E-VFIA : Event-Based Video Frame Interpolation with Attention

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Abstract

Video frame interpolation (VFI) is a fundamental vision task that aims to synthesize several frames between two consecutive original video images. Most algorithms aim to accomplish VFI by using only keyframes, which is an ill-posed problem since the keyframes usually do not yield any accurate precision about the trajectories of the objects in the scene. On the other hand, **event-based cameras provide more precise information between the keyframes of a video.** Some recent state-of-the-art event-based methods approach this problem by utilizing event data for better optical flow estimation to interpolate for video frame by warping. Nonetheless, those methods heavily suffer from the **ghosting effect.** On the other hand, some of kernel-based VFI methods that only use frames as input, have shown that **deformable convolutions**, when backed up with **transformers**, can be a reliable way of **dealing with long-range dependencies.** We propose event-based video frame interpolation with attention (E-VFIA), as a lightweight kernel-based method. E-VFIA fuses event information with standard video frames by deformable convolutions to generate high quality interpolated frames. The proposed method **represents events with high temporal resolution and uses a multi-head self-attention mechanism to better encode event-based information,** while being less vulnerable to blurring and ghosting artifacts; thus, generating crispier frames. The simulation results show that the proposed technique **outperforms current state-of-the-art methods** (both frame and event-based) with a **significantly smaller model size.**

Main Contributions

- E-VFIA, **the first kernel-based algorithm** to utilize deformable convolutions to **fuse event-based information and standard images** for video frame interpolation with events.
- **Significant improvement** (up to $1.04dB$) against the state-of-the-art methods that use only key-frames and events together with key-frames.
- Model has approximately 2.07 **million parameters.**
- Using **voxel grids with higher temporal resolutions** improves performance.
- Utilization of **both temporal and spatial pooling** operations to **associate fast-moving objects** between consecutive images.

Proposed Method

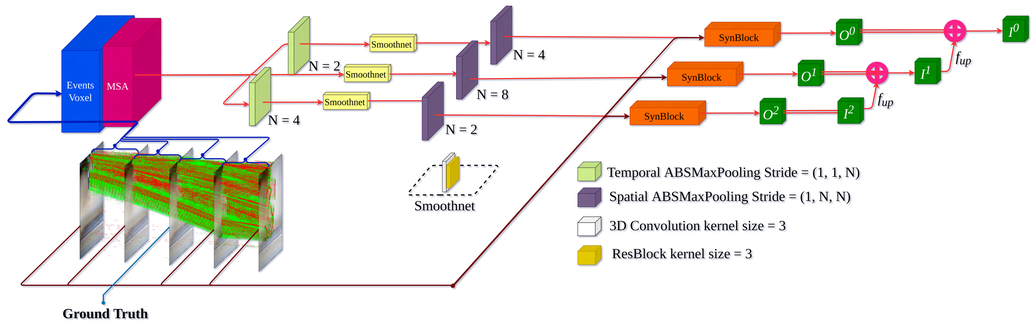


Figure 1. Overview of the proposed method.

Qualitative Comparisons

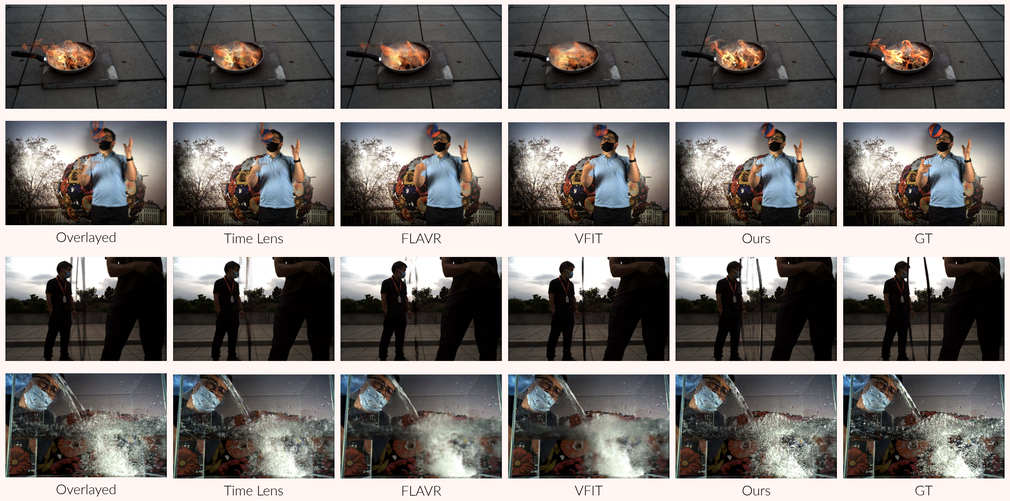
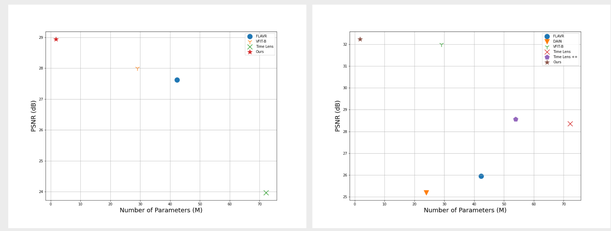


Figure 2. Qualitative comparisons against the state-of-the-art video interpolation algorithm. Our method is **less prone to blur and ghosting effects.**

(a) Time Lens (b) FLAVRFV (c) VFIT (d) Ours

Figure 3. Pixel-wise differences of the fire sample.

Quantitaive comparisons



(a) Full Scale (b) 256x256

Figure 4. Model Sizes vs PSNR

Table 1. Comparison of our method in BS-ERGB in **low resolution**

Method	Input	#Params (M)	PSNR (dB)	SSIM
FLAVRFV [1]	Frames	42.4	31.72	0.9469
VFIT [2]	Frames	29.0	32.08	0.9449
Timelens [3]	Frames Events	72.2	28.36	0.9320
Timelens++ [4]	Frames Events	53.9	28.56	-
Ours	**Frames Events**	**2.07**	**32.23**	**0.9581**

Table 2. Comparison of our method in BS-ERGB dataset in **full scale**

Method	Input	#Params (M)	PSNR (dB)	SSIM
FLAVRFV [1]	Frames	42.4	27.642	0.8729
VFIT [2]	Frames	29.0	28.00	0.8767
Timelens [3]	Frames Events	72.2	23.97	0.7838
Timelens++ [4]	Frames Events	53.9	-	-
Ours	**Frames Events**	**2.07**	**29.04**	**0.8771**

References

[1] T. Kalluri, D. Pathak, M. Chandraker, and D. Tran, "Flavr: Flow-agnostic video representations for fast frame interpolation," *ArXiv*, vol. abs/2012.08512, 2020.

[2] Z. Shi, X. Xu, X. Liu, J. Chen, and M.-H. Yang, "Video frame interpolation transformer," in *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR)*, June 2022, pp. 17 482–17 491.

[3] S. Tulyakov, D. Gehrig, S. Georgoulis, J. Erbach, M. Gehrig, Y. Li, and D. Scaramuzza, "Time lens: Event-based video frame interpolation," in *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR)*, June 2021, pp. 16 155–16 164.

[4] S. Tulyakov, A. Bochicchio, D. Gehrig, S. Georgoulis, Y. Li, and D. Scaramuzza, "Time lens++: Event-based frame interpolation with parametric non-linear flow and multi-scale fusion," in *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR)*, June 2022, pp. 17 755–17 764.