPX3	192
Y CPX4	255
Y CPX5	255
Y CPX6	255
Y CPX7	255
Y CPX8	255
Y SCALE CPY0	15
Y SCALE CPY1	16
Y SCALE CPY2	16
Y SCALE CPY3	12
Y SCALE CPY4	8
Y SCALE CPY5	8
Y SCALE CPY6	8
Y SCALE CPY7	8
Y SCALE CPY8	8
Y SCALE SP8	3

Range Filters

0	PTY RING RAT TH
8	Y L1 RING RAT TH
12	Y L2 RING RAT TH
12	Y L3 RING RAT TH
15	Y L3 RING RAT TH
	ITUNE ANR DUMP ML

Range Detection

Y LO RING RAT TH	8
Y L1 RING RAT TH	12
Y L2 RING RAT TH	12
Y L3 RING RAT TH	15
ITUNE ANR DUMP ML	

YNR Strength

L0 IDX	
L1 IDX	
L2 IDX	2
L3 IDX	3
L0 std	16
L1 std	16
L2 std	16
L3 std	8
Y SLOPE H TH	16
Y SLOPE V TH	20

CNR Strength

PTC1	2
PTC2	4
PTC3	6
PTC4	8

SL2 Link

SL2 LINK	<input checked="" type="checkbox"/>
SL2 X1	64
SL2 X2	128
SL2 X3	192
SL2 GAIN0	16
SL2 GAIN1	20
SL2 GAIN2	24
SL2 GAIN3	28
SL2 SP0	8
SL2 SP1	8
SL2 SP2	8
SL2 SP3	8
SL2 SCALE GAIN	0
SL2 C GAIN	6

Tab LUT

Table LUT

TBL CPX1	64
TBL CPX2	128
TBL CPX3	192
TBL GAIN CPY0	1
TBL GAIN CPY1	8
TBL GAIN CPY2	16
TBL GAIN CPY3	24
TBL GAIN SP0	14
TBL GAIN SP1	15
TBL GAIN SP2	15
TBL GAIN SP3	15

Chroma LUT

C CPX1	40
C CPX2	120
C CPX3	160
C SCALE CPY0	16
C SCALE CPY2	16
C SCALE CPY3	8
C SCALE SP0	0
C SCALE SP1	0
C SCALE SP2	-4

YANR Mods

0	K RAT
3	K LO TH
3	K HI TH
2	K LPF
1	K HPF
0	K LMT
0	CENGAINLO
0	CENGAINHI
0	CENGAINLO LPF
0	CENGAINHI LPF
32	CEN OFT
0	CEN GAIN
32	CEN TH

CANR Mods

40	C L DIFF TH
1	C SM EDGE
2	C SM EDGE TH

YANR Mods

2	IMPL MODE
0	CEN GAIN HI TH
0	CEN GAIN LO TH
6	CEN GAIN HI TH LP
1	CEN GAIN LO TH LP
32	CEN TH
0	CEN GAIN
32	CEN OFT

Act gain/thres

8	ACT SL2 GAIN
4	ACT DIF GAIN
16	ACT DIF LO TH
16	ACT DIF HI TH

P23 NR1 → P40 NR1

P23

NBC NBC2

Global

☒ ANR1 ENY
☒ ANR1 ENC
☐ TABLE EN

1 Scale Mode
☐ ITUNE ANR

Luma LUT

CPX1-3	CPY0-3	SP0-3
40	16	0
100	16	0
160	16	-9
0-255	12	-2

Range Filters

0 PTY GN TH
 16 PTC GN TH

LSC/LCE Link
☒ LCE LINK

X1-3 GAIN0-3 SP0-3

X1-3	GAIN0-3	SP0-3
64	16	0
128	16	0
192	16	0
	16	0
0	SCL GN	
4	C GAIN	

YANR Mods

0 K RAT
 3 K LO TH
 3 K HI TH
 2 K LPF
 1 K HPF
 0 K LMT
 0 CENGAINLO
 0 CENGAINHI
 0 CENGAINLO LPF
 0 CENGAINHI LPF
 32 CEN OFT
 0 CEN GAIN
 32 CEN TH

PTC/Y Auto Tune

PTY	PTC	LPF	COEF
1	2	1	8 A
2	3	2	6 B
3	4	3	6 C
4	6	4	4 D
	24	GainL	32 GainH

DIR FLT
☒ DIR EN

12 GAIN
 4 VER W TH
 4 VER W SL
 4 DIAG W TH
 2 DIAG W SL

CANR Mods

40 C L DIFF TH
 1 C SM EDGE
 2 C SM EDGE TH
 8 K TH C

Median Filter

☐ MEDIAN EN

3 VAR 4 LM WT

Y0-4 10 13 16 19 22

COR

TH 5
 SL 4

LV

OFT

Multi-L LMT

0 HI LMT1
 255 HI LMT2
 0 LO LMT1
 255 LO LMT2

Y act

CPY0-3 SP0-3

0	0
0	0
0	0
0	0

Act Map [Y 0/64 = BLF/Ori]

HH	HL	H	L	
0	0	0	0	TH Y
20	20	16	20	BLDBASEY
20	20	48	20	BLD TH Y
8	8	0	0	SLANT Y
200	160		128	Luma TH Y
0	0		0	LUMA BLDBASEY
64	64		64	LUMA BLD TH Y
4	4		4	LUMA SLANT Y
0	TH C		64	BLD BASE C
64	BLD TH C		0	SLANT C
8	DITH U		8	DITH V

Act gain/thres

8	ACT LCE GAIN
16	ACT SCALE OFT
0	ACT SCALE GAIN
0	ACT DIF GAIN
16	ACT DIF LO TH
16	ACT DIF HI TH
0	ACT SIZE GAIN
16	ACT SIZE LO TH

Table LUT

CPX1-3	CPY0-3	SP0-3
40	8	0
120	8	0
160	8	0
	8	0

Chroma LUT

CPX1-3	CPY0-3	SP0-3
40	16	0
100	16	0
160	16	0
0-255	16	0

P40

NBC NBCBlend FW NBC Link FWNBC

Act Map [Y 0/64 BLF/Ori]

