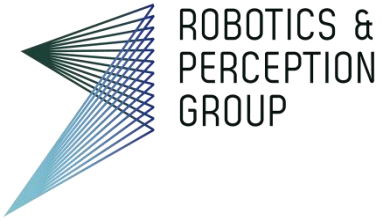
University of Zurich[UZH] | ETH zürich

Institute of Informatics – Institute of Neuroinformatics



2nd International Workshop on Event-based vision and Smart Cameras

CVPR, Room 101 A

June 17th, 2019, 8 am – 6 pm

Davide Scaramuzza, Guillermo Gallego, Kostas Daniilidis

Sponsor

Website

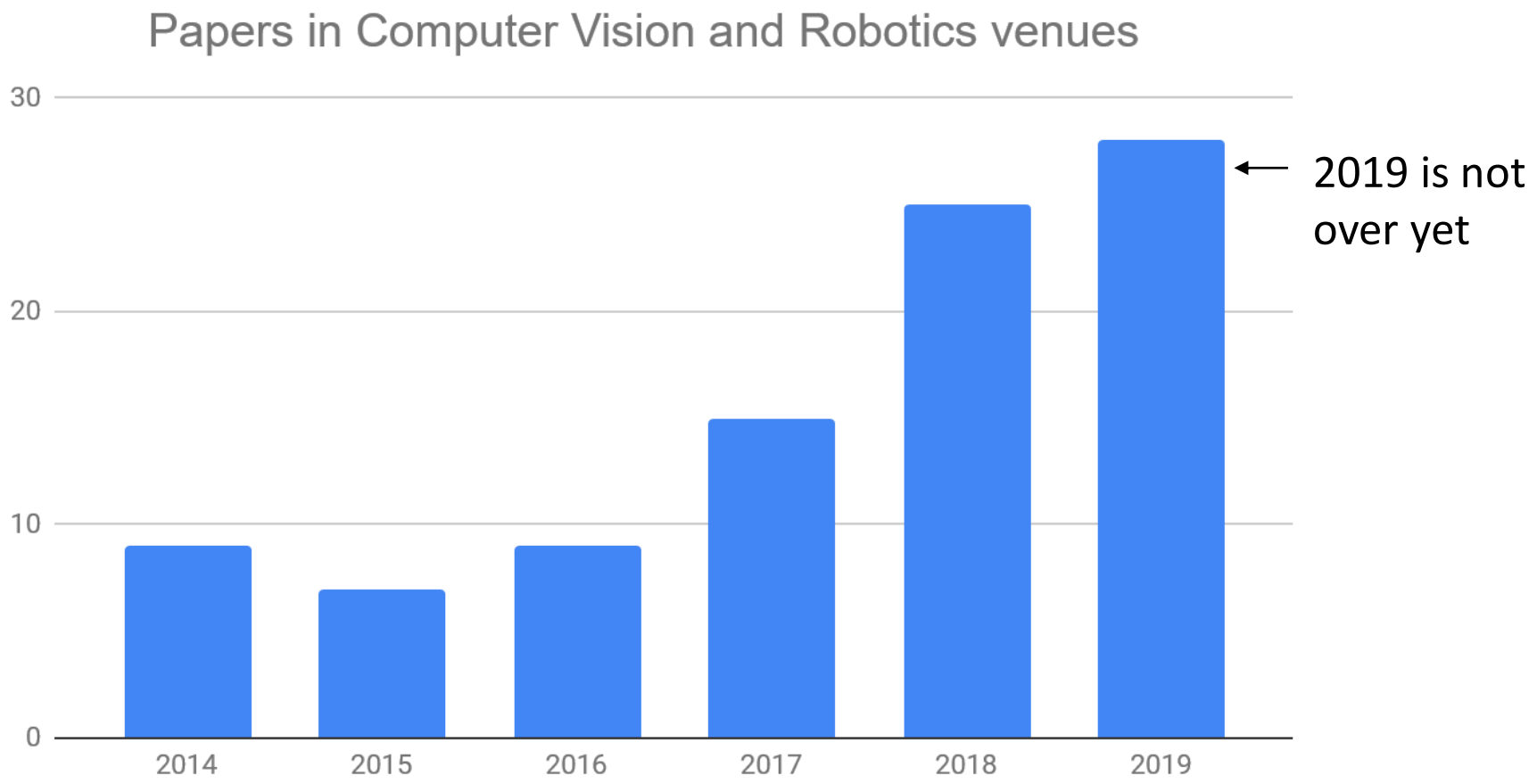
http://rpg.ifi.uzh.ch/CVPR19_event_vision_workshop.html

