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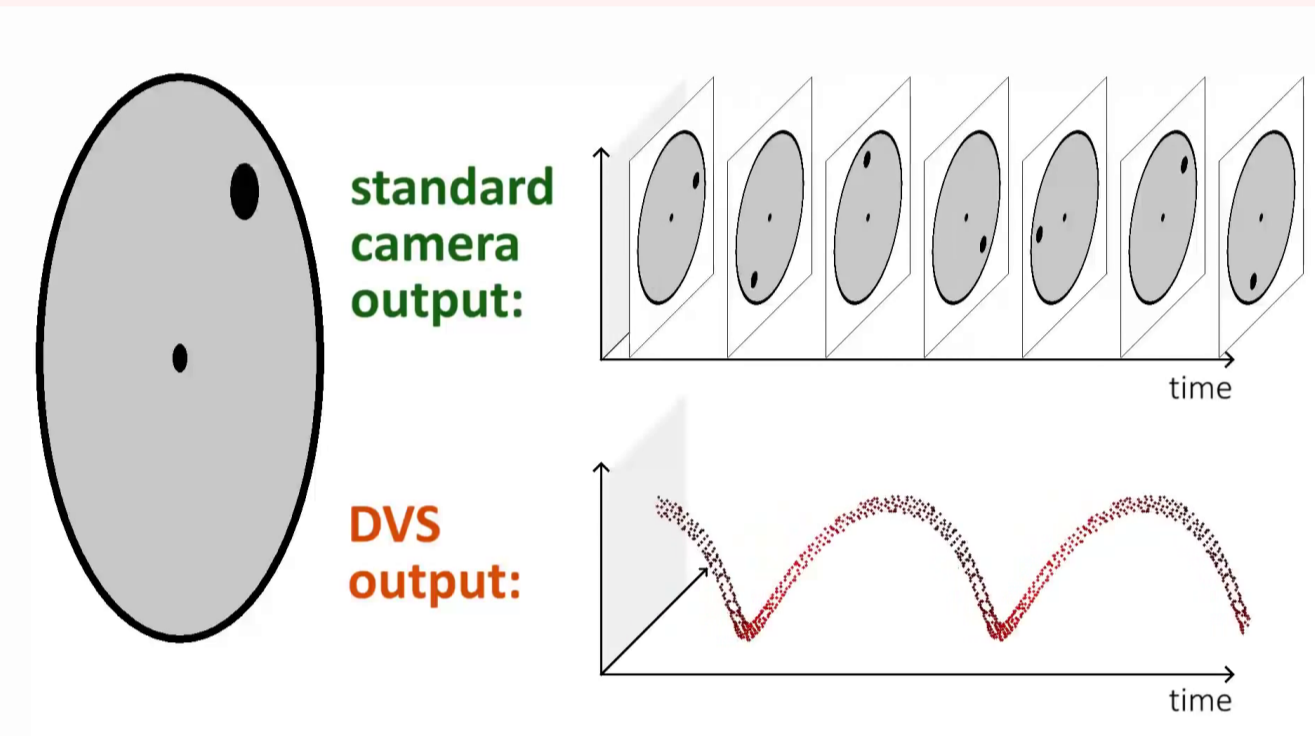
Real-time event simulation with frame-based cameras*