Y HF ACT X1	16
Y HF ACT X2	24
Y HF ACT X3	32
Y HF ACT X4	40
Y HF ACT Y0	24
Y HF ACT Y1	24
Y HF ACT Y2	56
Y HF ACT Y3	56
Y HF ACT Y4	40
Y HF ACT SP0	0
Y HF ACT SP1	31
Y HF ACT SP2	0
Y HF ACT SP3	-16
Y HF ACT SP4	0
Y HF LUMA X1	192
Y HF LUMA X2	224
Y HF LUMA Y0	0
Y HF LUMA Y1	0
Y HF LUMA Y2	4
Y HF LUMA SP0	0
Y HF LUMA SP1	1
Y HF LUMA SP2	0
C DITH U	8
C DITH V	8
ACT BLD BASE C	48

Blending Control

Y L0 HF W 16
 Y L1 HF W 8
 Y L2 HF W 4
 Y L3 HF W 4

ITUNE ANR BLD OFF ☐

Y act

Y ACT CPX1	64
Y ACT CPX2	128
Y ACT CPX3	192
Y ACT CPY0	0
Y ACT CPY1	0
Y ACT CPY2	0
Y ACT CPY3	0
Y ACT SP0	0
Y ACT SP1	0
Y ACT SP2	0
Y ACT SP3	0

