

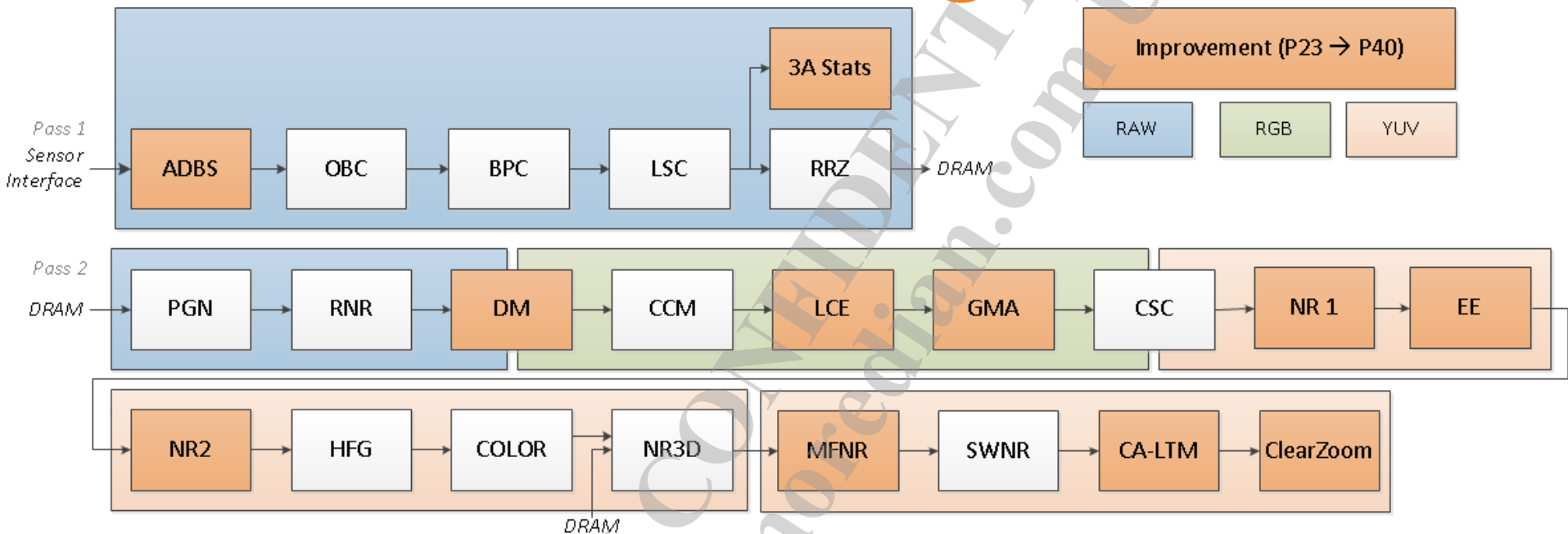
CONFIDENTIAL B

MEDIATEK

P40 Pipeline Introduction



P40 Block Diagram



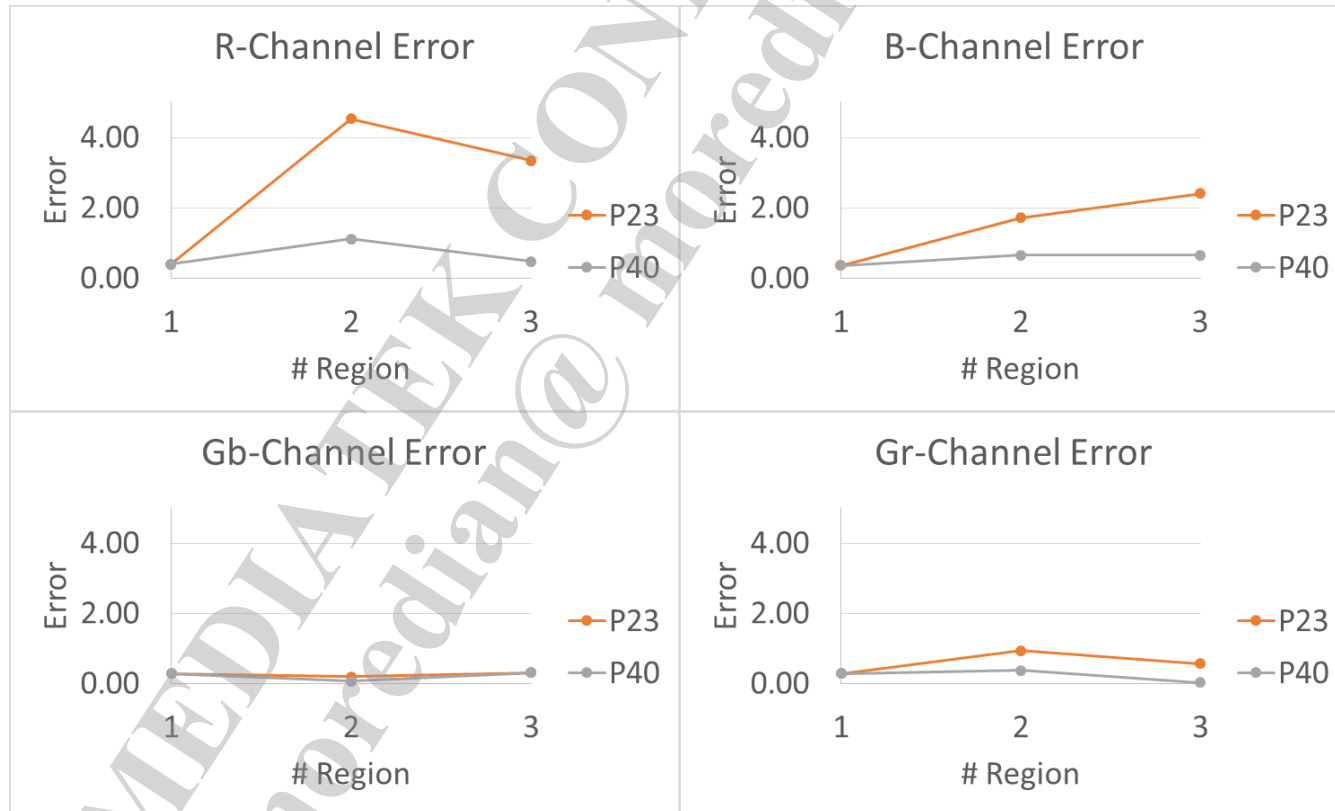
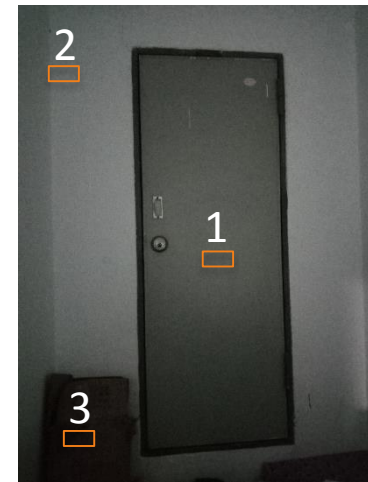
Noise		Tone		Color	
BPC	Bad Pixel Correction & G imbalance	ADBS	Advanced De-Bias	PGN	Pre-gain (WB gain)
NR 1	Noise Reduction 1	OBC	Optical Black Correction	CCM	Color Correction Matrix
NR 2	Noise Reduction 2	LSC	Lens Shading Correction	COLOR	Color Engine
NR2 - ABF	Anti-Blooming Filter	LCE	Local Contrast Enhancement	Morphing	
NR2 - CCR	Chroma Coring	GMA	Gamma Correction	RRZ	Raw Resizer
RNR	Raw Noise Reduction	CA-LTM	Content-Aware Local Tone Mapping	Texture	
HFG	High Frequency Generator	Others		DM	Demosaic
NR3D	Temporal Noise Reduction	3A Stats	3A Statistics	EE	Edge Enhancement
MFNR	Multi-Frame Noise Reduction	CSC	Color Space Conversion	ClearZoom	Clear Zoom
SWNR	SW-based Noise Reduction				

Major Module-Level Improvements

Module	Improvement Description
ADBS	Large-kernel local model to estimate precise optical black level
DM	Multi-scale interpolation to improve high-frequency content resolution
LCE	NR Link to reduce noise boosted after tone mapping
GGM	Support 192 control points (from 144)
NR1	Content-dependent multi-scale filtering with better frequency selectivity .Preserve more content/texture at same noise level .Preserve smooth gradation Direct 2D filter (instead of 1D+1D) to improve resolution and remove cross-line artifact Color-dependent NR Face IQ
EE	Preserve smooth gradation Preserve saturation on color edge after sharpening Color-dependent enhancement
NR2-ABF	HW support anti-blooming filter natively
CA-LTM	Content-aware local tone mapping
ClearZoom	Achieve better zoom IQ
MFNR	Overall IQ Improvement

