Powerline Tracking with Event Cameras

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Code & Dataset: https://github.com/uzhrpg/line_tracking_with_event_cameras

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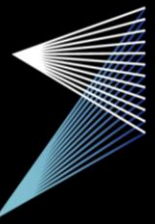

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Motivation

- Powerline inspection
  - High risk
  - Expensive

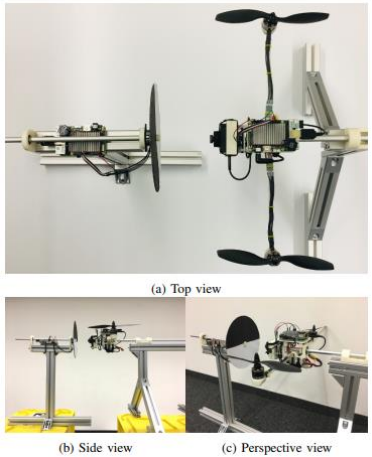
Photo: Meridian Helicopters

- **Autonomous** inspection exploiting **event cameras**
  - Robustness to motion blur
  - Low latency
  - High dynamic range

Related Work

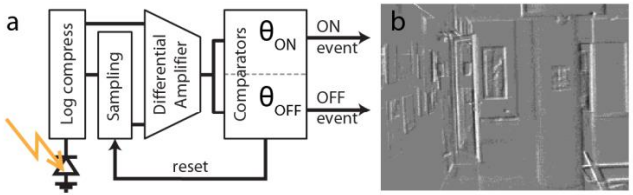
Hough Transform based approaches

- Sugimoto et al., Towards low-latency high-bandwidth control of quadrotors using event cameras, ICRA, 2020.



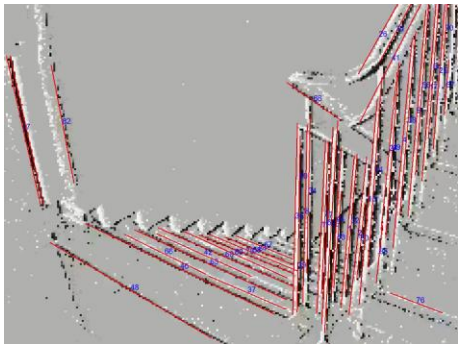
Nonparametric based methods

- C. Brandli et al., Elised—an event-based line segment detector, EBCCSP, 2016.



Spatio-temporal based approaches

- Everding et al., Low-latency line tracking using event based dynamic vision sensors, Frontiers in neurorobotics, 2018.

