A Unified HDR Imaging Method with Pixel and Patch Level

THU-PM-153
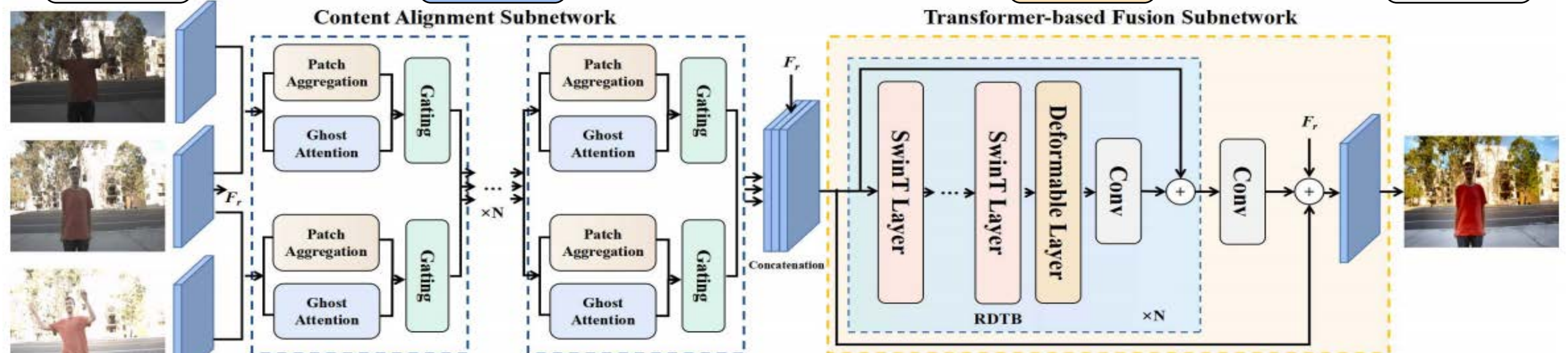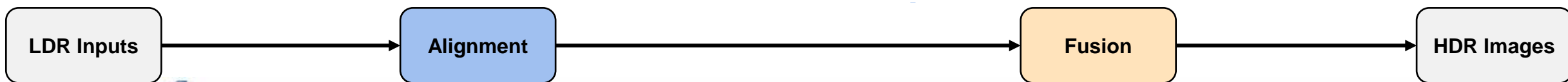
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Summary

Problems:

LDR images

HDR images

PA   GA   Full

Pipeline

| LDR Inputs | → | Alignment | → | Fusion | → | HDR Images |

Content Alignment Subnetwork

Patch Aggregation

Ghost Attention

Gating

×N

Patch Aggregation

Ghost Attention

Gating

F_r

Concatenation

Transformer-based Fusion Subnetwork

SwinT Layer ···· SwinT Layer — Deformable Layer — Conv — + — Conv — +

F_r

RDTB   ×N

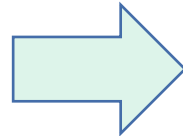Aligning the content when saturation and motion existing simultaneously.

Adaptively merging information of different regions with local and global viewpoints.