**Multiscale NR
Filter Tuning**

MULTISCALE NR FILTER TUNING – CONTENT AWARE

Luma

Multiscale NR Filter Tuning

Contour Tuning

P23

w/o blending

w/ blending



PTY: 10-19-28-41

50% constant blending

P40

w/o blending

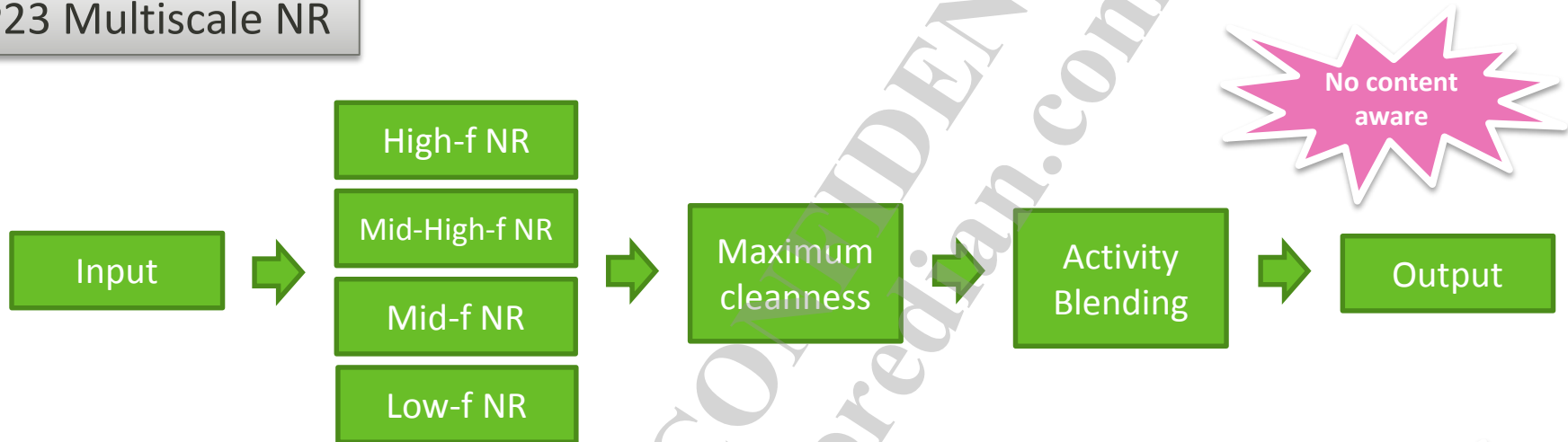
w/ blending



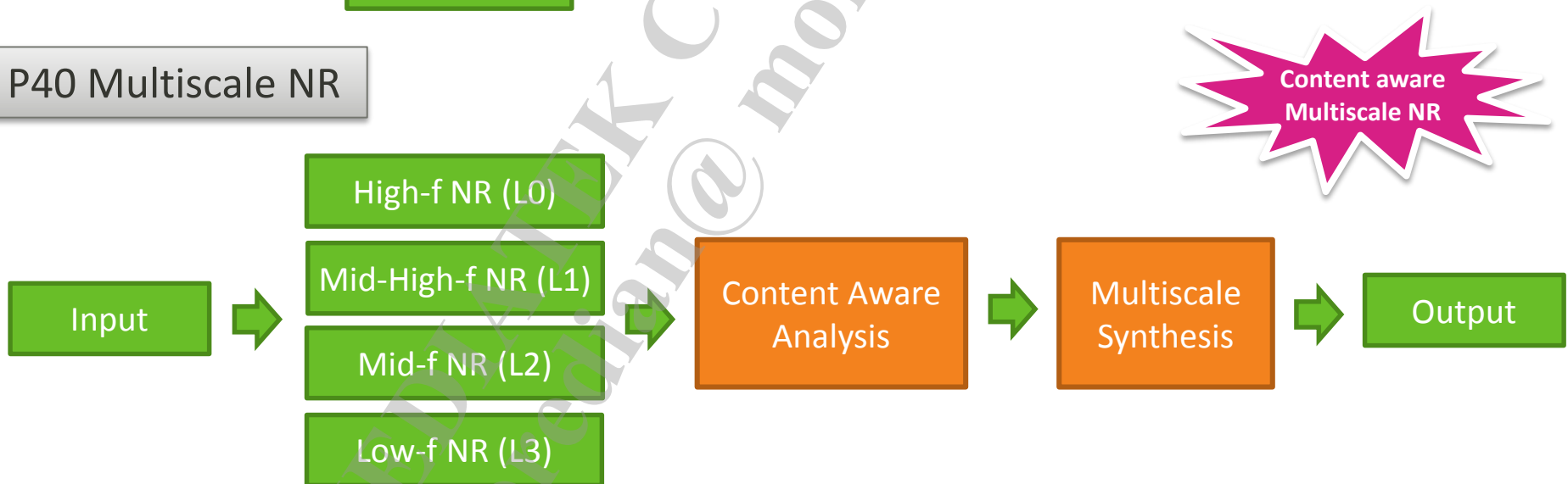
PTY: 10-19-28-41
50% constant blending

P23 → P40 Multiscale NR Filter Change

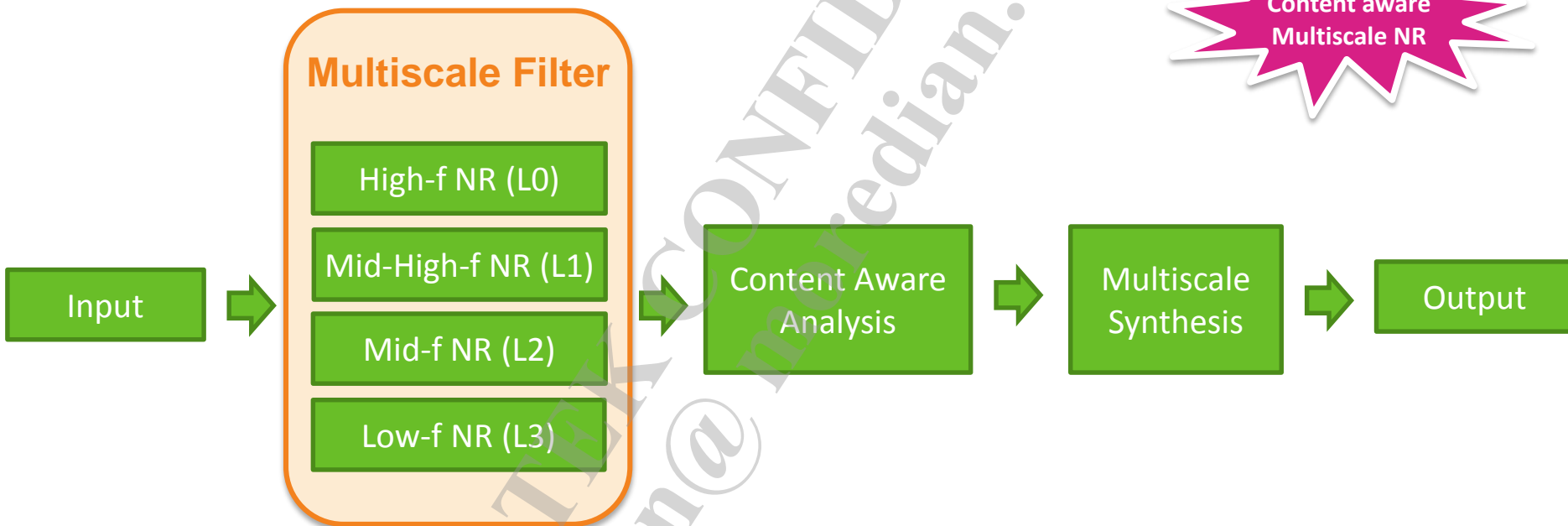
P23 Multiscale NR



P40 Multiscale NR



P40 Multiscale NR Filter Tuning



Multiscale Filter Tuning

■ Total 11 Filters

Register Name	Default	Description	Tuning
ANR_A_Y_FLT0_IDX	0	Filter L0 index	NR: 0~1, Value ↑, Frequency removal ↑ (Mainly for High-f)
ANR_A_Y_FLT1_IDX	0	Filter L1 index	NR: 0~1, Value ↑, Frequency removal ↑ (Mainly for Mid-High-f)
ANR_A_Y_FLT2_IDX	2	Filter L2 index	NR: 0~2, Value ↑, Frequency removal ↑ (Mainly for Mid-f)
ANR_A_Y_FLT3_IDX	3	Filter L3 index	NR: 0~3, Value ↑, Frequency removal ↑ (Mainly for Low-f)
NR_A_Strength_L0_std	16	Strength of L0	Value ↑, Strength ↑
NR_A_Strength_L1_std	16	Strength of L1	Value ↑, Strength ↑
NR_A_Strength_L2_std	16	Strength of L2	Value ↑, Strength ↑
NR_A_Strength_L3_std	8	Strength of L3	Value ↑, Strength ↑

YNR Strength

L0 IDX	<input type="checkbox"/>
L1 IDX	<input type="checkbox"/>
L2 IDX	2
L3 IDX	3
L0 std	8
L1 std	8
L2 std	8
L3 std	8

■ Filter Characteristic:

- L0: High-frequency Noise Reduction
- L1: Mid-high-frequency Noise Reduction
- L2: Mid-frequency Noise Reduction
- L3: Low-frequency Noise Reduction

