ICCV 2025

Event-guided HDR Reconstruction with Diffusion Priors

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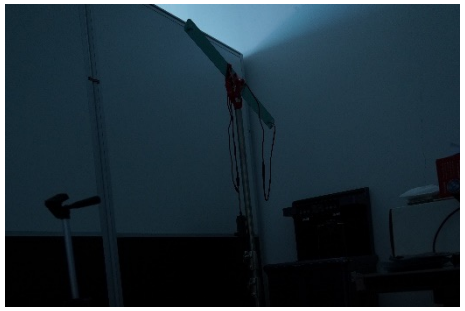
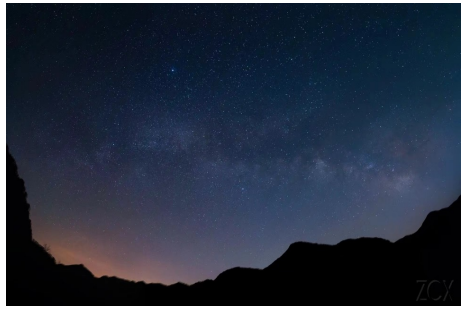
[†]This work is done during Yixin's internship at SenseTime.

Dynamic Range in the Real World



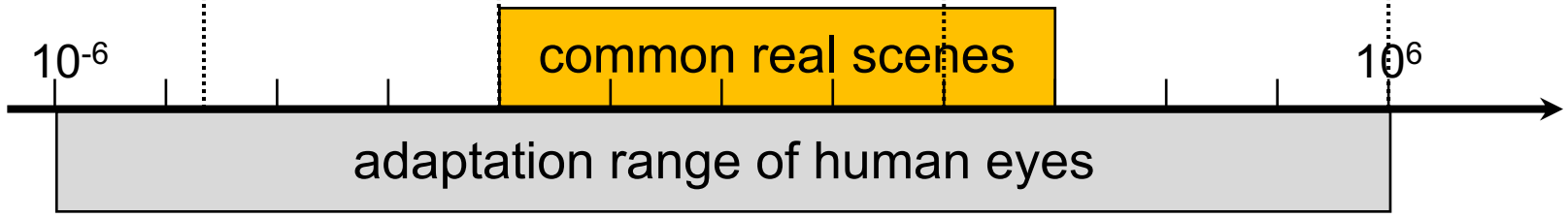
indoor without light

sunlight



moonless sky

outdoor shadow



The Dynamic Range covered by a single image is limited.

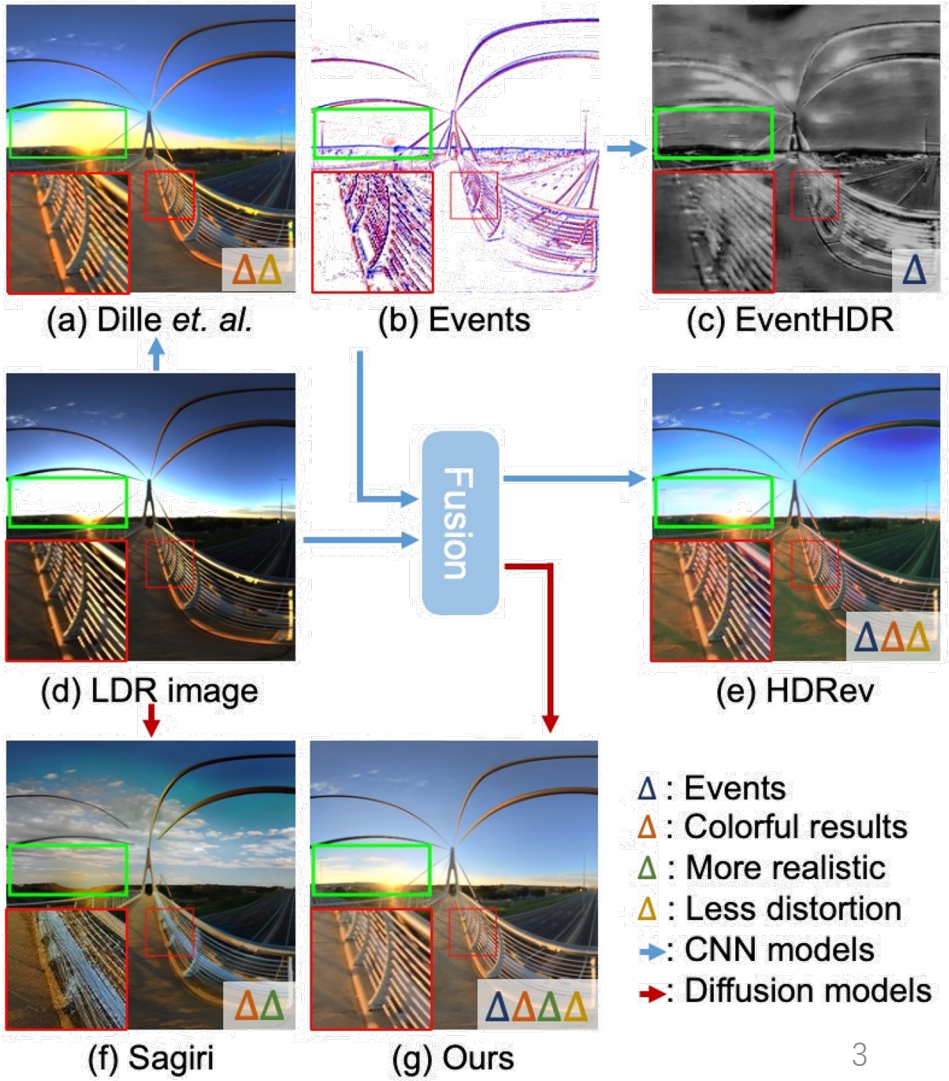
Low Exposure Image

High Exposure Image

Related Works

Image-based reconstruction

- CNN-based methods:
  [Dille *et al.*, ECCV'24] (a)
  [Liu *et al.*, CVPR'20]



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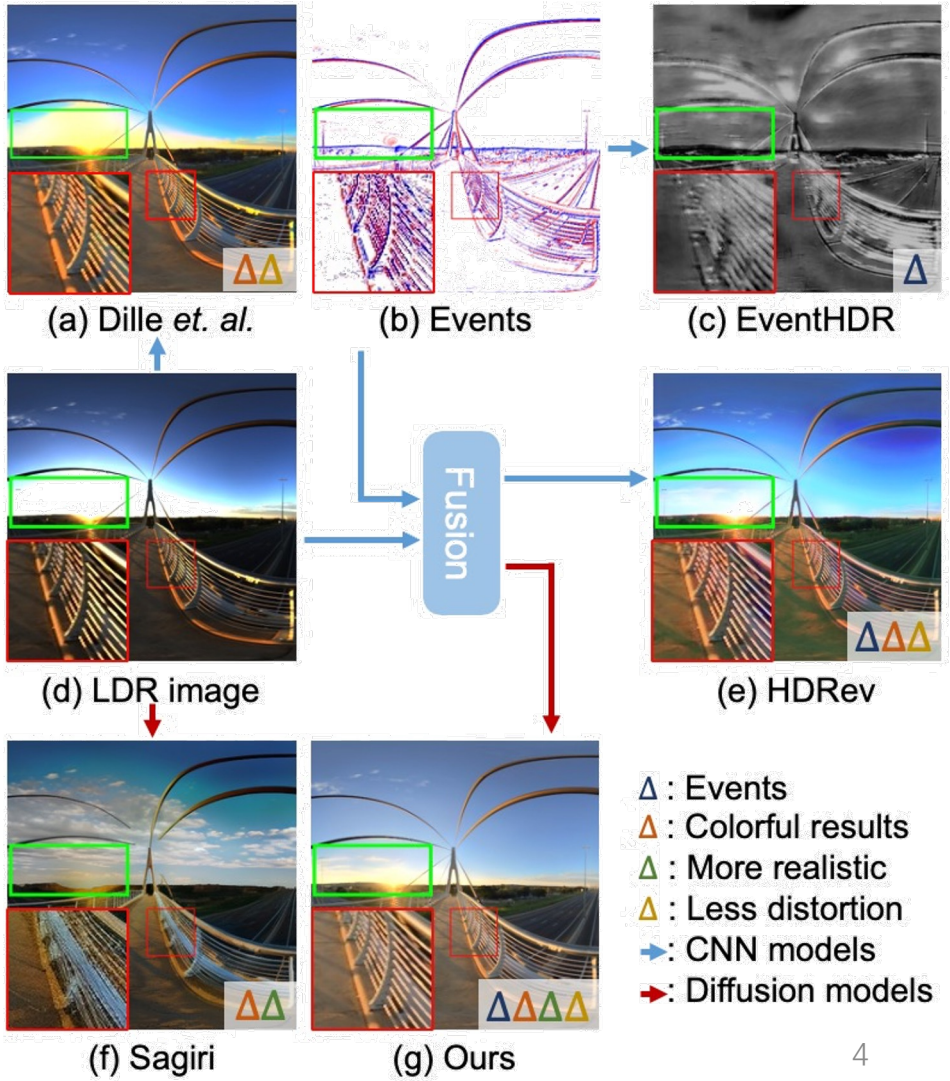
Cannot recover details