Background

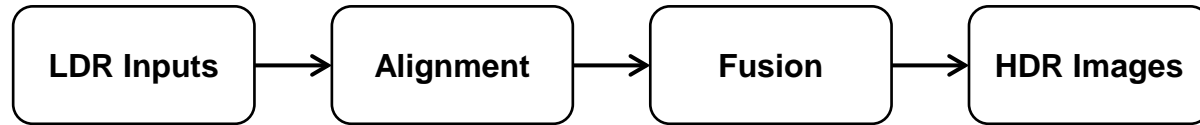- **HDR Deghotsting**

LDR Images

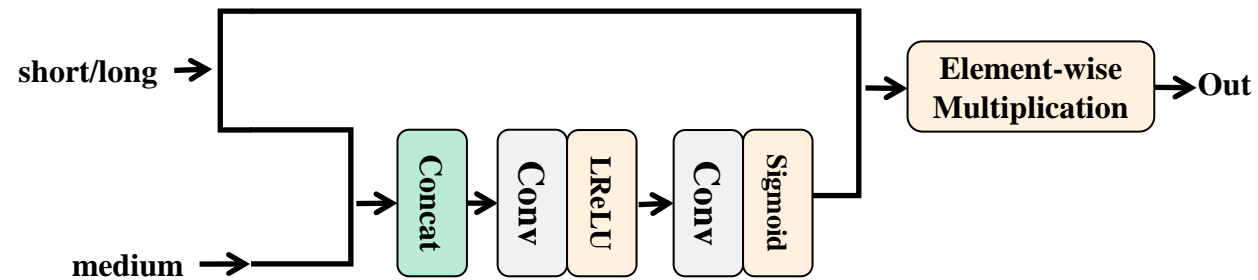Simultaneously

☑ Saturation   ☑ Motion

Ghost-free

HDR Images with ghosts
Ghost-free HDR Images

Background

- **Existing Methods**

```
┌──────────────┐      ┌──────────────┐      ┌──────────────┐      ┌──────────────┐
│  LDR Inputs  │ ───► │  Alignment   │ ───► │   Fusion     │ ───► │  HDR Images  │
└──────────────┘      └──────────────┘      └──────────────┘      └──────────────┘
```

- **Alignment**

Attention-based methods

short/long →

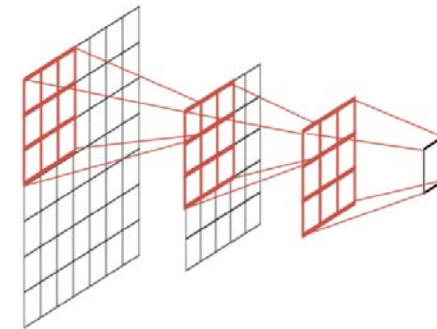medium →

Concat → Conv → LReLU → Conv → Sigmoid → Element-wise Multiplication → Out

☑ Only considers the features in the same positions with pixel level

☑ Local Information

☒ Patch level

☒ Global Information
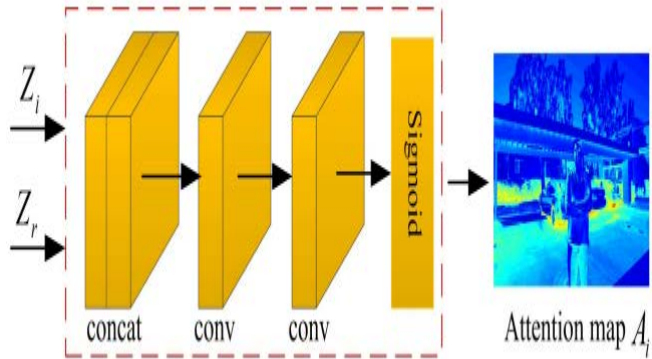
- **Fusion**

CNN-based methods

☑ Local Information

☑ Static Weights

☒ Global Information

☒ Dynamic Weights

Movtivation

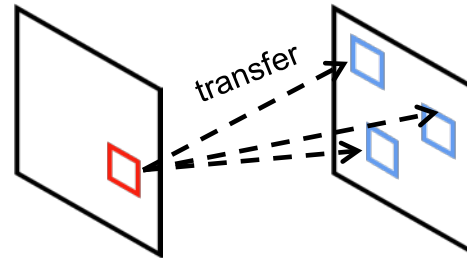**Attention-Based**

Drawbacks:
  1. Local information
  2. Point operation

Result

Pixel-based

Patch-Based

reference frame   non-reference frame

✓ Patch level   ✓ Global Information
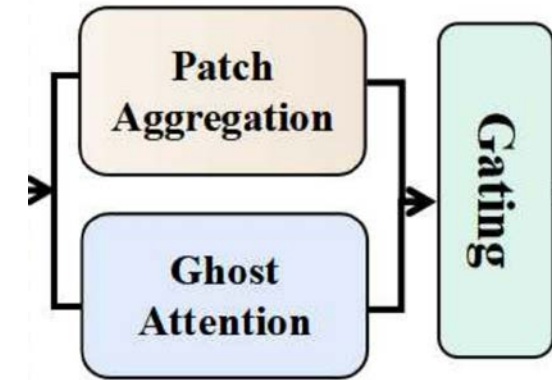
Drawbacks:
  1. Low Patch Utilization Ratio
  2. Structural Destruction
  3. High Computational Complexity

