Direct 3D model-based object tracking with event camera by motion interpolation

Y. Kang, G. Caron, R. Ishikawa, A. Escande, K. Chappellet, R. Sagawa, T. Oishi

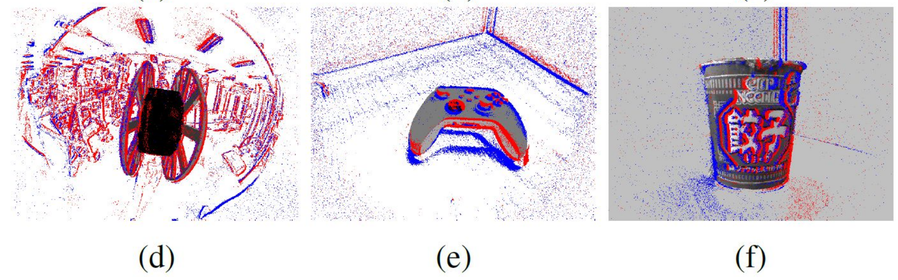
(*IIS, UTokyo JRL, CNRS-AIST MIS Lab, UPJV INRIA UMontpellier*)

Introduction

Problem: 6-Degree-of-Freedom (DoF) object tracking with event camera (estimate pose $\boldsymbol{p}$)

Challenges: 1) Motion blur in event frame accumulation
2) The background and light condition make the events unpredictable
3) Camera or object move in fast motion

(a) (b) (c)



(d) (e) (f)

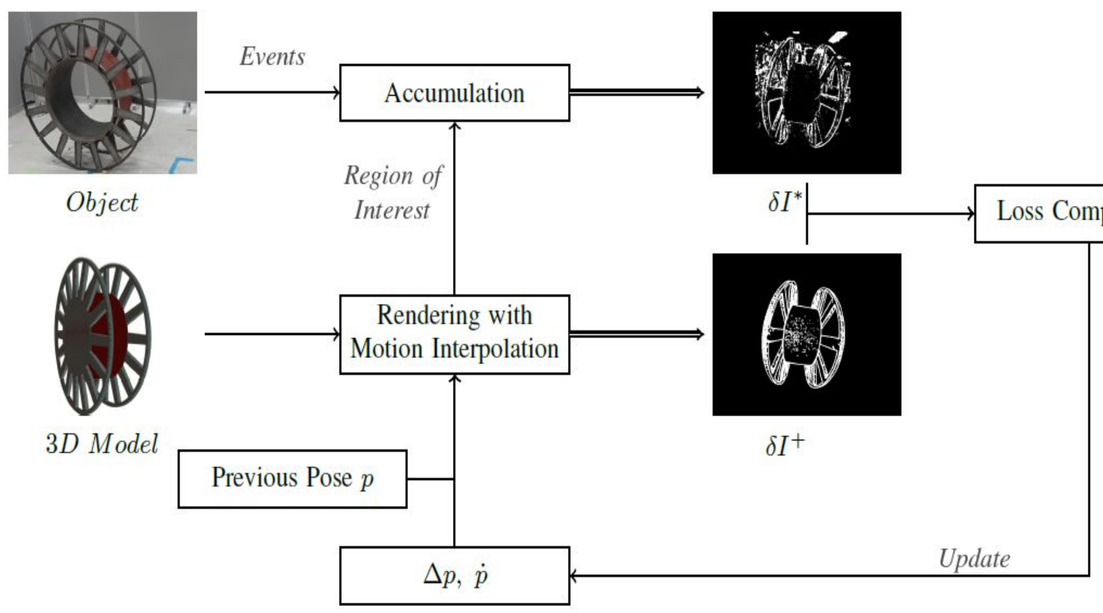
Event camera: novel sensors that measure brightness changes asynchronously

