Design and Benchmarking of an Embedded System for Low Power Event-Based Vision

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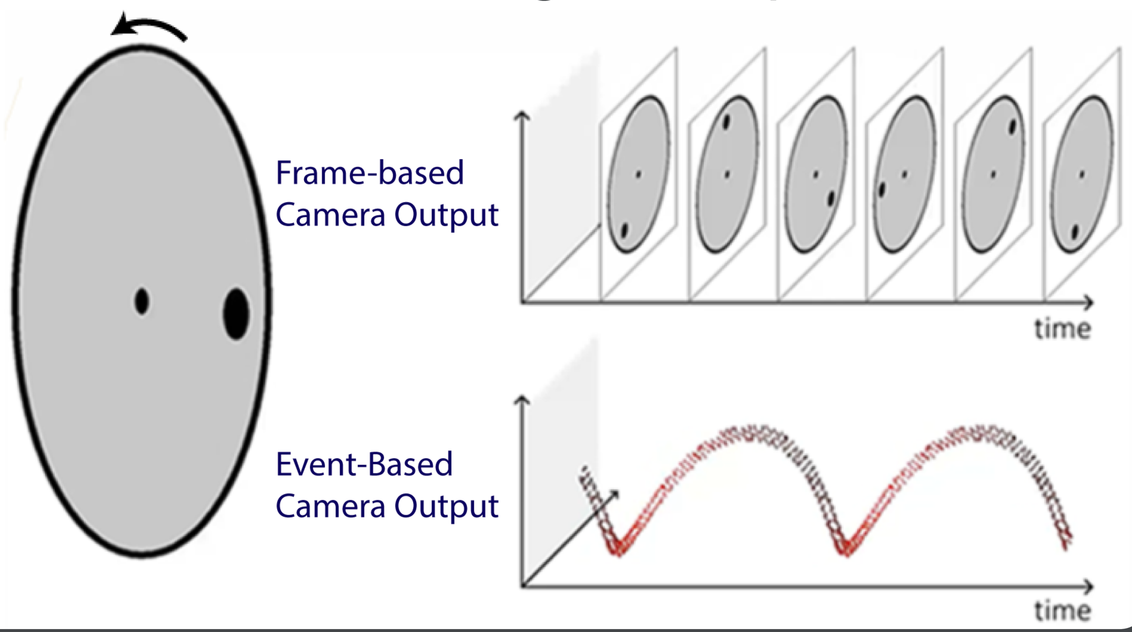
Context

Event Camera Introduction

Conventional cameras waste power by sending redundant data. Event-based vision sensors [1] send only pixel-level brightness changes, which results in:

- Higher temporal resolution
- Reduced data
- Reduced processing
- Lower power

Figure adapted from [2].



Motivation

Event-based vision enables always-on, low-power, real time sensing for wearables, robotics, and IoT by exploiting data sparsity.

Problem

Real system power costs are not well characterized, especially for acquiring/transmitting event streams.

Research Question

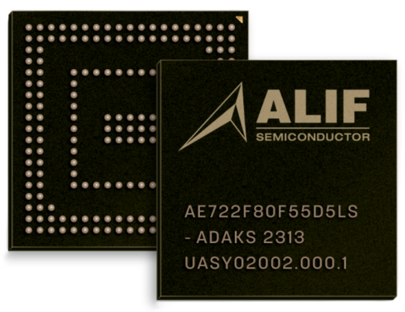
What is the baseline power needed to receive an event stream and how is it distributed across system components?