L0 FLT IDX = 0

L0 FLT IDX = 1

L1 FLT IDX = 0

L1 FLT IDX = 1

L2 FLT IDX = 0

L2 FLT IDX = 1

L2 FLT IDX = 2

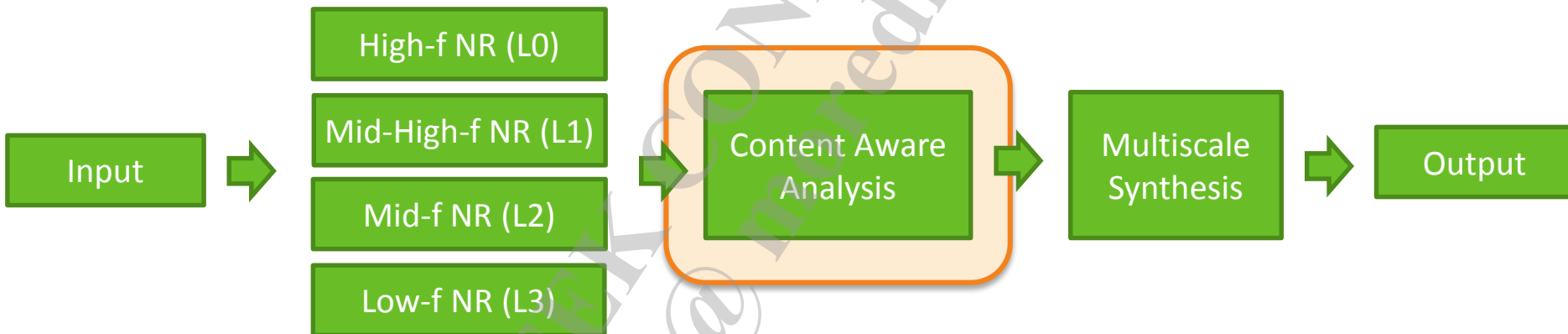
L3 FLT IDX = 0

L3 FLT IDX = 1

L3 FLT IDX = 2

L3 FLT IDX = 3

P40 Multiscale NR Filter Tuning



Content Aware Analysis

ITUNE ANR ☒

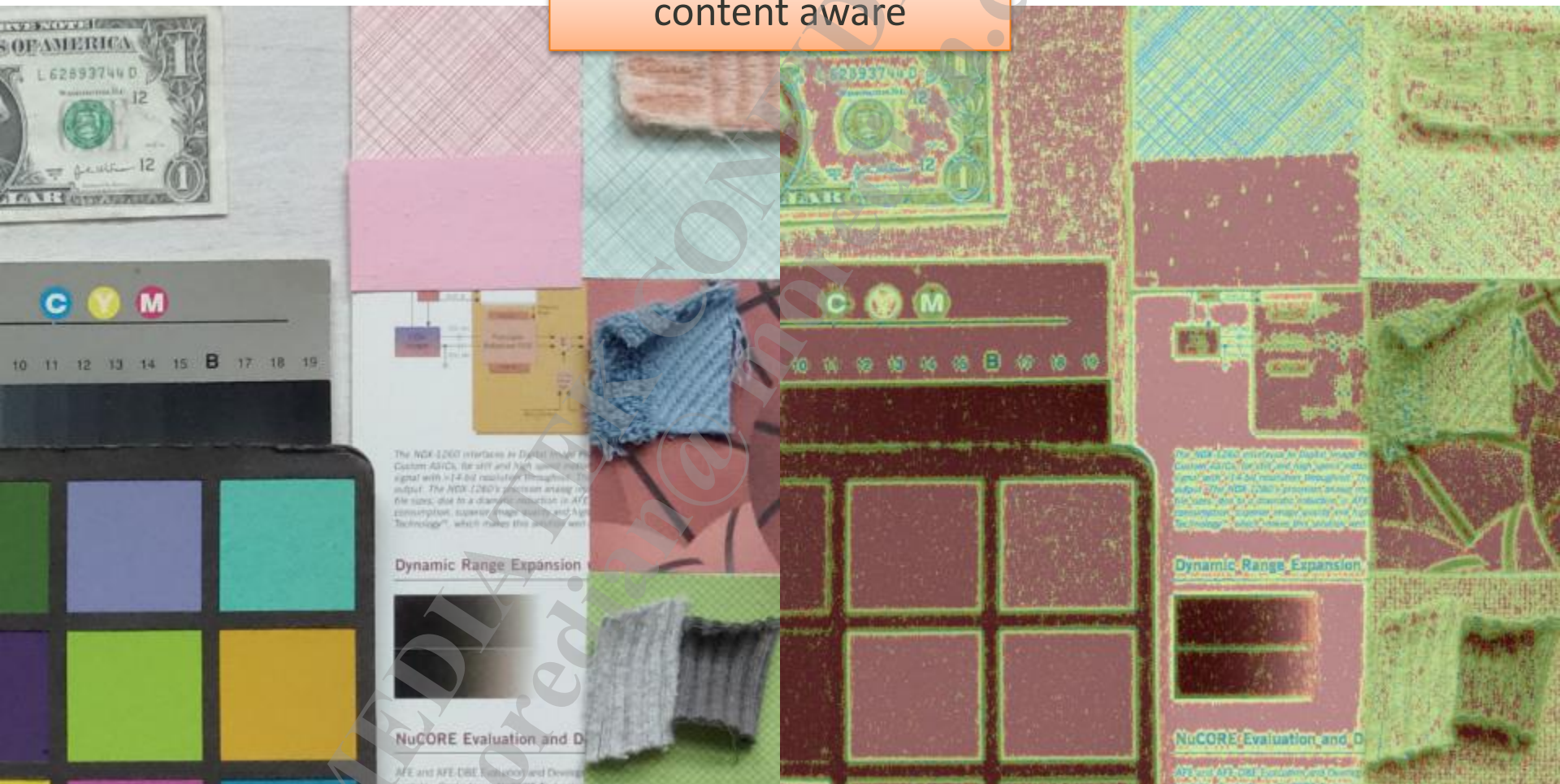
ITUNE ANR DUMP ML ☒

High Frequency NR ←



→ Low Frequency NR

content aware

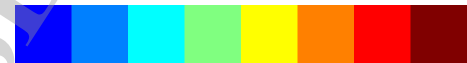


Content Aware Analysis

Range Detection	
Y L0 RNG RAT TH	8
Y L1 RNG RAT TH	12
Y L2 RNG RAT TH	15
Y L3 RNG RAT TH	15
ITUNE ANR DUMP ML	<input type="checkbox"/>

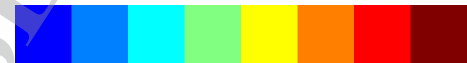
- Choose different scale depends on image content

Register Name	Default	Description	Tuning
ANR_Y_L0_RNG_RAT_TH	8	L0 select threshold	Suggest: 8 – 14 Value ↑, Cover Range↓ (keep more high-f detail) Value ↓, smooth peak noise
ANR_Y_L1_RNG_RAT_TH	12	L1 select threshold	Suggest: 8 – 14 Value ↑, Cover Range↓ (keep more mid-high-f detail) Value ↓, smooth peak noise
ANR_Y_L2_RNG_RAT_TH	15	L2 select threshold	Suggest: 8 – 15 Value ↑, Cover Range↓ Value ↓, smooth peak noise *Mainly for reduce noise in flat area
ANR_Y_L3_RNG_RAT_TH	15	L3 select threshold	Use 15 to protect content not to be smooth while L3 is used.
ITUNE_ANR_DUMP_ML	0	Output tuning ink map	1: Output tuning ink map