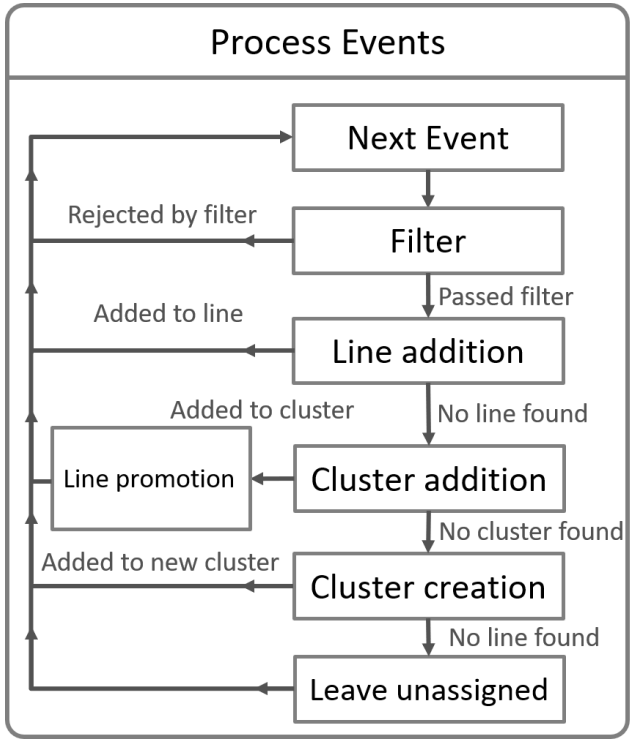


Related Work

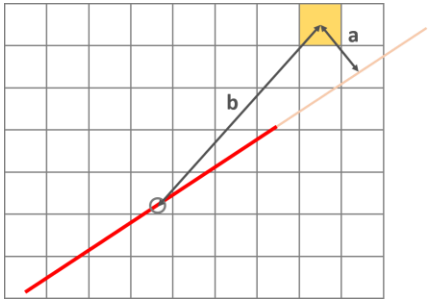
	Detection	Environment	Uniqueness	Persistence
Hough Transform	+	-	-	+
Nonparametric methods (ELiSED)	+	+	-	-
Spatio-temporal based methods	+	+	+	-
Ours	+	+	+	+

