Live Demonstration: CeleX-V: a 1M Pixel Multi-Mode Event-based Sensor

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Abstract

We demonstrate a new generation smart image sensor, CeleX-V. With 1280×800 pixels, 9.8um pitch, the sensor integrates several vision functions into one chip, such as full-array-parallel motion detection and on-chip optical flow extraction. CeleX-V is also capable of producing high-quality full-frame pictures and thus is compatible with traditional picture-based algorithms. The sensor supports both MIPI and parallel interface, with typical 400mW power consumption..

1. Introduction

Event-based motion sensors have shown great potential to improve the performance of real-time machine vision. Compared with conventional cameras, this type of sensors asynchronously respond to relative intensity change in the array. In order to extend these sensors into real applications, efforts have been made for new pixel architecture, reduced pixel size, higher resolution, less readout latency, higher readout throughput, less readout noise and smarter on-pixel processing circuits. In particular, our pixel integrates a logarithmic photodetector for intensity information, which doesn't need extra exposure time and our sensor is able to report an event packet of (x, y, a, t), where (x,y) reports the pixels coordinate, (a) is the pixel's intensity and (t) is the time stamp [1].

In this demo, we present a 1M-pixels multifunctional sensor, namely "CeleX-V", with 1280 × 800 pixels. The sensor is implemented with 65nm CIS process and is the latest member of CeleX families [2]. The pixel pitch is 9.8um. CeleX-V integrates several vision functions into one image senor, such as full-array-parallel motion detection and full-frame pictures output. Specifically, it could also realize on-chip optical flow extraction. With relatively small pixel area budget, the pixel architecture is optimized to ensure high bandwidth for high-speed motion detection and high sensitivity for temporal contrast detection and full-frame picture output. Two types of readout interface, serial MIPI interface and parallel interface, are supported by CeleX-V, which makes it be easily connected to the back-end host processor. The MIPI interface supports up to 2.4Gbps transfer rate while the parallel interface supports the maximum readout of 140M pixels per second. In addition, CeleX-V could compensate the influence of ambient environment on image quality with an embedded digital temperature sensor and back-end ambient light sensor. Figure 1 shows the sensor architecture and also some sample pictures.

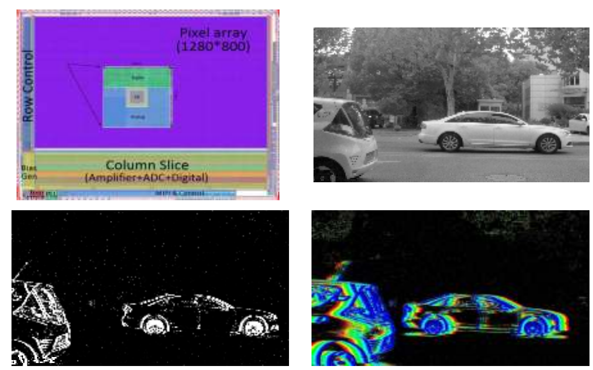

Figure 1: (top left) Sensor architecture. (top right) Sample images of a moving car on the road, full-frame picture. (bottom left) Picture reconstructed from events in 30ms. (bottom right) Picture of optical flow extraction reconstructed from events in 60ms (blue pixels means the early events, green for the later events and red for the latest, non-events area is shown in blank).

2. Demonstration setup

The demo system includes a laptop PC, a CeleX-V which is mounted on a PCB board and attached to a credit-card-sized host board employing Cypress CX3 to convert sensor data from MIPI to USB3.0 interface.

3. Visitors experience

During the demo, visitors may stand in front of the image sensor and make some movements, or play with some moving objects, such as a ball and so on. The GUI on computer will display the multiple format data from the sensor in the form of reconstructed videos. Some relevant signal processing results, such as object tracking and optical flow are also shown.

References

[1] M. Guo, J. Huang and S. Chen, "Live demonstration: A 768 × 640 pixels 200Meps dynamic vision sensor," 2017 IEEE International Symposium on Circuits and Systems (ISCAS), Baltimore, MD, 2017, pp. 1-1. doi: 10.1109/ISCAS.2017.8050397

[2] CeleX series of DVS sensor developed by Hillhouse Technology https://www.youtube.com/watch?v=Wlzc-5sgm1g