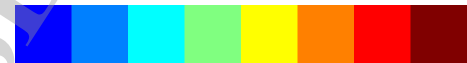
L2: Reduce Noise in Flat Area





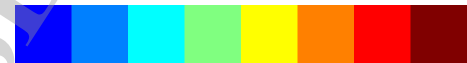
L2: Reduce Noise in Flat Area





L1: Keep More Mid-High-f Content

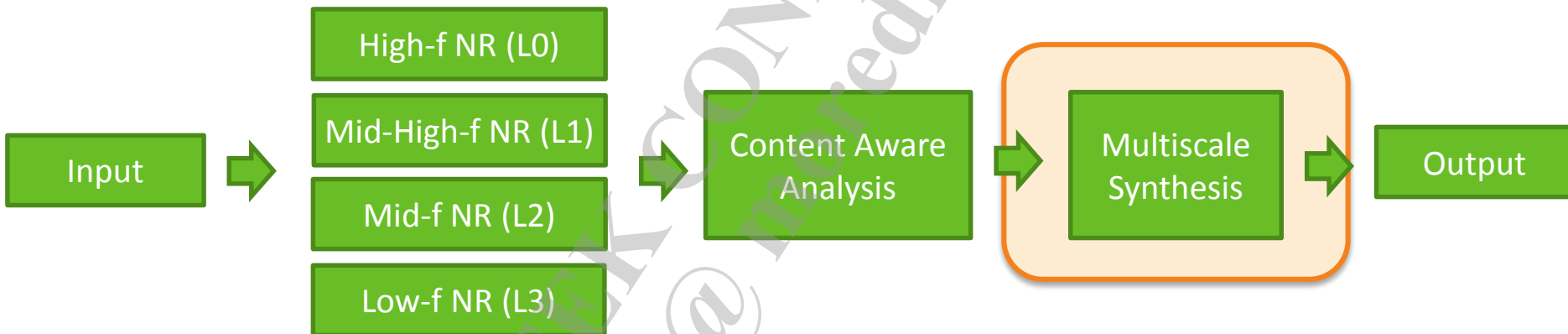




L1: Keep More Mid-High-f Content



P40 Multiscale NR Filter Tuning

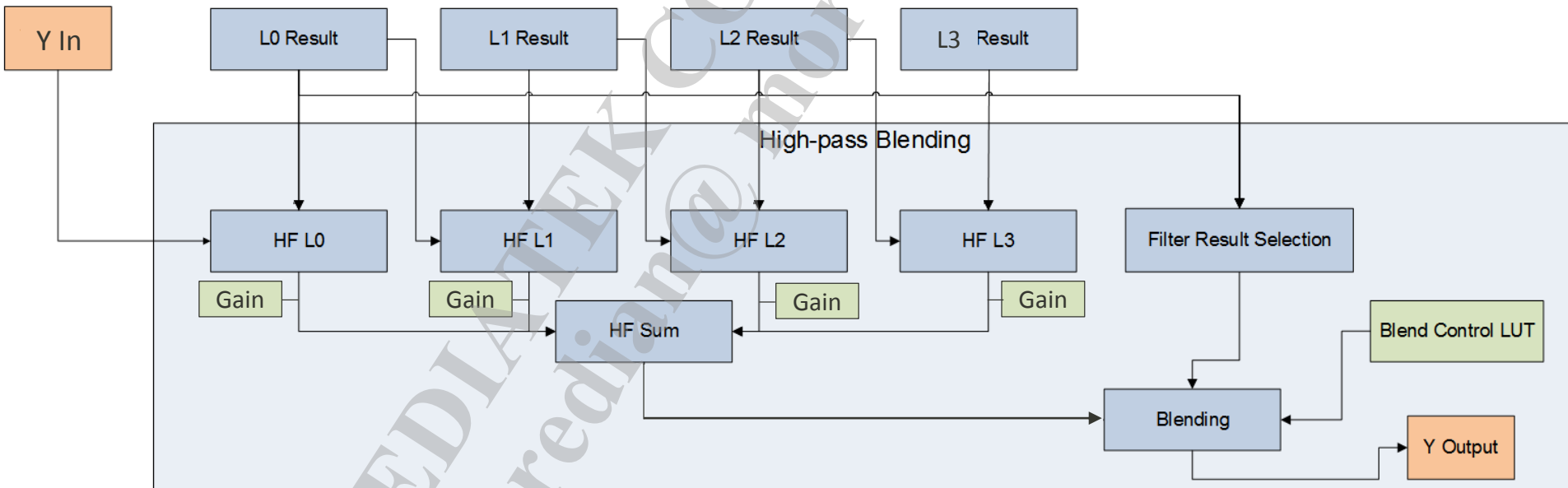


Multiscale Synthesis

Y L0 HF W	16
Y L1 HF W	8
Y L2 HF W	4
Y L3 HF W	4
ITUNE ANR BLD OFF	<input checked="" type="checkbox"/>

P23	Register Name	Default	Description	Tuning
HH	ANR_Y_L0_HF_W	16	Luma L0 high-pass weight	Value↑, Blend more high-f grain noise
HL	ANR_Y_L1_HF_W	8	Luma L1 high-pass weight	Value↑, Blend more mid-High-f grain noise
L	ANR_Y_L2_HF_W	4	Luma L2 high-pass weight	Value↑, Blend more mid-f noise
	ANR_Y_L3_HF_W	4	Luma L3 high-pass weight	Value↑, Blend more low-f noise
	ITUNE_ANR_BLD_OFF	0	Disable blending for tuning	1: Blending off Easily observe NR result without blending

■ Blending source from multiscale filter



Blending Ratio

Value: 0~64

Value: 0~31

- Ex: HF_ACT_Y4= 32,

Y_HF_LUMA_Y0 = 0,

Y_L0_HF_W = 16,

→ Blending ratio:

$\min((32+0), 64) / 64 * 16 / 16 = 0.5$

(Blending 50% from source)

