What's catching your eye?

Event-driven sensing and neuromorphic computing for active vision

Vision is an exploratory behaviour that emerges from the dynamic relationship between actions and sensory feedback. For any agent, whether biological or robotic, processing visual input efficiently is fundamental to understanding and interacting with the environment. The central challenge lies in continuously recalibrating perception through sensorimotor contingencies, where what an agent sees is shaped by how it moves. Embodiment is central to this vision: perception and action are inseparable, and intelligence emerges from their continuous interaction with the physical world, shaped by the very structure of our sensors. Selective visual attention is one of the many mechanisms by which the visual cortex meets this challenge, organizing and interpreting complex visual scenes in real time.
To address these challenges, I develop brain-inspired algorithms that harness the computational principles of biological neurons and spiking neural networks, optimized for neuromorphic hardware. These algorithms enable real-time robotic perception with microsecond latency and milliwatt power consumption, bringing the efficiency of biological vision systems within reach of autonomous systems at the edge.

Giulia D’Angelo

Assistant Professor, MSCA Postdoctoral Fellow, Czech Technical University (CTU), Prague

Giulia D’Angelo is an Assistant Professor at the Czech Technical University in Prague, where she develops neuromorphic algorithms for active vision. She earned a BSc in Biomedical Engineering from the University of Genoa and an MSc (with honours) in Neuroengineering. During her Master’s at King’s College London, she developed a neuromorphic system for the egocentric representation of peripersonal visual space. She completed her PhD in neuromorphic algorithms at the University of Manchester, where she received the President’s Doctoral Scholar Award, in collaboration with the Event-Driven Perception for Robotics Laboratory at the Italian Institute of Technology, proposing a biologically plausible model for event-driven, saliency-based visual attention. Following her PhD, she was awarded a Marie Skłodowska-Curie Postdoctoral Fellowship at the Czech Technical University in Prague, during which she explored sensorimotor contingency theories in neuromorphic active vision. After completing the fellowship, she joined the Czech Technical University in Prague as an Assistant Professor. Her current research, funded by the GACR Standard Grant from the Czech Science Foundation, bridges bio-inspired software and neuromorphic hardware to enable robust, efficient perception and control for low-power, low-latency autonomous systems.

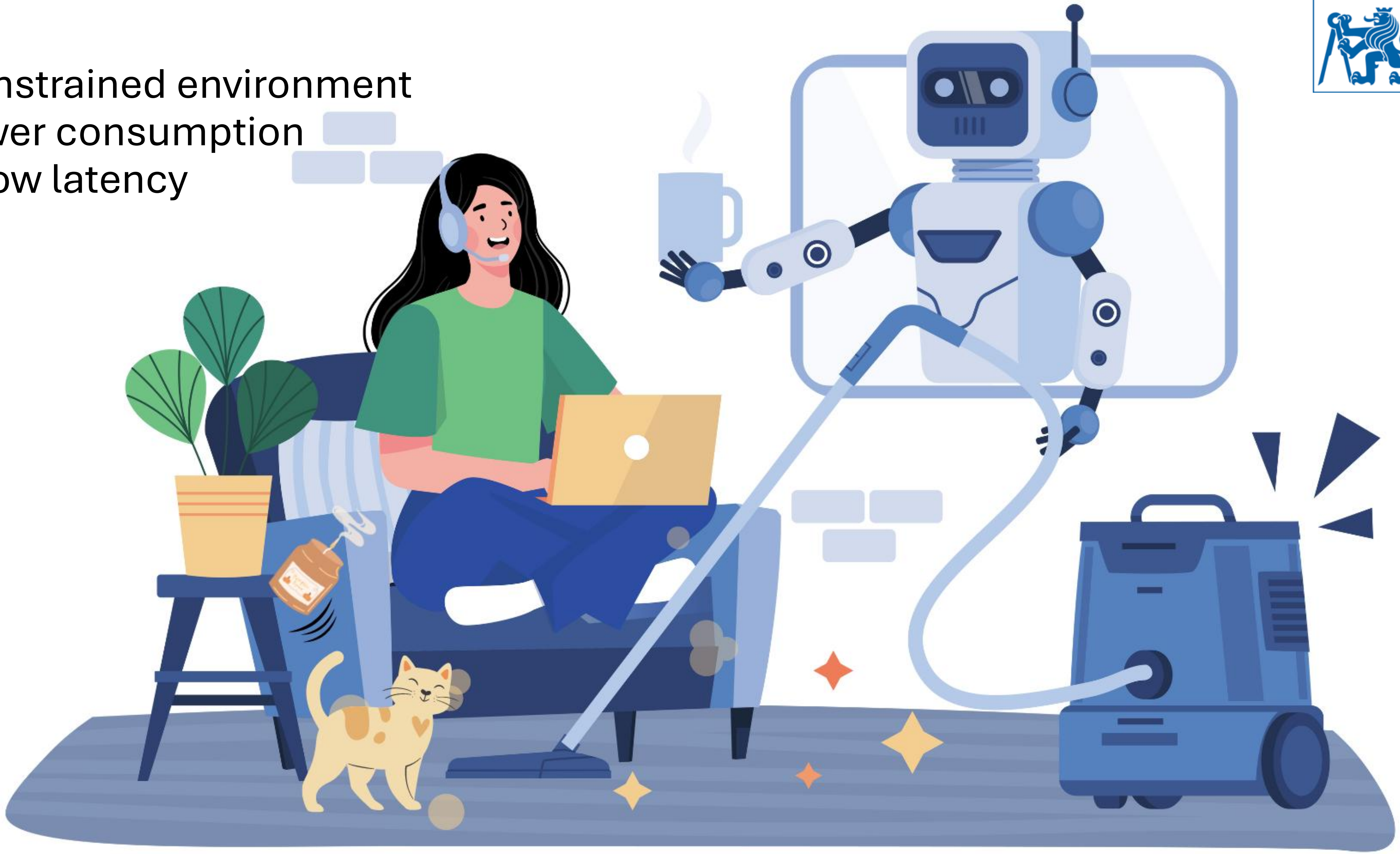
NEURO-INSPIRED PERCEPTION & COGNITION

What's catching your eye?

Event-driven sensing and neuromorphic computing for active vision

Giulia D’Angelo
Assistant Professor
Czech Technical University in Prague (CTU)

Unconstrained environment
Low power consumption
Low latency



Unconstrained environment

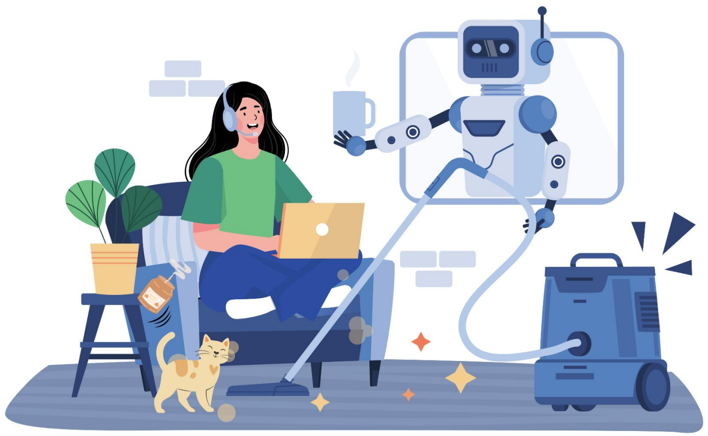
Low power consumption

Low latency

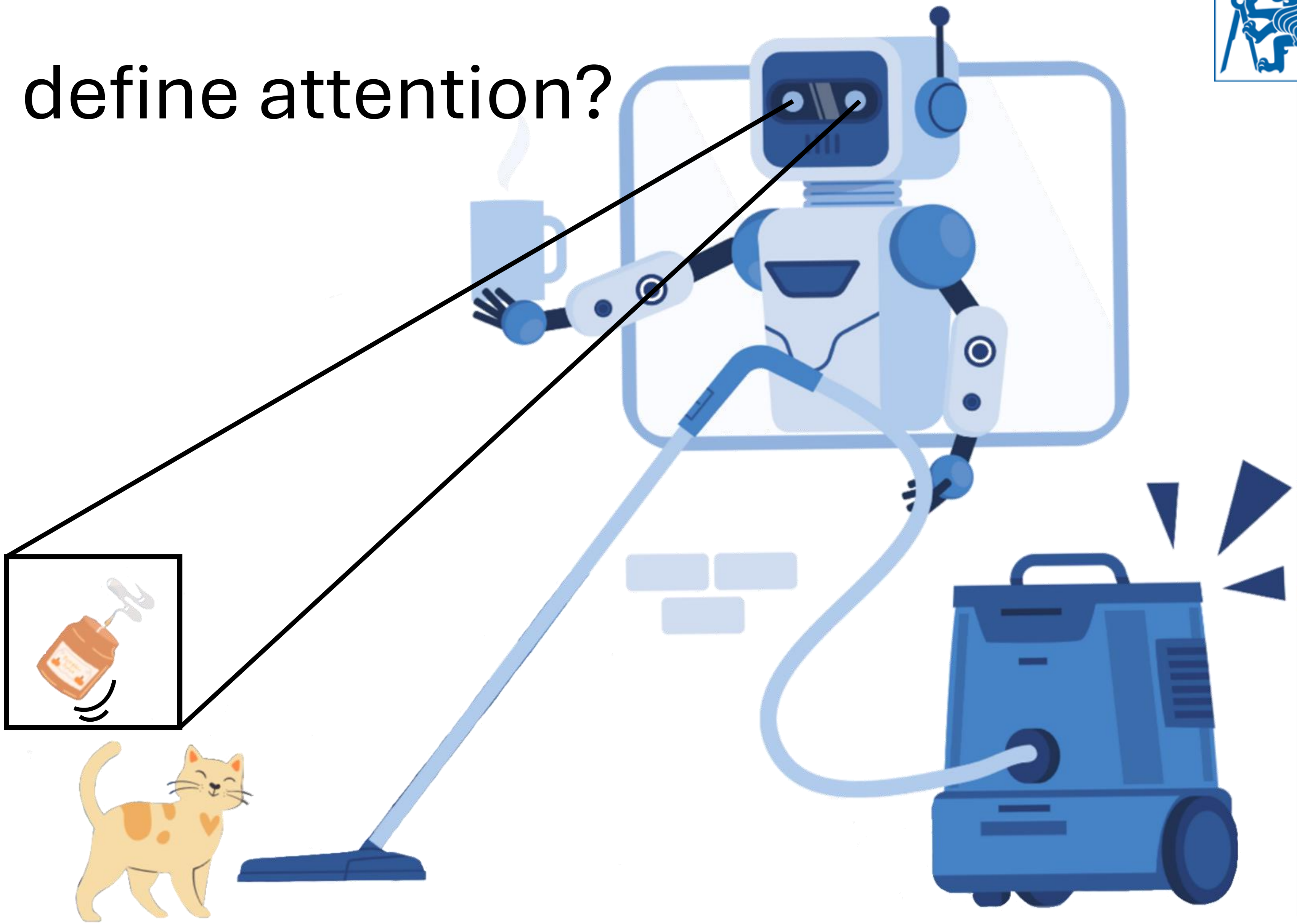
Someone has already done it!

"It consumes a paltry 20 watts, much less than a typical incandescent lightbulb"

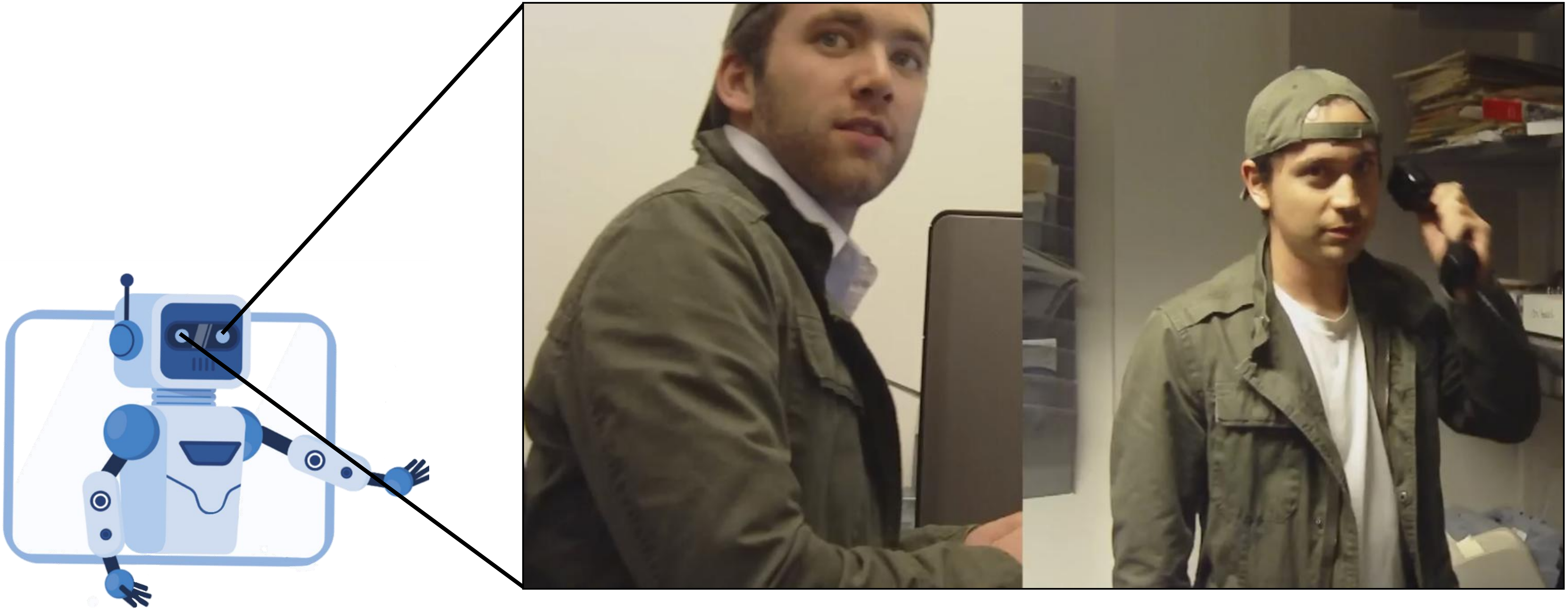
Furber, Steve. "To build a brain." *IEEE spectrum* 49.8 (2012): 44-49.



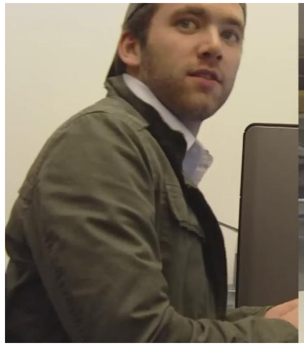
How do we define attention?

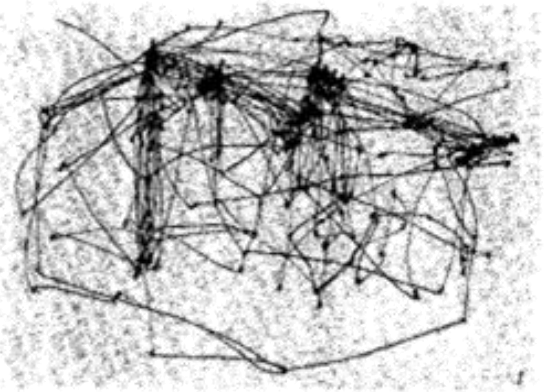


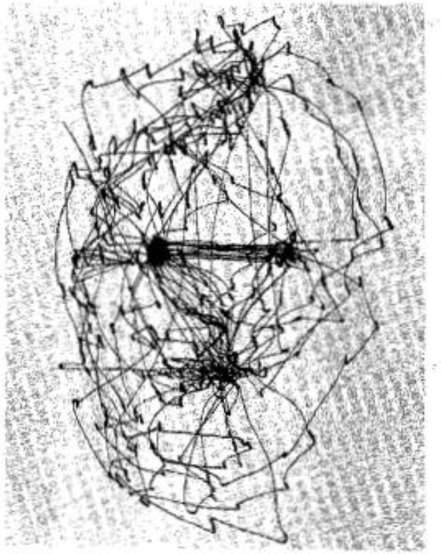
How do we define attention?