$$e_k = (u_k, v_k, p_k, t_k)$$

$$(u_k, v_k): 2D\ coordinate.\ p_k \in \{\pm 1\}.\ t_k : timestamp.$$

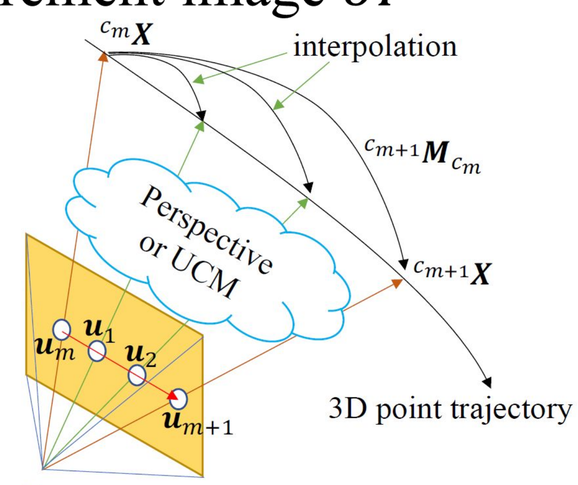
Contribution: The first method of object tracking using only events and 3D models as input

Methodology



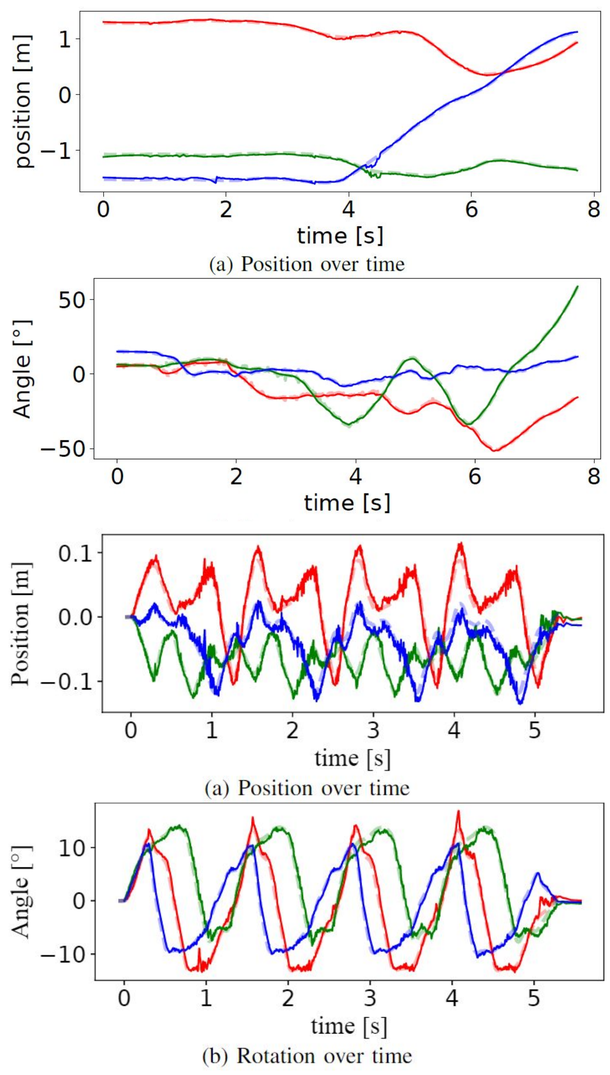
Brightness Increment Alignment with Motion Interpolation (**BIAM**)

- A novel 6-DoF object pose tracking system taking only events and 3D model as input.
- **Motion interpolation**: produce interpolation in predicted brightness increment image δI^+
- **Absolute brightness increments:** robust to background change
- **Region of Interest:** avoid irrelevant events



Results

Evaluation on public and original dataset (*Prophesee Gen* 3.1, 640×480)



(a) Position over time

(a) Position over time

(b) Rotation over time

Dense: estimated pose
Dash: ground truth

	BIA		BIAM	
	Pos. [mm]	Rot. [°]	Pos. [mm]	Rot. [°]
omni Traj. 1	28.4	1.83	**19.9**	**0.86**
omni Traj. 2	39.7	2.21	**33.0**	**1.54**
omni Traj. 3	**35.8**	1.35	36.8	**1.18**
omni Traj. 4	15.8	2.26	**15.5**	**2.19**
omni Traj. 5	22.4	1.50	**20.1**	**1.40**
omni Traj. 6	227	14.4	**12.9**	**2.11**
omni Traj. 7	502	30.9	**28.0**	**2.50**
omni Traj. 8	348	22.1	**16.6**	**2.56**
omni Traj. 9	/	/	**18.7**	**1.17**
omni Traj. 10	/	/	**16.3**	**1.59**

Our method reached **759 Hz** on sequence of fast motion (2m/s)
Stable tracking on 5 different objects

Gray: 3D model
Red & Blue: events