ADBS Improvement

- P40改善了區域bias的估計方式並加大window，消除色偏效果更佳



Comparison: P23



Comparison: P40



DM Improvement – P23



DM Improvement – P23

- Multi-scale interpolation



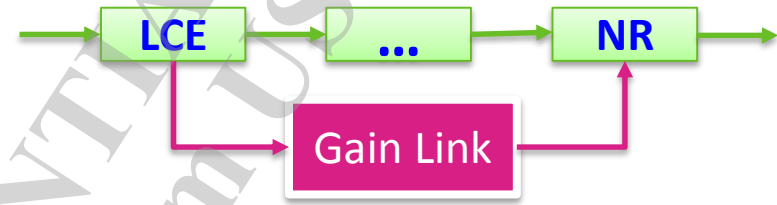
ISO100, 300%



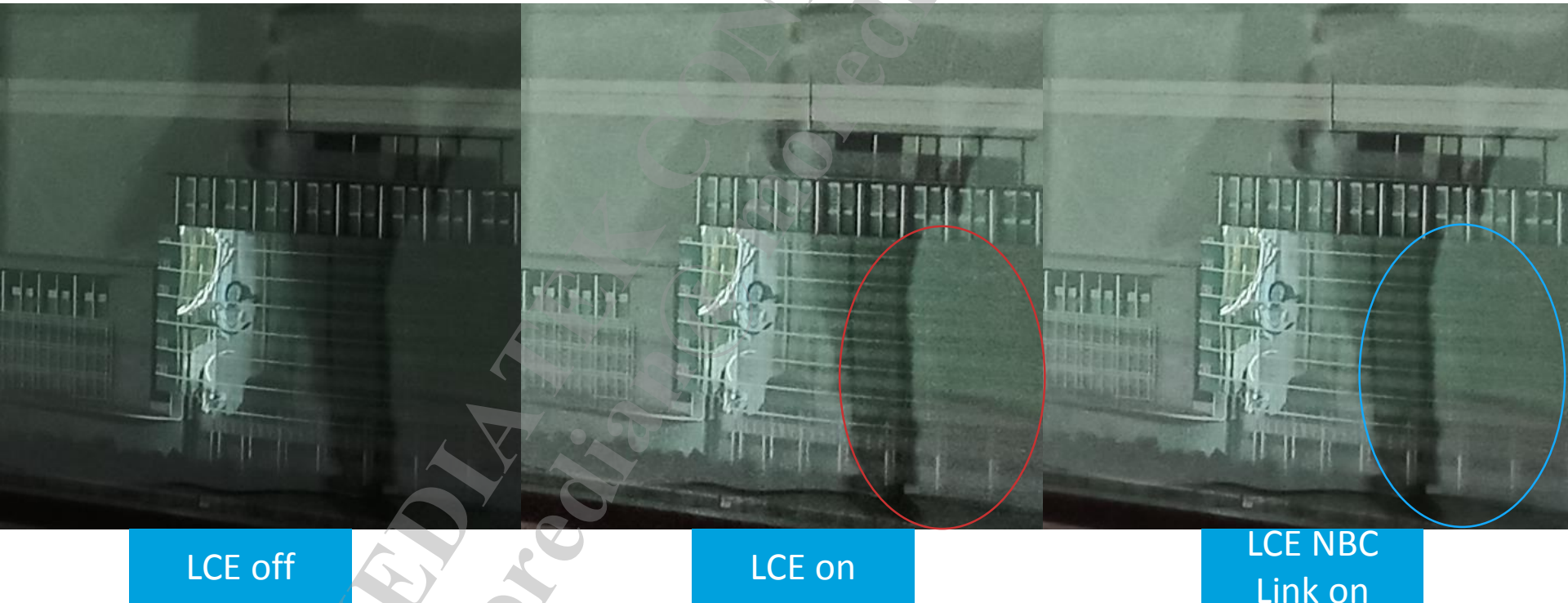
ISO327, 300%

Improve high-frequency content resolution

LCE Improvement



- LCE-NR Link
 - To suppress the noise which enhanced by LCE locally



Gamma Improvement

- Modify control points from 144 to **192** since P40

Input Range	Control Point Number	Step	Control Point
0~511	64	8	{0,8,16,... ,504}
512~1023	32	16	{512,528,... ,1008}
1024~2047	32	32	{1024,1056,... ,2016}
2048~4095	16 → 64	128 → 32	{2048,2064,... ,4064}

NR1 Improvement – P23



NR1 Improvement – P40

- NR Improvement
 - Content-dependent multi-scale filtering with better frequency selectivity
 - Direct 2D filter (instead of 1D+1D) to improve resolution and remove cross-line artifact

Preserve smooth gradation



Preserve more content/texture with same noise level



NR1 Improvement – Color-Dependent NR

- Adjust NR strength by luma & color

The screenshot displays the MEDIATEK software interface for color calibration. The main window is divided into several sections:

- Result:** A photograph of a red yarn spool with two yellow dashed boxes highlighting specific areas of interest.
- Target:** A light blue area with an orange box labeled "Preference color window".
- Color Wheel:** A circular color wheel with a red box labeled "1" indicating a specific color target.
- Preference color setting:** A blue box containing a histogram and a red box labeled "1" indicating a specific color target.
- Configuration:** A section with sliders for "Window 1", "Window 2", "Window 3", and "Window 4". The "Window 1" settings are: CB Window Cent: -16, Window Rang: 32, Gain: 0.1; CR Window Cent: 82, Window Rang: 32, Gain: 0.1. The "Y" settings are: Window Cent: 65, Window Rang: 32, Gain: 0.1. The "Configuration" section has a checkbox for "Window 1 Enable" which is checked.
- Auto Tuning Steps:** A section with a "Run" button.