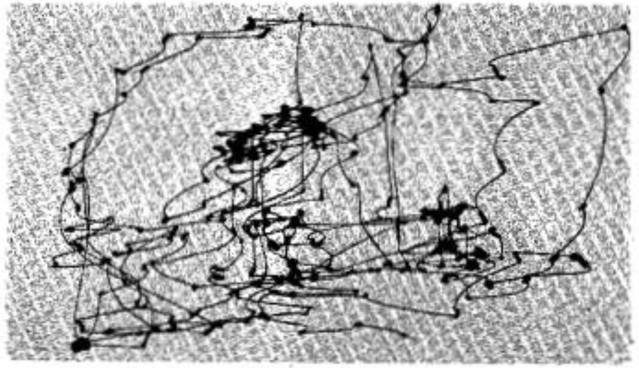


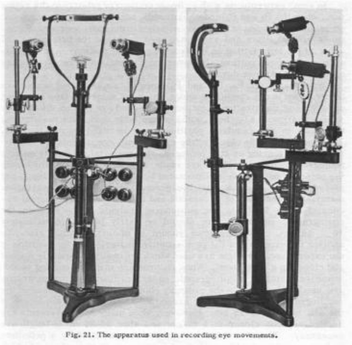
How do we define attention?







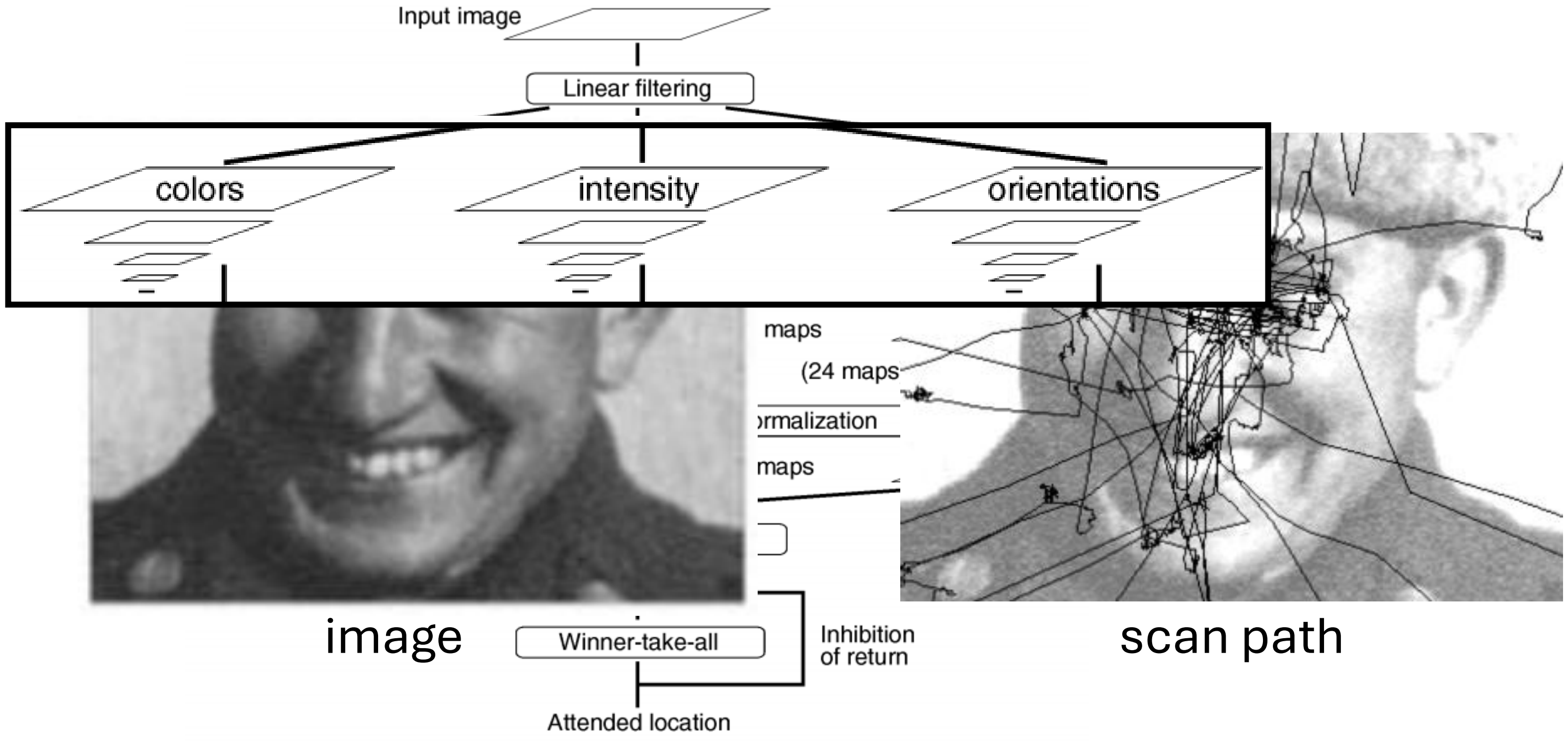




Yarbus, Alfred L. "Eye movements during perception of complex objects." *Eye movements and vision*. Springer, Boston, MA, 1967. 171-211.

Cool, but feature extraction is not enough

What is a saliency map ?



image

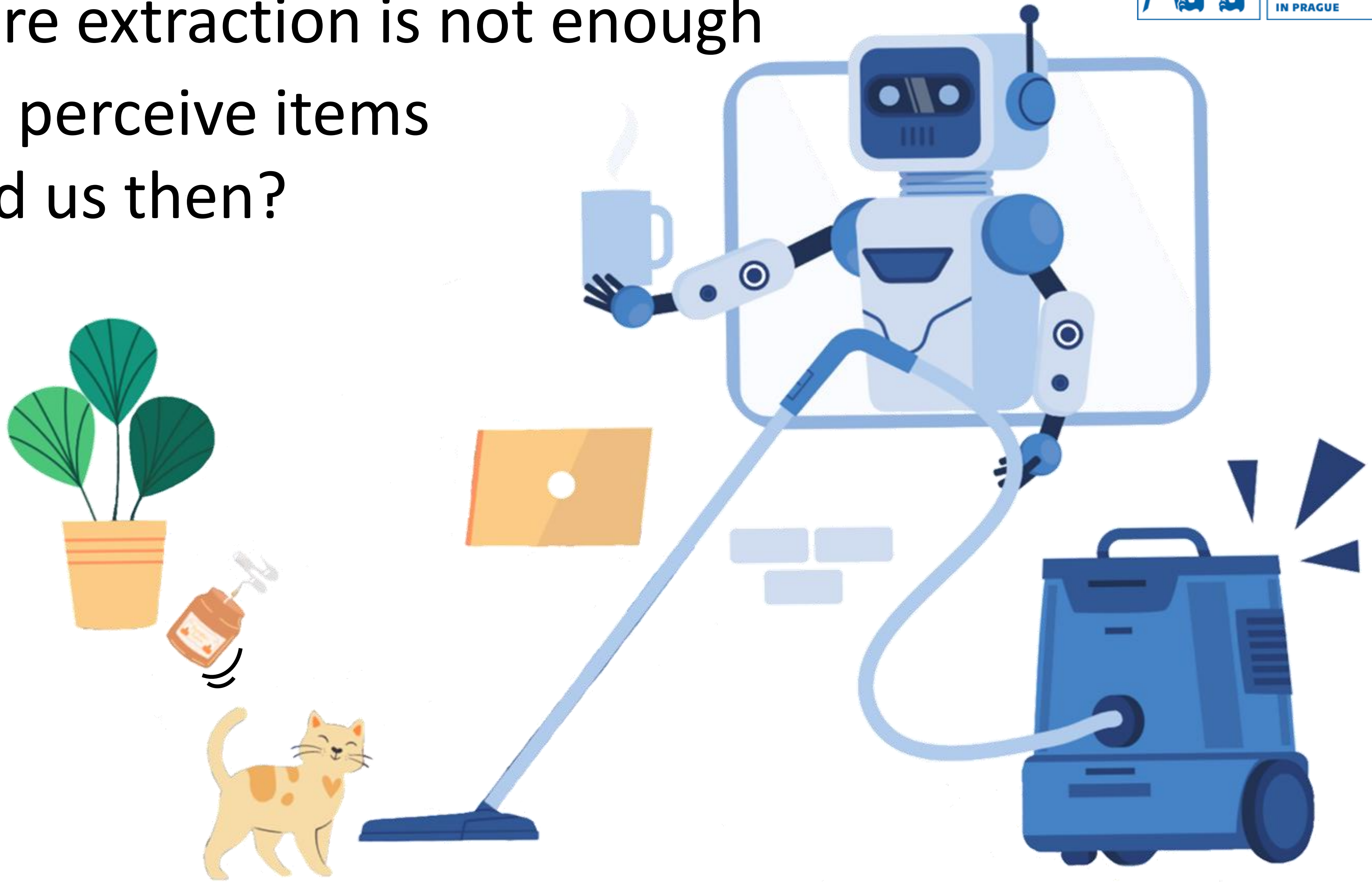
scan path

saliency map

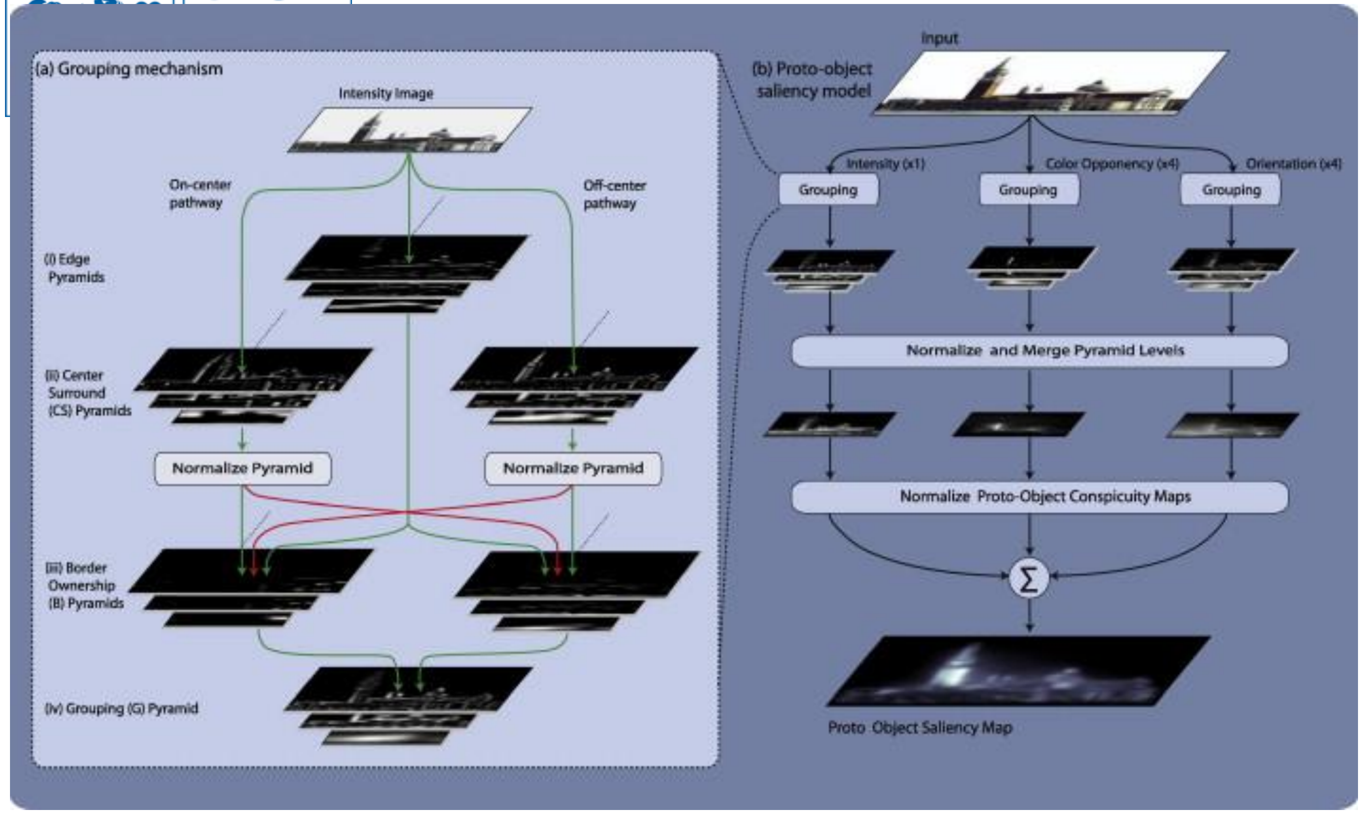
Itti, Laurent, Christof Koch, and Ernst Niebur. "A model of saliency-based visual attention for rapid scene analysis." *IEEE Transactions on Pattern Analysis & Machine Intelligence* 11 (1998): 1254-1259.

Cool, but feature extraction is not enough

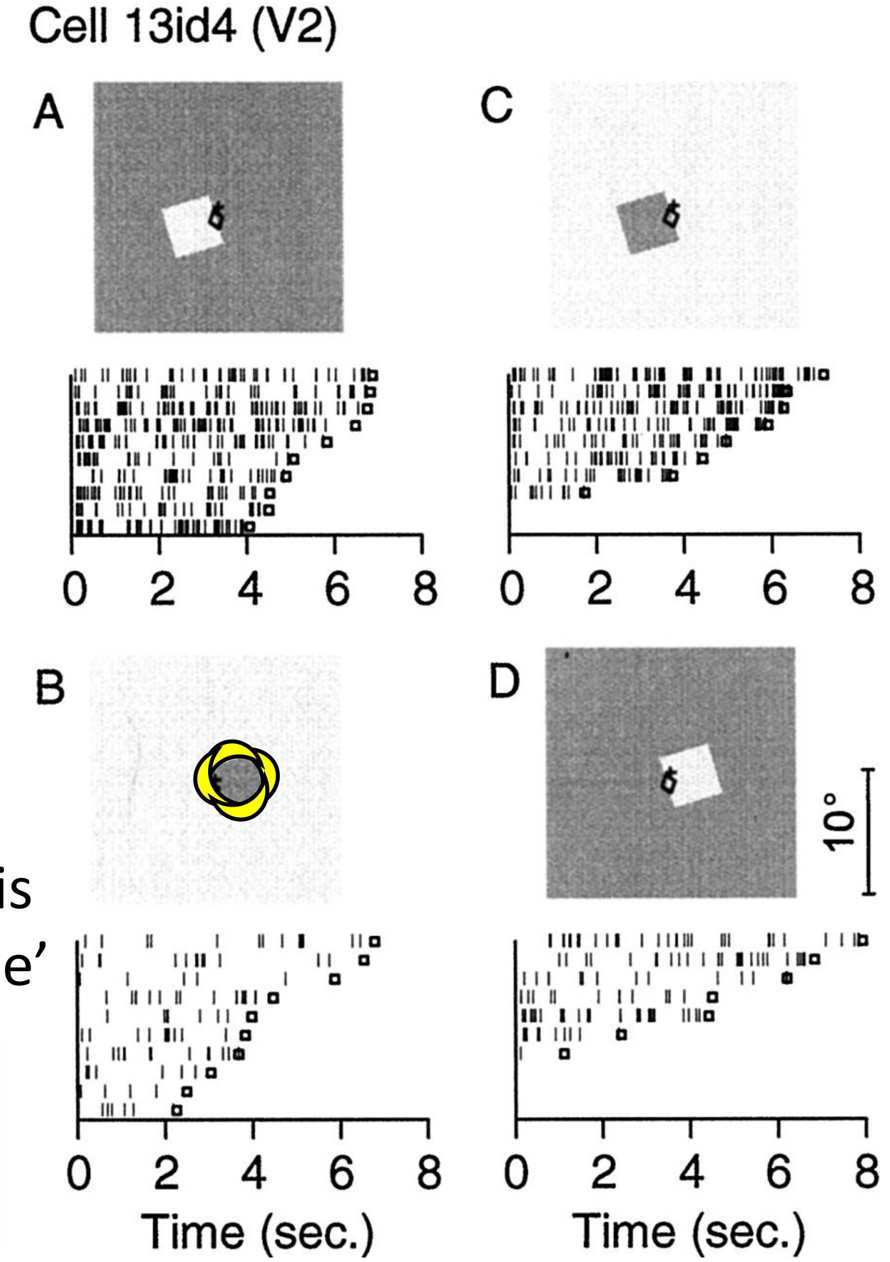
How do we perceive items around us then?