Workshop Topics

- The **latest event-based cameras** (5 manufacturers)
- **Near-focal plane processing** (cellular processor arrays, **SCAMP-5**)
- **Neuromorphic computing** (Spiking Neural Networks, Intel Loihi)
- **Learning-based** as well as **model-based** approaches
- **5 new datasets**
- **Algorithms**: visual odometry, SLAM, 3D reconstruction, optical flow estimation, image intensity reconstruction, recognition, feature/object detection and tracking, etc.
- **Applications**: automotive, robotics (navigation, drones...), AR/VR, space, inspection, surveillance, star tracking, etc.

Growing field in Computer Vision and Robotics

- Papers published during the last 5 years at CVPR, ECCV/ICCV, ICRA…



PAMI, IJCV, CVPR +W, ECCV +W, ICCV +W, BMVC, WACV, 3DV, ICIP, IROS +W, ICRA +W, RSS, ICCP, ICASSP, CoRL, IJRR, TRO, RAL

Event-based Vision: A Survey

Guillermo Gallego, Tobi Delbrück, Garrick Orchard, Chiara Bartolozzi, Brian Taba, Andrea Censi, Stefan Leutenegger, Andrew Davison, Jörg Conradt, Kostas Daniilidis, Davide Scaramuzza

Abstract— Event cameras are bio-inspired sensors that work radically different from traditional cameras. Instead of capturing images at a fixed rate, they measure per-pixel brightness changes asynchronously. This results in a stream of events, which encode the time, location and sign of the brightness changes. Event cameras posses outstanding properties compared to traditional cameras: very high dynamic range ($140\,\mathrm{dB}$ vs. $60\,\mathrm{dB}$), high temporal resolution (in the order of $\mu\mathrm{s}$), low power consumption, and do not suffer from motion blur. Hence, event cameras have a large potential for robotics and computer vision in challenging scenarios for traditional cameras, such as high speed and high dynamic range. However, novel methods are required to process the unconventional output of these sensors in order to unlock their potential. This paper provides a comprehensive overview of the emerging field of event-based vision, with a focus on the applications and the algorithms developed to unlock the outstanding properties of event cameras. We present event cameras from their working principle, the actual sensors that are available and the tasks that they have been used for, from low-level vision (feature detection and tracking, optic flow, etc.) to high-level vision (reconstruction, segmentation, recognition). We also discuss the techniques developed to process events, including learning-based techniques, as well as specialized processors for these novel sensors, such as spiking neural networks. Additionally, we highlight the challenges that remain to be tackled and the opportunities that lie ahead in the search for a more efficient, bio-inspired way for machines to perceive and interact with the world.

Index Terms—Event Cameras, Bio-Inspired Vision, Asynchronous Sensor, Low Latency, High Dynamic Range, Low Power.