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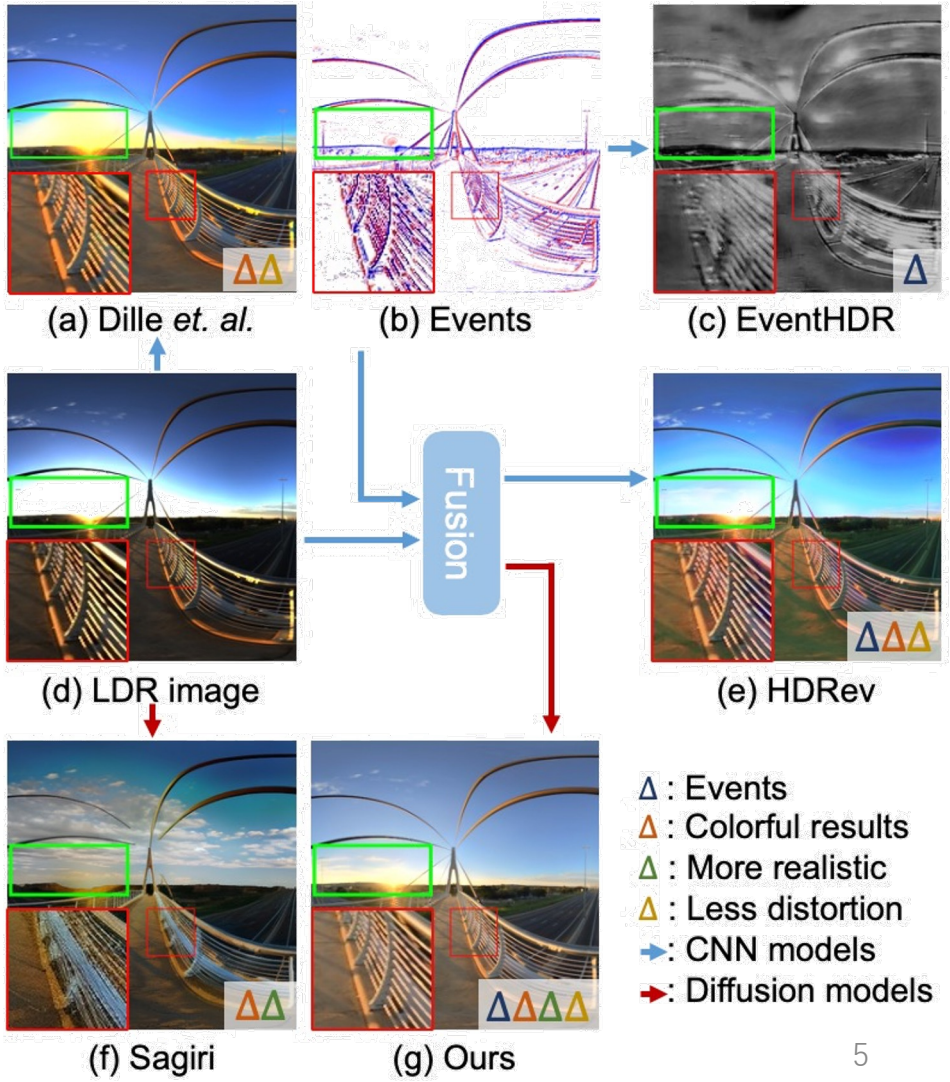
- Diffusion-based methods:
  [Sagiri, Arxiv'24] (f)



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- Diffusion-based methods:
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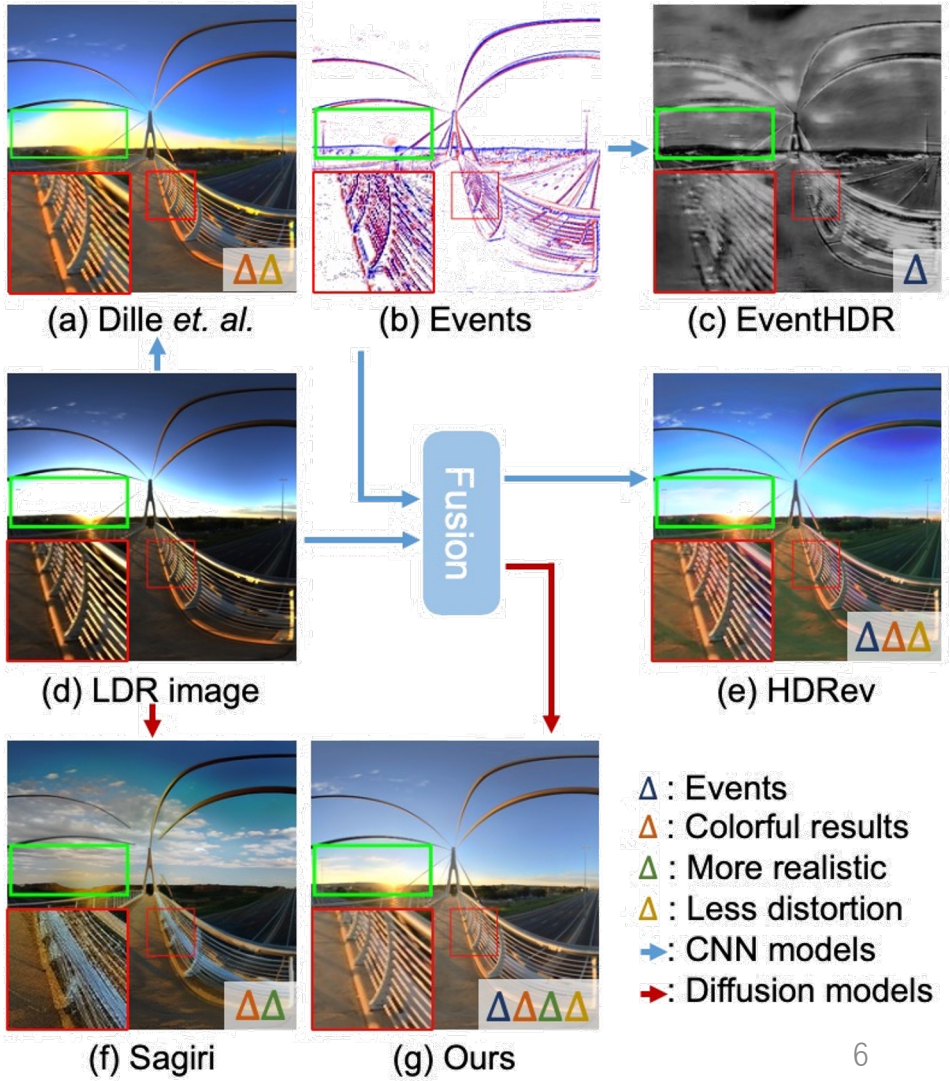
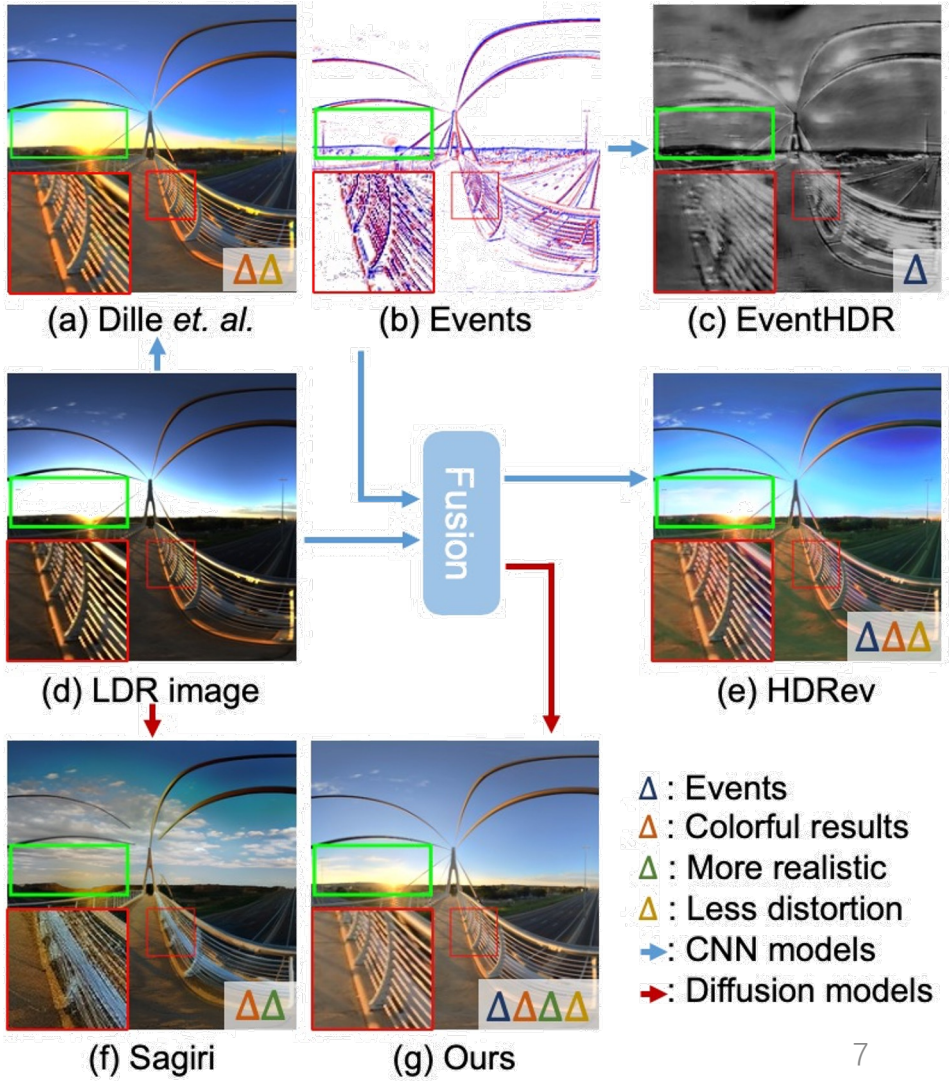
Cannot restore faithful details



