Department of Electrical Engineering
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MASTER PROJECT ET/CE/ESE

Beyond Frames: Modern Representations for Event-Based Vision

Semester: WS 2025/26

Background

Event cameras (DVS) provide asynchronous, high-dynamic-range data by capturing per-pixel intensity changes. However, standard computer vision algorithms cannot process raw event streams directly. To bridge this gap, events must be converted into structured representations. From classic Voxel Grids and Time Surfaces to advanced Motion-Compensated images and Learning-based latent features, the choice of representation is the most critical step in neuromorphic perception.

Project Goal

This project follows a two-phase "Experiment & Innovate" approach. In the first phase, students will implement and evaluate established event representations (e.g., Voxel Grids, Motion Compensation) using standard datasets. In the second phase, students are challenged to modify these existing methods or develop their own novel algorithms to improve data density, reduce noise, or optimize for real-time performance. The results will be validated through a comparative study on edge-case scenarios.

Intermediate Goals

- **Exploration of Representations:** Implement at least three different methods (e.g., Voxel Grid, HATS, Motion Compensation) and analyze their mathematical trade-offs.
- **Performance Benchmarking:** Run these methods on the MVSEC or DSEC datasets. Evaluate how different representations affect subsequent tasks like object tracking or depth estimation.
- **Algorithm Design & Modification:** Propose a modification to an existing representation or develop a custom "hybrid" approach. Students will test if their custom method outperforms baselines in specific conditions (e.g., high-speed motion).

References

[1] Gallego et al., *Event-based Vision: A Survey*, IEEE TPAMI 2020.

[2] Gehrig et al., *End-to-End Learning of Representations for Event-based Antialiasing*, CVPR 2019.

Requirements

- Strong C++ or Python skills
- Familiarity with ROS2 (highly recommended) or ROS
- Basic understanding of Digital Image Processing

Learning Outcomes

- Master the fundamentals of Neuromorphic Engineering and DVS hardware
- Design custom data structures for high-frequency, asynchronous data
- Gain hands-on experience with ROS2-based sensor fusion

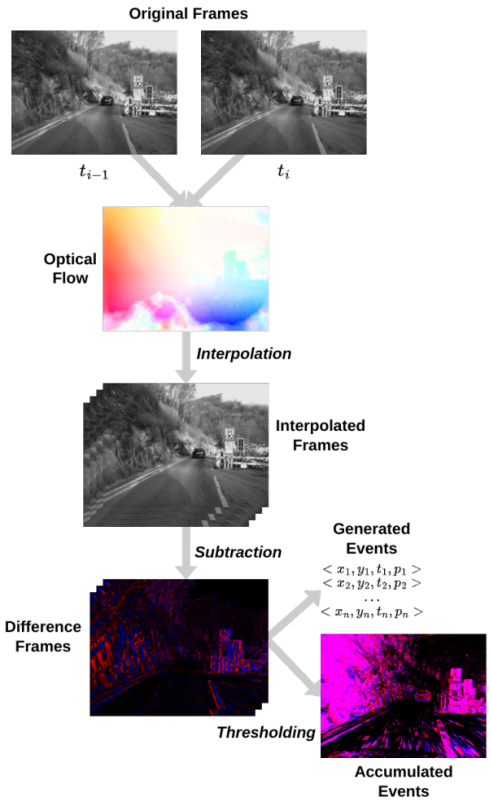

Figure 1: The process of the dense frame interpolation method.

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