FlyDVS: An Event-Driven Wireless Ultra-Low Power Visual Sensor Node

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BACKGROUND

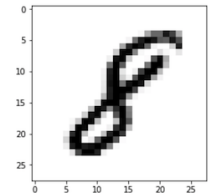
In battery supplied applications like wearable image acquisition, hand-gesture recognition, robotics, healthcare-oriented, and human-computer interaction (HCI), the **latency and energy efficiency are dominant constraints**.

Conventional imaging sensors output every pixel on the frame, resulting in massive data transmissions**. DVS cameras** are data-driven: they **only transmit pixels whose intensity change has exceeded a certain threshold**.

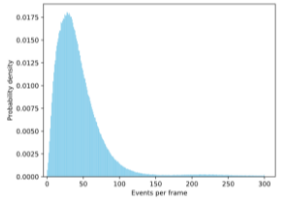
As edge-devices become more computationally capable, **eliminating the bottlenecks that prevent the deployment of event-based sensors** in-the-field **becomes a key enabler** for developing more energy efficient sensor nodes.

INSIGHTS

A promising approach to reduce the energy consumption of smart sensor nodes is to **exploit the energy-to-information proportionality of event sensors**. Contrarily to frame based cameras, event-cameras produce a variable amount of data, which is determined by the input activity of the sensor.

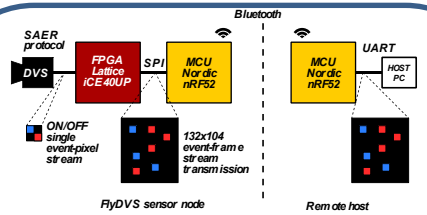


Sample, fixed-size frame



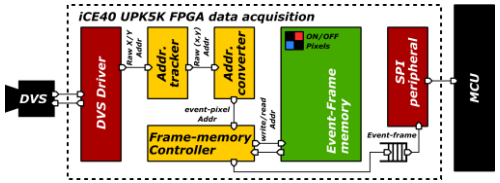
DVS event probability density of an event-frame

DESCRIPTION



FlyDVS is a wireless sensor node, capable to efficiently acquire event-pixels from a DVS camera, and transmit them to a host PC. The system is composed by:

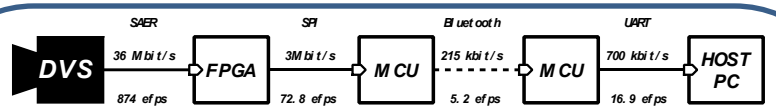
- A DVS132S event-camera.
- A low-power Lattice Semiconductor iCE40UP5K1 FPGA.
- A nRF52 system on chip (SoC) from Nordic Semiconductor as peripheral Microcontroller (MCU) units.



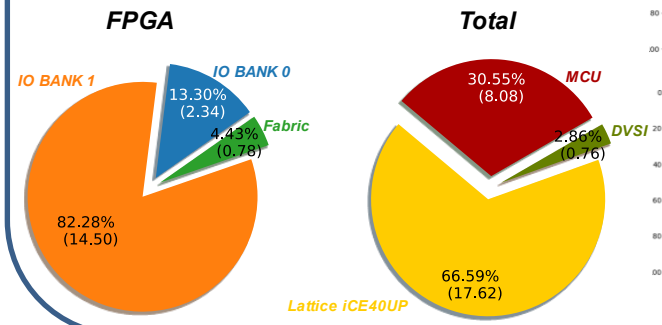
Event-frames are acquired as follows:

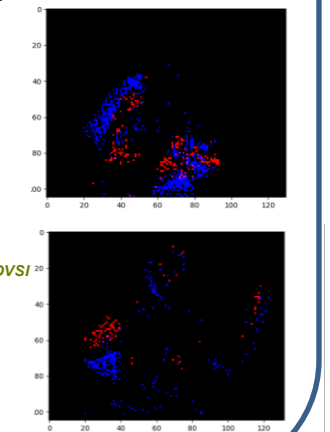
1. Event-pixels are read from the DVS and organized in event-frames by a sensor interface implemented on the low power FPGA.
2. Event-frames are transmitted to the peripheral MCU through a SPI interface.
3. The event-frame stream is transmitted through a wireless channel to a remote MCU connected to a host PC

QUANTITATIVE IMPACT



Experimental results acquiring a hand-gesture data set have shown the capability of the proposed solution to acquire up to **874 efps** (event-frames per second) **from the DVS camera**, and transmitting up to **200 efps over the wireless channel.** The total power consumption of the sensor node is **26.5mW** (17.6mW FPGA subsystem)





SUMMARY AND CONCLUSION

In this work we presented the design and the implementation of FlyDVS, to our best knowledge, this is the **first event camera-based sensor node designed for wireless and low-power imaging**.

As the FPGA power is dominant for the sensor node, future works aim at integrating the **DVS interface on a custom microcontroller IO subsystem,** which paves the way for **near-sensor event-stream processing with spiking neural networks or sparse convolution executed on constrained resource devices**.

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