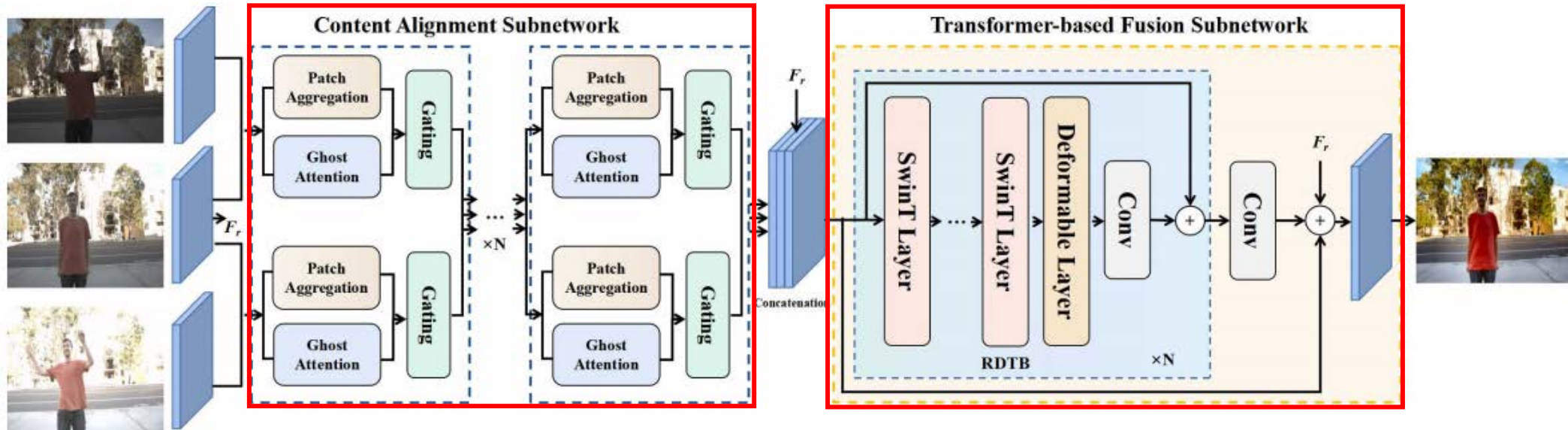**Result**

Patch-based

Hybrid-Based

✓ Local Information   ✓ Pixel level

✓ Global Information   ✓ Patch level

Result

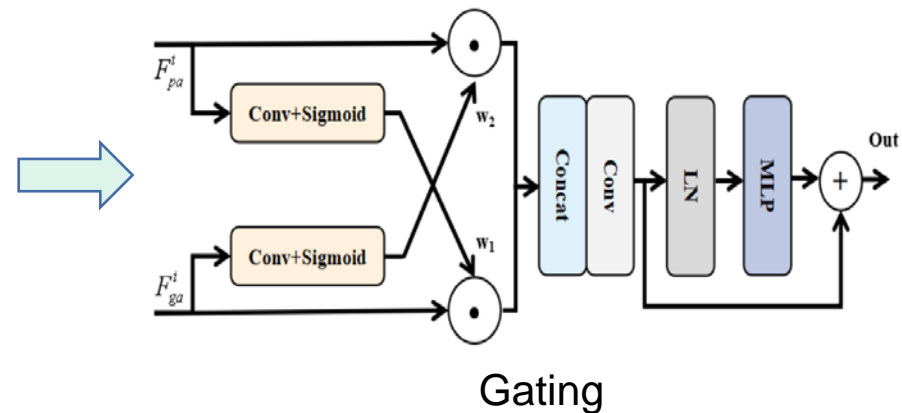# Our Method

- **Overview**

- The content alignment subnetwork removes ghosts and generates content of saturation and misalignment.

