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Ultimate SLAM? Robust Visual SLAM with Events, Images and IMU

DEMO!

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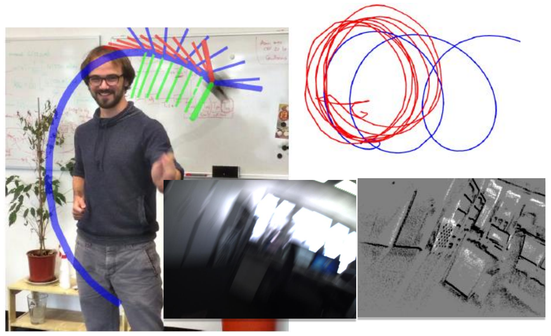
Motivation: **SLAM with standard cameras is not robust** to scenes characterized by high dynamic range (**HDR**), **motion blur, and low light**.

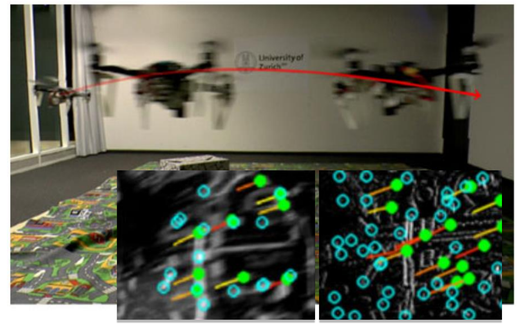
Goal: By **combining a standard camera with an event camera and an IMU**, we unlock SLAM scenarios with **unprecedented performance at very high speed, HDR, and even low light**.

Key properties:

- 6-DOF tracking using **events**, **frames**, and **IMU**
- Works even in **high-speed** and **HDR** scenes, where standard cameras fail.
- **Tightly-coupled** sensor fusion.
- **Real-time** on a **smartphone CPU**.

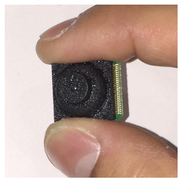


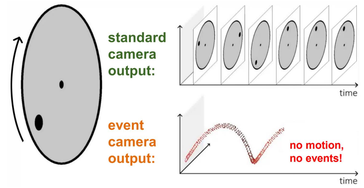
High-speed Tracking



Drone control in a dark room

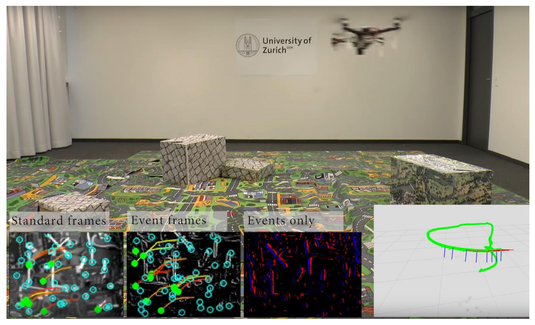
What is an event camera?



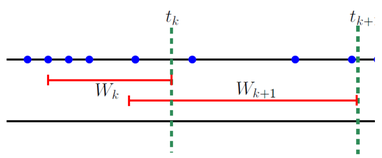


- Only transmits **brightness changes**.
- Output is a stream of **asynchronous events**.
- **Advantages:** low latency, no motion blur, HDR.

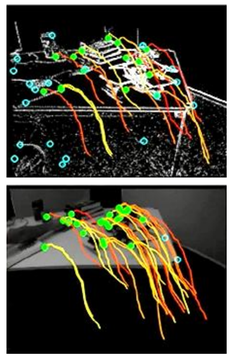
Watch video!



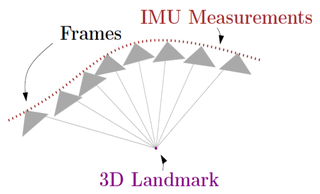
Approach



Selection of spatio-temporal windows of events



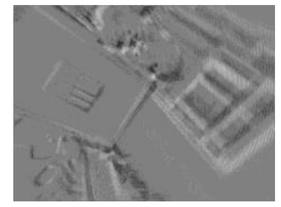
Feature tracking on event frames + standard frames



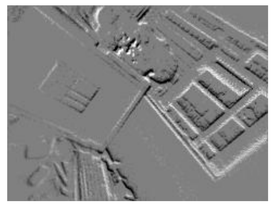
Visual-inertial fusion through keyframe-based optimization

1. Synthesize motion-compensated event frames using the camera motion and scene structure.
2. Track features across event frames & standard frames (KLT)
3. Refine the camera trajectory and scene structure using keyframe-based non-linear optimization [2]

Motion Compensation



Raw



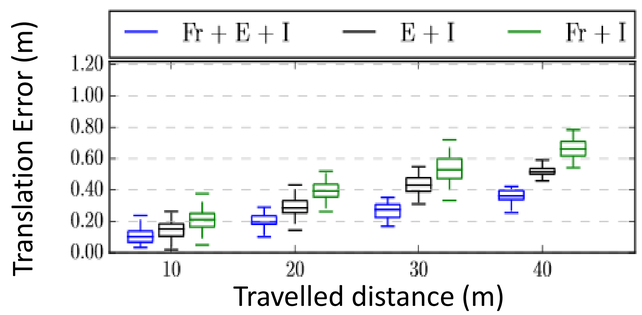
Motion compensated

Standard Frame

Results

Evaluation on the Event Camera Dataset [3]

85% accuracy gain over frame-based visual-inertial odometry!



References: [1] Rosinol et al., ***Ultimate SLAM?***, IEEE RAL'18.
[2] Leutenegger et al, ***OKVIS***. IJRR'15.
[3] Mueggler et al., **The Event Camera Dataset and Simulator**, IJRR'17.