Method

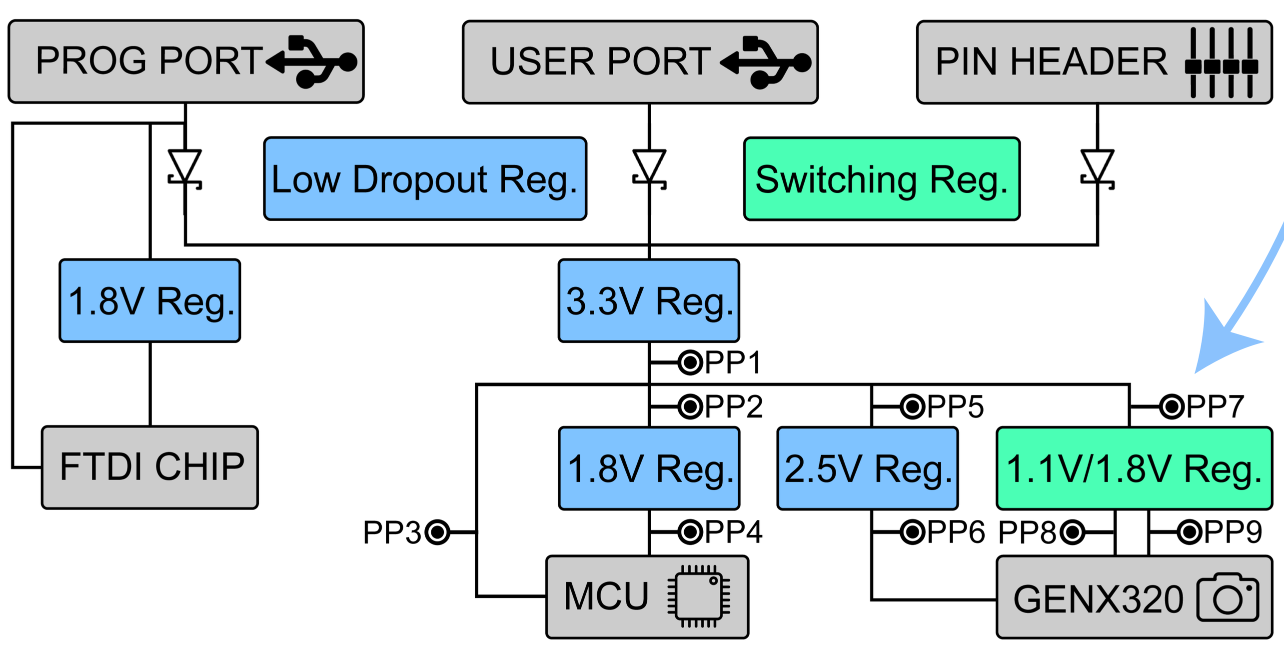
Objectives

Build an embedded system with

- Multi-core MCU with μNPUs
- Integrated event camera with CPI
- Power measurement points in power tree

