Joint Filtering of Intensity Images and Neuromorphic Events for High-Resolution Noise-Robust Imaging

Zihao W. Wang[1]* Peiqi Duan[2]* Oliver Cossairt[1] Aggelos Katsaggelos[1] Tiejun Huang[2] Boxin Shi[2]
[1]Northwestern University [2]Peking University *Equation contrubution

CVPR SEATTLE WASHINGTON JUNE 16-18 2020

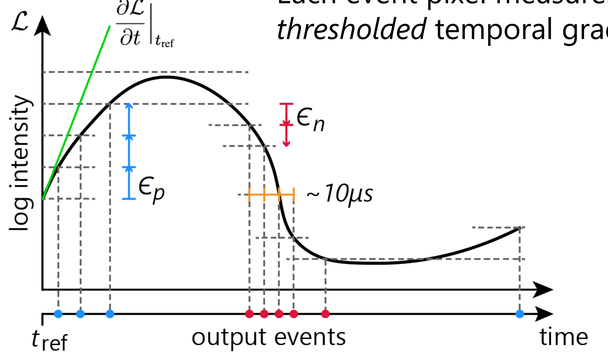
Project page

RGB cam vs. event cam

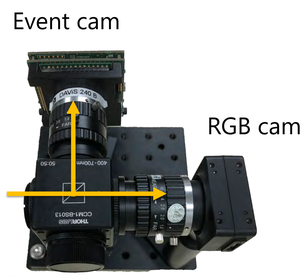
30/60FPS	High speed (1us latency)
~60dB	HDR (120dB)
>1W	Low power (10mW)
HD UHD 4/8k	Low resolution (240x180)
Less noisy	noisy

How does event camera work?

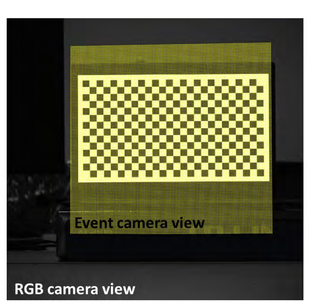
Each event pixel measures *thresholded* temporal gradient



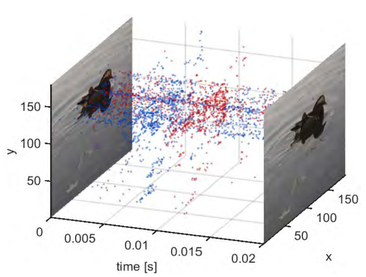
Proposal: RGB + Event hybrid camera



camera



calibration

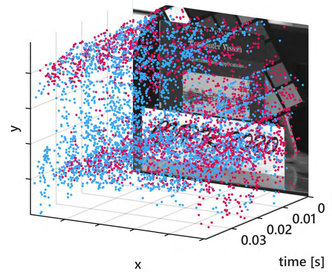


Captured data: regular frame-rate images *and* events

Guided Event Filtering (GEF): a unifying framework

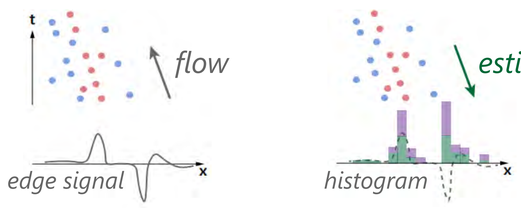
Input

an intensity image
a stream of events

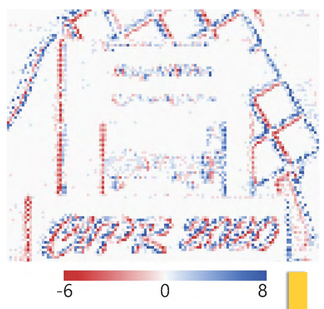


Motion model

Assuming events are generated by moving edges

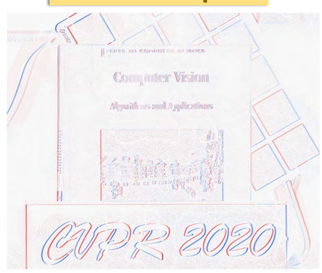


Motion compensation



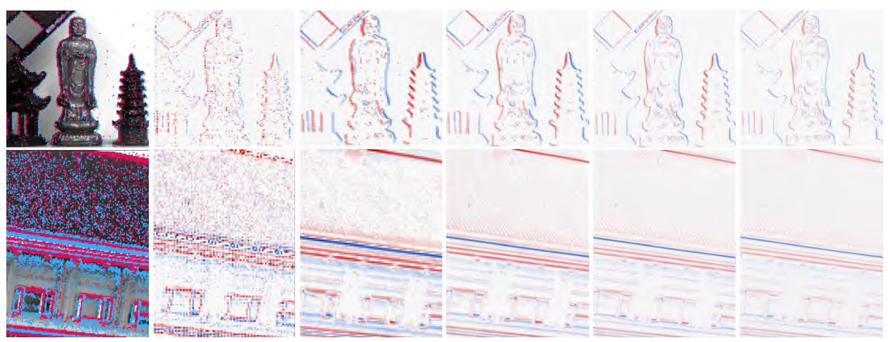
Step 1: Motion compensation by Joint Contrast Maximization
- *maximizes the contrast of the histogram jointly formed by the image and events*
- *registers events with image edges*
- *estimates optical flow robust to event noise*

Filter output



Step 2: Joint/guided image filtering
- *extracts mutual structure from image and events*
- *recursively upsamples by 2x, until 8x*

Guided event upsampling

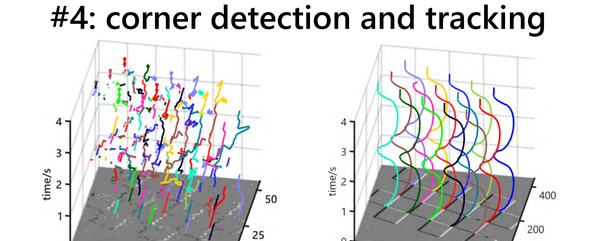


(a) Img+events (b) MC events (c) 1× (d) 2× (e) 4× (f) 8×

Applications

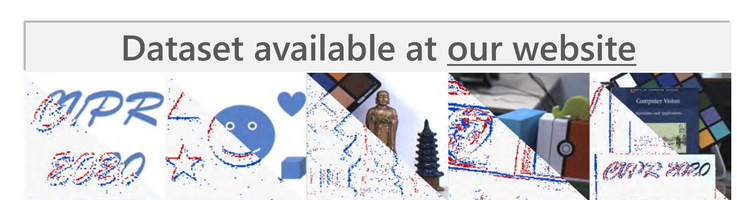
GEF can improve performance for event-based algorithms

#1: video frame synthesis



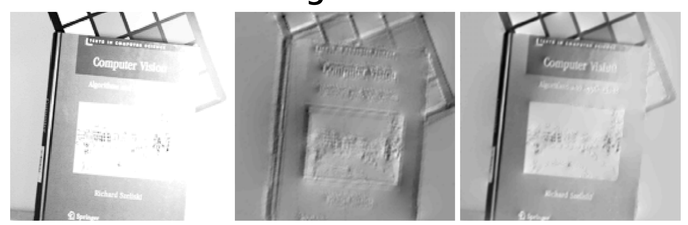
w/o GEF w/ GEF

#2: image motion deblur



Blurry image deblur w/o GEF w/ GEF

#3: HDR image reconstruction



LDR image HDR w/o GEF w/ GEF

#4: corner detection and tracking

w/o GEF, 1× w/ GEF, 8×

Dataset available at our website