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Event-Guided Temporally Super-Resolved Synchrotron X-ray Imaging

Friday 30 August 2024 14:40 (20 minutes)

Synchrotron-based X-ray micro-computed tomography is the reference technique for a number of studies investigating fundamental properties and functions of materials and organisms. However, the increased use of imaging technologies is becoming more and more challenging, as high-speed dynamical imaging experiments either produce exorbitant amounts of data or remain limited in temporal resolution. Recently, event cameras have been introduced as an alternative approach to conventional frame-based cameras, in the sense that they detect per-pixel brightness changes asynchronously and generate a stream of events encoding the triggering time, location, and polarity of each pixel [1]. This adaptive and asynchronous feature offers several advantages, including high temporal resolution (on the order of μs) and high dynamic range (up to 140dB), making event cameras particularly suitable for applications requiring fast response times and/or operation in dynamic environments. Although event-based vision has recently gained popularity in various applications, its realization in X-ray imaging remains unexplored.

At the TOMCAT beamline of the Swiss Light Source (Paul Scherrer Institut, Villigen, Switzerland), we have developed a new inline dual-camera setup which incorporates a high-speed frame-based CMOS detector [2], and a bio-inspired neuromorphic event camera (Prophesee, Metavision Evaluation Kit 4, EVK) [3]. Both cameras were combined with magnifying visible light optics to achieve a pixel size of 1.1 μm and were synchronized with an external 1Mhz TTL signal by utilizing the PandABox (Position and Acquisition Box). Based on this setup, we present a novel event-guided approach for temporal super-resolution of the sampled frame data. As a first example, we characterize the system by imaging a live sandclock in radiographic mode and present all necessary post-processing steps for achieving greater than five-fold super-resolution. Our work marks the first exploration of the potential of event cameras in dynamic X-ray imaging. We report its current performance and limitations and discuss the potential to reduce the data generation rate, facilitating more efficient data transmission, real-time processing, and visualization in future time-resolved synchrotron X-ray imaging experiments.

References:
[1]G. Gallego et al., "Event-based Vision: A Survey,"IEEE Trans. Pattern Anal. Mach. Intell., vol. 44, no. 1, pp. 154–180, Jan. 2022, doi: 10.1109/TPAMI.2020.3008413.
[2]R. Mokso et al., "GigaFRoST: the gigabit fast readout system for tomography,"J Synchrotron Rad, vol. 24, no. 6, pp. 1250–1259, Nov. 2017, doi: 10.1107/S1600577517013522.
[3]"Event Camera Evaluation Kit 4 HD IMX636 Prophesee-Sony,"PROPHESEE. Available: https://www.prophesee.ai/event-camera-evk4/

I plan to submit also conference proceedings

No

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