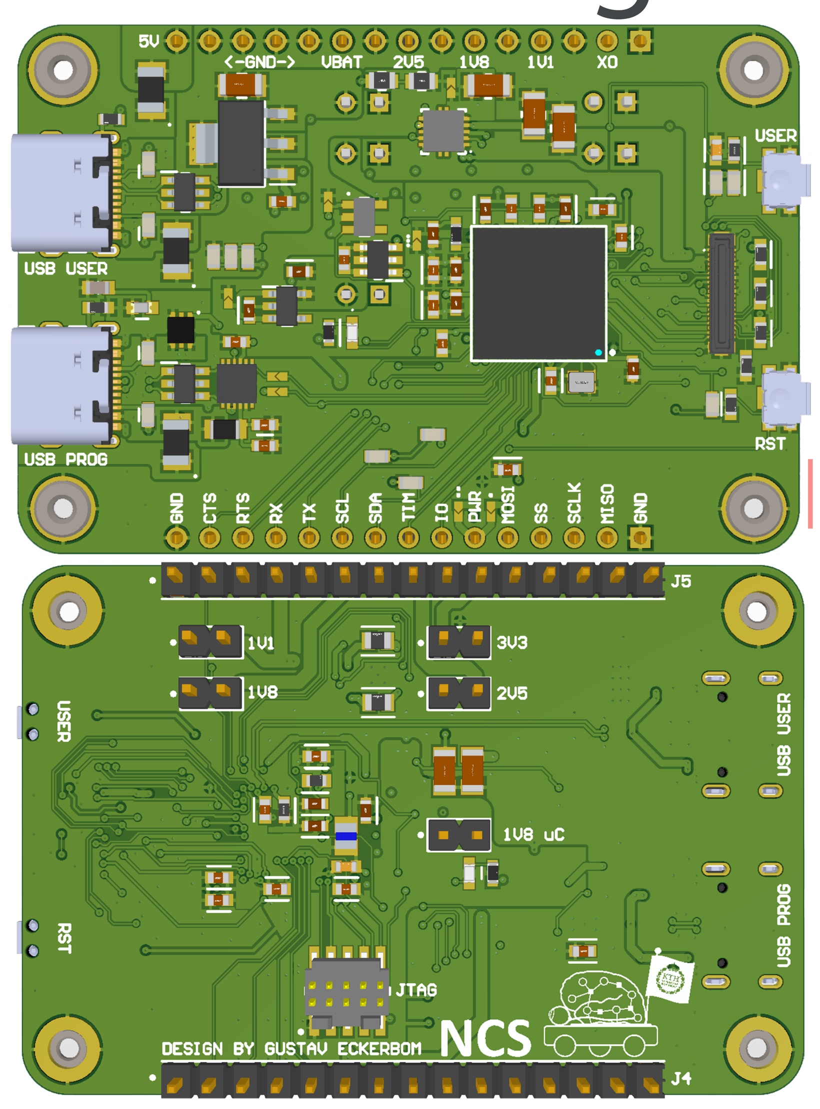


Alif E7 MCU



GENX320

PCB Design



Testing

Probe I/V for Test Scenarios:

- Camera Off
- Idle Scene
- Active Scene

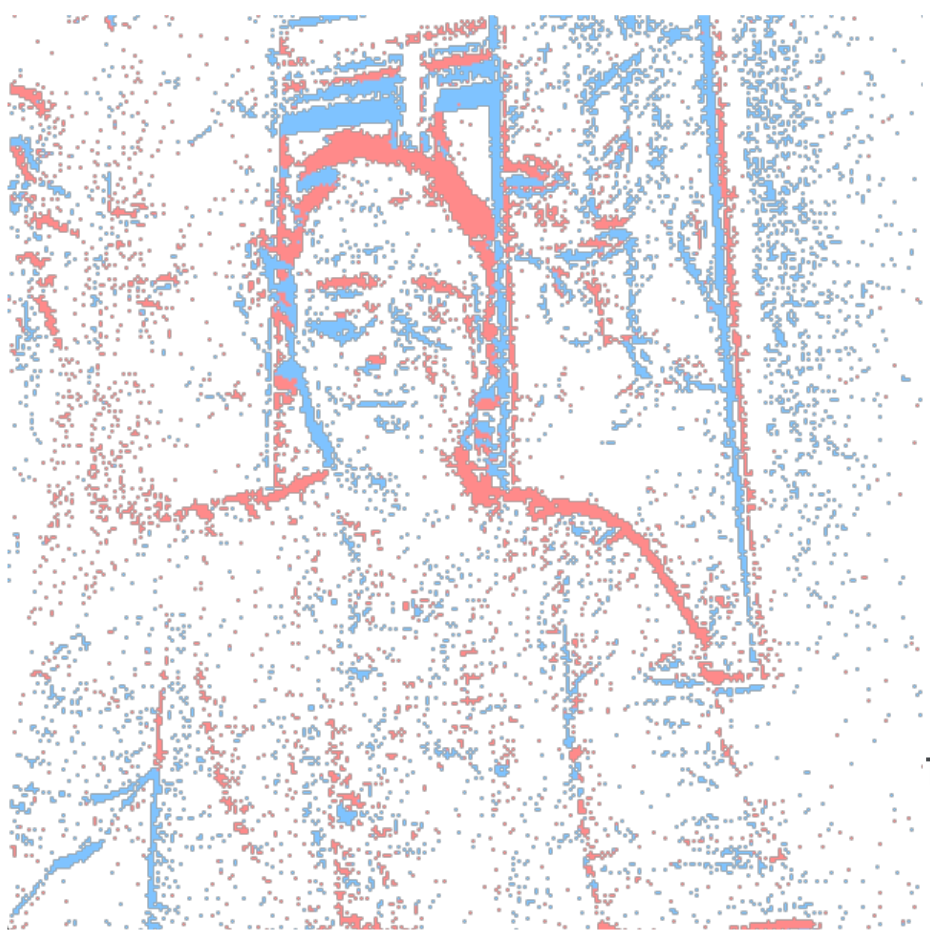
MCU Peripheral clock scaling to assess power savings.