Related Works

Event-based reconstruction:

[EventHDR., CVPR'21] (c)

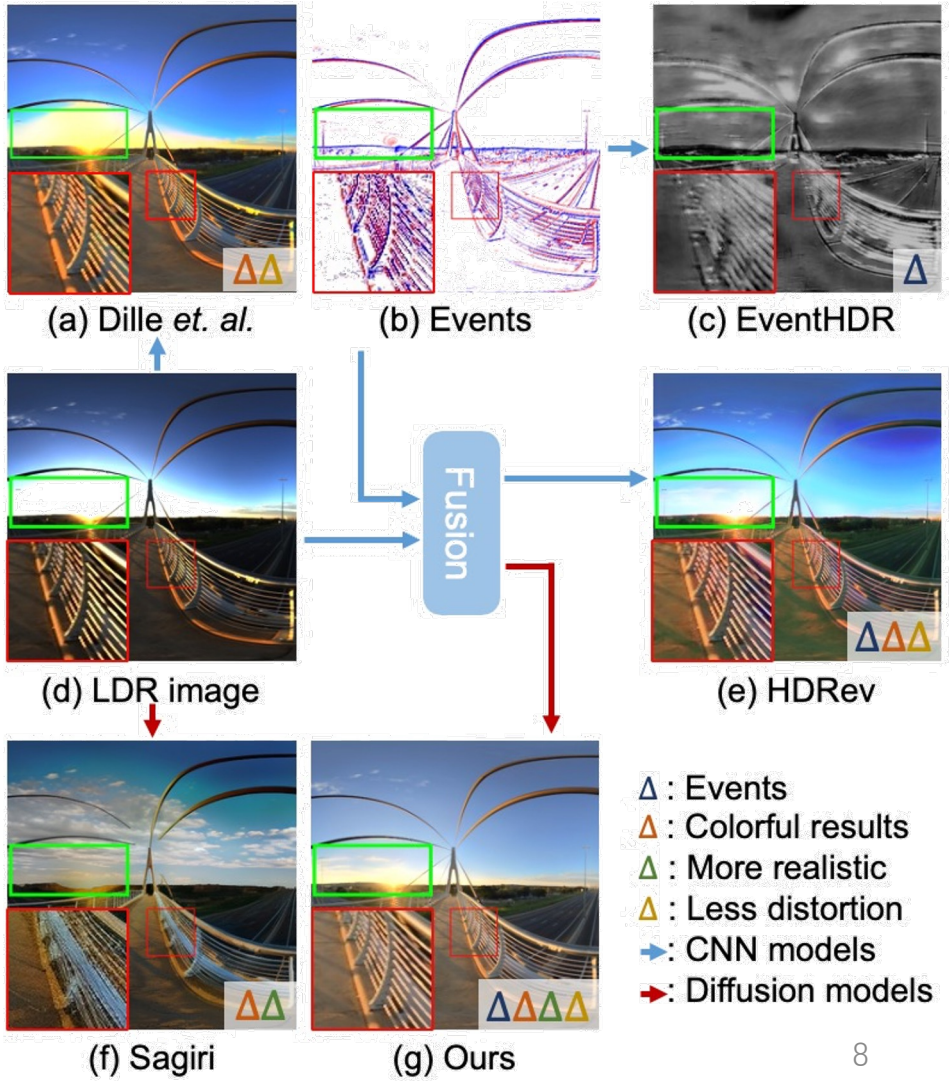


Related Works

Event-based reconstruction:

[EventHDR., CVPR'22 (c)]

Cannot reconstruct color



Related Works

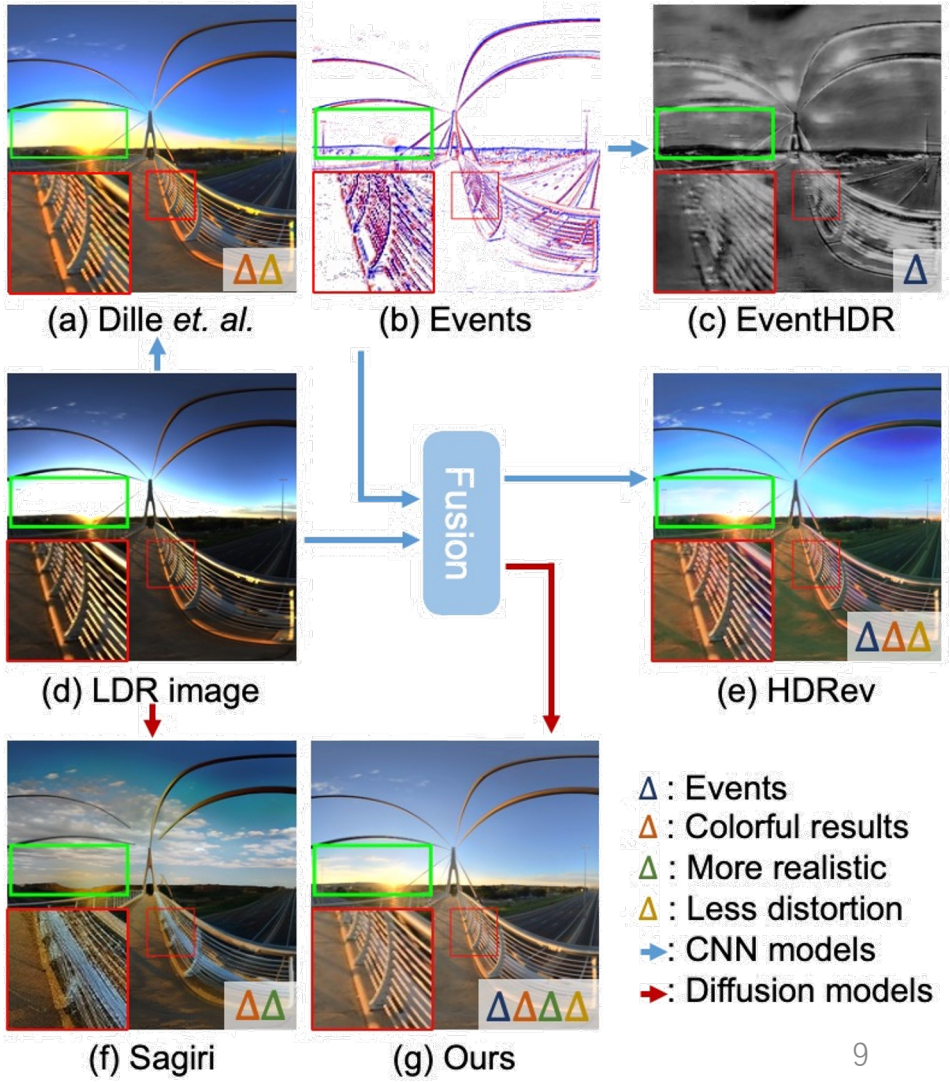
Event-based reconstruction:

