Event-Based Intensity Reconstruction: A Comparative Study of Filtering Techniques in High-Speed Dynamic Environments

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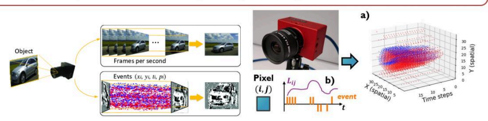
Motivation

Problem Statement: Event-based vision sensors (EVS) provide high-speed, low-latency image capture but suffer from noise and artifacts, degrading intensity image quality

Key Challenges

- Noise from sensor limitations
- Loss of fine details from basic filtering techniques
- Balancing real-time performance

Objective: Improve event-based intensity reconstruction by applying effective noise filtering techniques to enhance clarity while preserving details



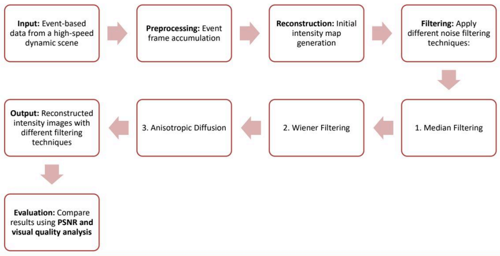
Related Works

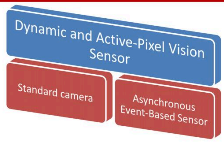
Frame-Assisted Interpolation:	Combines sparse intensity frames with event data for continuous-time reconstruction
	Limitation: Struggles in high-speed, low-light conditions
Variational Optimization	Estimates optical flow and intensity simultaneously
	Limitation: Computationally expensive and noise-sensitive
Contrast-Based Methods	Maximizes event contrast to refine intensity reconstruction
	Limitation: Trade-off between noise suppression and image accuracy

References

[1] Scheerlinck, Barnes, Mahony, "Continuous-time intensity estimation using event cameras," Asian Conference on Computer Vision (ACCV), 2018.
[2] Bardow, Davison, Leutenegger, "Simultaneous optical flow and intensity estimation from an event camera," IEEE Conference on Computer Vision and Pattern Recognition (CVPR), 2016.
[3] Stoffregen, Gallego, Scaramuzza, "Event cameras, contrast maximization, and reward functions: An analysis," IEEE Conference on Computer Vision and Pattern Recognition (CVPR), 2019.

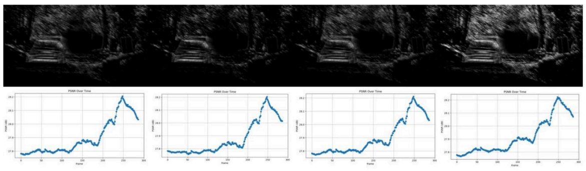
Methodology





Experimental Results

No Filtering	Median Filtering	Wiener Filtering	Anisotropic Diffusion Filtering
PSNR: 27.88dB Frame 150	PSNR: 27.85dB Frame 150	PSNR: 27.88dB Frame 150	PSNR: 27.91dB Frame 150



Key Observations

No Filtering and Wiener Filtering: Similar PSNR values, suggesting minimal differences in noise reduction for that specific frame.

Median Filtering: Slightly lower PSNR, indicating potential noise removal but also possible minor detail loss.

Anisotropic Diffusion Filtering: Slightly higher PSNR, suggesting effective noise reduction and edge preservation.