Measure event throughput.

Results

Event Camera

Active scene



Power Consumption

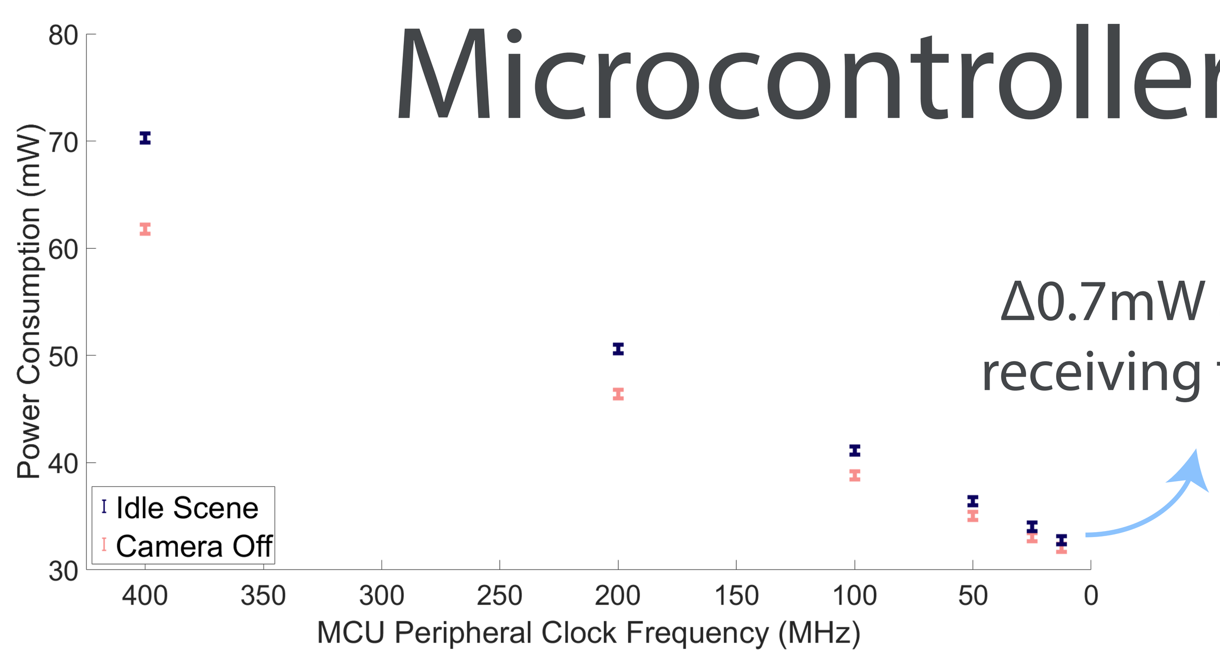
Scenario	mW
Idle Scene	1.57
Active Scene	2.44

Event throughput

Scenario	(kevents/s)
Idle Scene	122.67
Active Scene	2485.70

Comparable to state of the art frame-based cameras but with μS temporal resolution and high dynamic range [3, 1].

Microcontroller



Δ0.7mW associated with receiving the event stream

Lessons Learnt

At the lowest peripheral clock rate, active scene sensing draws:
3.14 mW (2.44 mW sensor + 0.7 mW MCU I/O)
Including processing, all subsystems draw a total of:
35.24 mW (2.44 mW sensor + 32.8 mW MCU)
For reference this allows >428 hours (≈18 days) of continuous sensing on a typical 4000 mAh phone battery (15 Wh).

References

1. Gallego, Guillermo, et al. "Event-based vision: A survey." IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 44, no. 1, pp. 154–180, 2022. DOI: 10.1109/TPAMI.2020.3008413
2. D. Scaramuzza, Introduction to event cameras, https://www.youtube.com/watch?v=A7UfeUnG6c4, UZH Robotics and Perception Group, accessed 2025-05-12, 2020.
3. Himax Imaging, Inc. HM01B0 Ultra-Low Power Image Sensor. A 320×320 QVGA CMOS sensor optimized for always-on computer vision applications.