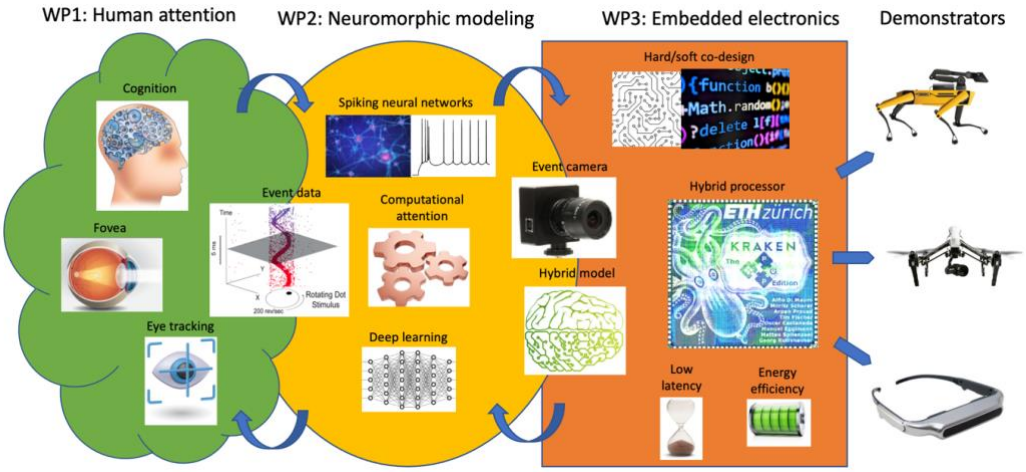
Attention models for event data

MSc research internship proposal – Mar-Aug 2024 (6 months)
PhD proposal – Oct 2024-Sept 2027 (36 months)
Postdoc proposal – Anytime from March 2024 (18 months)



Context

These multiple proposals take place in the context of an international collaborative project co-funded by the French ANR and the Swiss NSF. The project NAMED (Neuromorphic Attention Models for Event Data) that will start on February 1st, 2024.

The field of embedded computer vision has become increasingly important in recent years as the demand for low-latency and energy-efficient vision systems has grown [Thiruvathukal et al. 2022]. One of the key challenges in this area is developing intelligent vision systems that can efficiently process large amounts of visual data while still maintaining high accuracy and reliability.

The biological retina has inspired the development of a new kind of camera [Lichtsteiner et al. 2008]: event-based sensors asynchronously measure per-pixel brightness changes and output a stream of events that encode the time, location, and sign of the brightness changes (positive or negative). In addition to eliminating redundancy, they benefit from several advantages over conventional frame cameras, from which they fundamentally differ. Event sensors are inspired from the human eye, that is primarily sensitive to changes in the luminance falling on its individual sensors. These changes are processed by layers of neurons in the retina through to the retinal ganglion cells that generate action potentials, or spikes, whenever a significant change is detected. Then these spikes propagate through the optic nerve to the brain.

Cognitive attention mechanisms, inspired by the human brain's ability to selectively focus on relevant information, can offer significant benefits in embedded computer vision systems. The human eye has a small high-resolution region (the fovea) in the center of the field of vision, and a much larger peripheral vision, which has much lower resolution, combined with an increased sensitivity to movement. Therefore, limited resources are deployed to extract the most salient information from the scene without wasting energy capturing the entire scene at the highest resolution. This foveation mechanism has inspired the recent development of a variable-resolution event sensor [Serrano-Gotarredona et al., 2022]. This sensor has an electronic control of the resolution in selected regions of interest, allowing to focus downstream computational resources on specific areas of the image that convey the most useful information. This sensor even goes beyond biology by allowing multiple regions of interest.

Scientific objectives

The general objective of this research project (with specific tasks for internship, PhD, postdoc) is to design and implement computer vision attention models adapted to event data. A first step will consist in studying state-of-the-art attentional mechanisms in deep networks and their link with cognitive attention as implemented in the brain. Cognitive attention refers to the selective processing of sensory information by the brain based on its relevance and importance to the current task or goal. It involves the ability to focus one's attention on specific aspects of the environment while filtering out irrelevant or distracting information. In particular, the study will distinguish between both top-down and bottom-up attention. The second step will be the design an attention architecture that will allow selectively focusing on relevant regions while ignoring irrelevant part, which will depend on the target task (e.g., segmentation, object tracking, obstacle avoidance, etc.). The model will be based either on standard deep networks, or on spiking neural networks, based on previous work [GIT]. Spiking Neural Networks are a special class of artificial neural networks, where neurons communicate by sequences of asynchronous spikes. Therefore, they are a natural match for event-based cameras due to their asynchronous operation principle. This selection of regions will result in less data usage and smaller models (frugal system). In the third step, we will evaluate the impact of the attention mechanism on the general performance of the computer vision system. The target metrics will obviously depend on the selected task, and will include accuracy, MIOU, complexity, training time, inference time, etc. of the system.

Job information

Location
Université Côte d'Azur, Sophia Antipolis (Nice area) France

Types of contracts
Internship: duration 4-6 months / PhD: duration 36 months / Postdoc: duration 18 months

Job status
Full-time for all

Candidates' profiles
Master 2 / PhD in Computer Science (Machine Learning, Computer Vision, AI) or Mathematics or Computational Neuroscience. Programming skills in Python/C++, interest in research, machine learning, bio-inspiration and neurosciences are required.

Salary
Standard French internship allowance / PhD salary / Postdoc (research engineer) salary by CNRS

Offer starting date
Internship: Around March 2024 / PhD: Flexible around October 2024 / Postdoc: Flexible from October 2024 (PhD opportunity after the internship)

Application period
From December 2023 to the offer starting date

How to apply
Send a resume (CV), transcript of grades, and motivation letter to the contact given below

Contact
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References

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