arXiv - arXiv:2503.19916

Home - event-fly.github.io

GitHub - event-fly/toolkit

EventFly: Event Camera Perception from Ground to the Sky

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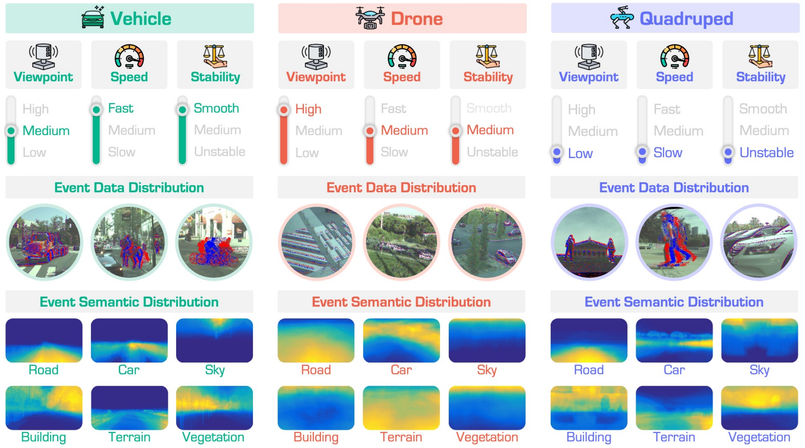
Motivation & Contribution

TL;DR (Project Overview)

- **EventFly** is a new benchmark that facilitates event camera perception from three platforms: **Vehicle**, **Drone**, and **Quadruped**, aiming to achieve robust perception across motion dynamics, viewpoints, and class distributions.

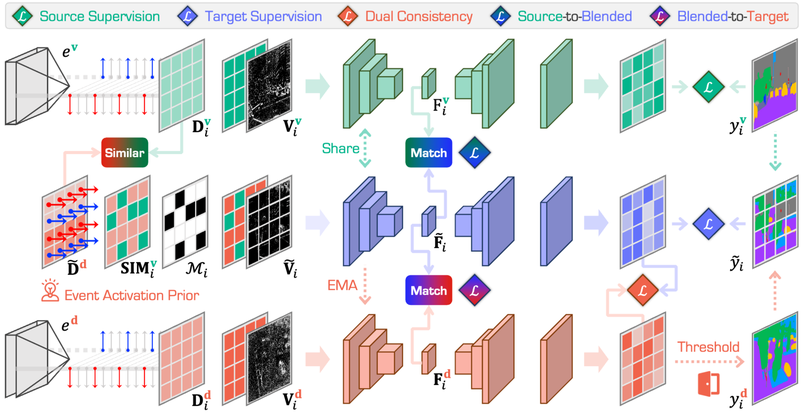


- We construct the **first** cross-platform benchmark, **EXPo**, for event-based semantic segmentation, tackling unique challenges of platform adaptation.
- We introduce Event Activation Prior (EAP), EventBlend, and EventMatch – a set of tailored techniques that utilize platform-specific **activation patterns**, **spatial data mixing**, and **dual-domain alignment** to mitigate the domain gap among heterogeneous robot platforms, providing a strong foundation for further research in robust and adaptive event camera applications.

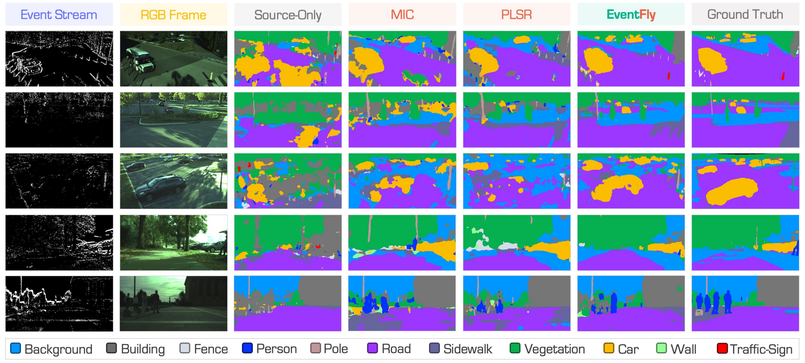
Design & Methodology

Cross-Platform Perception (Framework)

- **EventFly** is driven by **EAP** and leverages **EventBlend** for direct domain data mixing and **EventMatch** for implicit distribution alignments across platforms.



- **EventBlend** creates domain **similarity maps** by identifying the activated and non-activated event voxels, followed by generating mixed data for adaptation.
- **EventMatch** leverages **dual-domain** adversarial learning for bridging gaps, reducing discrepancy among source/blended and blended/target domains.