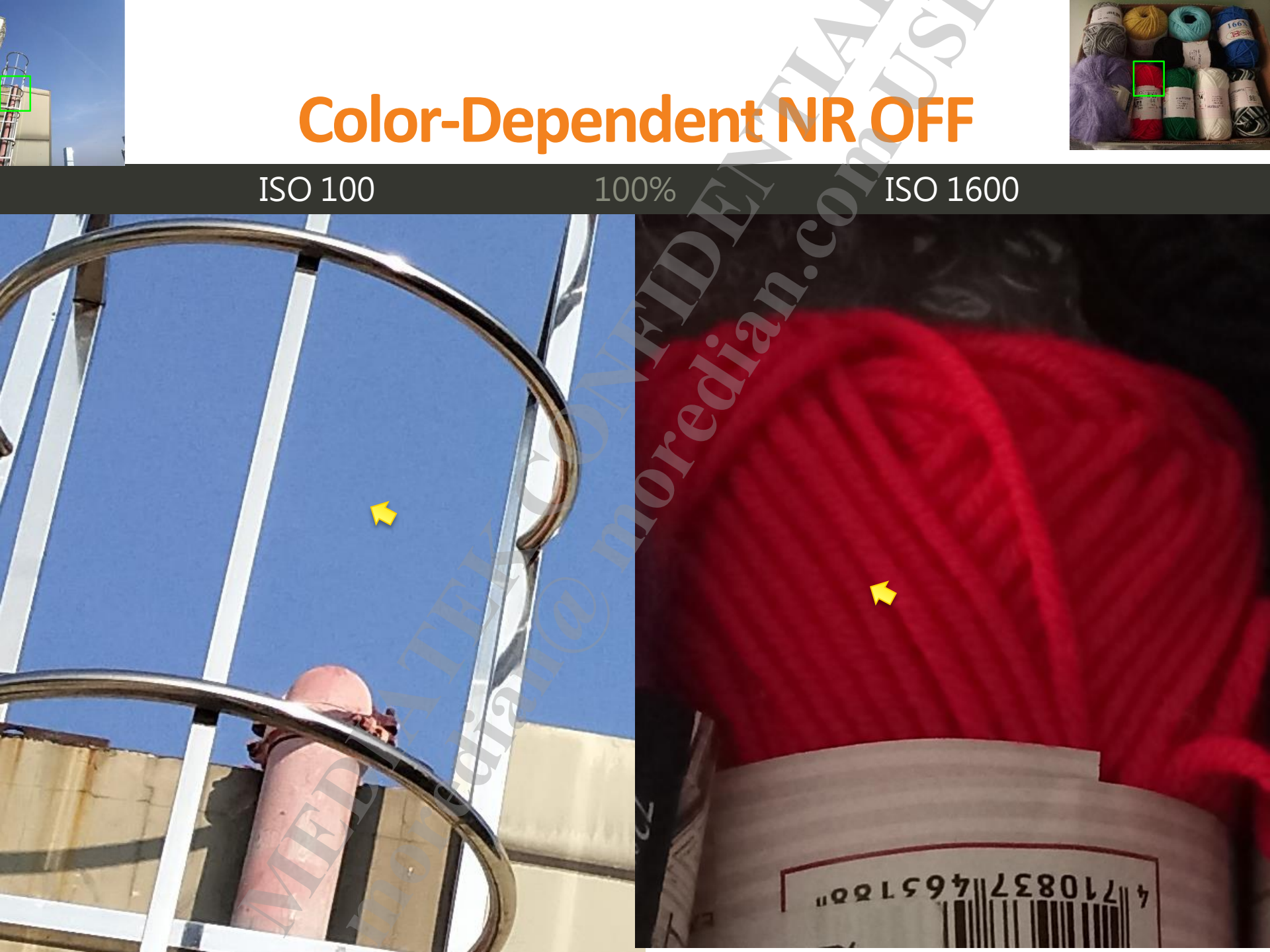
The bottom status bar shows the coordinates: x:2751 y:885, R:138 G:122 B:133, Y:128 H:69 S:7.