Border Ownership cells

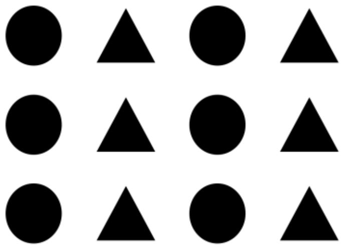


Russell, Alexander F., et al. "A model of proto-object based saliency." *Vision research* 94 (2014): 1-15.

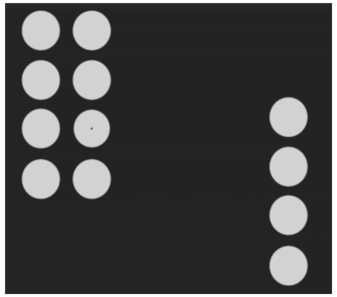


Zhou, Hong, Howard S. Friedman, and Rüdiger Von Der Heydt. "Coding of border ownership in monkey visual cortex." *Journal of Neuroscience* 20.17 (2000): 6594-6611.

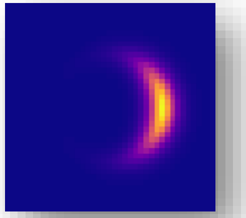
similarity



proximity



Proto-object is an ‘object to be’



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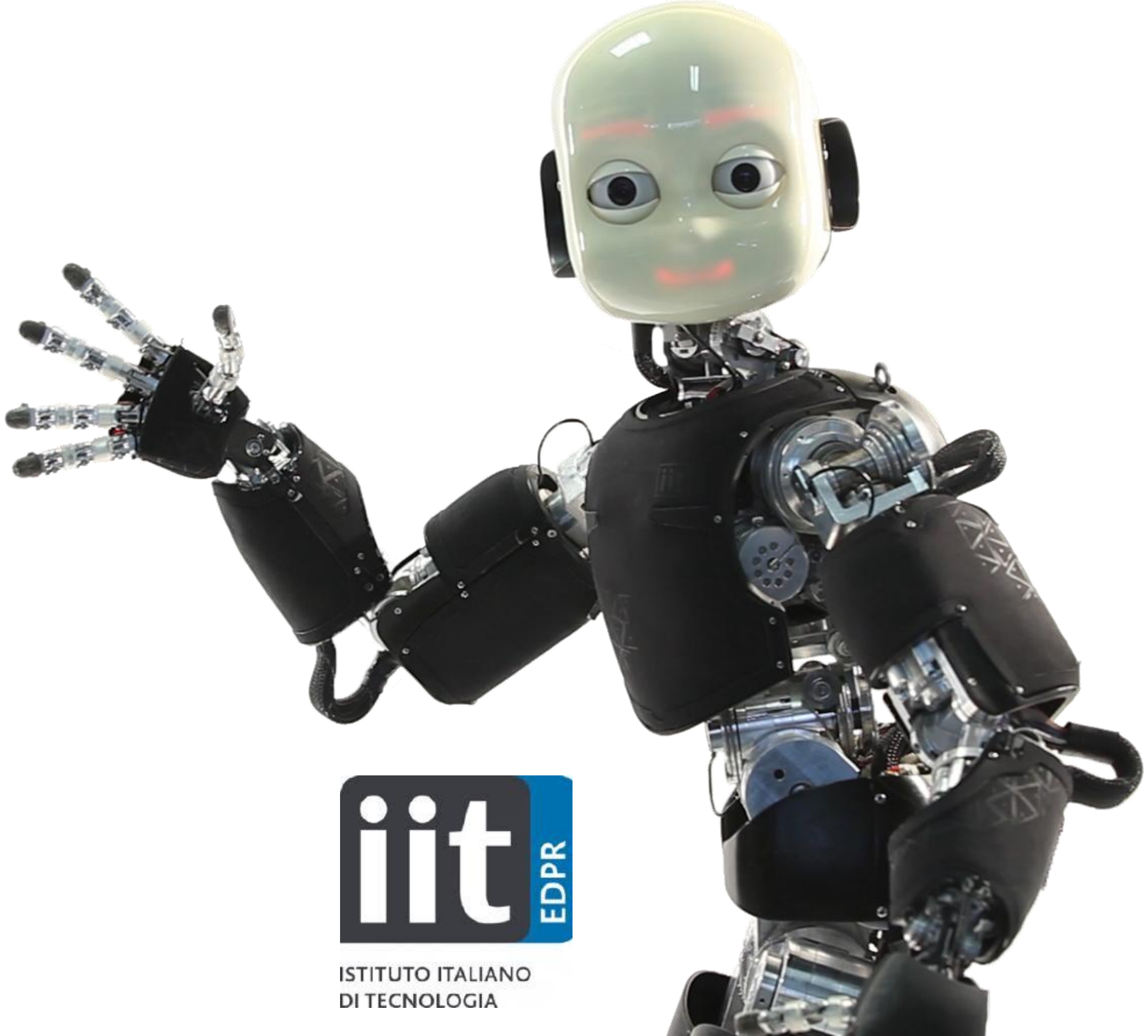
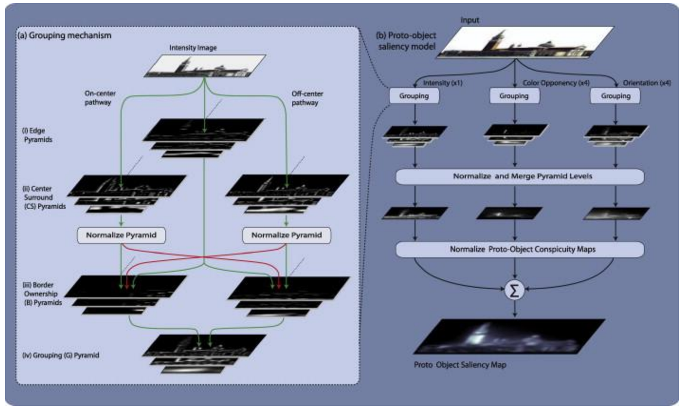
iCub



ISTITUTO ITALIANO DI TECNOLOGIA



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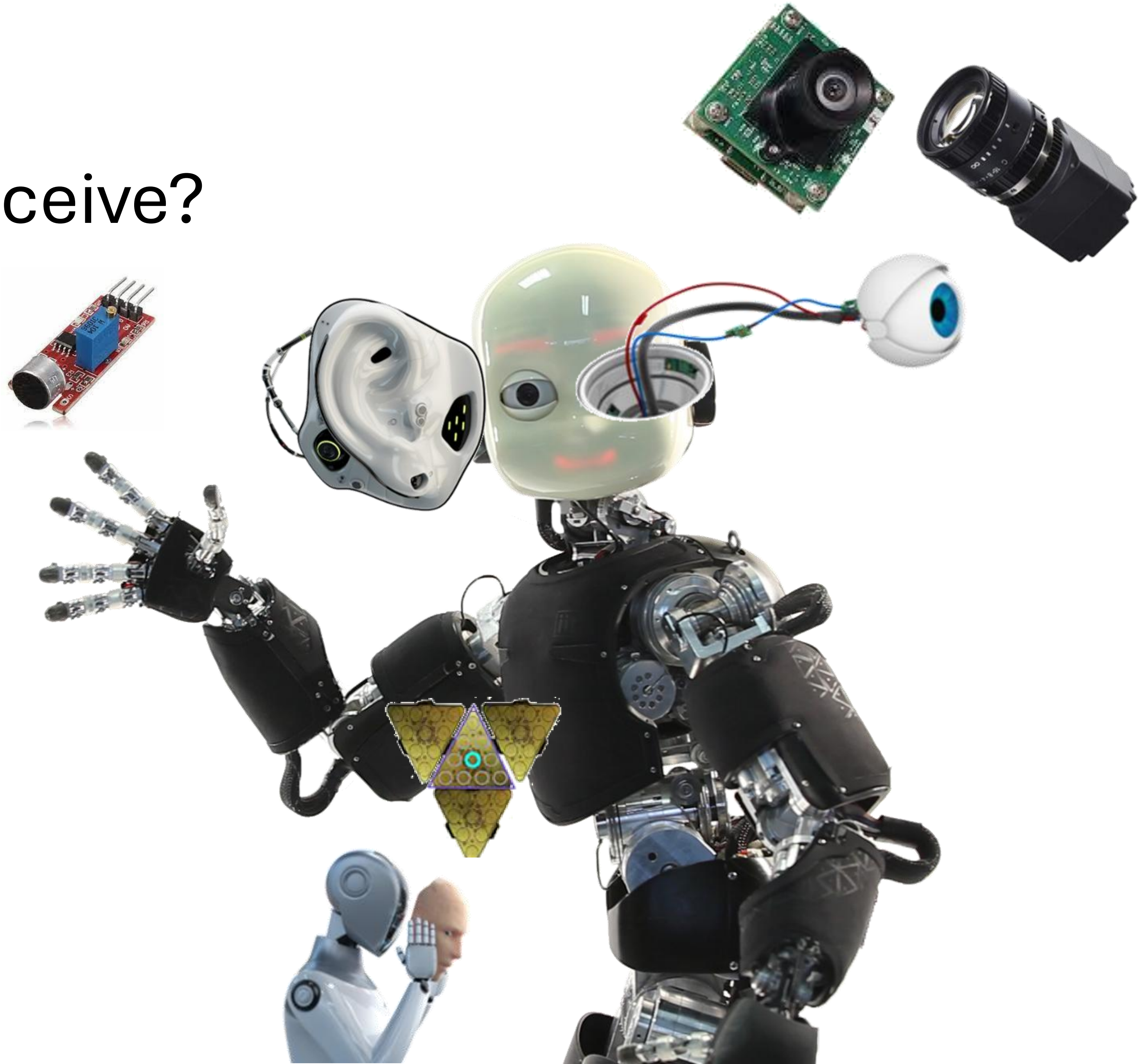
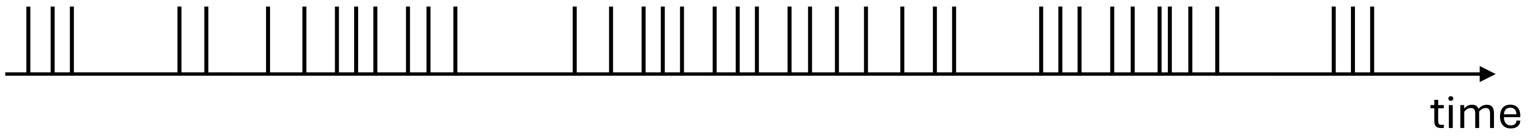
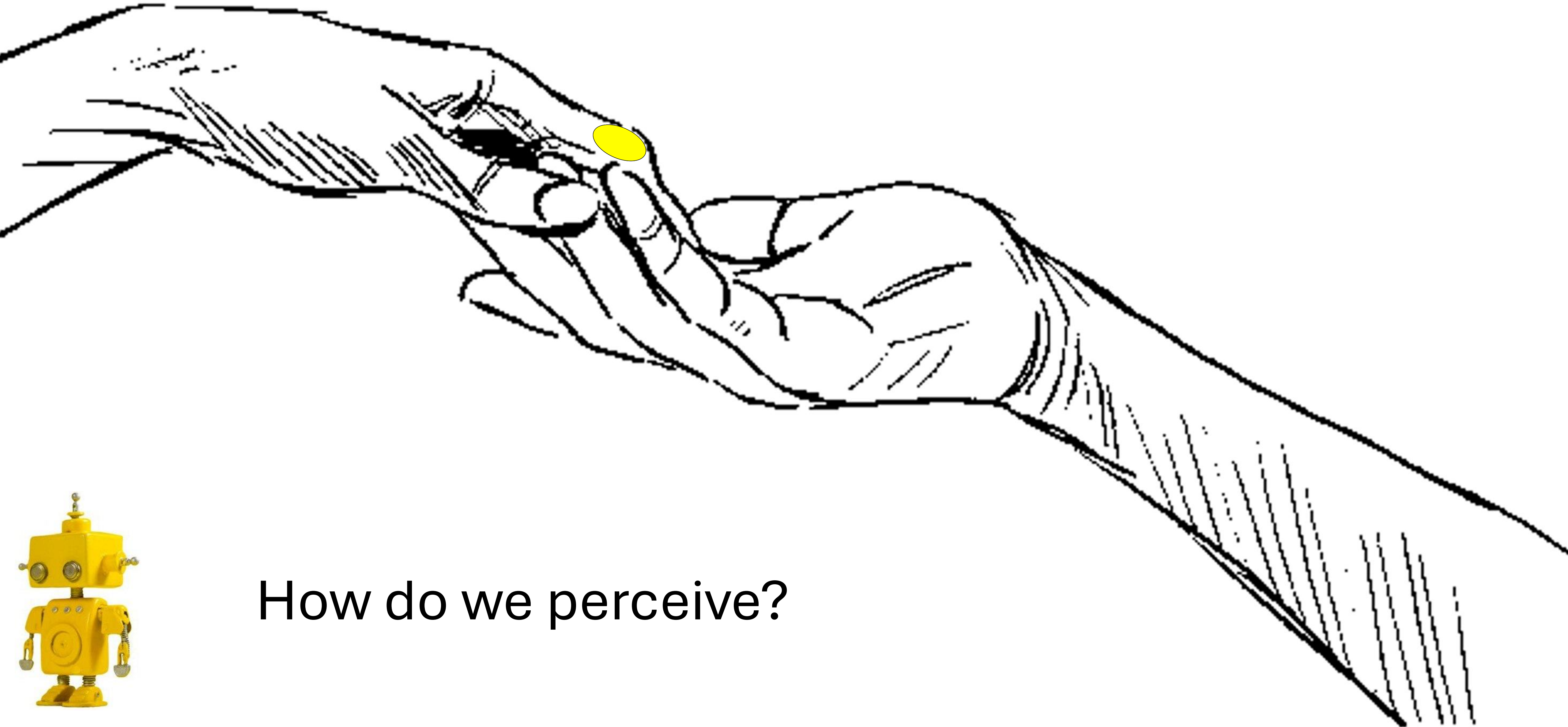
CZECH TECHNICAL UNIVERSITY IN PRAGUE

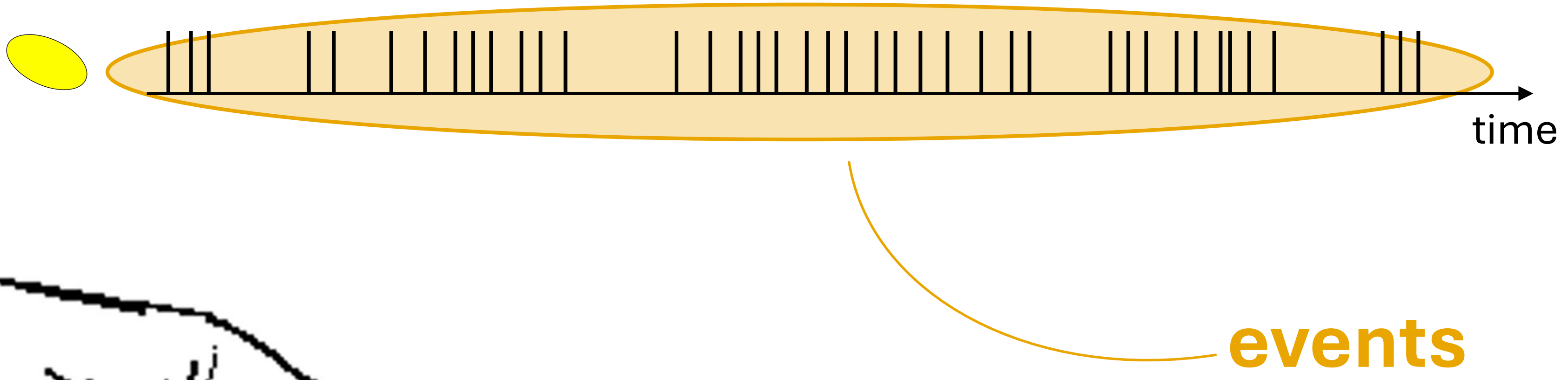
How does a robot perceive?