Experiments & Analysis

Comparative & Ablation Study (Findings & Observations)

- **EventFly** achieved SoTA results across adaptation tasks in-between **Vehicle**, **Drone**, and **Quadruped** platforms, exhibiting better robustness in real world.

Tab. Cross-platform event camera perception from Vehicle to Drone.

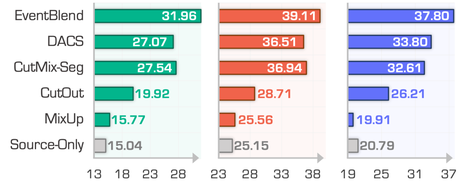
Method	Acc	mAcc	mIoU	fIoU	ground	build	fence	person	pole	road	walk	veg	car	wall	sign
Source-Only ○	43.69	33.81	15.04	11.81	48.71	11.57	0.92	8.42	13.33	25.48	8.18	31.51	14.88	0.04	2.41
AdaptSegNet [79]	49.14	35.38	21.16	12.15	29.37	23.57	0.17	0.48	13.45	38.23	17.85	48.73	29.42	35.55	0.40
CBST [104]	57.95	41.18	24.31	16.02	33.05	24.43	0.00	3.08	18.24	56.32	16.84	56.15	23.61	35.65	0.00
IntraDA [61]	57.37	38.85	23.58	15.91	32.31	23.17	0.00	4.90	14.91	56.70	18.67	54.94	20.71	33.08	0.00
DACS [77]	59.81	42.01	27.07	16.14	35.16	26.12	0.18	4.11	18.49	55.64	21.74	56.81	34.69	44.73	0.05
MIC [38]	63.11	45.60	28.87	17.46	41.40	25.19	0.01	10.11	22.86	59.25	20.84	58.86	33.95	44.18	0.90
PLSR [94]	64.61	45.93	29.69	17.99	42.09	30.06	0.00	9.75	23.32	62.48	20.65	60.15	31.69	44.27	2.06
EventFly (Ours)	69.17	48.20	32.67	20.01	46.64	30.55	1.27	10.91	25.50	67.17	24.21	61.01	41.30	44.54	6.21
Target ●	79.57	52.25	42.90	23.30	74.48	39.40	7.10	0.33	31.67	71.96	31.64	67.87	57.51	66.14	23.79

Tab. Cross-platform event camera perception from Vehicle to Quadruped.

Method	Acc	mAcc	mIoU	fIoU	ground	build	fence	person	pole	road	walk	veg	car	wall	sign
Source-Only ○	66.59	39.73	25.15	16.52	63.01	39.26	3.88	17.88	10.12	51.67	9.27	68.02	12.35	0.24	0.99
AdaptSegNet [79]	67.25	48.73	32.79	14.89	45.00	45.88	30.00	34.92	12.22	55.50	15.85	73.84	16.07	31.35	0.00
CBST [104]	69.25	49.58	35.06	14.95	47.39	54.68	34.27	36.83	13.78	56.15	18.13	74.23	16.18	34.06	0.00
IntraDA [61]	68.29	48.91	34.25	14.82	43.75	55.36	32.64	33.39	11.60	55.31	17.00	76.00	20.30	31.40	0.00
DACS [77]	69.55	53.88	36.51	14.66	43.72	57.27	38.43	35.42	14.02	57.10	18.43	76.16	24.79	36.21	0.00
MIC [38]	70.78	49.22	36.93	15.60	51.71	51.73	33.54	38.10	9.44	54.27	20.74	74.40	29.79	41.78	0.70
PLSR [94]	70.91	53.65	37.57	15.25	49.04	53.28	37.54	36.64	12.91	57.60	25.29	75.92	24.92	39.85	0.24
EventFly (Ours)	73.42	54.14	40.05	15.78	50.07	61.33	39.17	41.97	12.83	59.14	23.51	79.80	27.26	42.65	2.86
Target ●	80.02	60.55	49.84	19.58	74.80	56.23	46.08	55.28	21.79	59.90	30.31	77.24	58.38	62.47	5.81

- We observe that the **Drone** domain is the most difficult to adapt to, mainly due to unique motion patterns, viewpoints, and perspective-based dynamic.
- The **Quadruped** platform captures sporadic patterns that well align with its lower viewpoint. Also, it covers off-road environments with unique semantics.
- We believe that **strong generalization ability** is crucial for the deployment of event camera perception algorithms in the real-world environments.

Fig. Ablation on different mixing strategies



- **EventFly** aims to shed lights on the future development of more **robust** event systems.
- By providing the cross-domain adaptation benchmark, a solid foundation is expected to be laid across robot platforms.