Live Demonstration: A High-Speed-Pass Asynchronous Motion Detection Sensor

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***Abstract*—We demonstrate an asynchronous address event representation (AER) motion detection sensor [1][2], that only responds to motions with speed higher than a tunable threshold. Each pixel in the sensor can individually monitor the relative change in light intensity and report a digital event if a threshold is reached. The output of the sensor is not a frame, but a stream of asynchronous digital events. By adjusting a variable slow-motion filter, low speed motion can be filtered.**

I. Introduction

In comparison with other types of sensors such as temperature, pressure, humidity, velocity and acceleration, vision sensors generate much higher bandwidth data. In the application of high speed motion detection, trade-offs exist between frame-rate and image resolution. Moreover, it is a big challenge to transmit, store and process the huge amount of video data in realtime.

We designed an image sensor that allows pixel-parallel image processing at the focal plane and combines with Address-Event-Representation (AER) readout, providing efficient allocation of the transmission channel to only active pixels [1]. AER readout scheme has become a norm in many machine vision sensors [2]. Each pixel in our sensor can individually monitor the relative change in light intensity and reports an event if a threshold is reached. Asynchronous row and column arbitration circuits process the pixel requests and make sure only one request is granted at a time in a fairly manner when they receive multiple requests simultaneously. Once the arbitration process is completed, the pixel address is sent out, and the pixel will re-start its operation. Therefore the speed of the sensor is not limited by any traditional concept such as exposure time, frame rate, etc., though event latency and contrast threshold are among the performance parameters to be considered.

In addition to the above-mentioned features, each of the pixel-level circuit equips with a tunable slow-motion filter ($M7$ in Fig. 11 of [1]). When the light intensity changes slower than a threshold, the circuits wont trigger digital events. Moreover, adjusting the strength of the filter will produce different motion-speed responses and result in a useful feature of speed-selectivity. As such, the sensor can be tuned to catch motion objets with speed faster than a certain threshold. Test result shows that the sensor can detect fast motion which is traditionally captured by high speed cameras running at thousands frames per second, but with hundreds times less of data. The sensor was implemented using GlobalFoundries 0.18 μm 6M1P process, with die size of 2.5×2.5 mm^2. The chip consumes about 70 mw with power supply at 1.8 V.

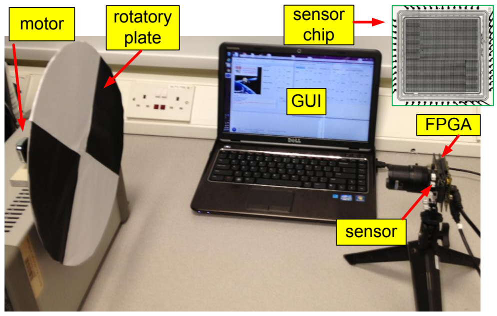

Fig. 1. Setup of the demo system

II. Demonstration Setup

The equipments of the demo system (Fig. 1) include: a laptop PC, an image sensor PCB board, an Opal-Kelly XEM 3010 FPGA board, a motor driven rotatory plate and DC power-supply. The FPGA is configured to provide input control signals (sensor reset, tune motion speed selectivity). The FPGA also temporarily stores the events data to an on-board SDRAM and communicates with a PC through a high speed USB link. On the PC side, a C++ graphic user interface program translates the digital events into time-window based snap-shot pictures.

III. Visitors Experience

During the demo, visitors can observe the speed selectivity property of the sensor. At a lower rotary speed, a full flying wheel can be seen on the computer; while at a higher speed, only the outer flying ring left. Adjusting the leakage strength will result in different speed response. The GUI on computer will display the motion image in realtime.

IV. Track Selection

This demo would be related to track 11.4: Spiking Sensing and Processing.

References

[1] Xiangyu Zhang and Shoushun Chen,“A Hybrid-Readout and Dynamic-Resolution Motion Detection Image Sensor for Object Tracking,” the IEEE International Symposium on Circuits and Systems (ISCAS), pp. 1628 - 1631, Seoul, Korea, May 2012.

[2] P. Lichtsteiner, C. Posch, and T. Delbruck, “A 128×128 120 dB 15 μs latency asynchronous temporal contrast vision sensor,” IEEE Journal of Solid-State Circuits, vol. 43, no. 2, pp. 566 - 576, 2008.