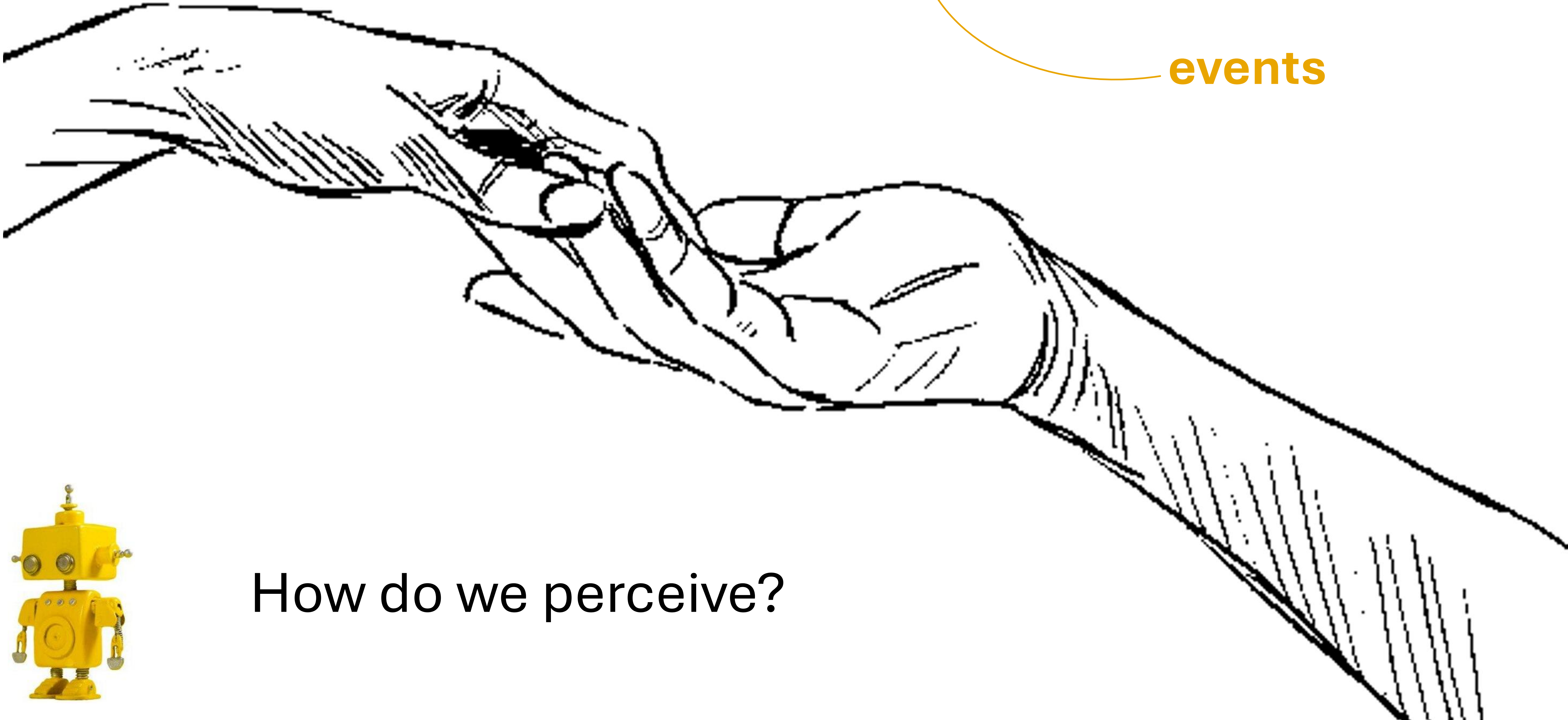






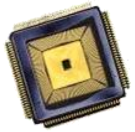
How do we perceive?

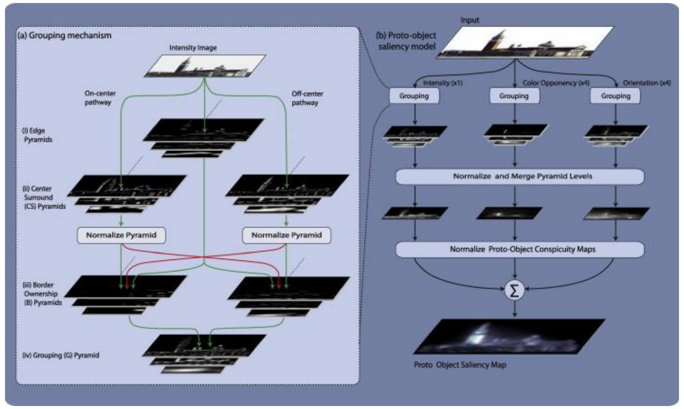


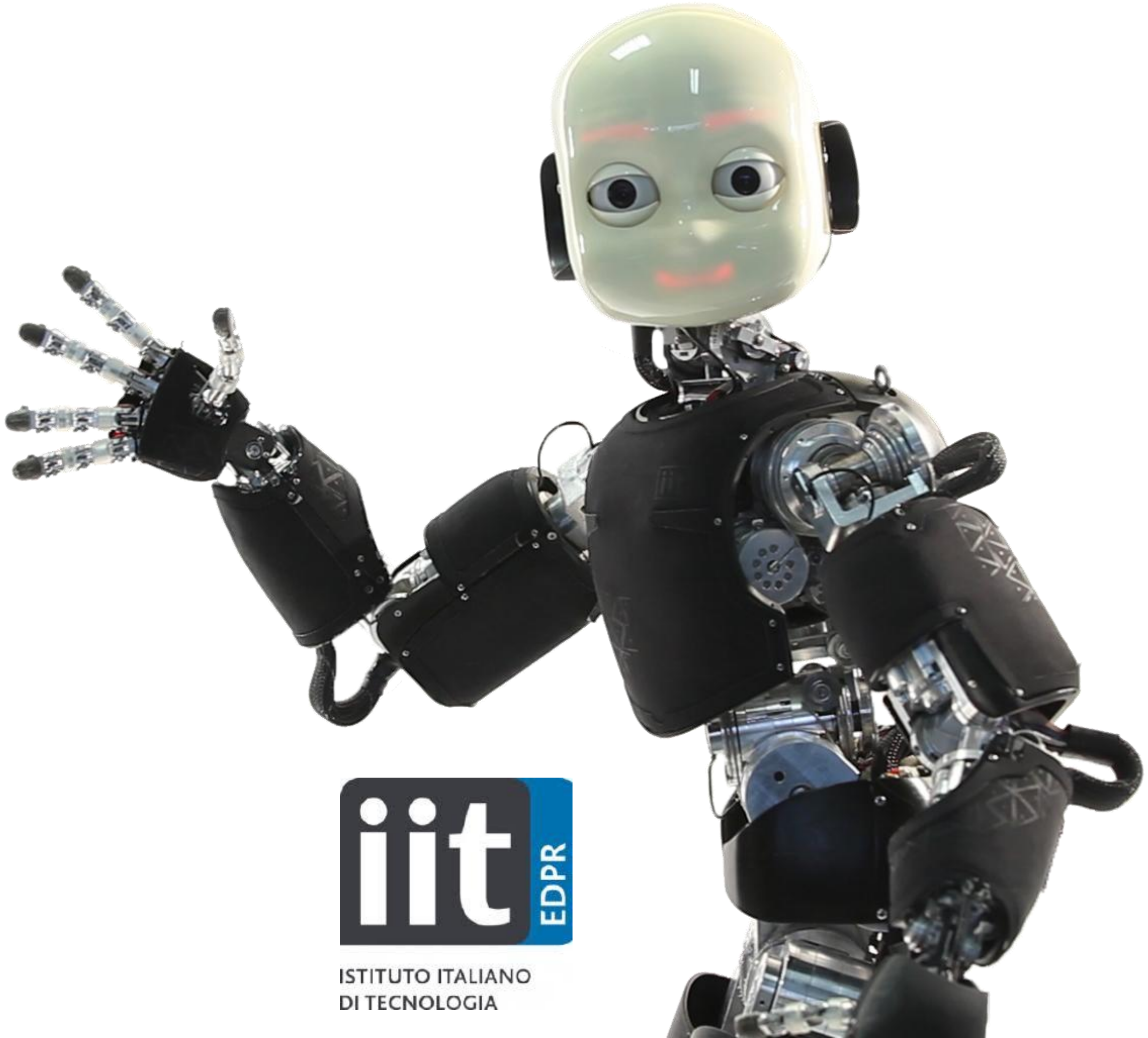


How do we perceive?

Neuromorphic iCub

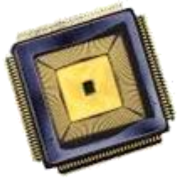






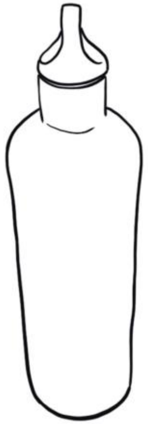
ISTITUTO ITALIANO DI TECNOLOGIA

How does a neuromorphic camera work?

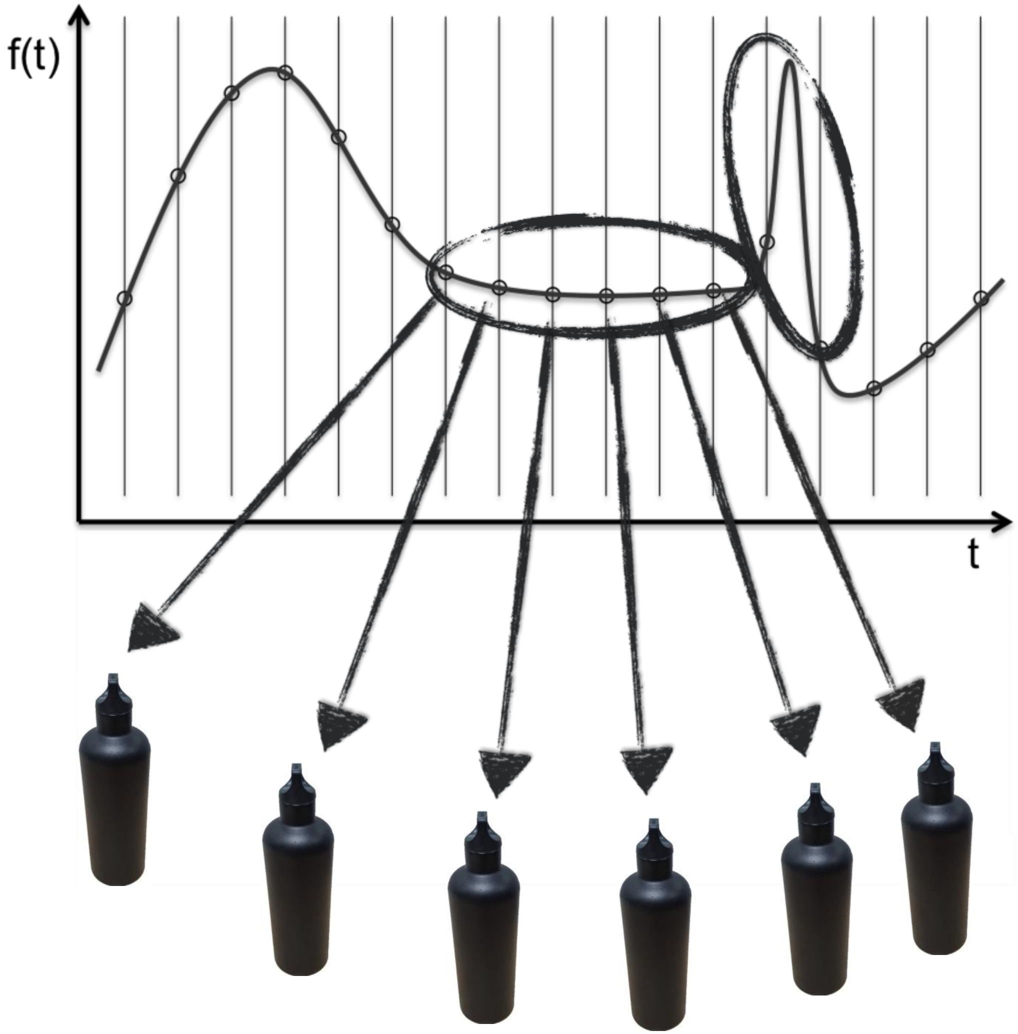


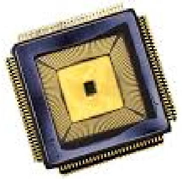
44 slides

Let’s start from a
frame-based camera!

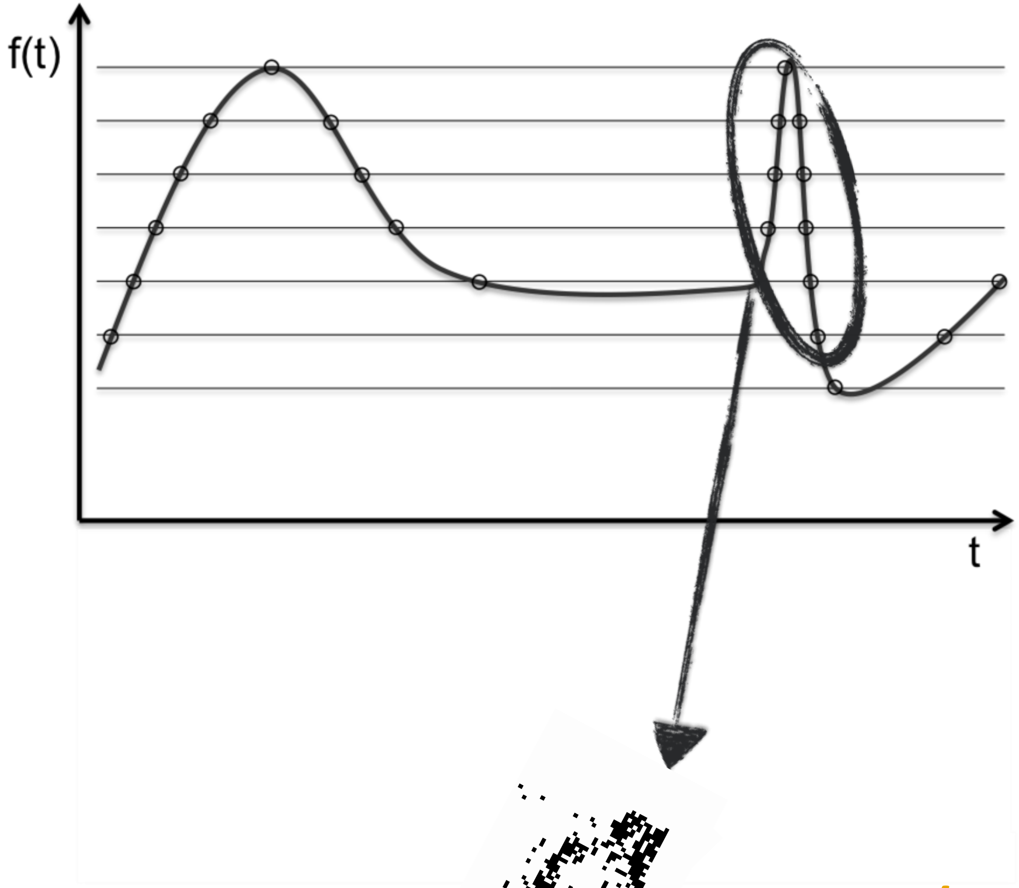


Clock-Based Sampling — fixed Δt





Data-Driven Sampling — fixed Δf (or Δf/f)



event = e(x,y,t,p)