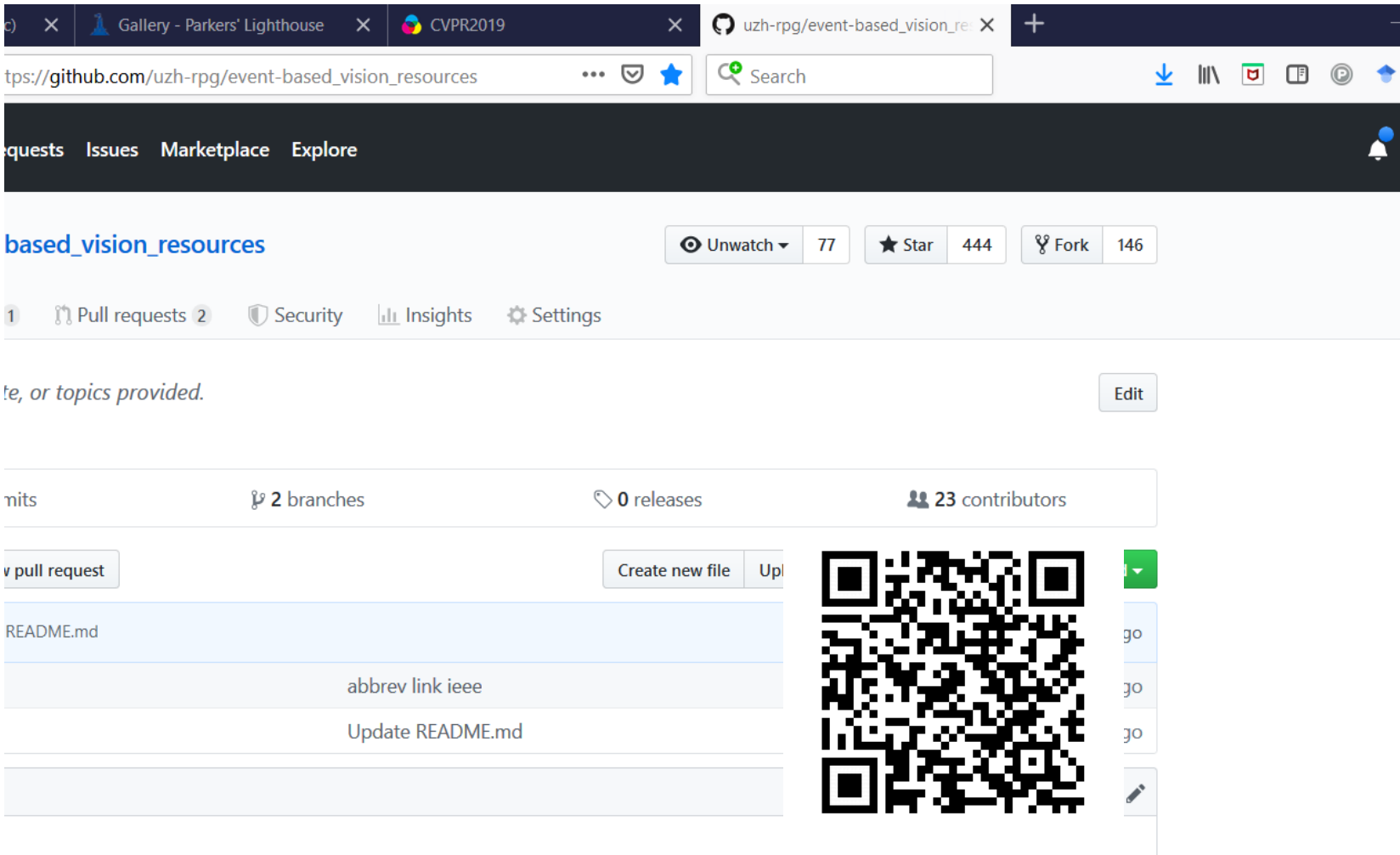
1 Introduction and Applications

"THE *brain is imagination, and that was exciting to me; I wanted to build a chip that could imagine something*[1]." that is how Misha Mahowald, a graduate student at Caltech in 1986, started to work with Prof. Carver Mead on the stereo problem from a joint biological and engineering perspective. A couple of years later, in 1991, the image of a cat in

as well as new computer vision and robotic tasks. Sight is, by far, the dominant sense in humans to perceive the world, and, together with the brain, learn new things. In recent years, this technology has attracted a lot of attention from both academia and industry. This is due to the availability of prototype event cameras and the advantages that these devices offer to tackle problems that are currently unfeasible

http://rpg.ifi.uzh.ch/docs/EventVisionSurvey.pdf

List of Event-based Vision resources

Code, papers, videos, companies on event cameras

https://github.com/uzh-rpg/event-based_vision_resources