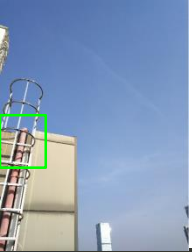
Color-Dependent NR OFF

ISO 100

100%

ISO 1600





Color-Dependent NR ON

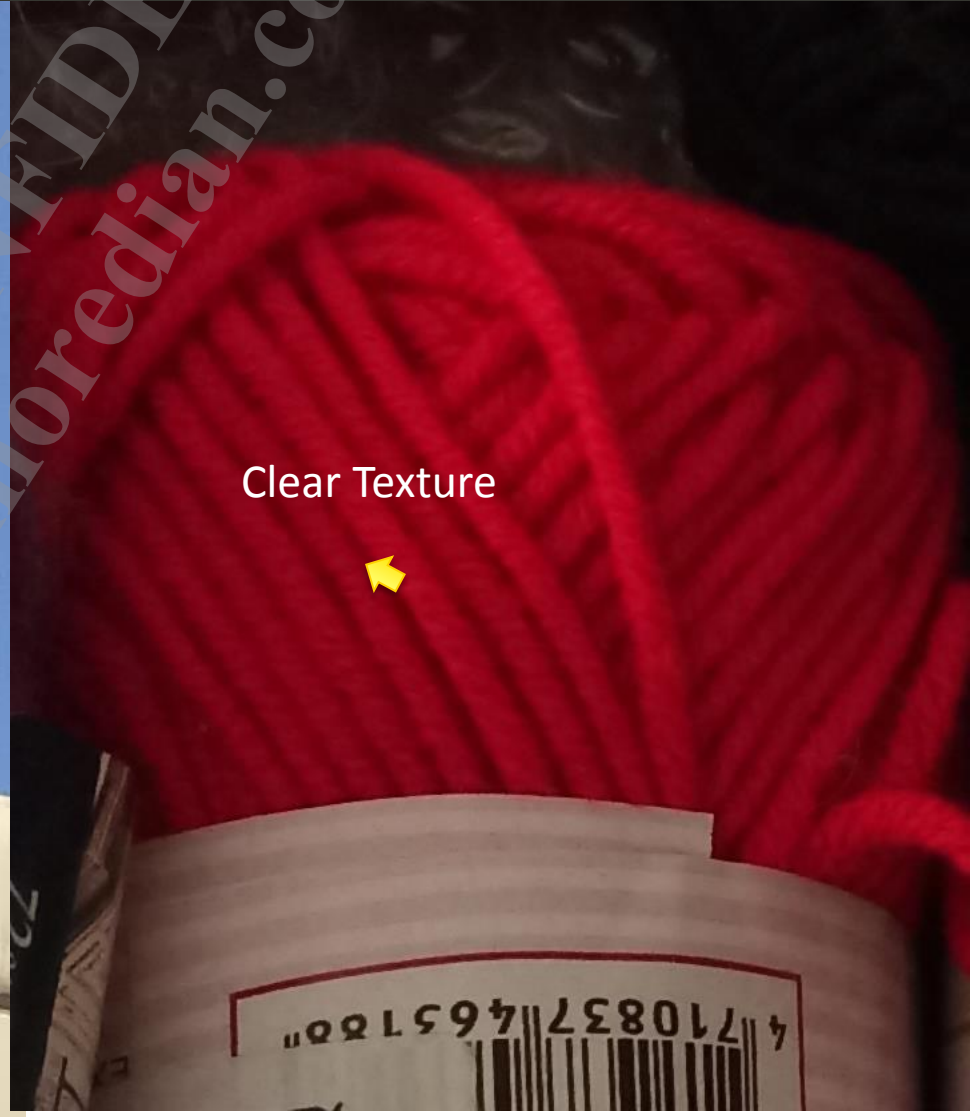
ISO 100

100%

ISO 1600



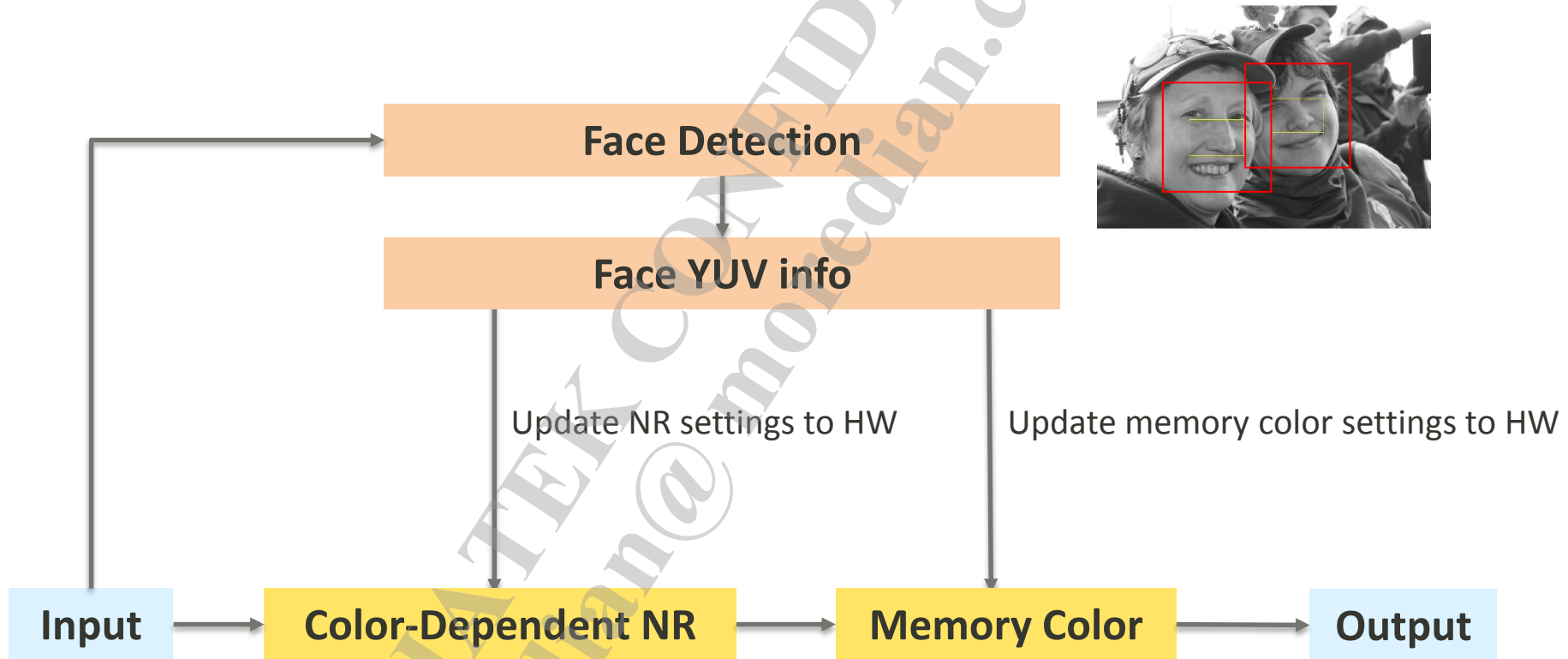
Smooth Sky



Clear Texture



NR1 Improvement – Face IQ



Face IQ



Face IQ



OFF



ON

EE Improvement: Preserve Smooth Gradation



EE Input

P23

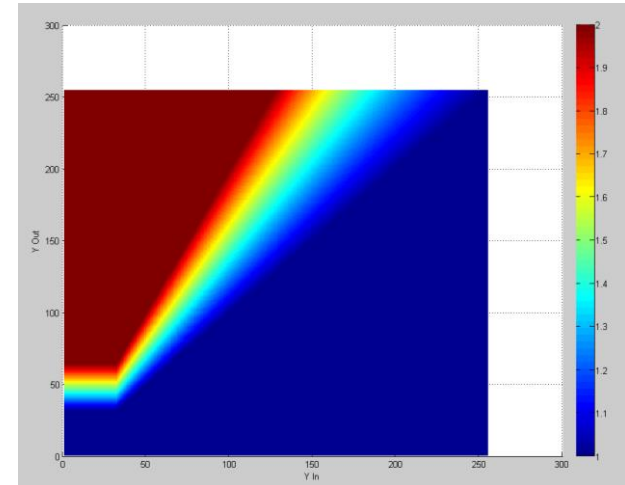
P40

EE Improvement: Preserve Saturation on Color Edge



P23

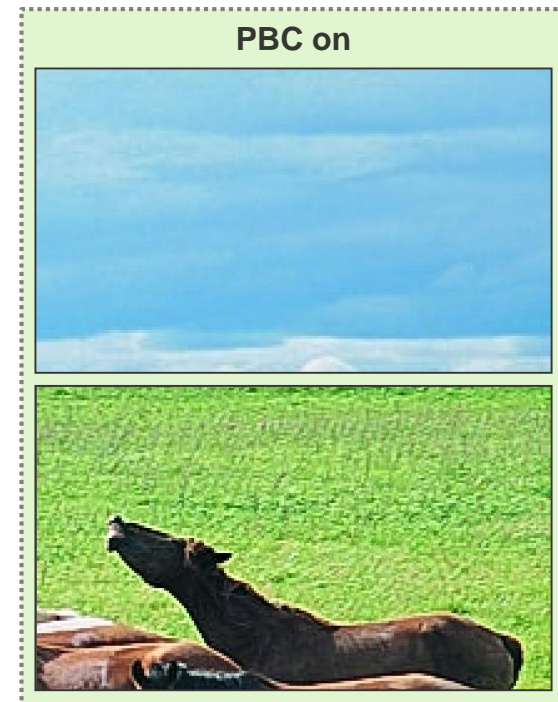
EE Improvement: Preserve Saturation on Color Edge



P40

EE Improvement: PBC (Peaking By Color)