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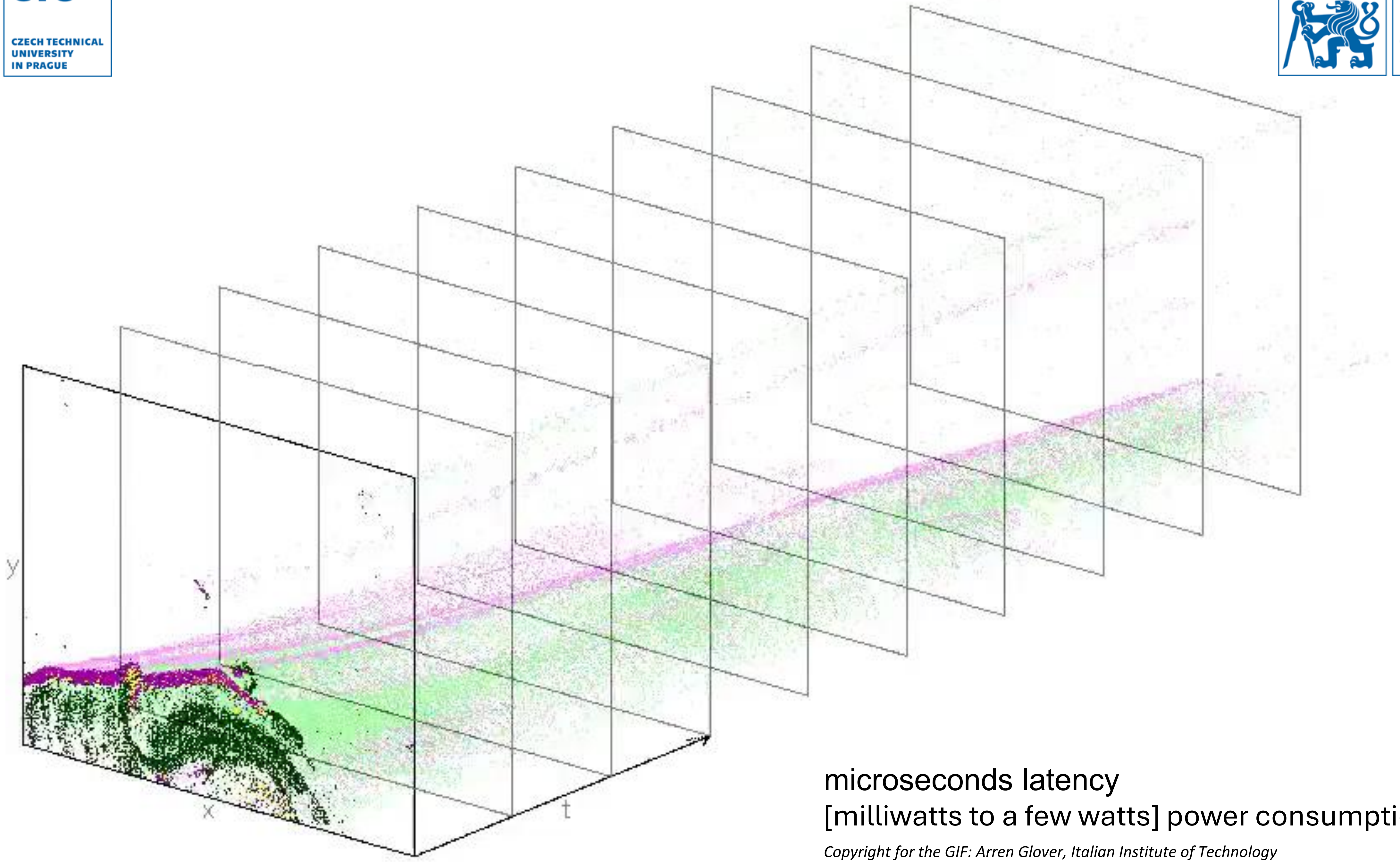
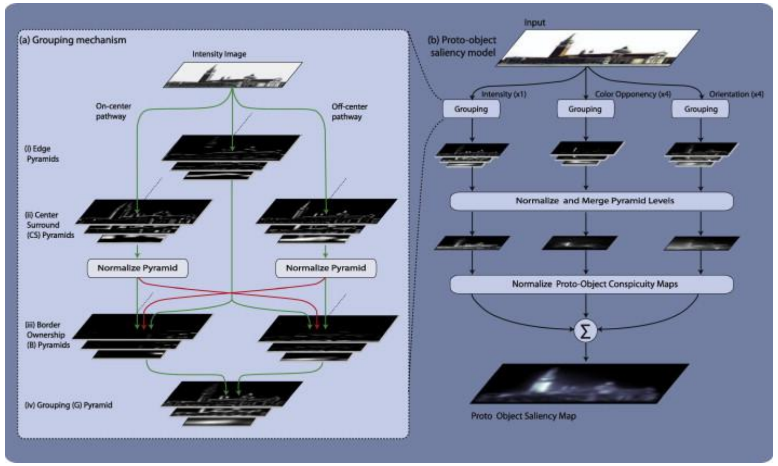


microseconds latency
[milliwatts to a few watts] power consumption

Is it just fancy bioinspiration?

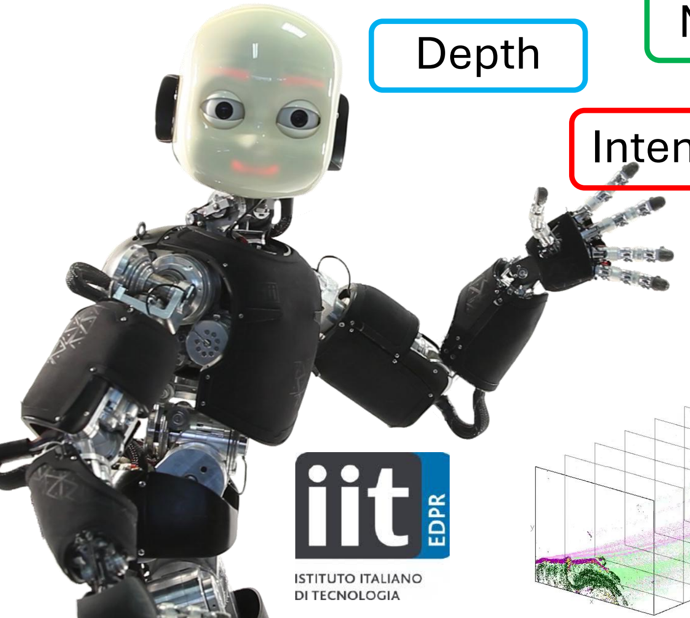


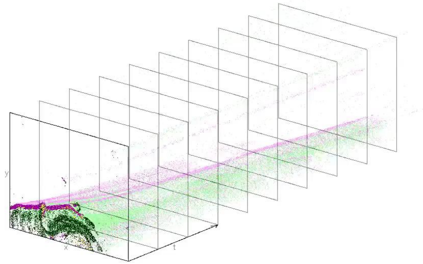
Russell, Alexander F., et al. "A model of proto-object based saliency." *Vision research* 94 (2014): 1-15.

Depth

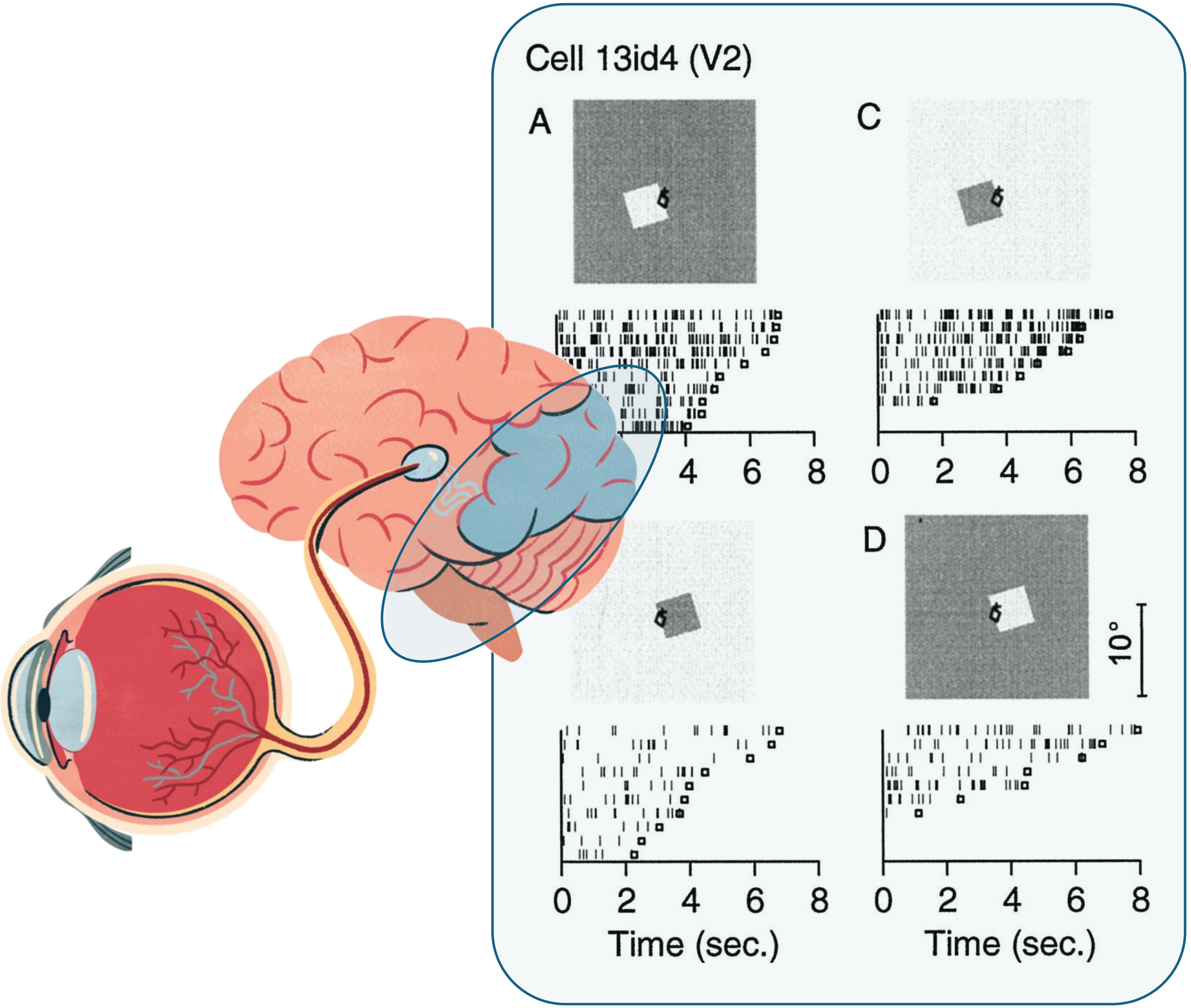
Motion

Intensity

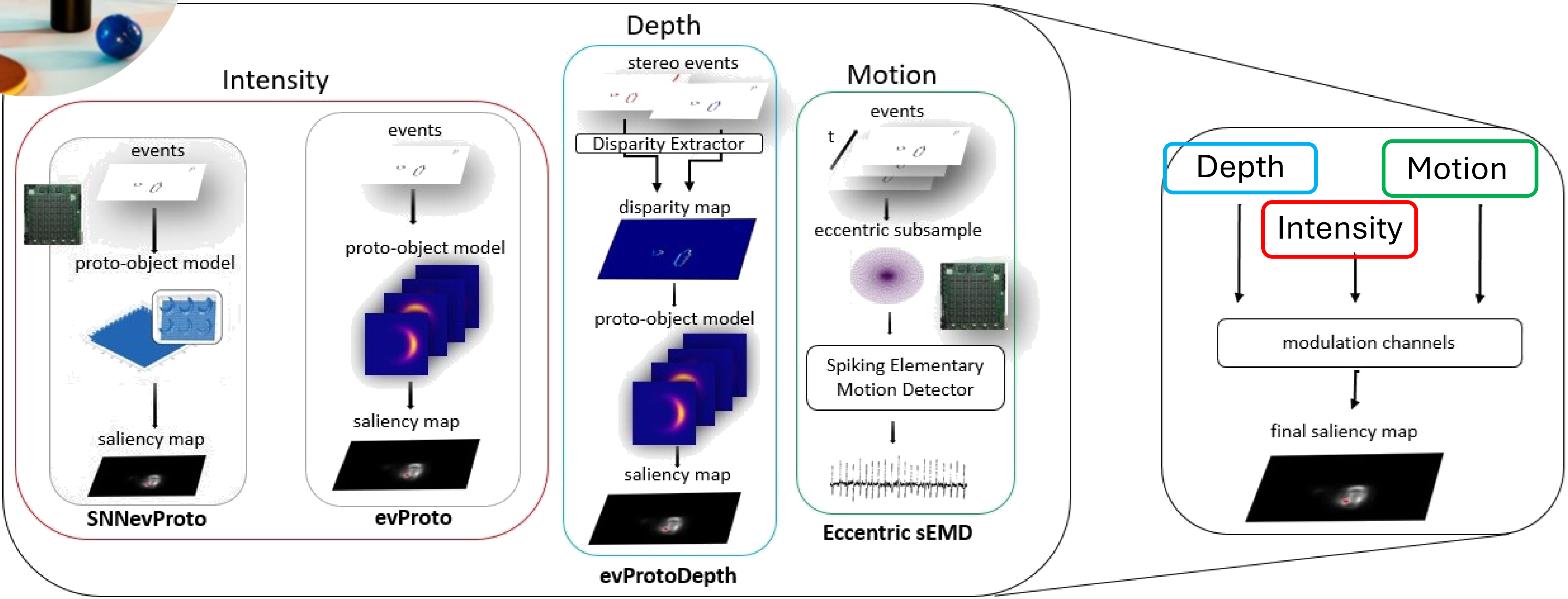




Visual attention



Bioinspired saliency-based attention model



D'Angelo, G., Janotte, E., Schoepe, T., O'Keeffe, J., Milde, M. B., Chicca, E., & Bartolozzi, C. (2020). Event-based eccentric motion detection exploiting time difference encoding Front. Neuroscience

D'Angelo, G., Perrett, A., Iacono, M., Furber, S., & Bartolozzi, C. (2022). Event driven bio-inspired attentive system for the iCub humanoid robot on SpiNNaker. Neuromorphic Computing and Engineering

Ghosh, S & D'Angelo, G., Glover, A., Iacono, M., Niebur, E., & Bartolozzi, C. (2022). Event-driven proto-object based saliency in 3D space to attract a robot's attention. *Scientific reports*

Iacono, M., D'Angelo, G., Glover, A., Tikhanoff, V., Niebur, E., & Bartolozzi, C. (2019, November). Proto-object based saliency for event-driven cameras. In 2019 IEEE/RSJ International IROS

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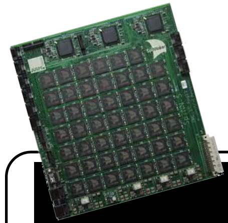

Intensity

Iacono, M. et al. (2019, November). Proto-object based saliency for event-driven cameras. In 2019 IEEE/RSJ International IROS

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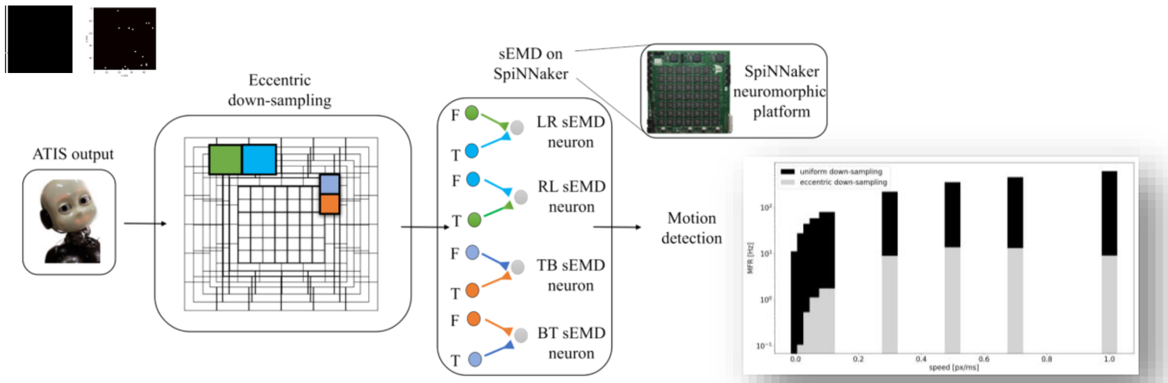
Depth

What interests a robot: Event-Driven Proto-object saliency in 3D space

Giulia D'Angelo and Suman Ghosh, Arren Glover, Massimiliano Iacono, Ernst Niebur, Chiara Bartolozzi

Motion

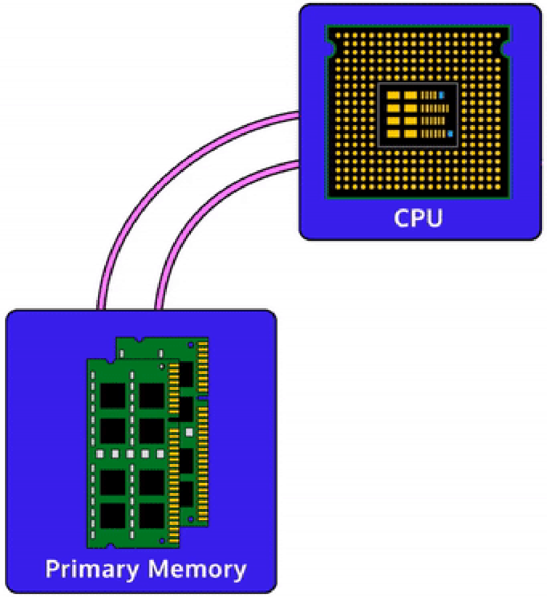


D'Angelo, G. et al. (2020). Event-based eccentric motion detection exploiting time difference encoding. *Frontiers in neuroscience*, *14*, 451.