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1 Motivation

1.1 Event-based cameras
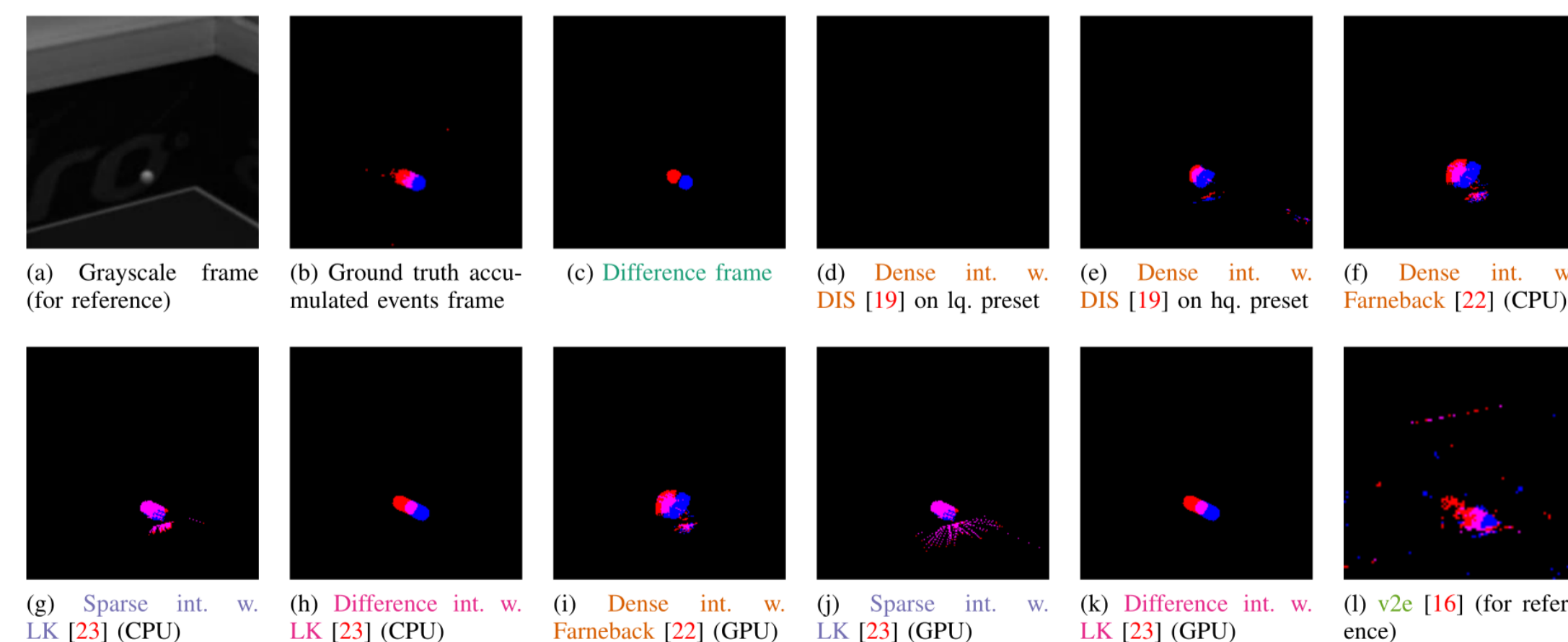

Description:

- Only transmits **brightness changes**.
- Output is a stream of **asynchronous events**.
- Low latency, HDR, almost no motion blur