[EventHDR., CVPR'21] (c)

Cannot reconstruct color

Hybrid Event-and-image reconstruction:

[HDRev., CVPR'23] (e)



Related Works

Event-based reconstruction:

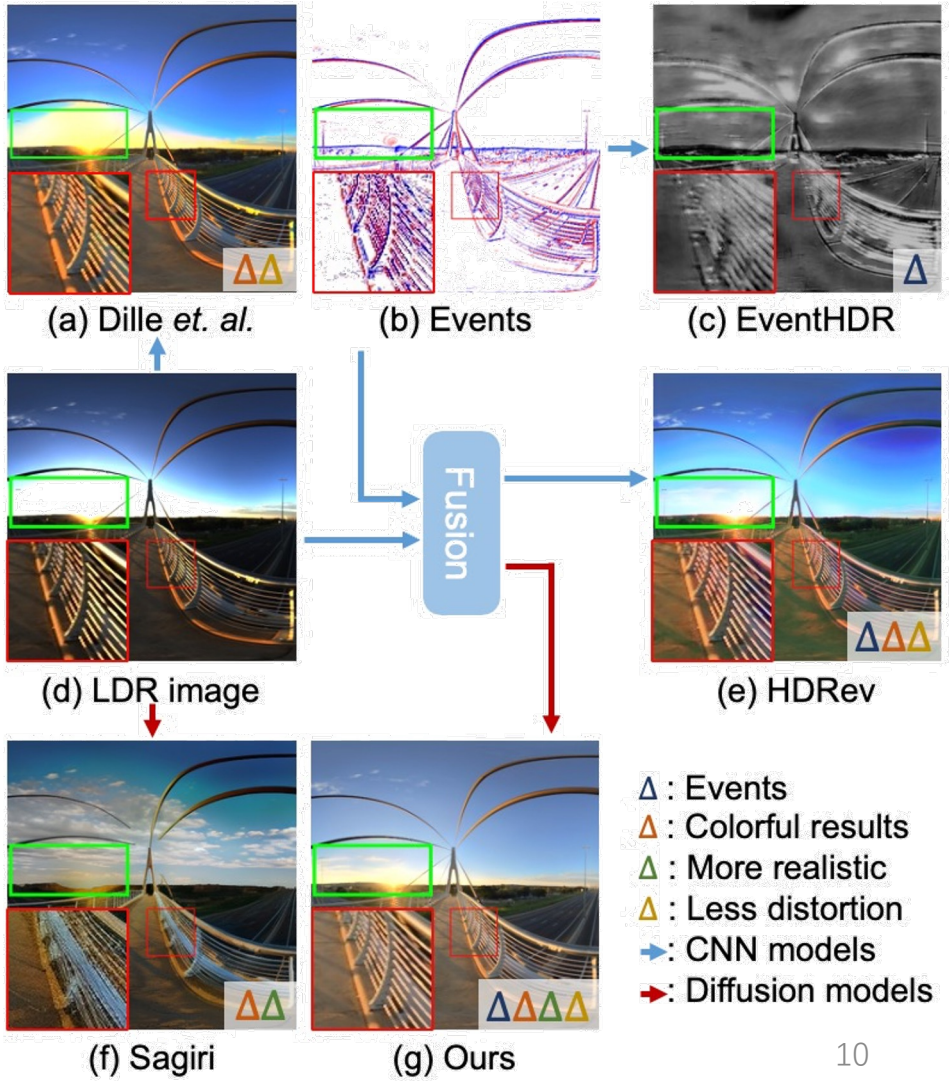
Cannot reconstruct color

[EventHDR., CVPR 21] (c)

Hybrid Event-and-image reconstruction:

Cannot well-utilize events

[HDRev., CVPR 23] (e)