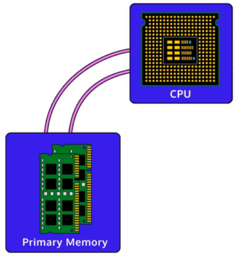
How does a neuromorphic platform work?

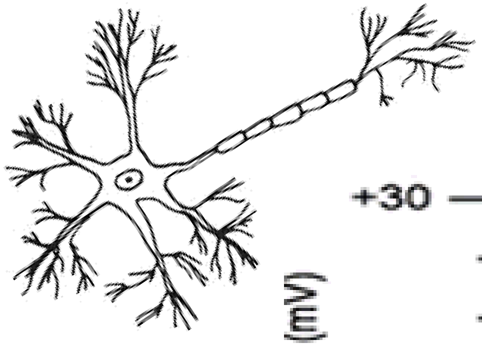
44 slides

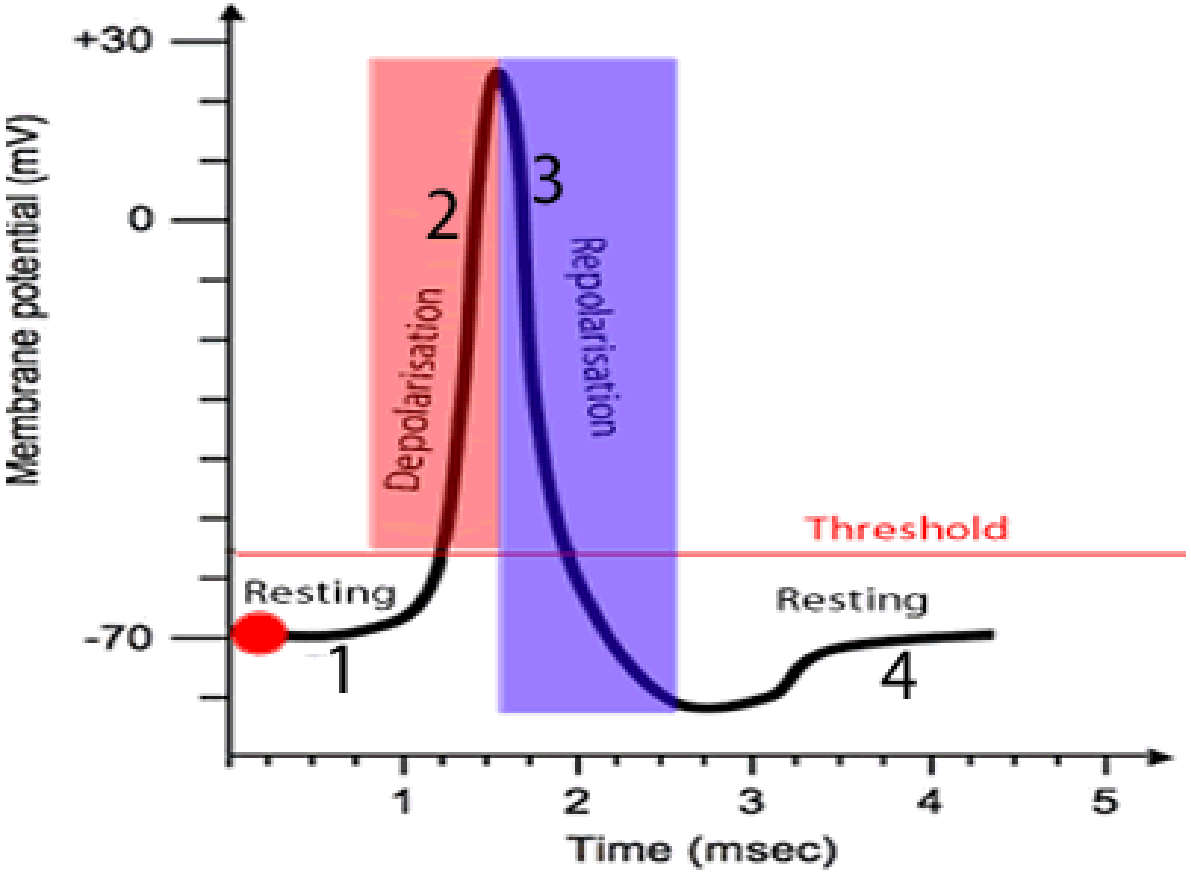
Let’s start from classic CPU!

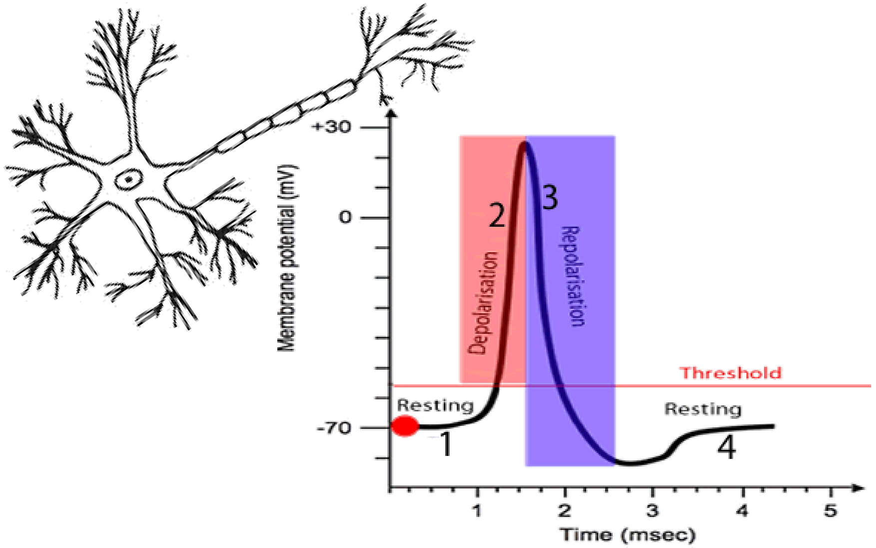


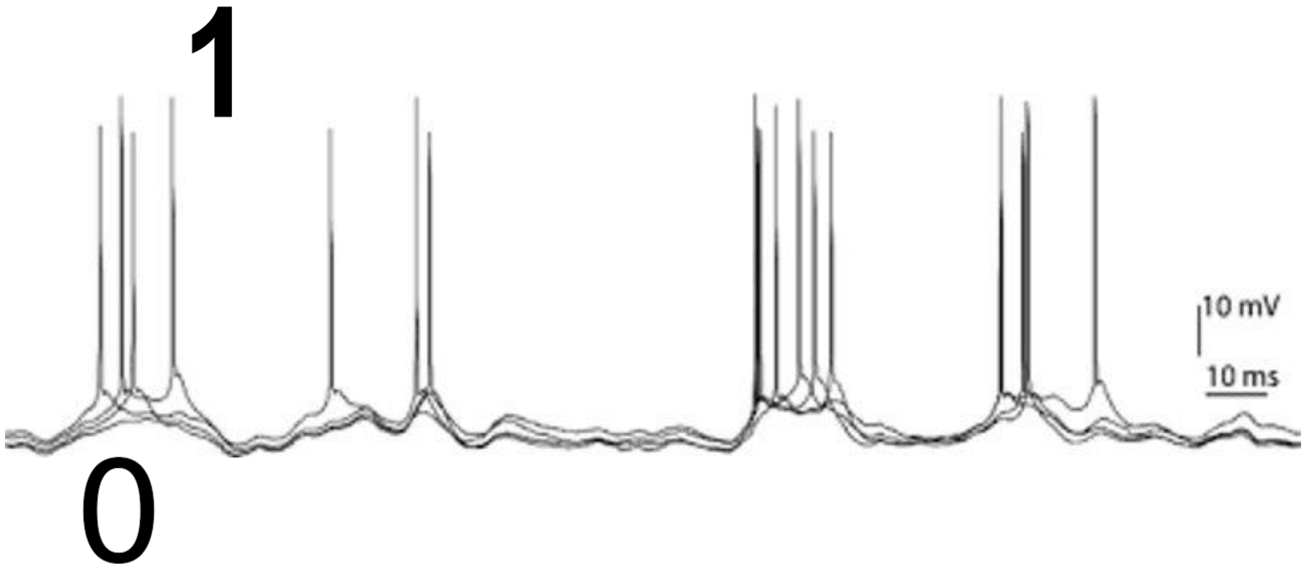
Let’s start from classic CPU!

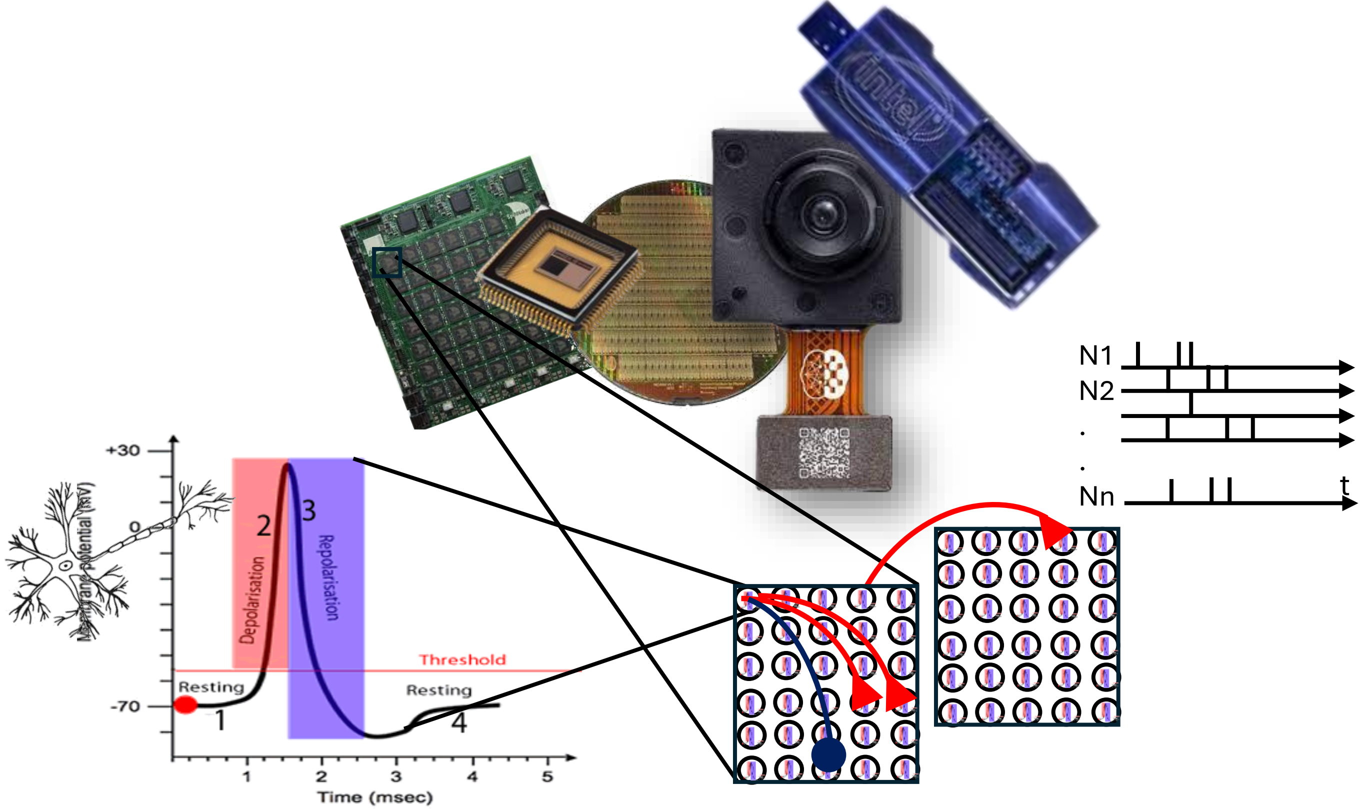


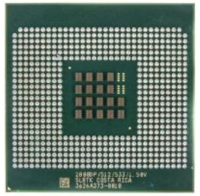





+30
0
-70
Membrane potential (mV)
Depolarisation
Repolarisation
Threshold
Resting
Resting
1
2
3
4
1
2
3
4
5
Time (msec)


1
0
10 mV
10 ms

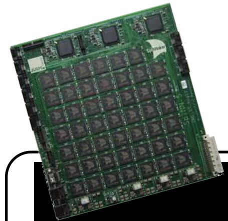




NON von Neumann architecture $e^{\frac{-\Delta T}{\tau}}$ LIF neuron
Connections among neurons Exitatory and Inhibitory connections
DIGITAL: SpiNNaker (i.e. ARM cores; old 18 cores 1ms clock, new 256 Cortex M4 180 MHz; RISC) ANALOG: DYNAP-SE (asynchronous analog circuits, NO global clock)
~mW power consumption (even less)

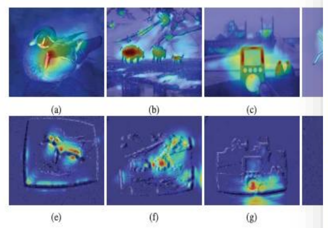
von Neumann architecture	NON strictly von Neumann
Single core	NO connections among cores
CISC 1 to 3 GHz	CISC 1.4 to 2.5 GHz
~125 to 250 W	~300 to 400 W

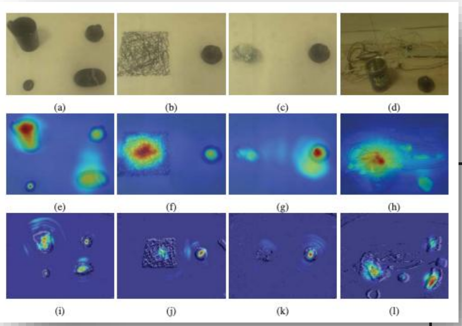
D’Angelo, G. et al. (2022). Event driven bio-inspired attentive system for the iCub humanoid robot on SpiNNaker. Neuromorphic Computing and Engineering



Intensity

Iacono, M
saliency f
Internatio





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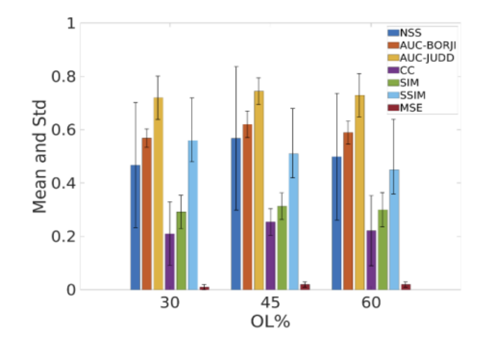
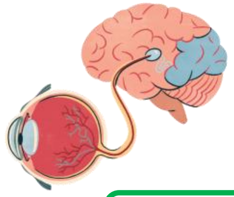
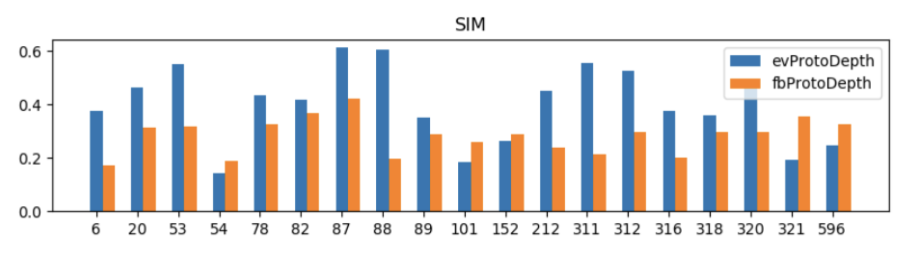