- Event cameras are becoming increasingly popular in robotics and computer vision
- But they remain expensive and quite scarce
- Thus, event simulators makes them more accessible
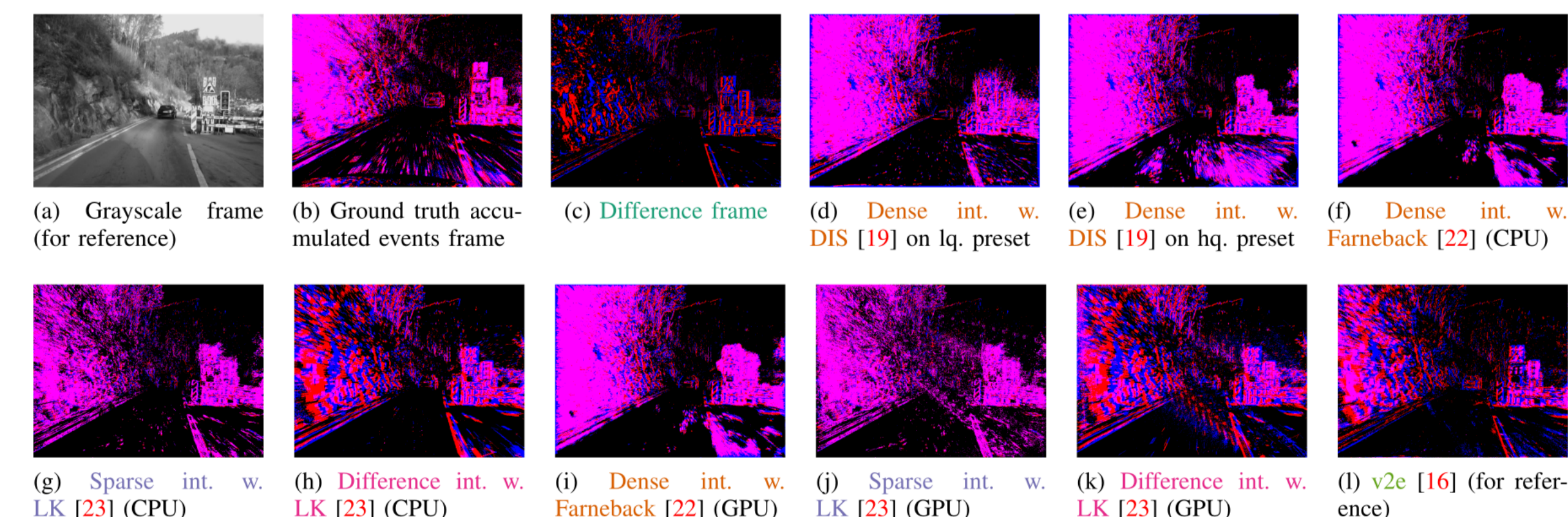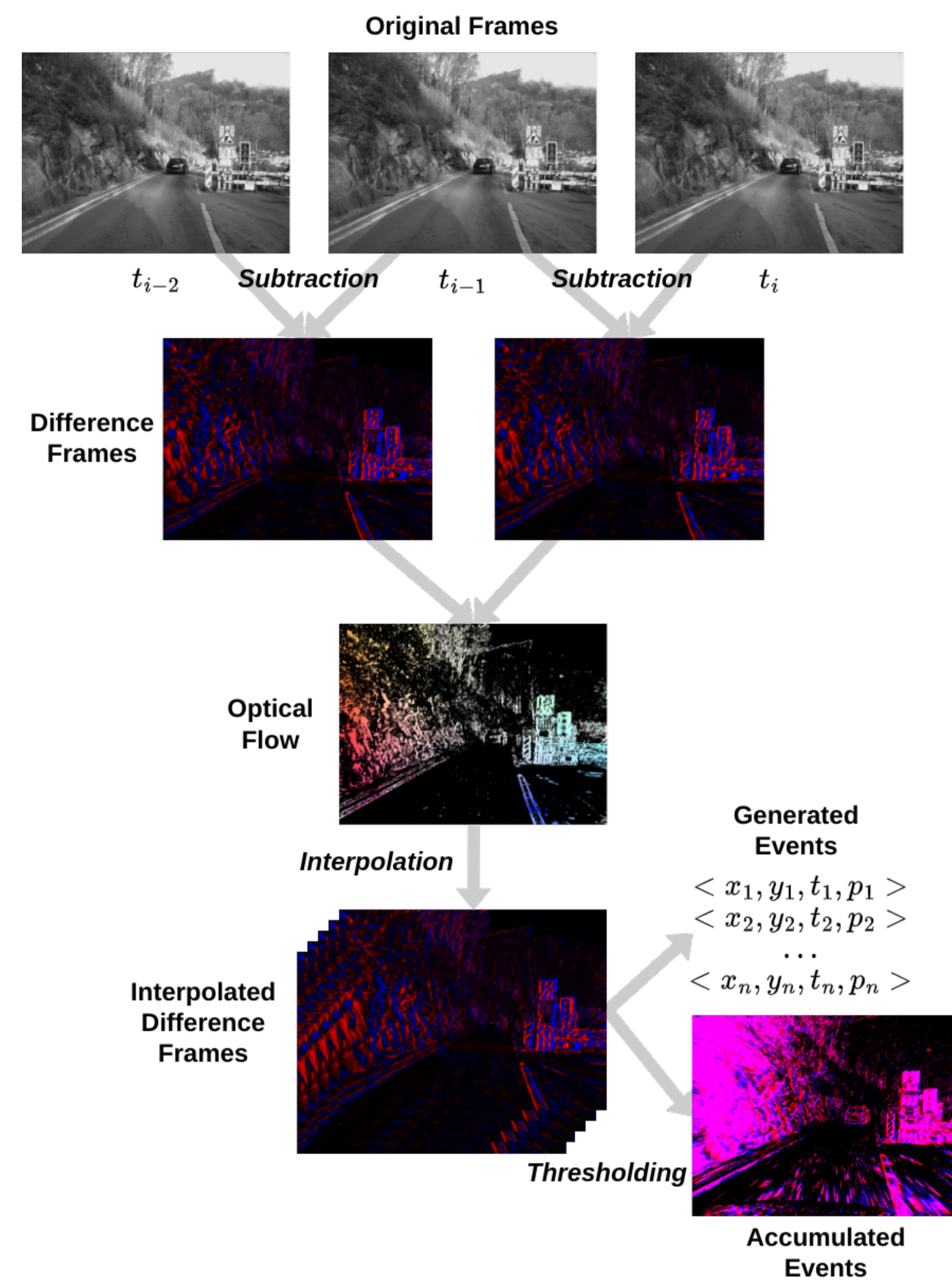
1.2 Existing event-based camera simulators

