Live Demonstration: Asynchronous Time-based Image Sensor (ATIS) Camera with Full-Custom AE Processor

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Abstract— **This live demonstration shows high DR, high temporal resolution, frame-free image/video acquisition based on asynchronous events. The presented camera features 9-bit gray-level imaging at up to 143dB DR and <0.25% FPN with hardware-based lossless video compression and time-domain correlated double sampling. The main components of the camera – an asynchronous, time-based image sensor (ATIS) and a general purpose Address-Event processor with 20-Bit 10ns-resolution sensor data interface – have been specifically designed for the application. The presented system optimally combines the advantages of time-based (PWM) imaging, bio-inspired temporal contrast dynamic vision and event-based (AER) information encoding and data communication.**

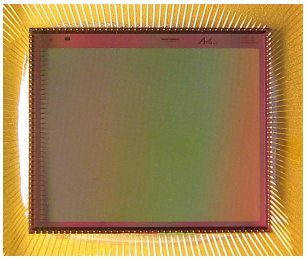
I. DESCRIPTION

The presented camera, featuring a novel asynchronous time-based image sensor and a full-custom SPARC-compatible post-processor with hardware-accelerated AER data interface, draws on the combination of PWM imaging, bio-inspired temporal contrast dynamic vision and event-based information encoding and data communication. The vision/imaging system achieves exceptional performance in terms of dynamic range, FPN, temporal resolution, gray-level resolution and data reduction.

The CMOS image/video sensor is based on an array of asynchronous, fully autonomous pixels containing event-based change detector and PWM photo-measurement circuits. A gray-level measurement is initiated at the pixel-level only if a change has individually been detected by a pixel in its field-of-view. Pixels do not need any external timing signals and independently and asynchronously request access to an asynchronous output channel when they have new illumination values to communicate. Communication is address-event based (AER) and gray-levels are encoded in inter-event intervals. Pixels that are not stimulated visually do not produce output. This operation ideally results in optimal lossless video compression through temporal redundancy suppression at the focal-plane. Compression factors depend on scene activity. Due to the time-based (PWM) encoding of the illumination information, very high dynamic range (intra-scene DR: 143dB static and 125dB at 30fps equivalent temporal resolution) is achieved. A novel time-domain correlated double sampling (TCDS) method yields array FPN of <0.25%. SNR is >56dB for >10Lx at the sensor plane.

The general-purpose SPARC-compatible post-processor features a 20-bit parallel AER data interface with 10ns resolution time-stamping and hardware-accelerated event pre-processing including robust peak-rate handling, ROI/RONI filtering and flexible DMA functionality.

- ISCAS track selection: Sensory Systems
- Demonstration setup: The demo setup consists of the camera and a laptop/computer screen for visualization of the live sensor data. Camera output in the form of raw Address-Events as well as live images and videos can be displayed. Additional information such as instantaneous data rate, scene dynamic range, etc. is shown on the screen. The photographs show a chip-photo of the image sensor and a prototype camera with the imager board stacked on top of the processor board. For the live demo, a new more compact camera design will be available.



- Visitor experience: The visitor will learn about dynamic vision and image/video encoding in asynchronous spikes (AER) and will experience the advantages of change event based pixel-level video compression/redundancy suppression, the temporal resolution and exceptional dynamic range of time-based/PWM image information encoding and the excellent FPN performance of time-domain correlated double sampling (TCDS). Different modes-of-operation of image/video acquisition (ATIS, TTFS, ACPR) are demonstrated and compared, advantages and drawbacks are discussed.

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