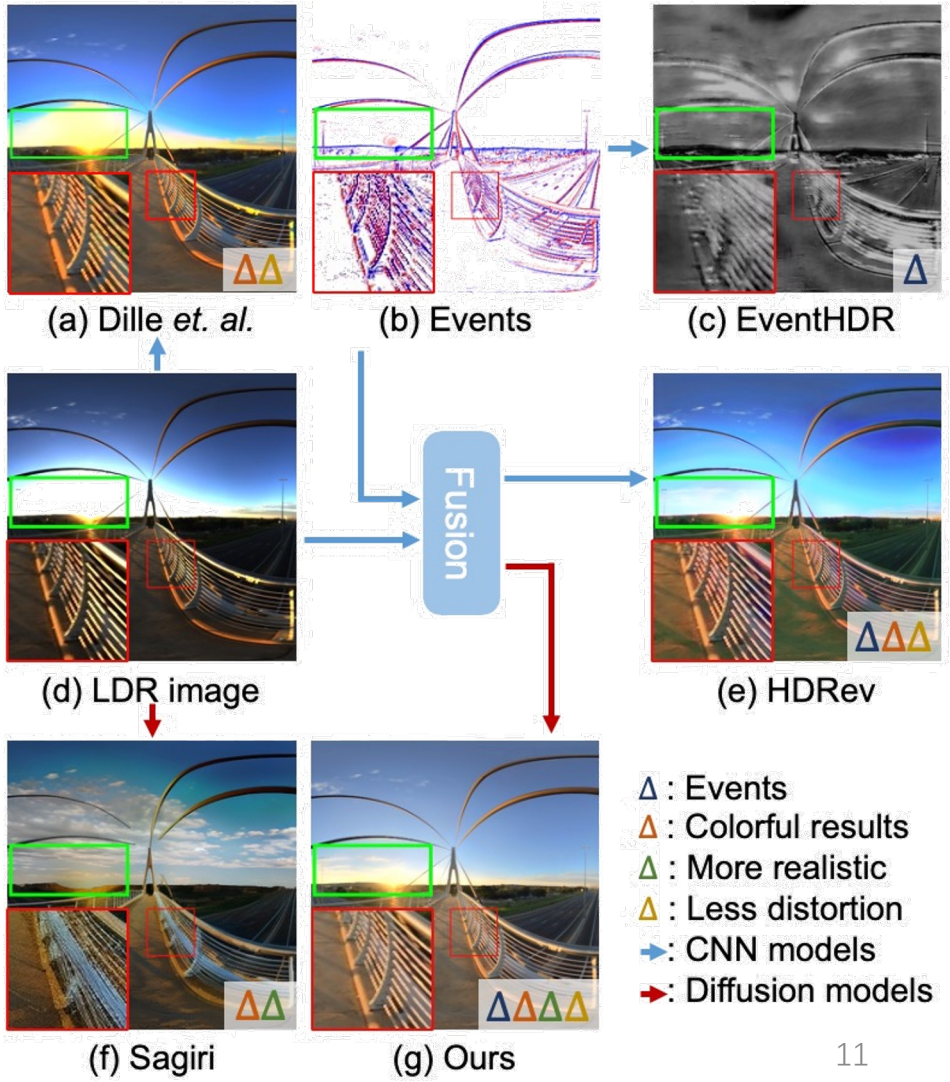
Motivation

Event: provide HDR information

LDR: provide partial color and details

Diffusion: high-quality realistic image priors

Distortion: less distortion artifacts



Motivation

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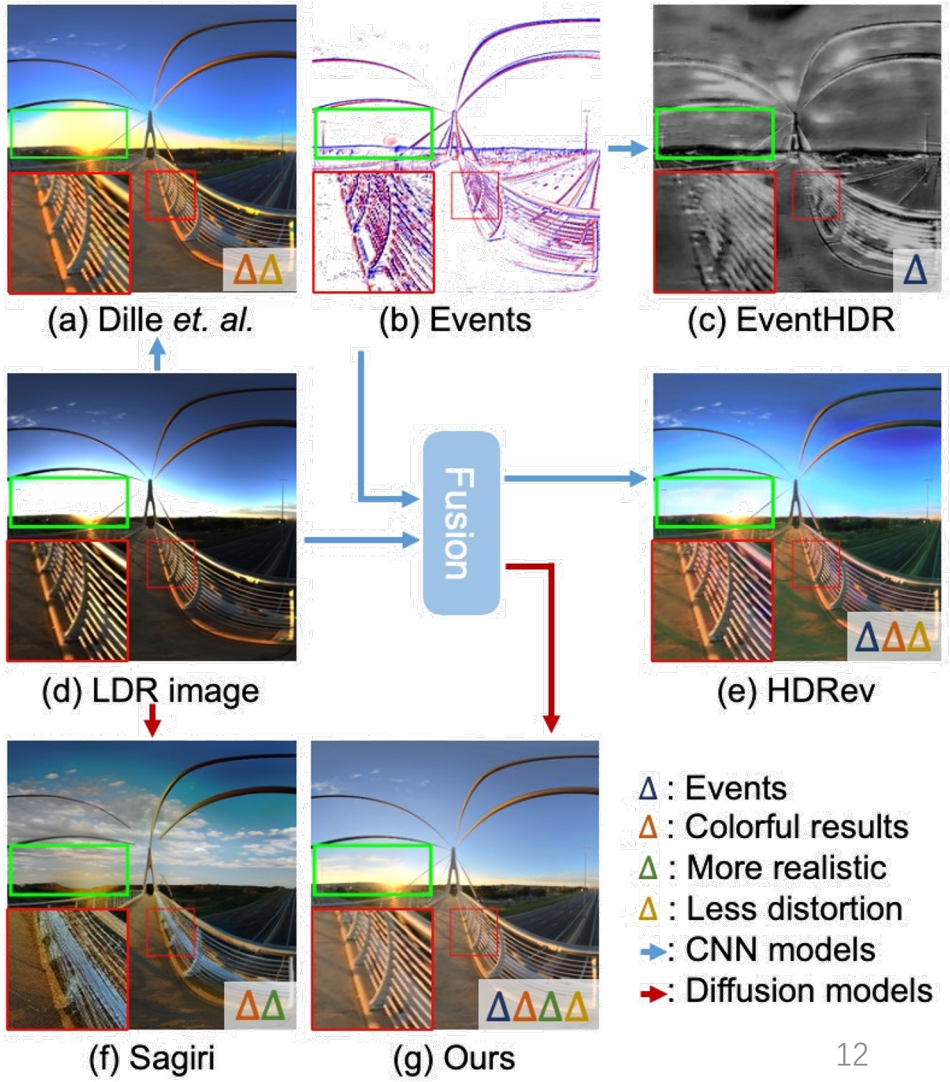
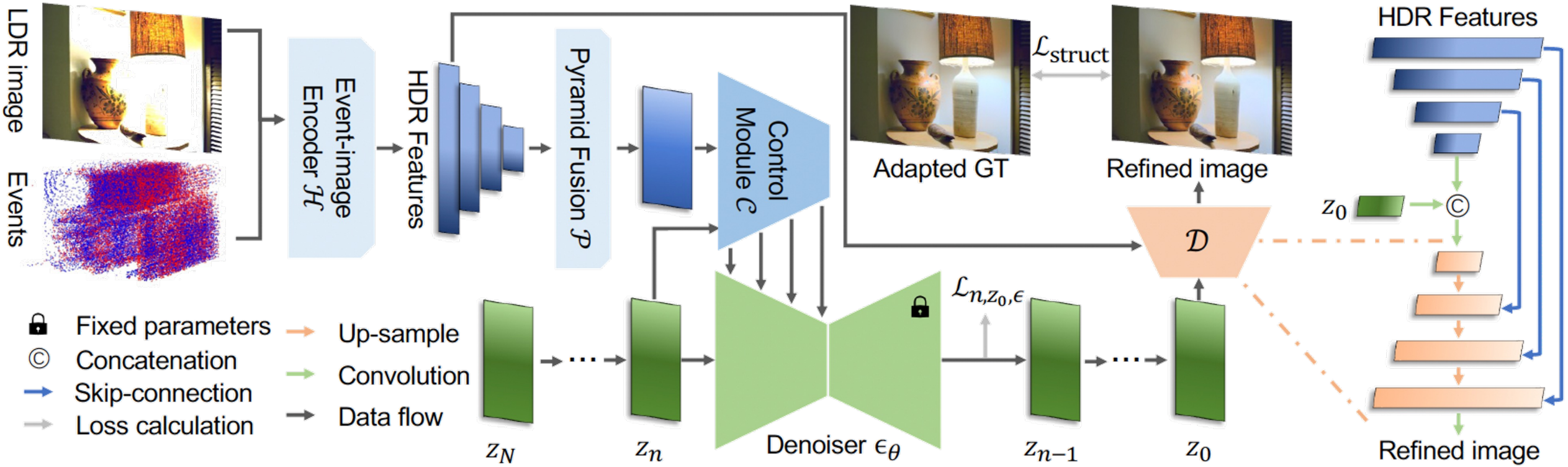
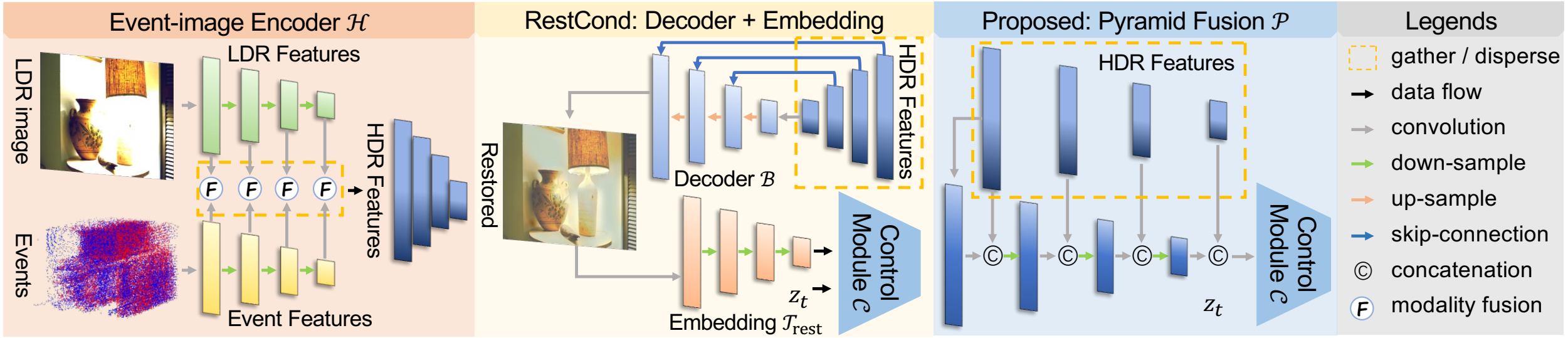
We propose to fuse them to reconstruct HDR image to be consistent with the original scene.