- Color dependent sharpness/blurring
 - Apply different settings for different colors, e.g.,
 - Stronger sharpness for the grass and trees
 - Less sharpness for the skin and sky
 - Blur the details on the sky



NBC2-ABF Improvement

- Real-time processing



Purple fringe removal

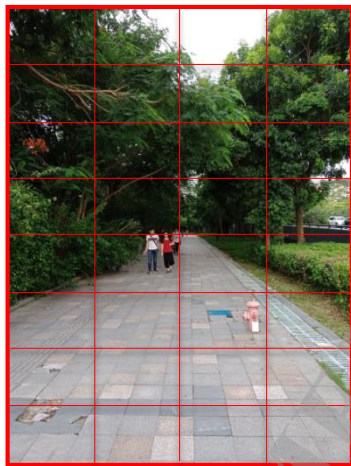
Keep chroma detail

Input

HWABF output

CA-LTM: Content-Aware Local Tone Mapping

- Key features
 - Keep overall luma average
 - Local contrast/detail enhancement
 - Skin/flat region protection
 - No noise boost



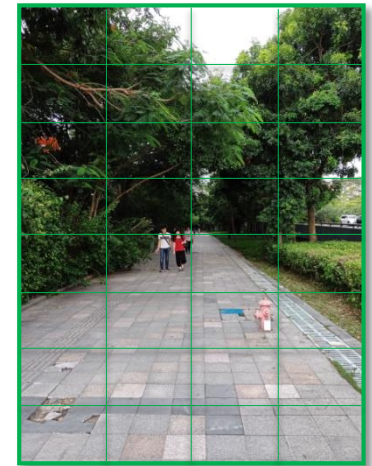
H	H	H	H
H	H	H	H
H	H	H	H
H	H	H	H
H	H	H	H
H	H	H	H
H	H	H	H
H	H	H	H