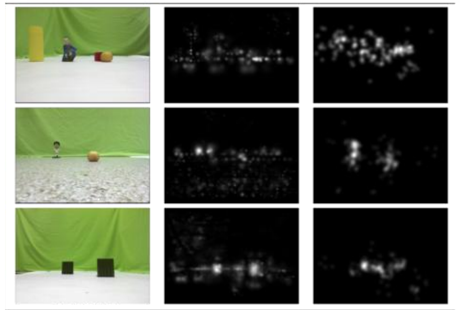


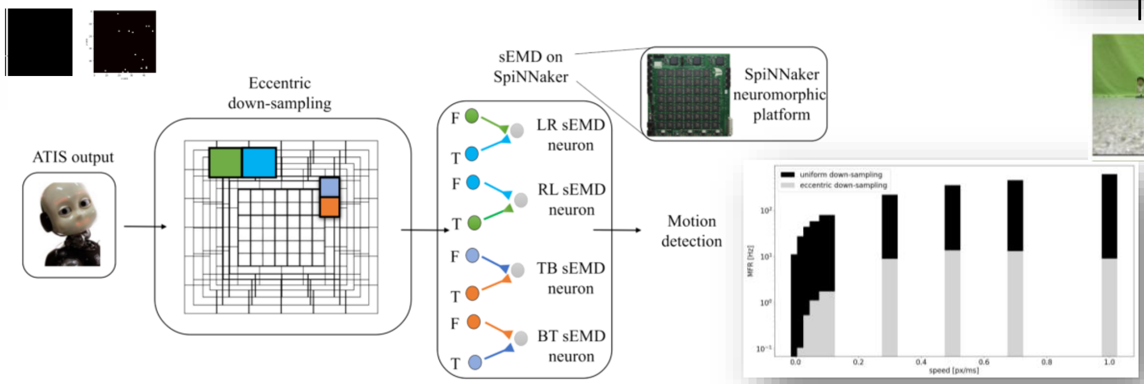
Motion

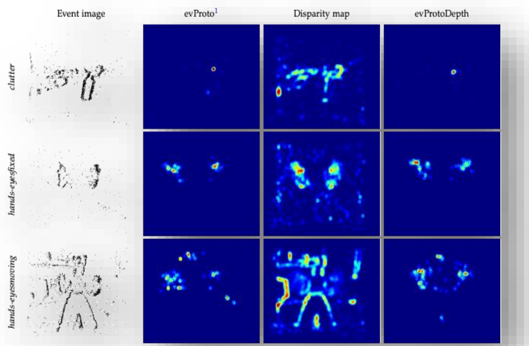


Input | Depth map | RGB sal map | ED sal map | 3D fixations

Input | ED sal map | 2D fixations

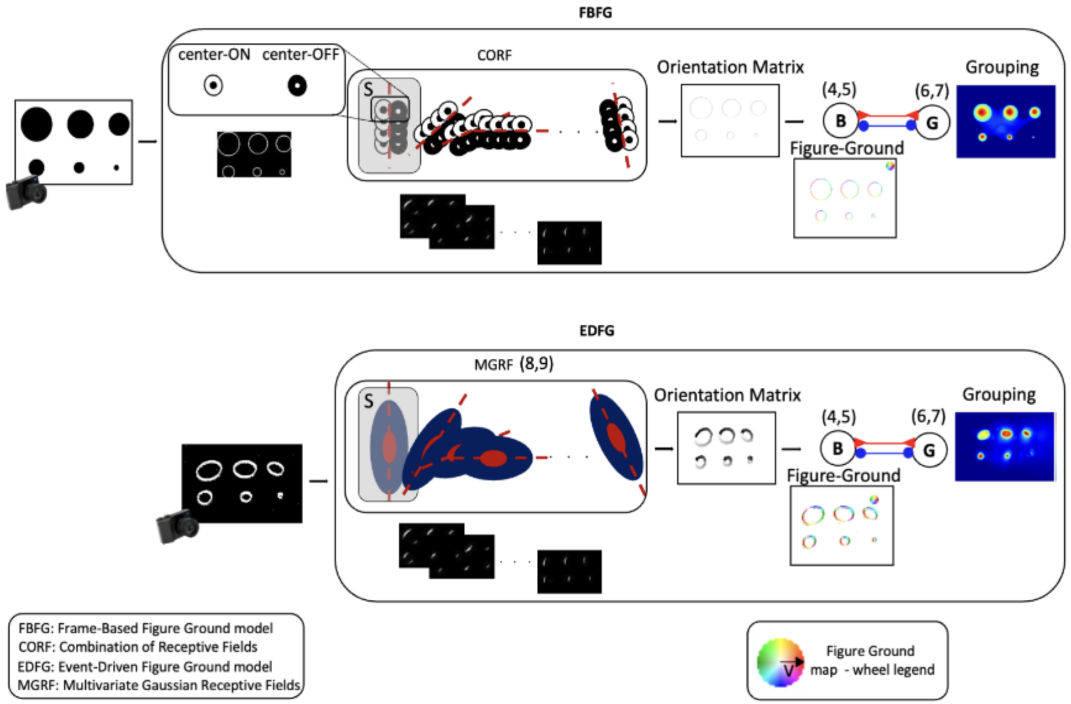




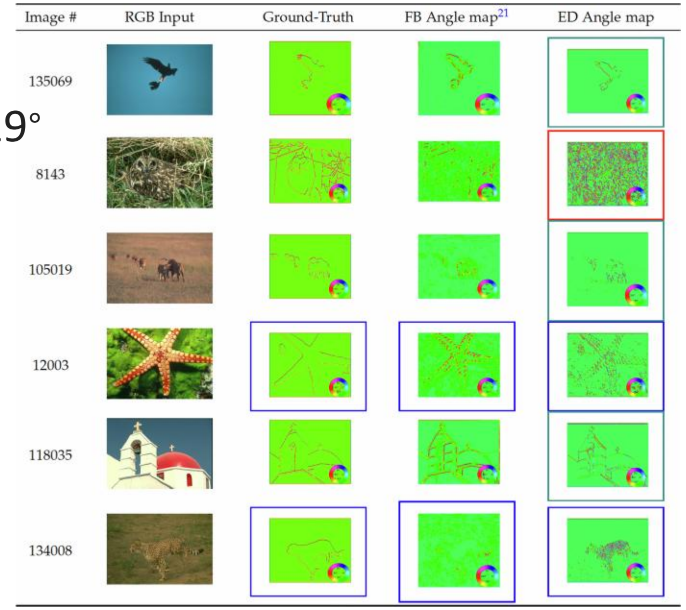


D'Angelo, G. et al. (2020). Event-based eccentric motion detection exploiting time difference encoding. *Frontiers in neuroscience*, *14*, 451.

Can we segment the scene?

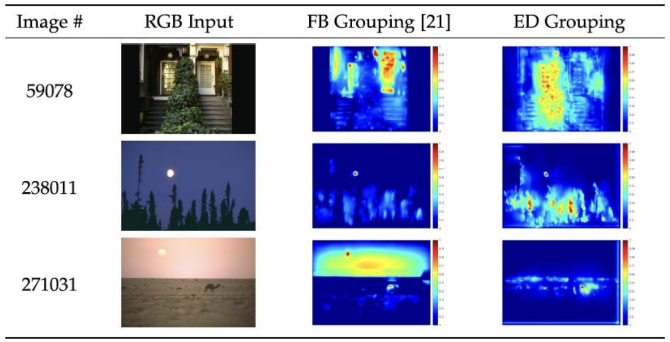


FB and ED Angle maps vs. Ground-Truth

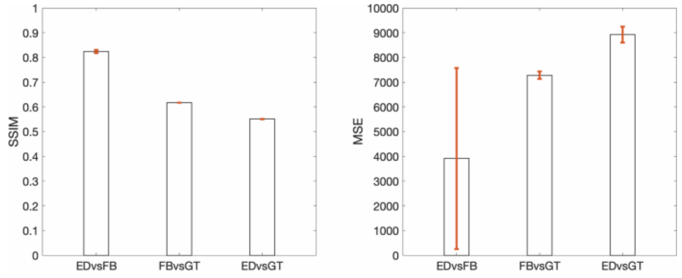


Means errors 5.29°

FBFG vs EDFG



What is an object?



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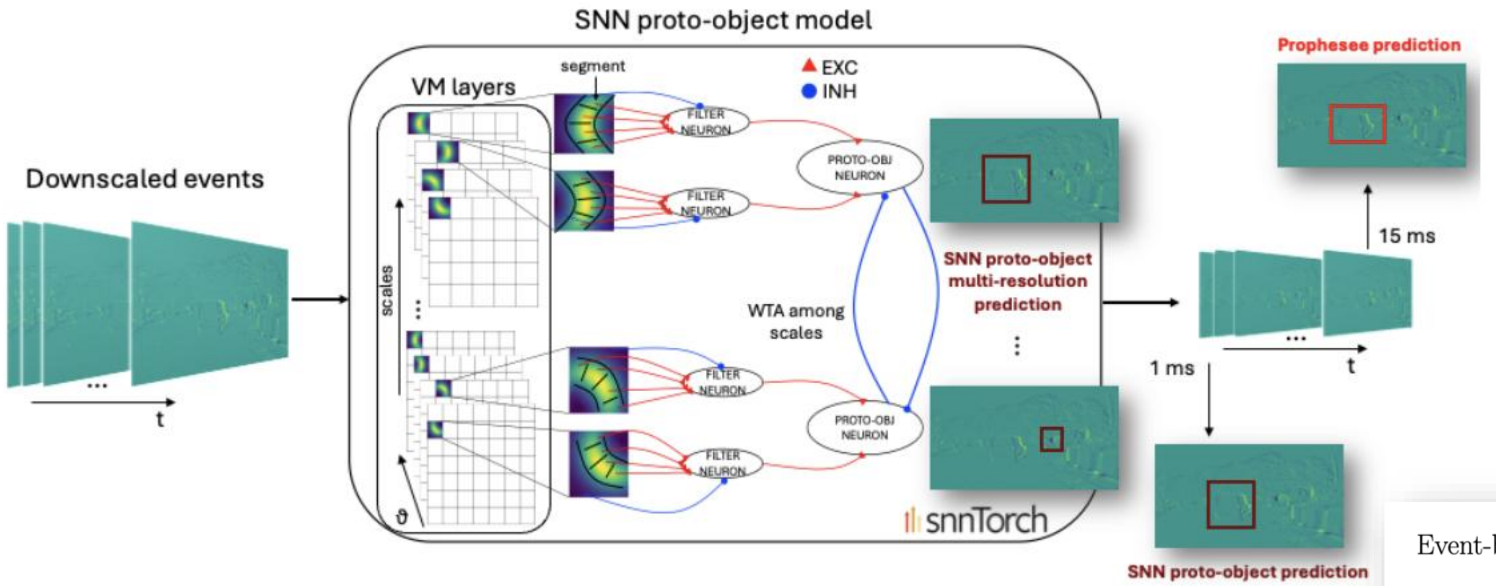
D’Angelo, G., Voto, S., Iacono, M., Glover, A., Niebur, E., & Bartolozzi, C. (2025). Event-driven figure-ground organisation model for the humanoid robot iCub. *Nature communications*, *16*(1), 1874.

Ghosh, S & D'Angelo, G. et al. (2022)

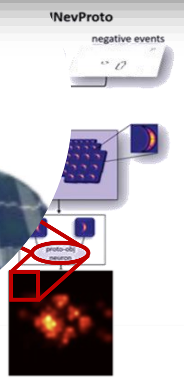
170 ms GPU

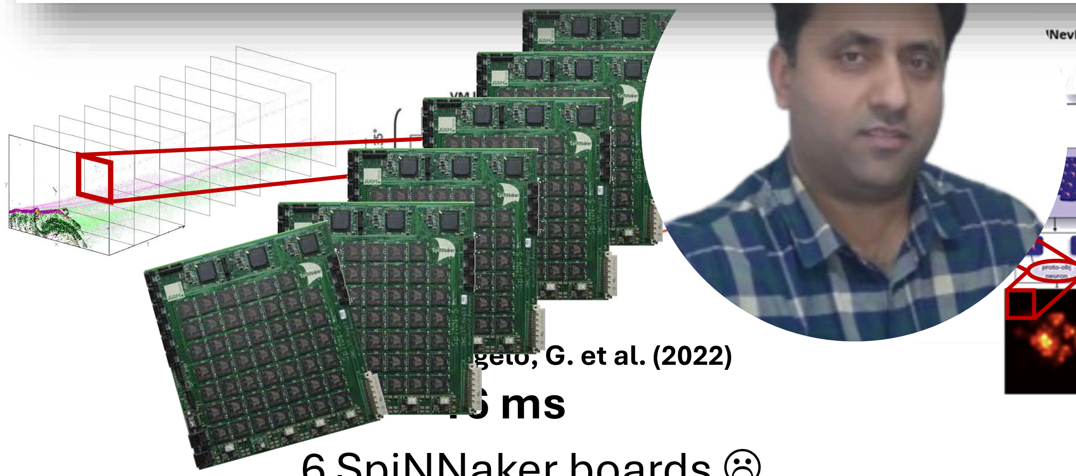
Depth



interests a robot: Event-Driven Proto-object saliency in 3D space

and Suman Ghosh, Arren Glover, Massimiliano Iacono, Ernst Niebur, Chiara Bartolozzi

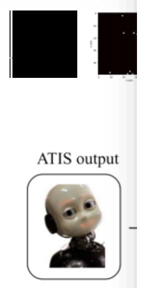


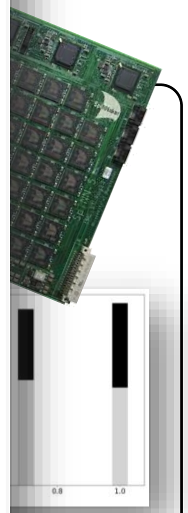


...gelo, G. et al. (2022)

...5 ms

6 SpiNNaker boards ☹





Event-based Selective Attention for Multi-resolution Fast Region of Interest (ROI) Detection

Luca Peres*[1], Giulia D'Angelo[2,3], Chiara Bartolozzi[3], and Oliver Rhodes[1]

[1]Advanced Processor Technologies Group, Department of Computer Science, The University of Manchester, Manchester, United Kingdom

[2]Department of Cybernetics, Faculty of Electrical Engineering, Czech Technical University in Prague, Czech Republic

[3]Istituto Italiano di Tecnologia, Genoa, Italy

Abstract

Neuromorphic vision systems operate under strict constraints on bandwidth, memory, and energy, particularly at the edge, motivating early mechanisms for data reduction and selective processing. In this work, we investigate a multi-scale training-free, saliency-based, bottom-up visual attention model that operates directly on low-resolution event-based input and selects regions of interest (ROIs) within the visual scene. The model is evaluated across multiple downscaling factors applied to the incoming event stream, with input resolutions reduced by up to 256× relative to full resolution. Performance is assessed on the Prophesee Automotive dataset, the largest publicly available event-based dataset, demonstrating robust ROI selection across different scales on a real-world use-case. The proposed approach is capable of detecting ROIs belonging to multiple object classes, including various vehicle types, pedestrians, traffic lights, and traffic signs, with accuracy up to 70.8%, while operating at millisecond temporal resolution, 16× finer than the temporal resolution provided by the dataset ground truth. These results highlight the potential of combining early event downscaling with saliency-based attention as an effective front-end for efficient edge neuromorphic vision systems.