- The Transformer-based fusion subnetwork aims to generate high-quality ghost-free HDR images from the extracted features of LDR inputs.

Our Method

- **Content Alignment Subnetwork**

Patch Aggregation

Patch Aggregation

Ghost Attention

Attention

Gating
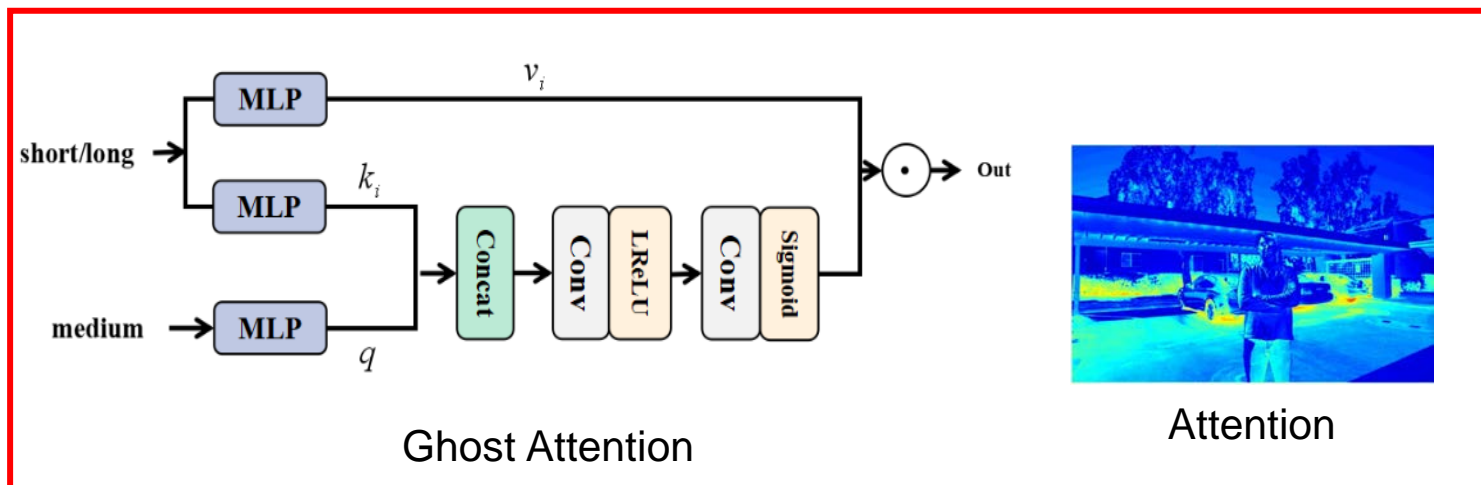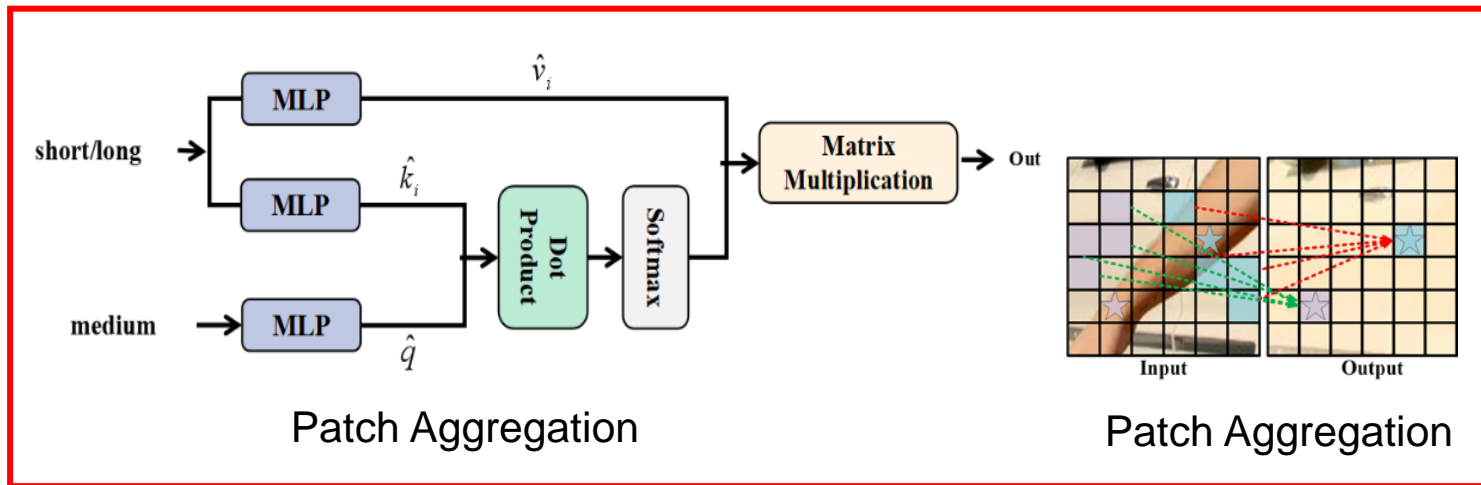
Our Method