H: Histogram

CA-LTM
SW

M	M	M	M
M	M	M	M
M	M	M	M
M	M	M	M
M	M	M	M
M	M	M	M
M	M	M	M
M	M	M	M

M: Mapping Curve



不影響整體平均亮度

- 即使強度不同，整體平均亮度皆一致



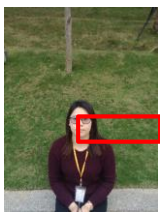
OFF



DEFAULT

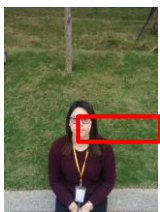


STRONG



局部對比/細節強化



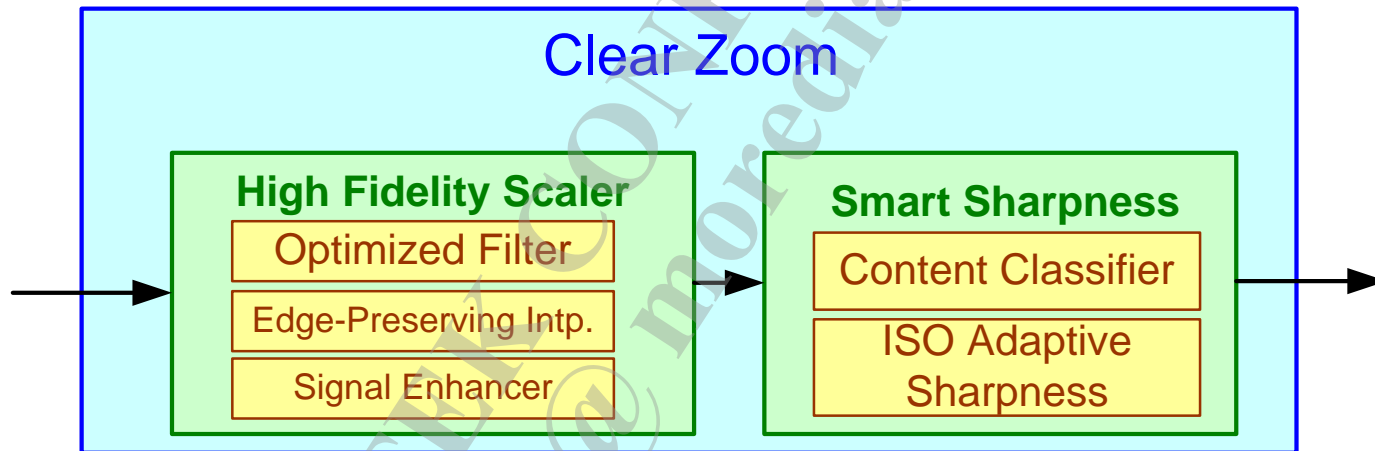


局部對比/細節強化



ClearZoom

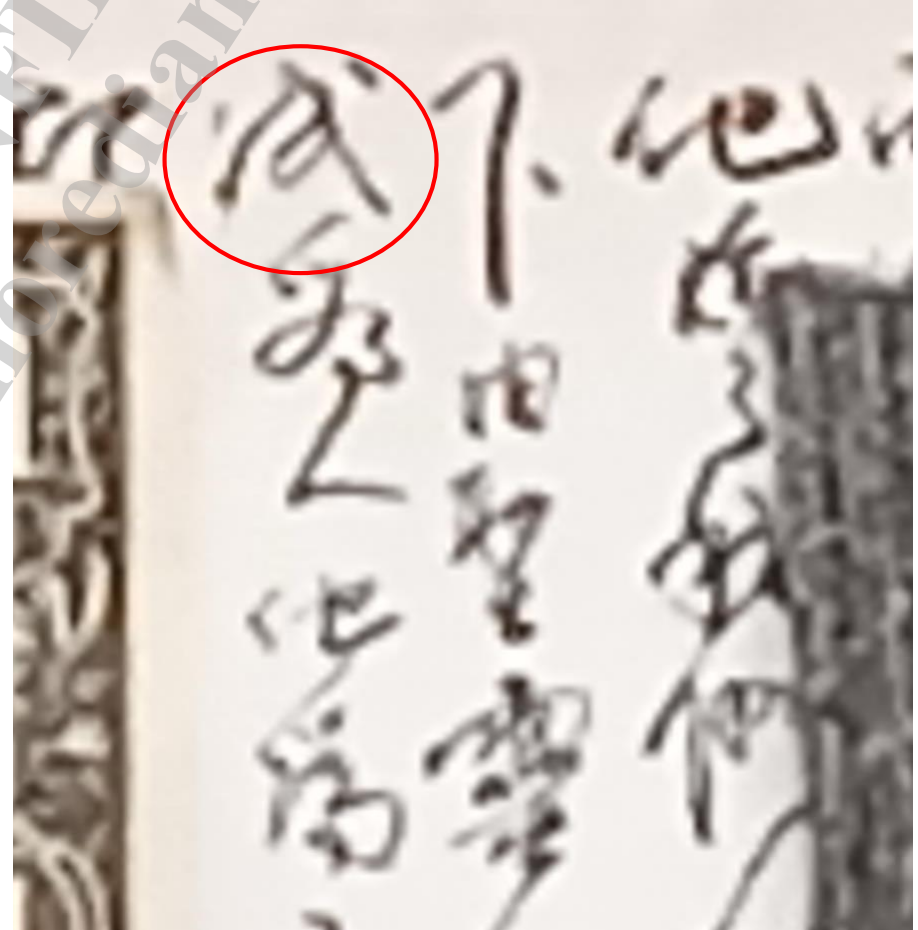
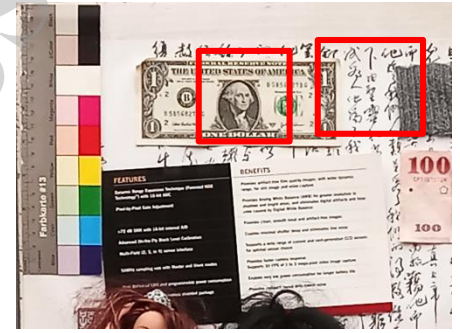
- Combination of **High Fidelity Scaler** and **Smart Sharpness** to achieve best digital zoom IQ