Hibernation

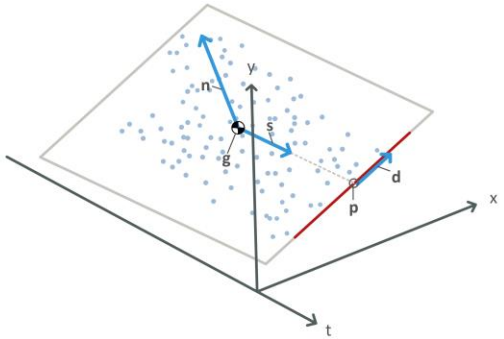
Methodology



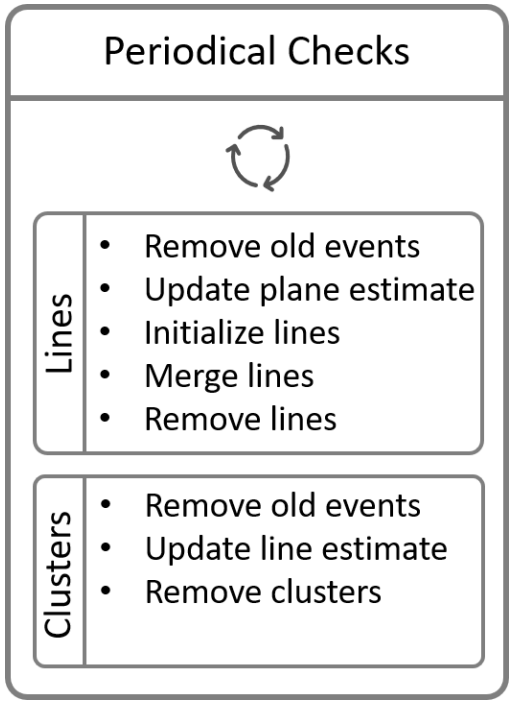
Line addition

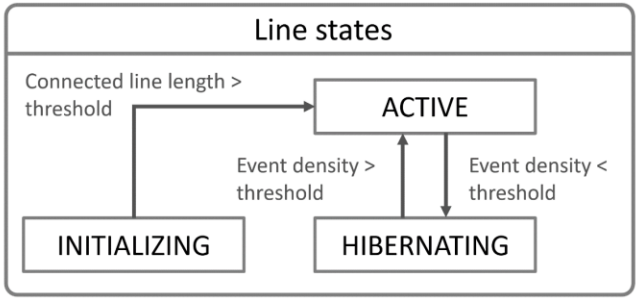


Line promotion



Methodology





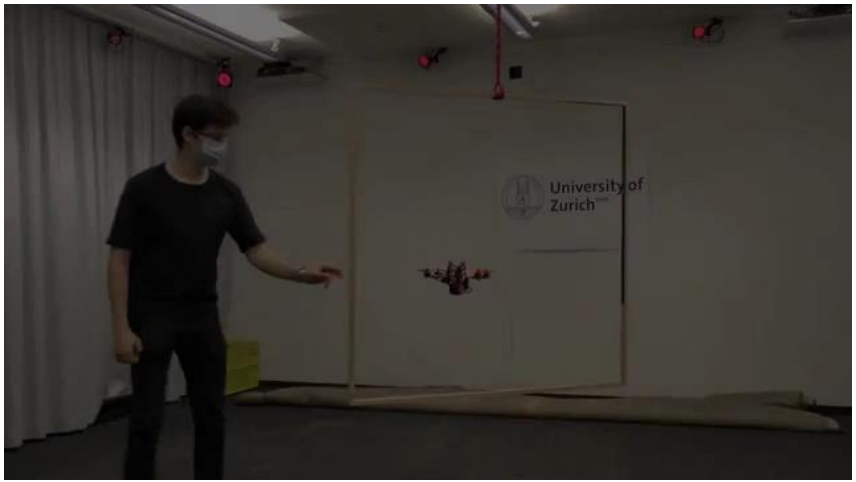
- *Hibernation* makes the line tracker **robust** to lines that change directions.
- *Hibernated* lines are kept in memory, but their positions are not updated until new events are added.

Experiments

Powerline tracking

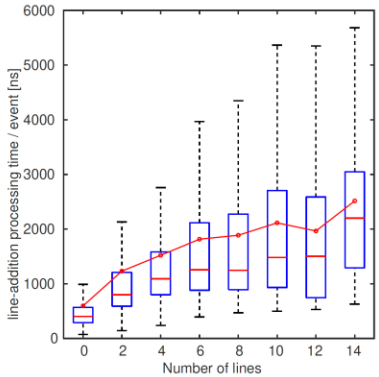
Experiments

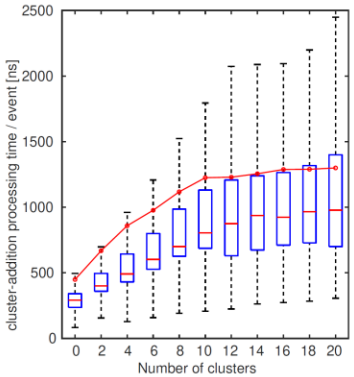
Closed-loop control



- Computational cost is **linear** in the number of lines and clusters

Processing step	Processing time [ns]
Filtering	276.6
Line addition	1,369.8
Cluster addition	744.0
Cluster creation	585.7





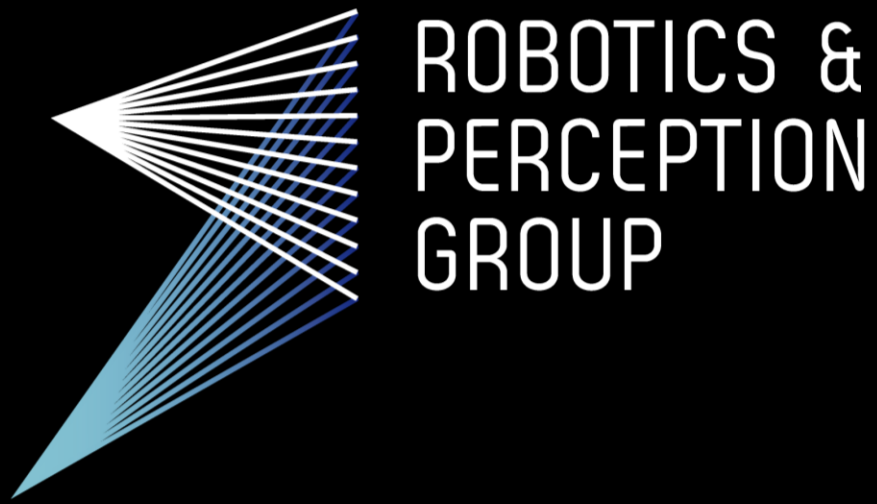
Summary

- Spatio-temporal event-based line tracker optimized for powerline inspection.

- We introduce *hibernation* to improve the persistence of the line tracker.
  - Our method is able to track lines **10x longer** than the state-of-the-art spatio-temporal based methods.

- **Real-time implementation** capable to run onboard a lightweight resource-constrained quadrotor platform.

- Code fully **open-source**
  - https://github.com/uzh-rpg/line_tracking_with_event_cameras



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