- **Transformer-based Fusion Subnetwork**

Transformer-based Fusion Subnetwork
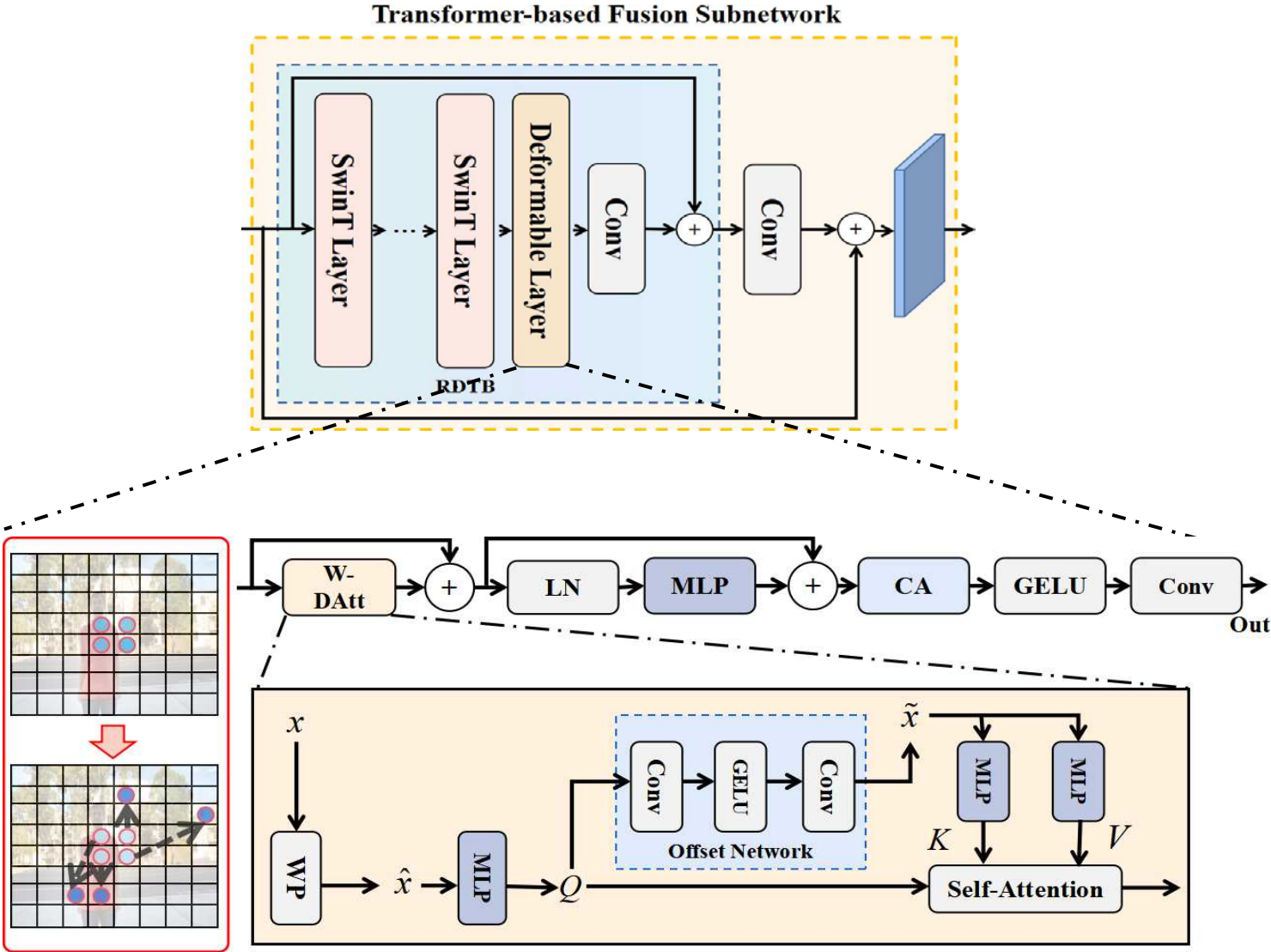
Experiment