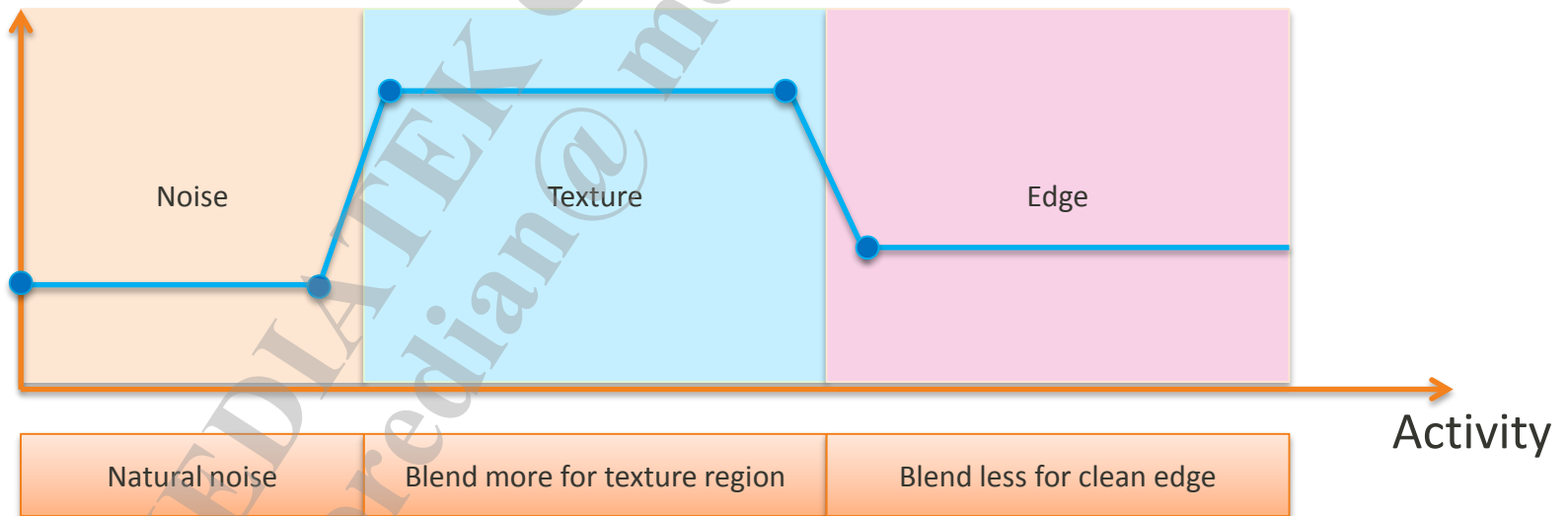
Act Map [Y 0/64 BLF/Ori]	
Y HF ACT X1	16
Y HF ACT X2	20
Y HF ACT X3	24
Y HF ACT X4	28
Y HF ACT Y0	32
Y HF ACT Y1	32
Y HF ACT Y2	32
Y HF ACT Y3	32
Y HF ACT Y4	32
Y HF ACT SP0	0
Y HF ACT SP1	0
Y HF ACT SP2	0
Y HF ACT SP3	0
Y HF ACT SP4	0
Y HF LUMA X1	0
Y HF LUMA X2	0
Y HF LUMA Y0	0
Y HF LUMA Y1	0
Y HF LUMA Y2	0
Y HF LUMA SP0	0
Y HF LUMA SP1	2
Y HF LUMA SP2	0

Blending Control	
Y L0 HF W	16
Y L1 HF W	16
Y L2 HF W	16
Y L3 HF W	16

Activity Blending LUT

- 5 Control Points
- Blending low ratio on edge to avoid noisy
- Blending high ratio to keep texture

Blending Ratio



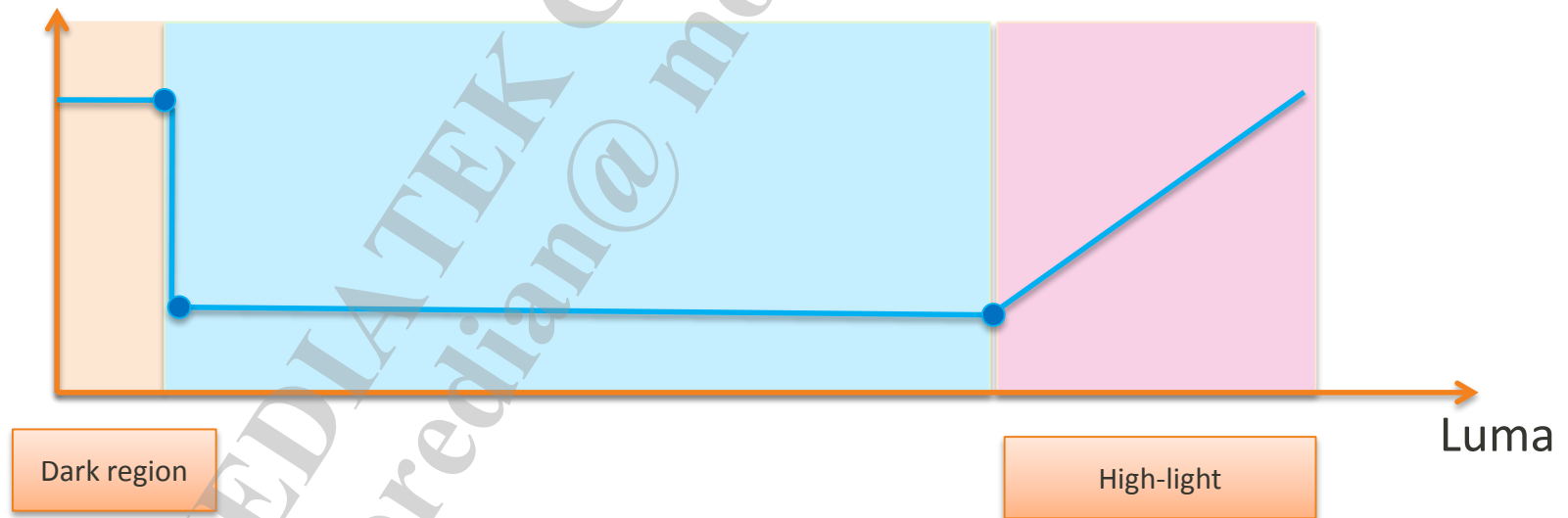
Y HF ACT X1	16
Y HF ACT X2	20
Y HF ACT X3	24
Y HF ACT X4	28
Y HF ACT Y0	19
Y HF ACT Y1	19
Y HF ACT Y2	19
Y HF ACT Y3	19
Y HF ACT Y4	19
Y HF ACT SP0	0
Y HF ACT SP1	0
Y HF ACT SP2	0
Y HF ACT SP3	0
Y HF ACT SP4	0