- Focus on a realistic camera model
- Are successfully used for learning-based applications
- **Limitation:** They do not run in real-time
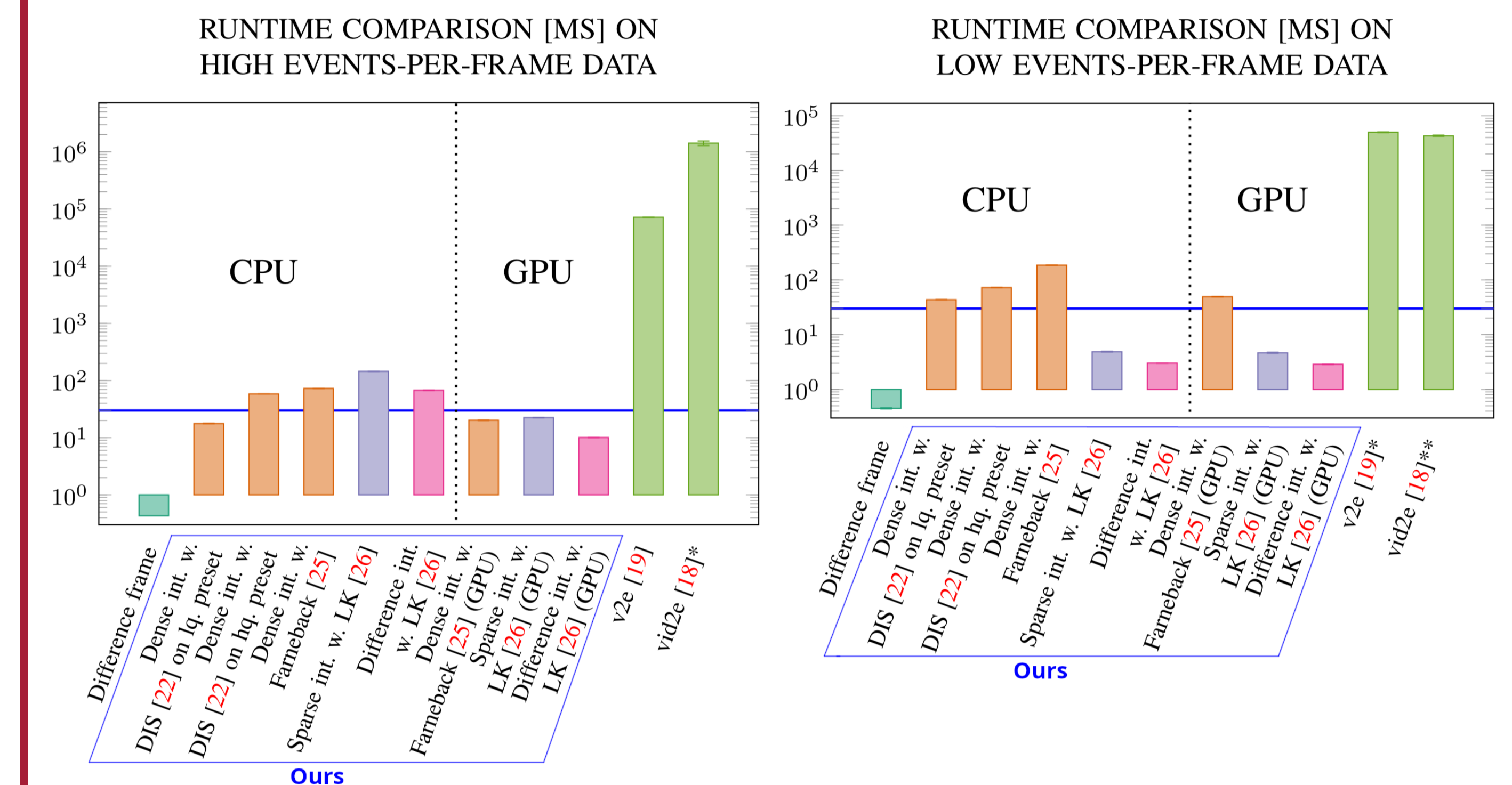
3.3 Qualitative results