- **Datasets w/ Ground Truth.**

LDRs   Our Result   LDR Patches   LDRs   Our Result   LDR Patches

Kalantari   DeepHDR   AHDR   NHDRR   HDR-GAN   ADNET   APNT   CA-ViT   Ours   GT   Kalantari   DeepHDR   AHDR   NHDRR   HDR-GAN   ADNET   APNT   CA-ViT   Ours   GT

(a) Kalantari's dataset   (b) Hu's dataset
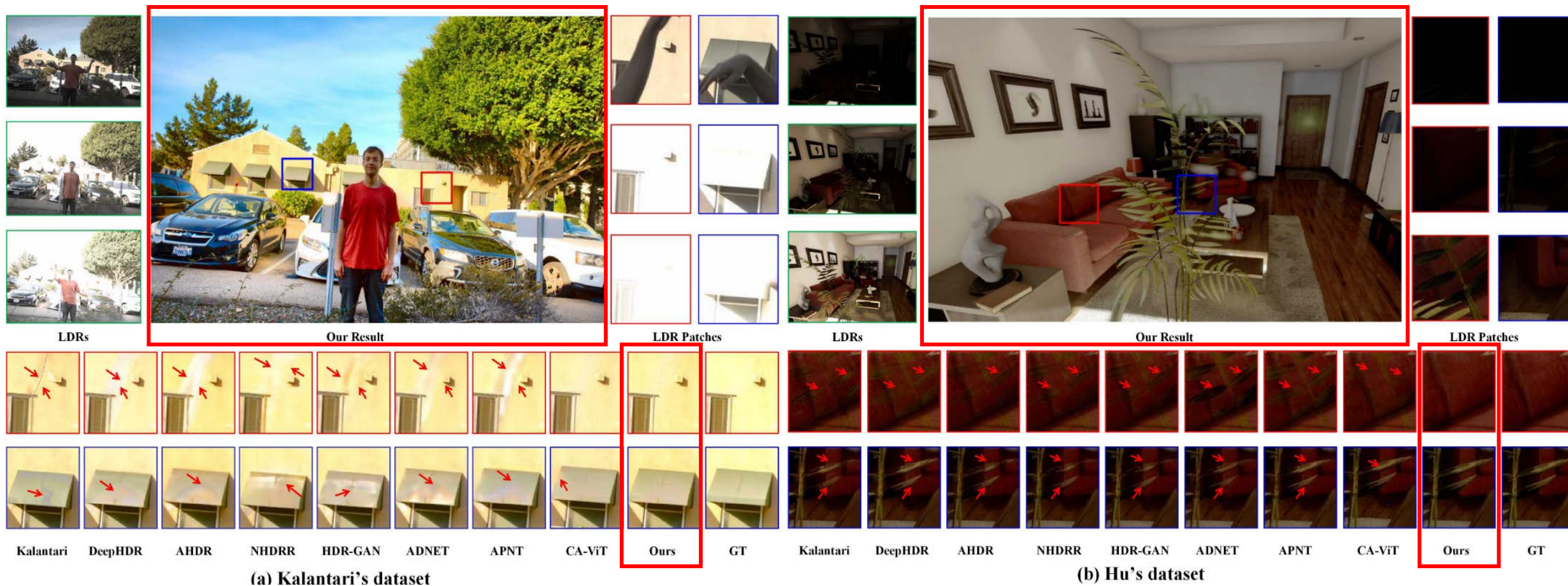
Experiment