Luma Blending LUT

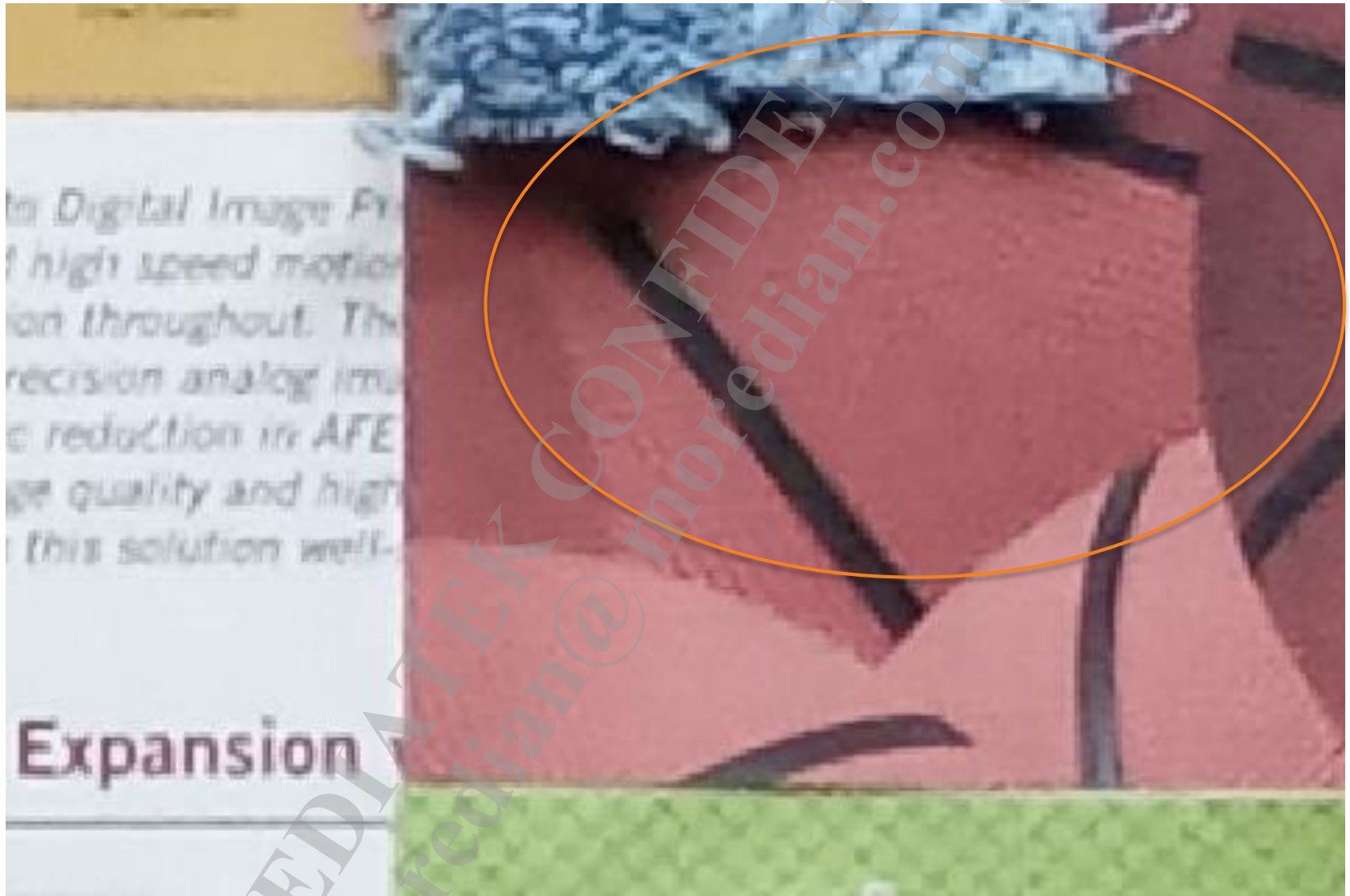
Y HF LUMA X1	0
Y HF LUMA X2	0
Y HF LUMA Y0	0
Y HF LUMA Y1	0
Y HF LUMA Y2	0
Y HF LUMA SP0	0
Y HF LUMA SP1	0
Y HF LUMA SP2	0

