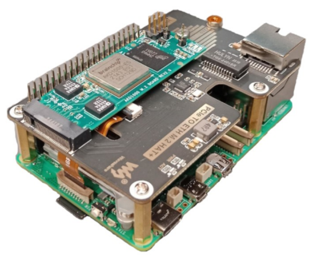
AIS4501 Specialisation Project in Mechatronics and Automation

Training a Spiking Neural Network for Object Detection with an Event Camera and a Neuromorphic Chip

HARDWARE

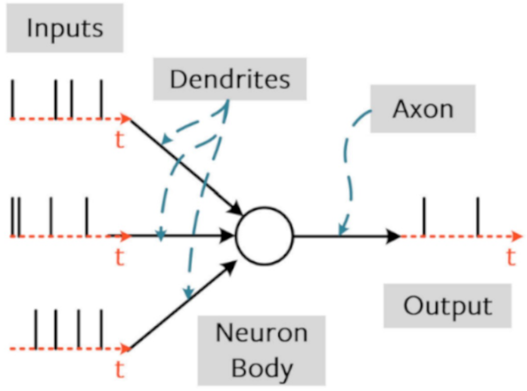
NVIDIA Jetson AGX Orin + Brainchip Akida PCIe Board

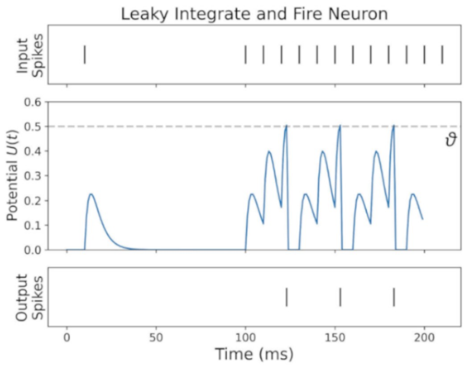


Raspberry Pi 5 + Brainchip Akida M2 Card

Prophesee EVK4 Event Camera

SPIKING NEURAL NETWORK (SNN)



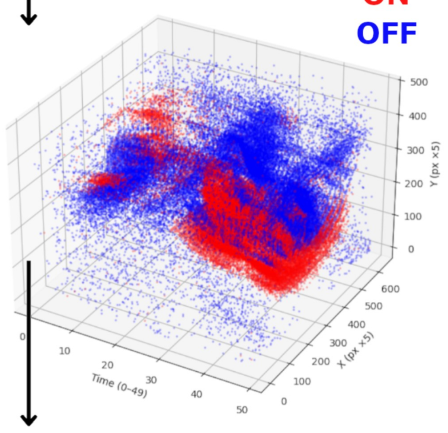


INFERENCE FLOW

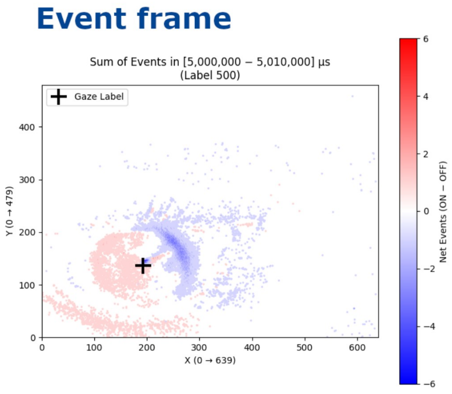
Sparse and asynchronous events: [t, x, y, p]

ON

OFF



Event frame

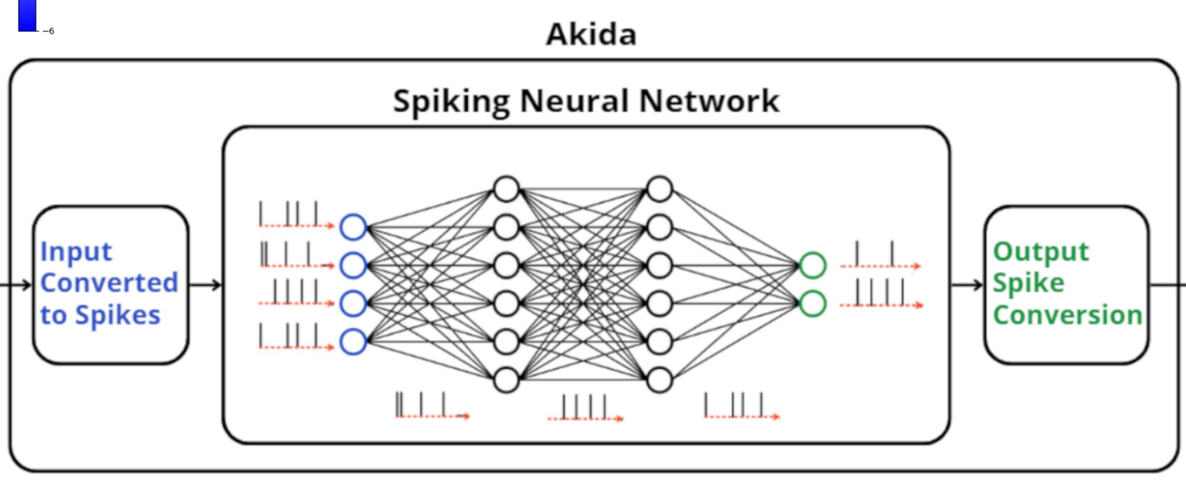


Downsampling + Channel division

Input Tensor [C=2, H=96, W=128]

Channel 0: positive
Channel 1: negative

Akida

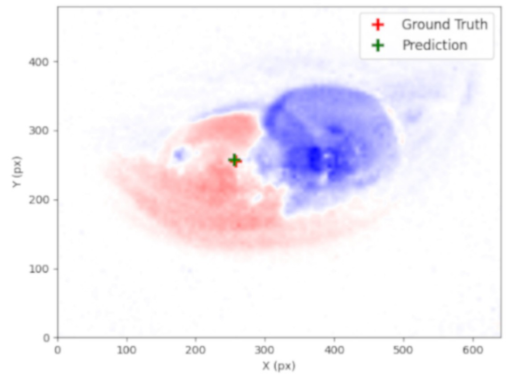


Output Tensor [C=3, H=3, W=4]

Channel 0: confidence
Channel 1: x offset
Channel 2: y offset

Reconstruction to original pixel frame

Final prediction



PROJECT DESCRIPTION

The main goal of this project has been to develop the hardware setup and training workflow for an event-based eye-pupil center tracking SNN on a neuromorphic chip.

The main advantages of event cameras rely on their high temporal resolution (µs level), high dynamic range (>120 dB), low throughput (due to sparse data), and low power consumption, making them ideal for dynamic, challenging lighting conditions where traditional frame-based cameras fail.

When combined with SNNs and neuromorphic chips, this creates a fully event-driven vision system: the camera outputs asynchronous spikes on brightness changes; the SNN processes these spikes sparsely and asynchronously; and the neuromorphic hardware executes the computation in parallel and asynchronously, having the potential to achieve ultra-low power energy comsumption compared with GPU-based systems.

The project explored Akida's workflow for obtaining an SNN, consisting of (1) training a standard neural network, (2) quantizing it to low-precision 8- or 4-bit integers, (3) converting it to an Akida-compatible SNN, and (4) mapping it to the available Akida device.

Akida's official eye-tracking example has successfully been replicated from scratch, establishing a well-defined reproducible workflow for training and deploying event-based detection tasks using event cameras, SNNs, and the Akida neuromorphic chip.

Student: **Jon Urcelay San Roman**

Supervisor: **Erlend Magnus Levis Coates**