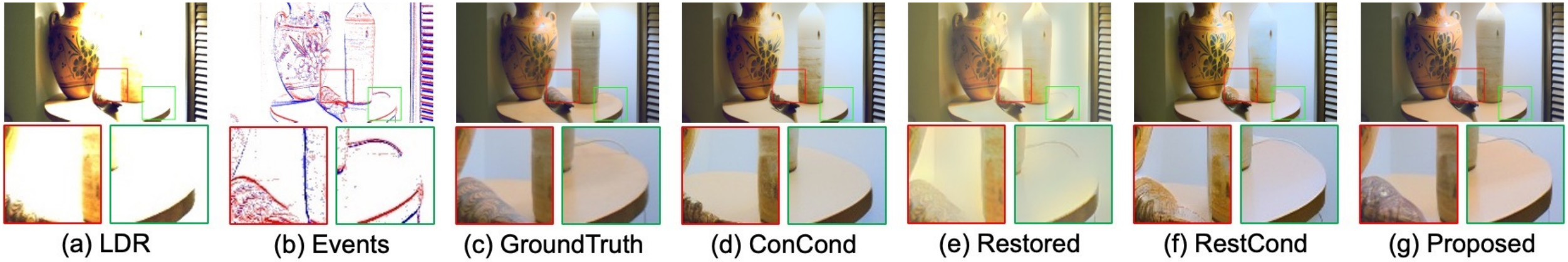


Pipeline


LDR image
Events
Event-image Encoder $\mathcal{H}$
HDR Features
Pyramid Fusion $\mathcal{P}$
Control Module $\mathcal{C}$
Adapted GT
$\mathcal{L}_{struct}$
Refined image
HDR Features
z_0
©
$\mathcal{D}$
Fixed parameters
© Concatenation
Skip-connection
Loss calculation
Up-sample
Convolution
Data flow
z_N
z_n
Denoiser ϵ_θ
$\mathcal{L}_{n,z_0,\epsilon}$
z_{n-1}
z_0
Refined image

Event-guided Conditioning and Generation





(a) LDR (b) Events (c) GroundTruth (d) ConCond (e) Restored (f) RestCond (g) Proposed

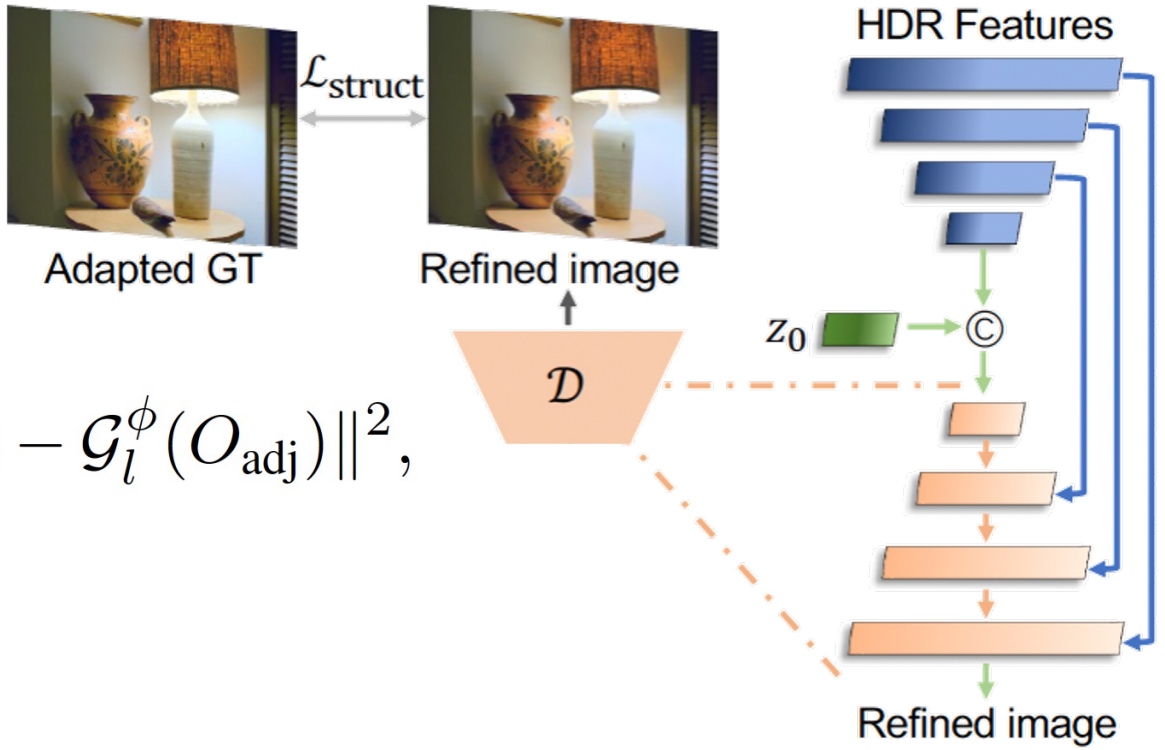
Fine-grained Detail Refinement

$$O_{\text{adj}} = \text{Hist}(O, H_{\text{diff}}).$$

$$\mathcal{L}_{\text{MSE}}(H, O_{\text{adj}}) = \|H - O_{\text{adj}}\|^2,$$

$$\mathcal{L}_{\text{perc}} = \sum_l \|\phi_l(H) - \phi_l(O_{\text{adj}})\|^2 + \|\mathcal{G}_l^\phi(H) - \mathcal{G}_l^\phi(O_{\text{adj}})\|^2,$$

$$\mathcal{L}_{\text{struct}} = \alpha\mathcal{L}_{\text{MSE}} + \beta\mathcal{L}_{\text{perc}},$$



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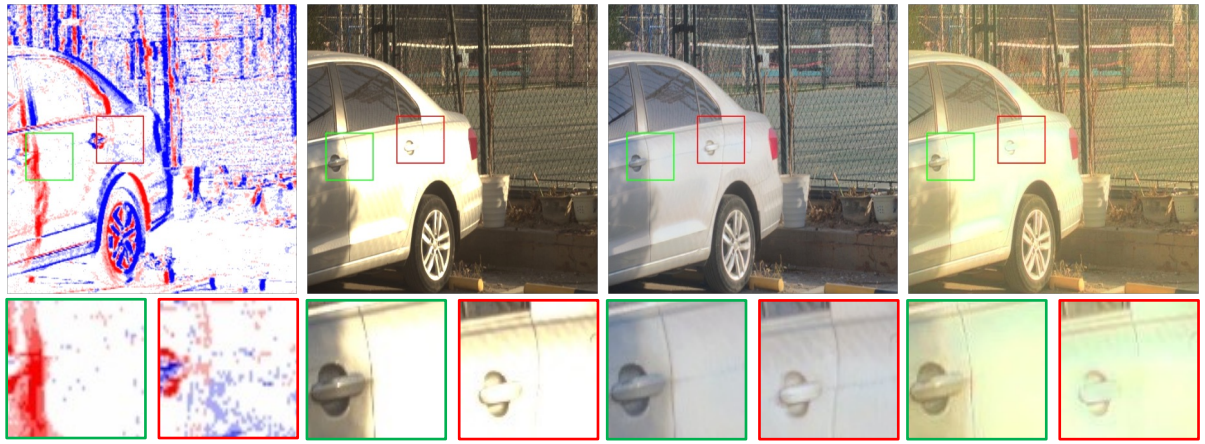
Quantitative Evaluation on Synthetic Data