- **Evaluation on Datasets w/o Ground Truth.**

LDRs   Our Result   LDR Patches   LDRs   Our Result   LDR Patches

Kalantari   DeepHDR   AHDR   NHDRR   HDR-GAN   ADNET   APNT   CA-ViT   Ours

(c) Tursun's dataset

Kalantari   DeepHDR   AHDR   NHDRR   HDR-GAN   ADNET   APNT   CA-ViT   Ours

(d) Sen's dataset
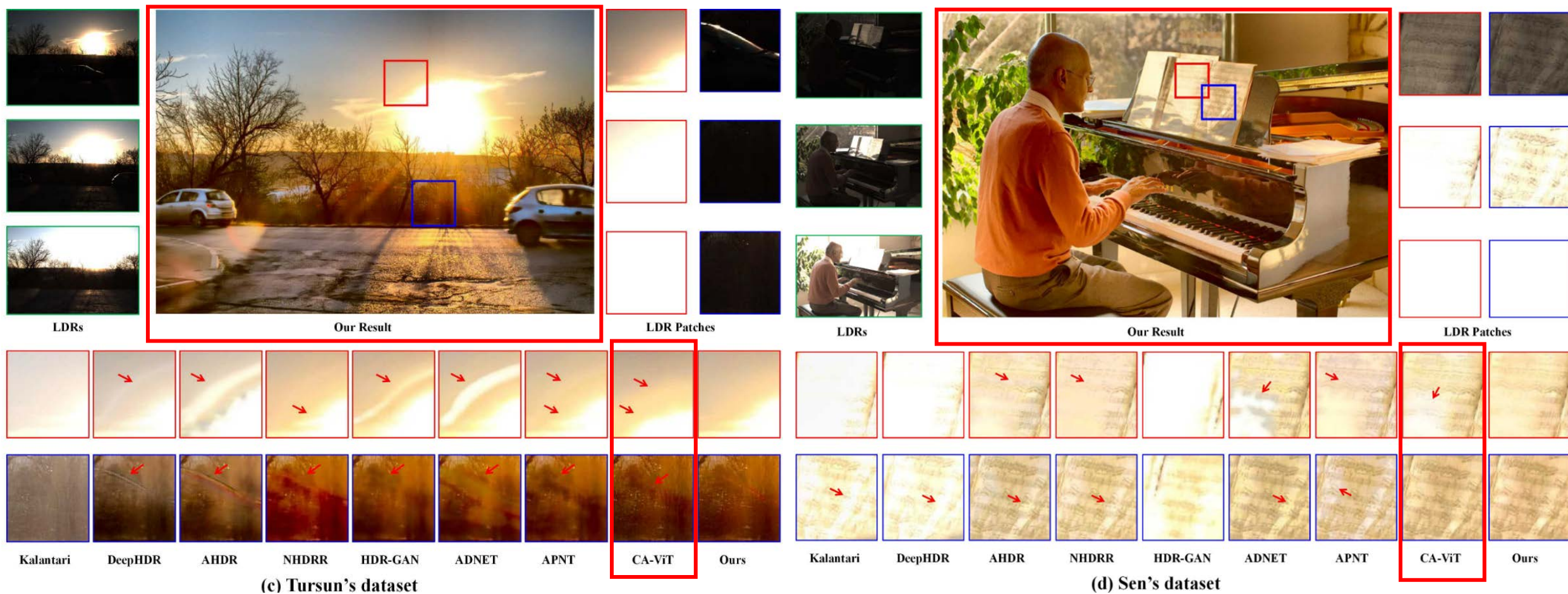
Experiment

- **Quantitative Result**

Datasets	Models	Sen	Hu	Kalantari	DeepHDR	AHDRNet	NHDRR	HDR-GAN	ADNet	APNT	CA-ViT	Ours
Kalantari	PSNR-μ	40.95	32.19	42.74	41.64	43.62	42.41	43.92	43.76	43.94	<u>44.32</u>	**44.64**
	PSNR-L	38.31	30.84	41.22	40.91	41.03	41.08	41.57	41.27	41.61	<u>42.18</u>	**42.47**
	SSIM-μ	0.9805	0.9716	0.9877	0.9869	0.9900	0.9887	0.9905	0.9904	0.9898	**0.9916**	<u>0.9915</u>
	SSIM-L	0.9726	0.9506	0.9848	0.9858	0.9862	0.9861	0.9865	0.9860	0.9879	<u>0.9884</u>	**0.9894**
	HDR-VDP-2	55.72	55.25	60.51	60.50	62.30	61.21	65.45	62.61	64.05	<u>66.03</u>	**66.05**
Hu	PSNR-μ	31.48	36.56	41.60	41.13	45.76	45.15	45.86	46.79	46.41	<u>48.10</u>	**48.46**