- 3 Control Points
- Blending for high-light region
- Blending for dark region

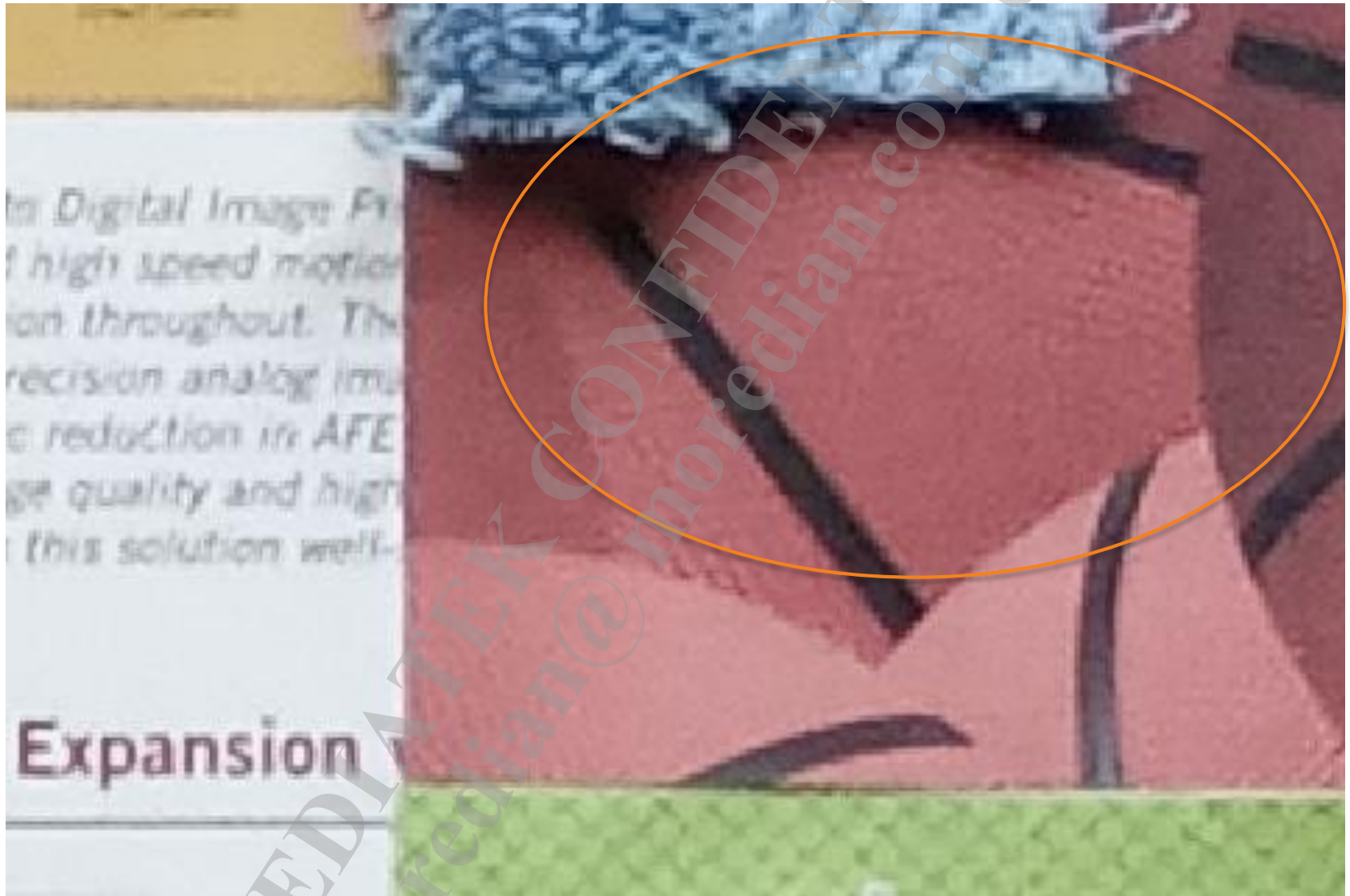
Blending Ratio



L0 HF W: Keep More high-f Detail



L0 HF W: Keep More high-f Detail



CONTOUR TUNING

Luma

Multiscale NR Filter Tuning

Contour Tuning

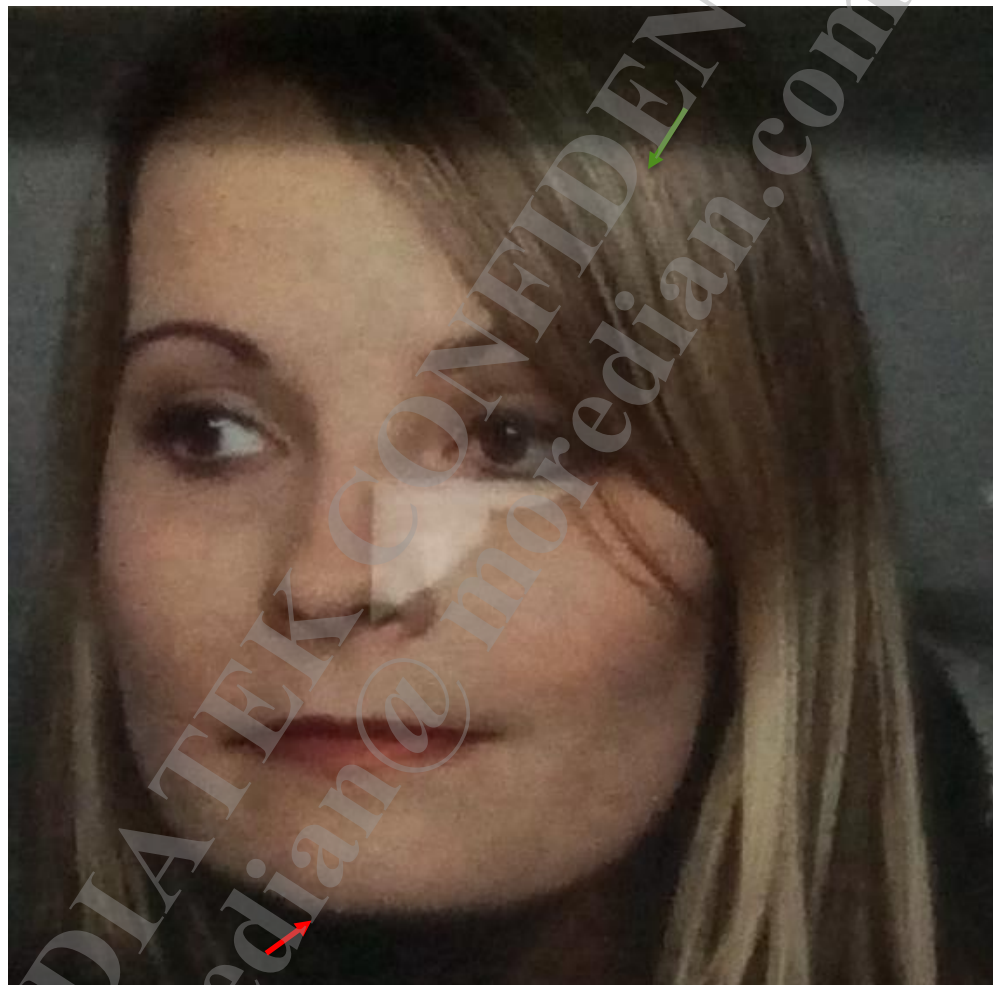
Contour Tuning

Y SLOPE H TH	8
Y SLOPE V TH	10

Register Name	Default	Description	Tuning
ANR_Y_SLOPE_V_TH	8	Luma vertical plane fitting threshold	The higher the smoother
ANR_Y_SLOPE_H_TH	10	Luma horizontal plane fitting threshold	The higher the smoother

- To reduce contour artifact
- Suggest Tuning
 - ANR_Y_SLOPE_H_TH → 8
 - ANR_Y_SLOPE_V_TH → 10 ($\text{ANR_Y_SLOPE_H_TH} * 5 / 4$)

Contour Tuning



- Contour Smoother
- Too Strong might Lose Edge

Y SLOPE H TH = 4

Y SLOPE V TH = 5

Contour Tuning



- Contour Smoother
- Too Strong might Lose Edge

Y SLOPE H TH = 40
Y SLOPE V TH = 50

MEDIATEK

everyday genius