- Usage
 - Zoom for capture/preview/video
 - 4 cell sensor support

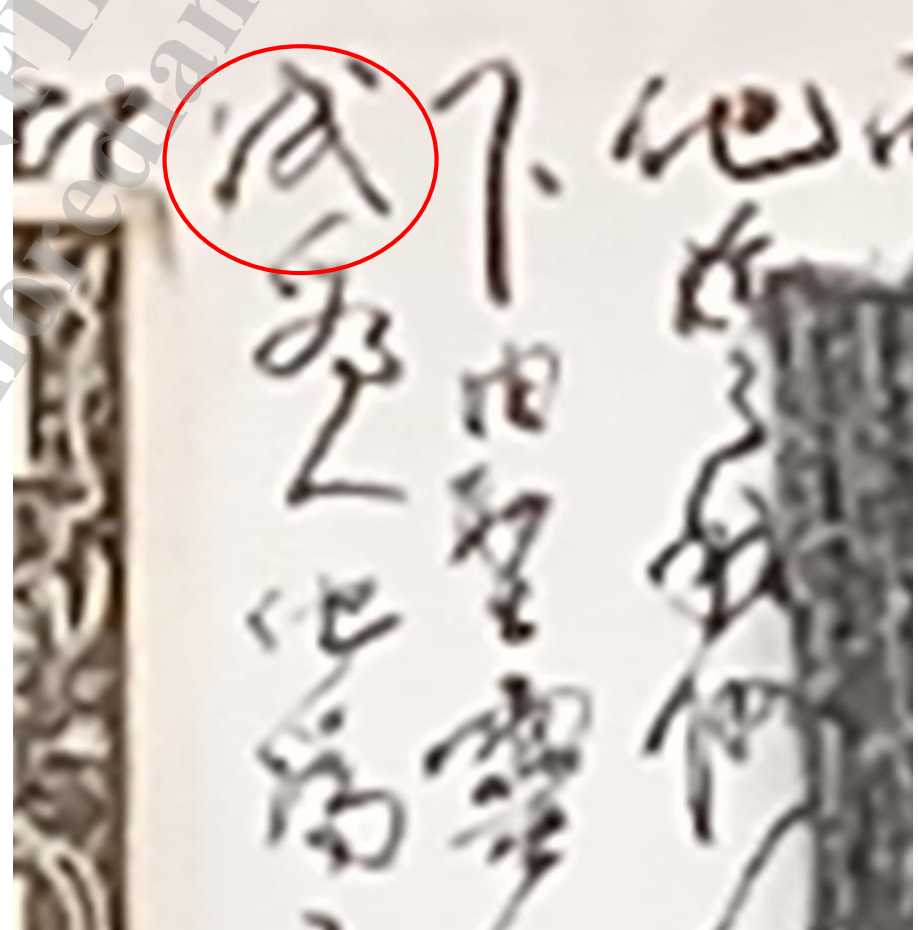
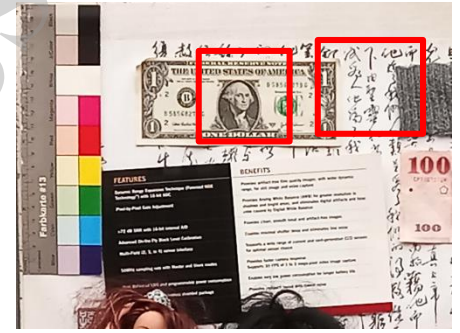
8X Digital Zoom (w/o ClearZoom)

- 100%

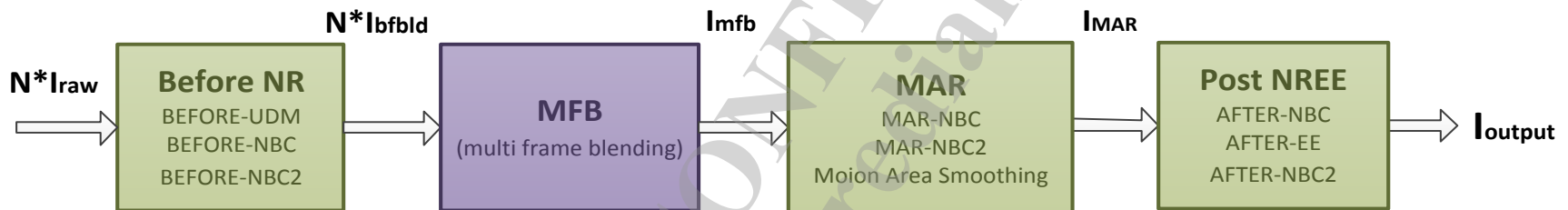


8X Digital Zoom (w/ ClearZoom)

- 100%



MFNR Flow



$N \cdot I_{raw}$

Input RAW files. In P40, $N=2 \sim 6$

$N \cdot I_{bfbl}$

Images prepared to do multi-frame blending

I_{mfb}

Single blended Image

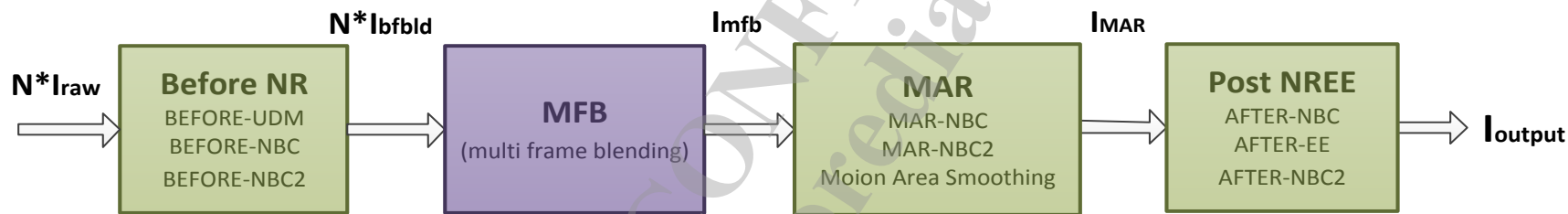
I_{MAR}

Image after motion area refinement

I_{output}

Image after post-NR/EE processing

Module Control of Each Stage



Before Stage	Similar as single capture (no EE/ABF/CCR/HFG/COLOR)
MFB	MFB only
MAR	Only NR1/NR2 (no EE/HFG)
Post Stage	NR1/EE/NR2/ ABF /CCR/EE/HFG/ COLOR

MEDIATEK

everyday genius