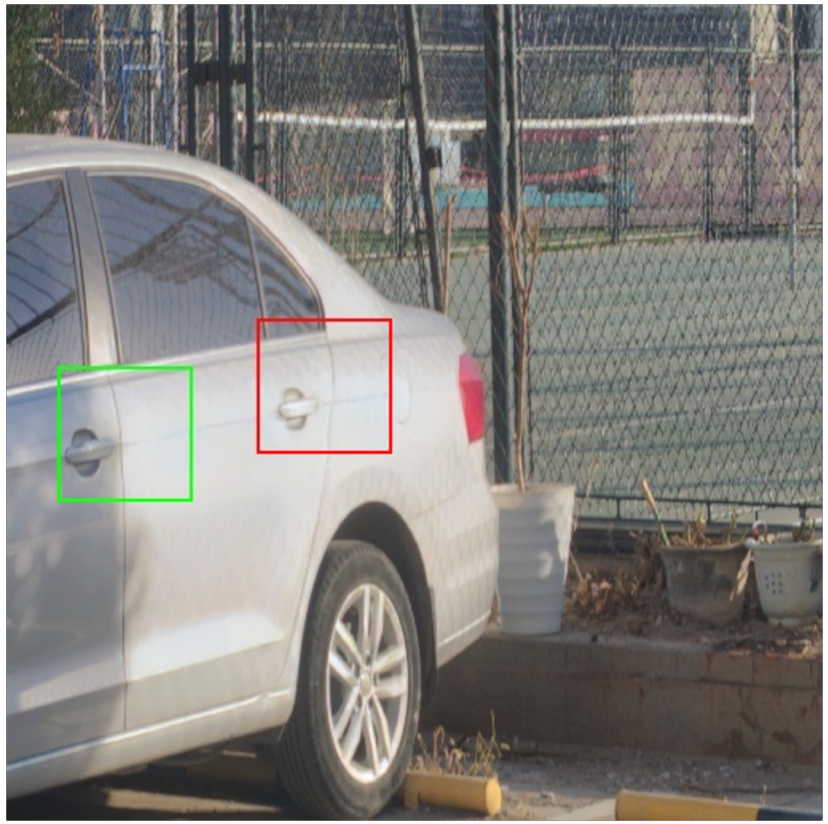
	PSNR↑	SSIM↑	LPIPS↓	CIEDE↓	FID↓	NIQE↓
Liu *et al.* [1]	18.35	0.771	0.276	15.33	78.41	4.02
EventHDR [2]	11.04	0.334	0.447	23.44	182.11	4.58
Sagiri [3]	12.50	0.453	0.414	17.67	83.46	5.35
HDRev [4]	14.05	0.619	0.238	17.69	46.23	3.88
NeurImg [5]	18.53	0.621	0.338	17.42	105.07	4.04
Dille *et al.* [6]	19.73	0.820	0.243	9.76	76.83	4.22
Ours	**25.67**	**0.926**	**0.099**	**6.01**	**27.09**	**3.86**

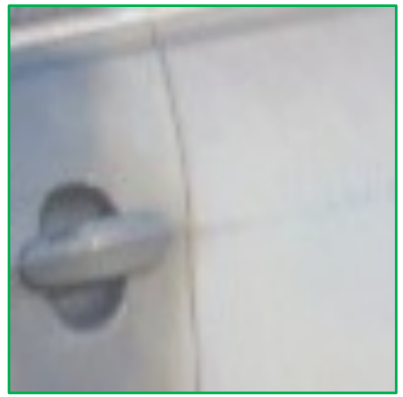
Evaluation on Real Data



Events LDR Ours HDRev [44]

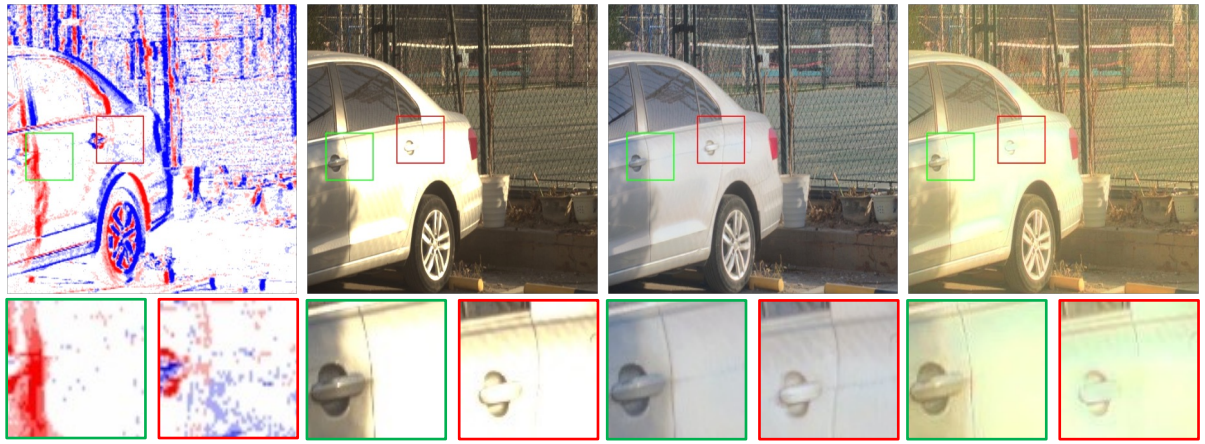
NeurImg [13] Sagiri [20] Liu *et al.* [22] EventHDR [49]





Ours

Evaluation on Real Data



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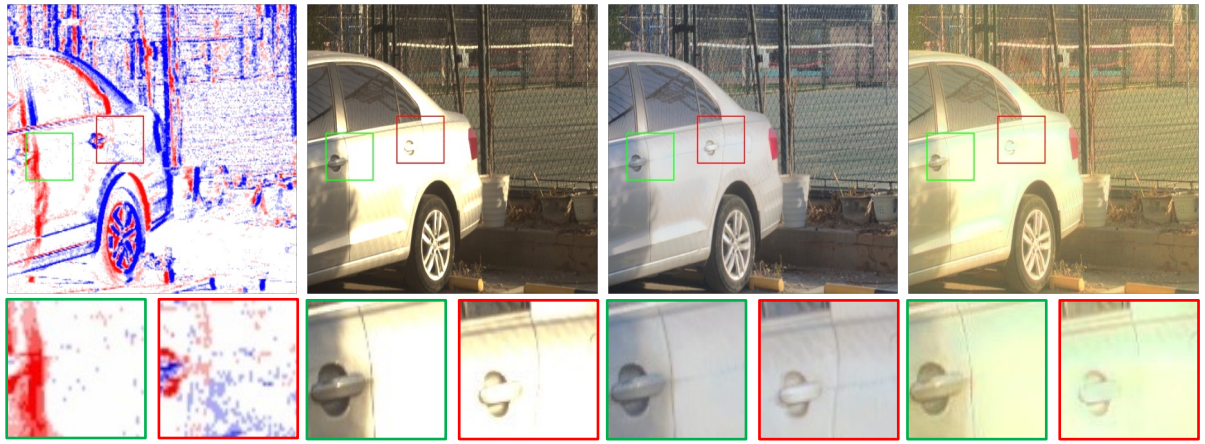

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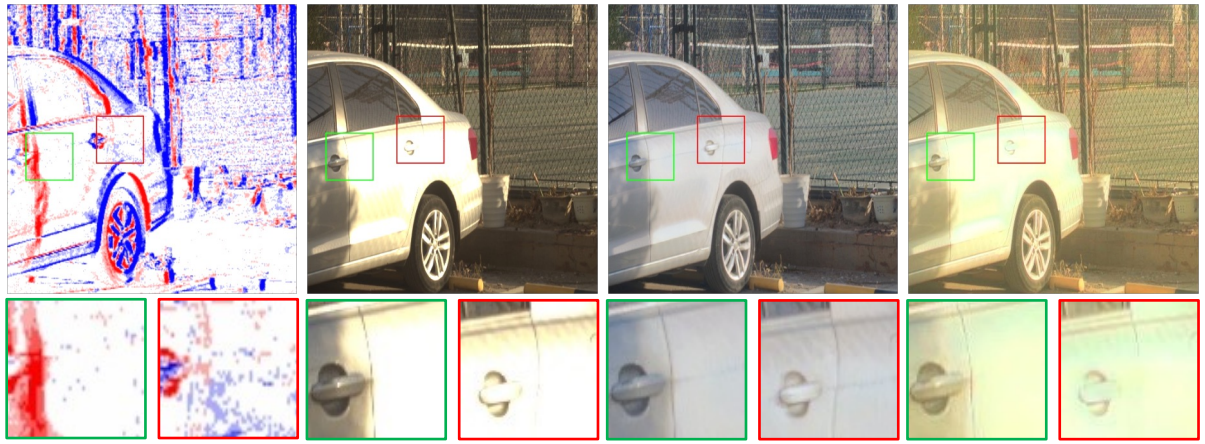