	PSNR-L	33.58	36.94	43.76	41.20	49.22	48.75	49.14	50.38	47.97	<u>51.17</u>	**51.91**
	SSIM-μ	0.9531	0.9824	0.9914	0.9870	<u>0.9956</u>	0.9945	<u>0.9956</u>	0.9908	0.9953	0.9947	**0.9959**
	SSIM-L	0.9634	0.9877	0.9938	0.9941	0.9980	<u>0.9989</u>	0.9981	0.9987	0.9986	<u>0.9989</u>	**0.9991**
	HDR-VDP-2	66.39	67.58	72.94	70.82	75.04	74.86	75.19	76.21	73.06	<u>77.12</u>	**77.24**

Experiment

- **Ablation study**

Table 2. The Ablation study on Kalantari dataset

Models	PSNR-μ	PSNR-L	HDR-VDP-2
1.Baseline	43.56	41.72	63.80
2.+GA	43.99	41.95	65.43
3.+PA	44.22	42.03	65.57
4.+GA+PA+Gating	44.49	42.32	65.98
5.+GA+PA+Addition	44.28	42.10	65.79
6.+GA+PA+Concat	44.32	42.16	65.84
7.+GA+PA+Gating+DL	44.60	42.41	66.03
8.A-DRDB	44.06	41.66	65.49
9.Ours	**44.64**	**42.47**	**66.05**

Table 3. The Ablation study on Patch Utilization method

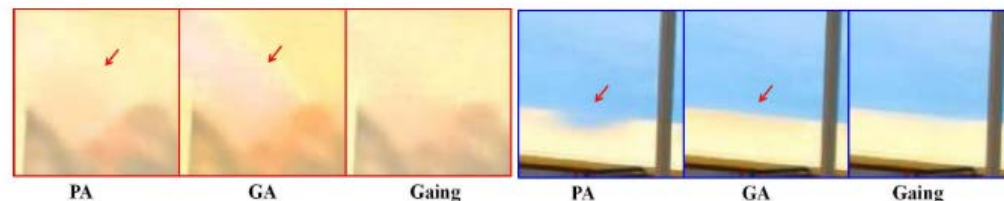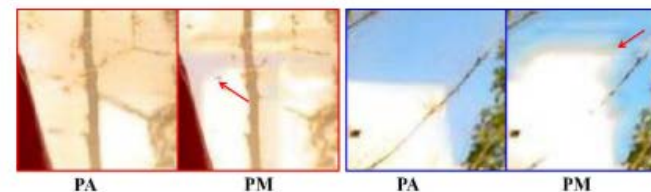| Patch methods	PSNR-μ	PSNR-L	HDR-VDP-2
PM	43.24	40.60	63.10
PA	**44.64**	**42.47**	**66.05**

Figure 8. Visual results of ablation study.

Figure 9. Visual results on PM and PA methods.