(a) Grayscale frame (for reference)
(b) Ground truth accumulated events frame
(c) Difference frame
(d) Dense int. w. DIS [19] on lq. preset
(e) Dense int. w. DIS [19] on hq. preset
(f) Dense int. w. Farneback [22] (CPU)
(g) Sparse int. w. LK [23] (CPU)
(h) Difference int. w. LK [23] (CPU)
(i) Dense int. w. Farneback [22] (GPU)
(j) Sparse int. w. LK [23] (GPU)
(k) Difference int. w. LK [23] (GPU)
(l) v2e [16] (for reference)

2 Method

Our simulator generates events directly from a camera.

Original Frames

t_{i-2} *Subtraction* t_{i-1} *Subtraction* t_i

Difference Frames

Optical Flow

Interpolation

Interpolated Difference Frames

Thresholding

Generated Events
$< x_1, y_1, t_1, p_1 >$
$< x_2, y_2, t_2, p_2 >$
...
$< x_n, y_n, t_n, p_n >$

Accumulated Events

(a) Grayscale frame (for reference)
(b) Ground truth accumulated events frame
(c) Difference frame
(d) Dense int. w. DIS [19] on lq. preset
(e) Dense int. w. DIS [19] on hq. preset
(f) Dense int. w. Farneback [22] (GPU)
(g) Sparse int. w. LK [23] (CPU)
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(l) v2e [16] (for reference)

3 Results

3.1 Run times

RUNTIME COMPARISON [MS] ON HIGH EVENTS-PER-FRAME DATA

RUNTIME COMPARISON [MS] ON LOW EVENTS-PER-FRAME DATA

3.2 Event statistics

EVENT STATISTICS ON A HIGH EVENTS-PER-FRAME VIDEO SEQUENCE

Method	Events / (pixel · s)	
	mean	std. dev.
Real events	62.7933	82.7128
Dense int. w. DIS, lq. preset	56.3079	58.9868
Dense int. w. DIS, hq. preset	65.6304	66.793
Dense int. w. Farneback	65.999	67.4279
Sparse int. w. LK	59.3083	52.3827
Difference int. w. LK	59.3034	55.0075
v2e [15]	58.8313	78.3513
vid2e [14]	63.6588	77.9866

EVENT STATISTICS ON A LOW EVENTS-PER-FRAME VIDEO SEQUENCE

Method	Events / (pixel · s)	
	mean	std. dev.
Real events	0.046	1.0228
Dense int. w. DIS, lq. preset	0.0472	1.165
Dense int. w. DIS, hq. preset	0.0462	0.8783
Dense int. w. Farneback	0.0445	0.574
Sparse int. w. LK	0.0467	0.439
Difference int. w. LK	0.0461	0.8785
v2e [15]	0.0455	0.4912
vid2e [14]	0.0318	1.776

4 Contributions

- Optical flow-based event simulator running in real-time
- Novel method which leverages the sparsity of events
- Qualitative and quantitative results
- Comparison to SOTA event simulators and a real DVS
- A guideline when to use which simulator method