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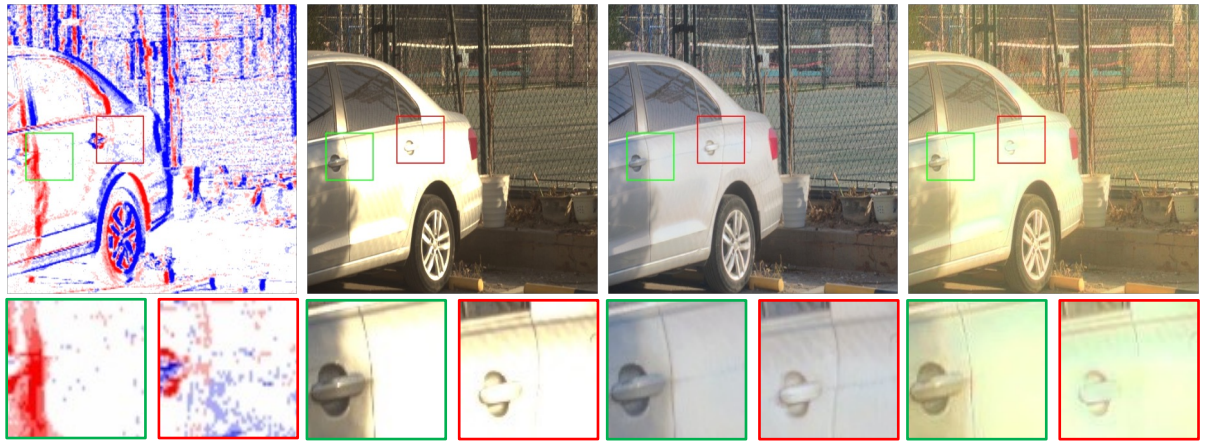

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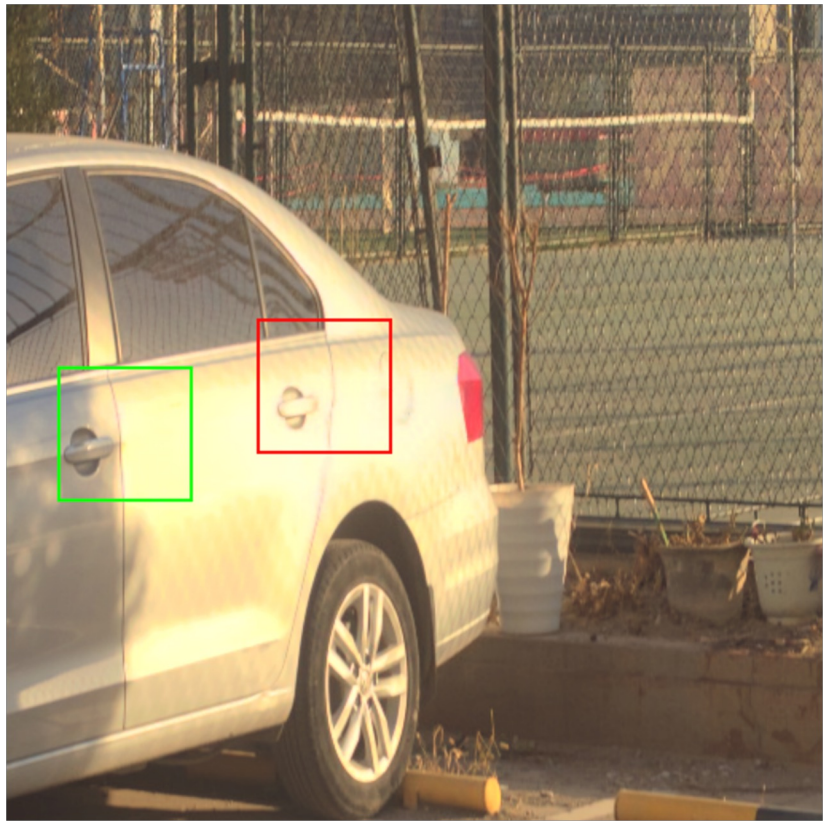

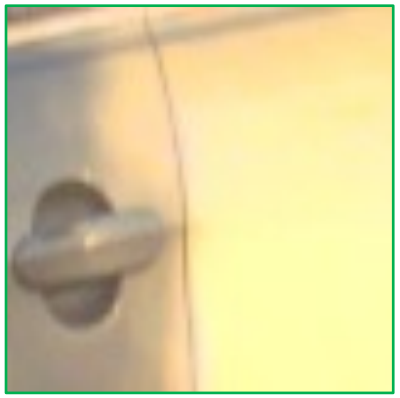

Liu *et al.* [22]

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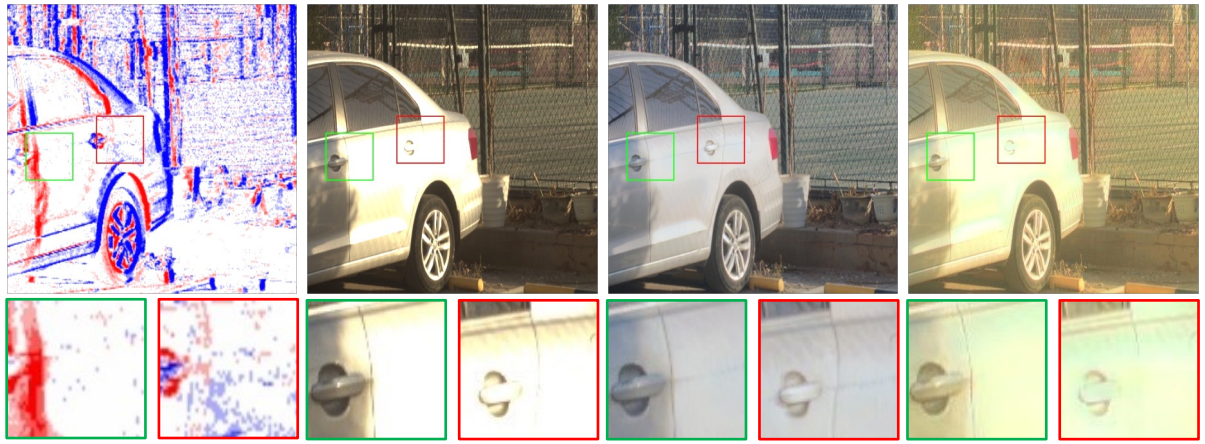

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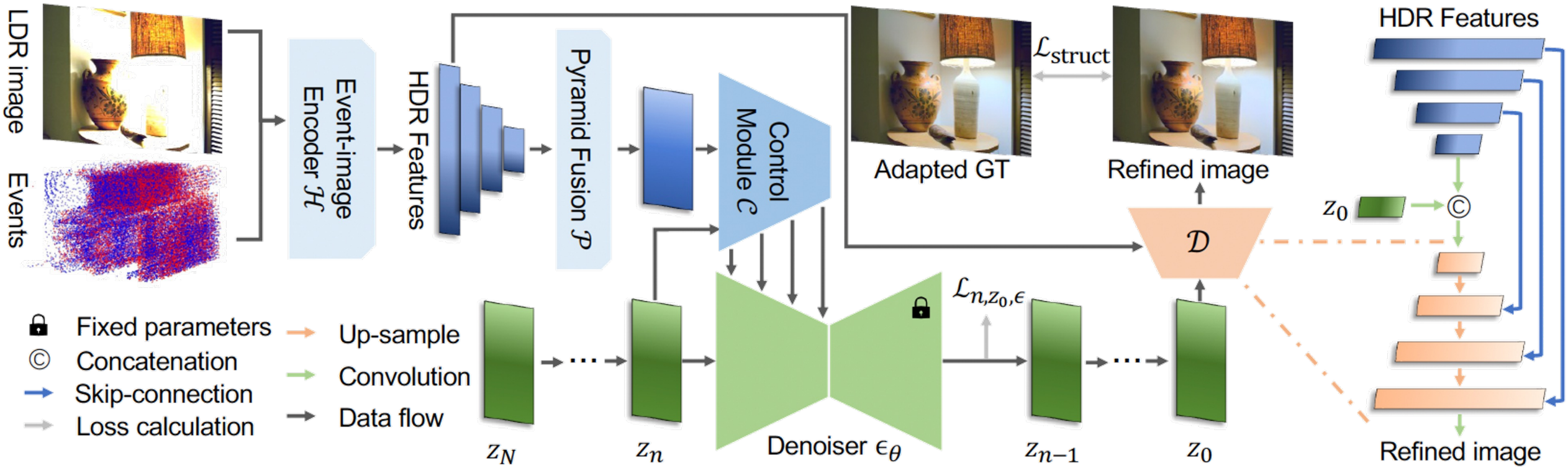
EventHDR [49]

Conclusion



- We integrate events and the conditional diffusion models to recover missing information faithfully;
- We adopt the pretrained event-image encoder and pyramid fusion to effectively apply conditions; and
- We design the refinement module and histogram-based structure loss to further strengthen fine-grained details.

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Thank You!