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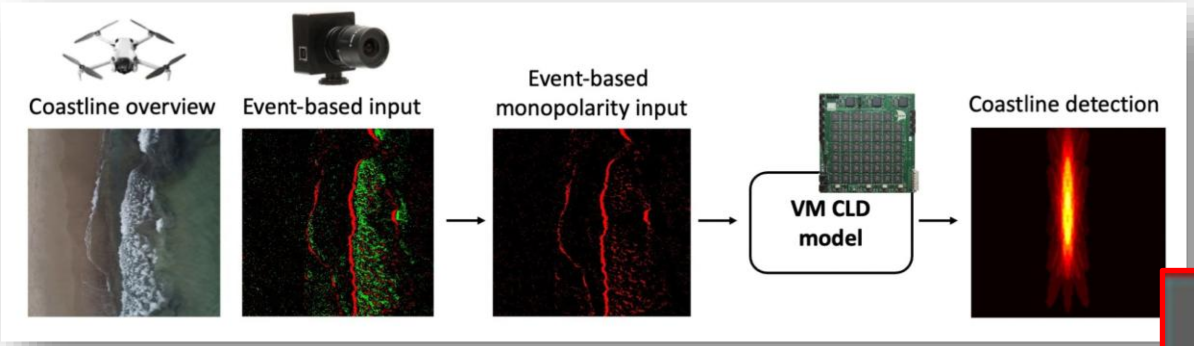
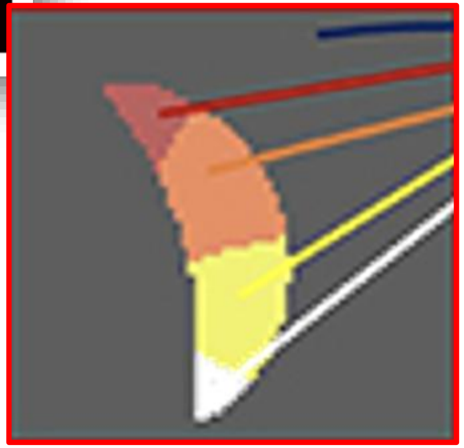
Mazdak Fatahi
PhD student
Université de Lille
Spiking Neural Networks for robotics applications

Event-driven nearshore and shoreline coastline detection on SpiNNaker neuromorphic hardware





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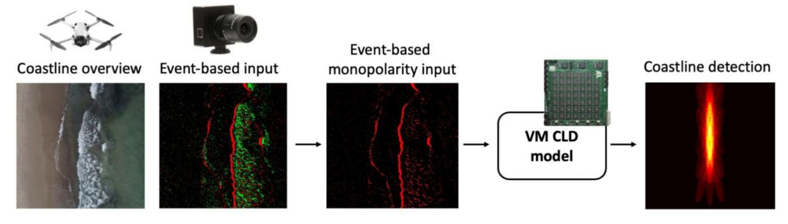
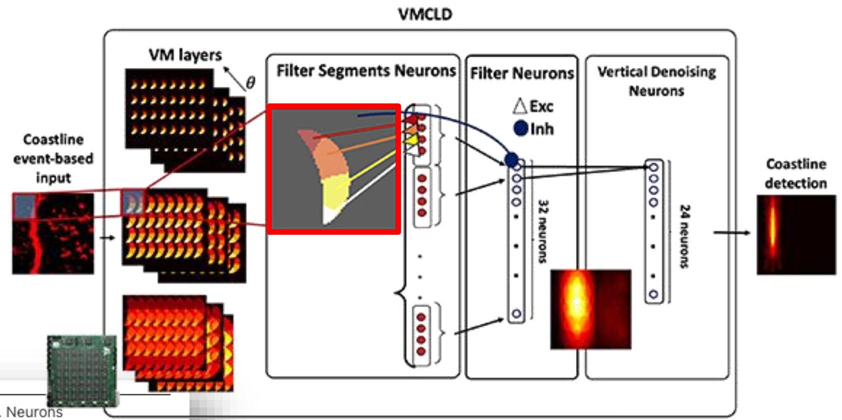
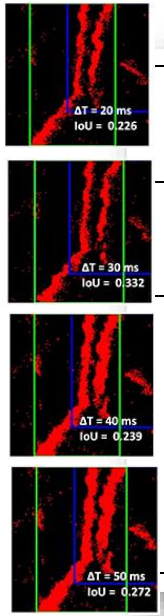
Event-driven nearshore and shoreline coastline detection on SpiNNaker neuromorphic hardware





Populations	No. Neurons
Input Population	16 384 (128×128)
Filter Segments Neurons Population	128 (32×4)
Filter Neurons Population	32
Vertical Denoising Population	24
Total	$16\,384 + 184 \times 9 = 18\,040$

Average consumption **ΔT=20 ms** is **0.3756 mW**



ΔT	Average of IoU	Accuracy (%) (Threshold = 0.80)	Accuracy (%) (Threshold = 0.70)	Accuracy (%) (Threshold = 0.60)	Accuracy (%) (Threshold = 0.50)	Accuracy (%) (Threshold = 0.40)	Accuracy (%) (Threshold = 0.30)
20	61.68	18.69	37.88	57.07	73.23	85.35	92.93
30	65.66	22.78	49.44	67.78	78.89	90.56	**98.33**
40	67.06	**26.35**	55.69	70.66	82.04	89.82	95.81
50	**69.59**	24.64	**57.97**	**78.99**	**87.68**	**93.48**	96.38

Fatahi, M., Boulet, P., & D'angelo, G. (2024). Event-driven nearshore and shoreline coastline detection on SpiNNaker neuromorphic hardware. *Neuromorphic Computing and Engineering*, *4*(3), 034012.

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Can Spiking Neural Networks play pinball? A neuromorphic motion detector for target tracking

148 μW

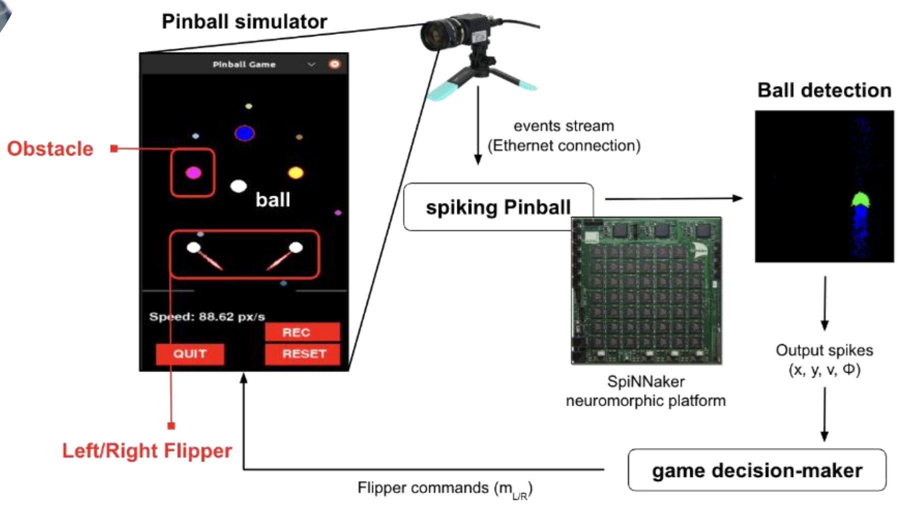


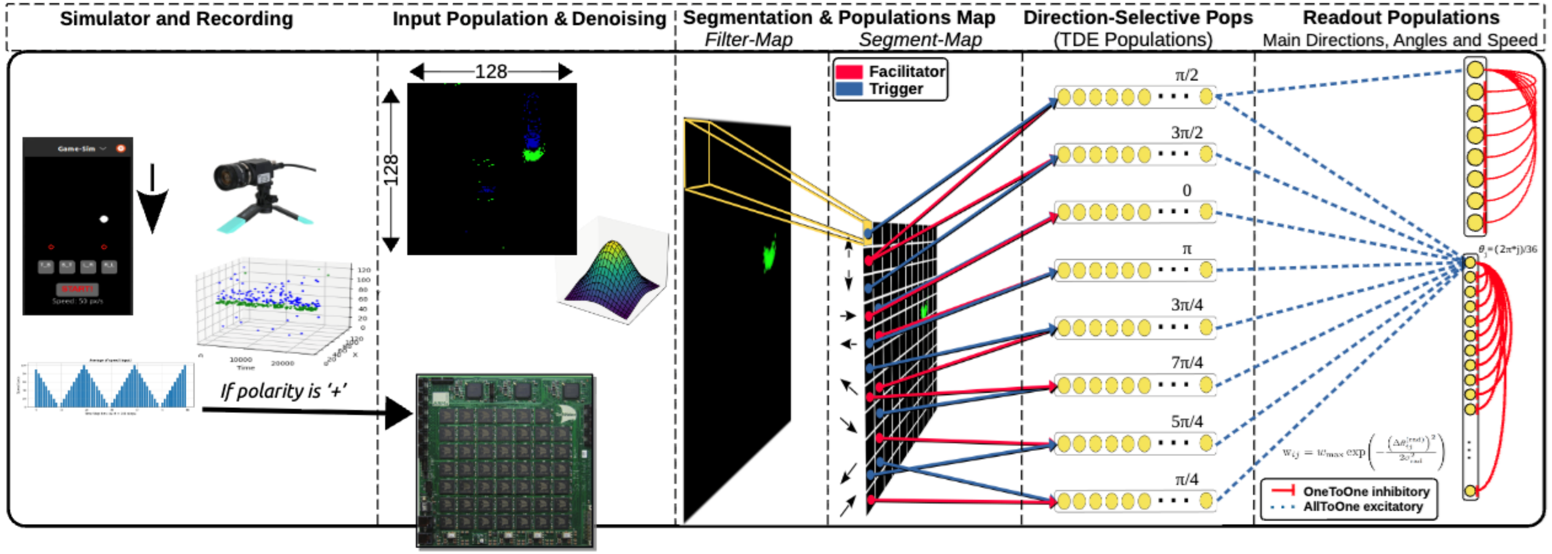
Table 4: Human baseline performance in the pinball game compared with the average game results.

Metric	Players 1	2	3	4	5	6	7	8	9	10	Min	Max	Avg	CLN* Avg
Successful hits	28	34	50	49	33	40	127	112	62	48	28	127	58.3	**64**
Number of actions	321	56	317	422	197	88	436	394	384	206	56	436	282.1	**114**
Hit rate (%)	9.0	61.0	16.0	12.0	17.0	45.0	29.0	28.0	16.0	23.0	9.0	**61.0**	**25.6**	**56.1**
Miss rate (%)	91.0	39.0	84.0	88.0	83.0	55.0	71.0	72.0	84.0	77.0	39.0	91.0	74.4	**43.9**

* Closed-Loop Neuromorphic

Table 2: Upward direction detection accuracy for different receptive field sizes in the segmentation map and ΔT values, evaluated at a constant ball speed of 1000 px/s.

ΔT (ms)	Accuracy [%] (RF-size = 3x3)	Accuracy [%] (RF-size = 5x5)	Accuracy [%] (RF-size = 7x7)	Accuracy [%] (RF-size = 9x9)	Accuracy [%] (RF-size = 11x11)
16.7	**96.15**	92.31	90.38	86.54	63.46
33.4	**93.10**	**93.10**	**93.10**	89.66	75.86
50	**100.00**	95.00	95.00	85.00	75.00



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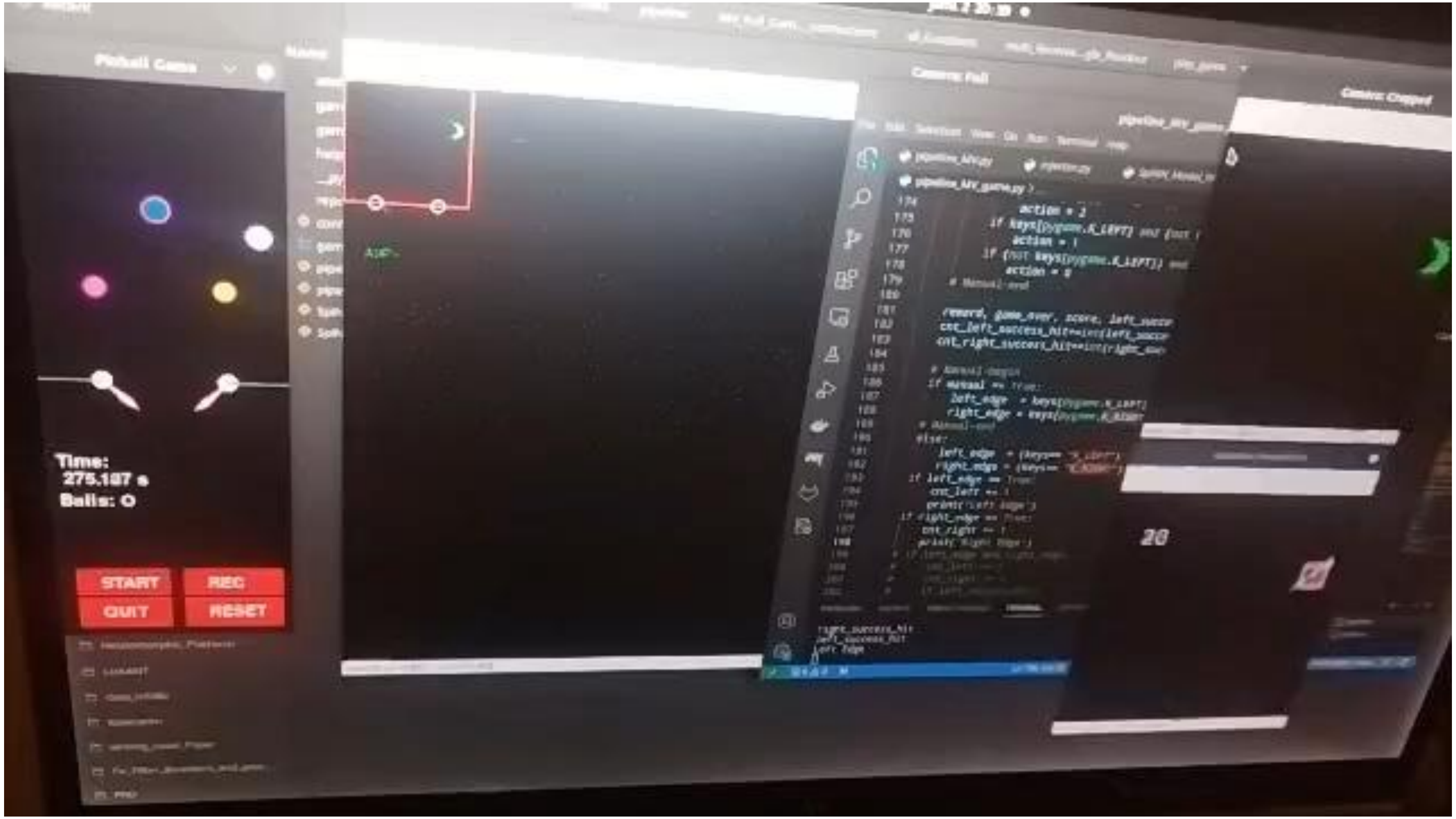
Can Spiking Neural Networks play pinball? A neuromorphic motion detector for target tracking

148 µW



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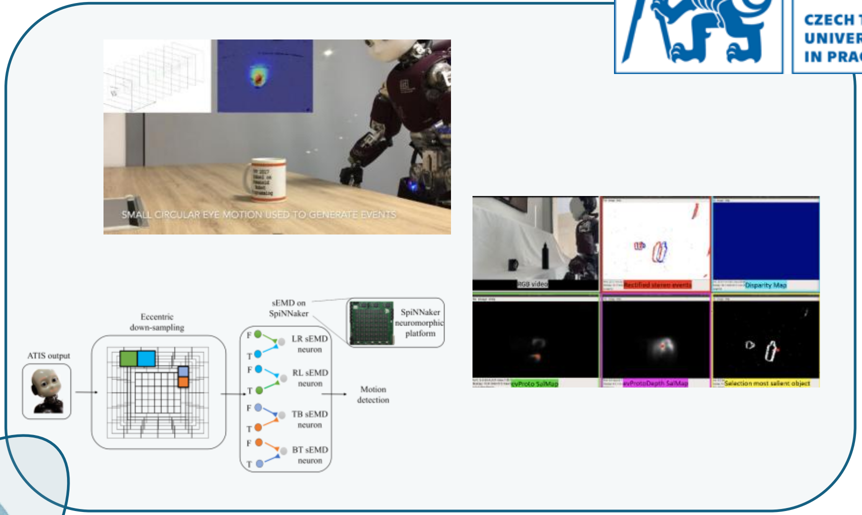
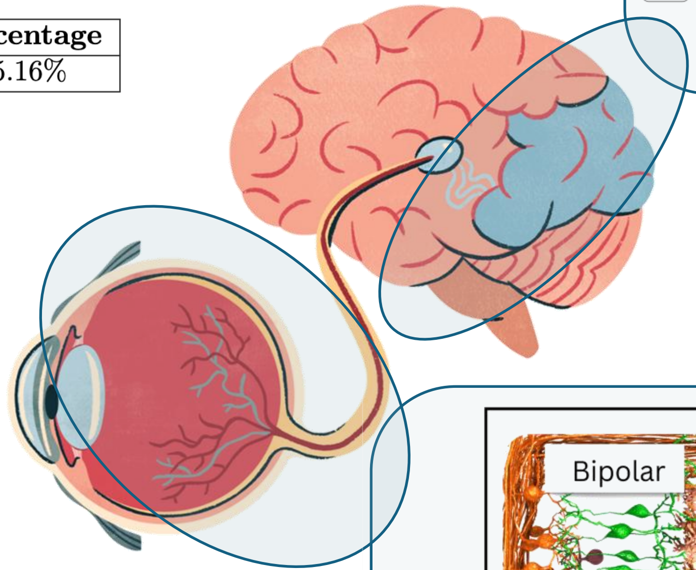
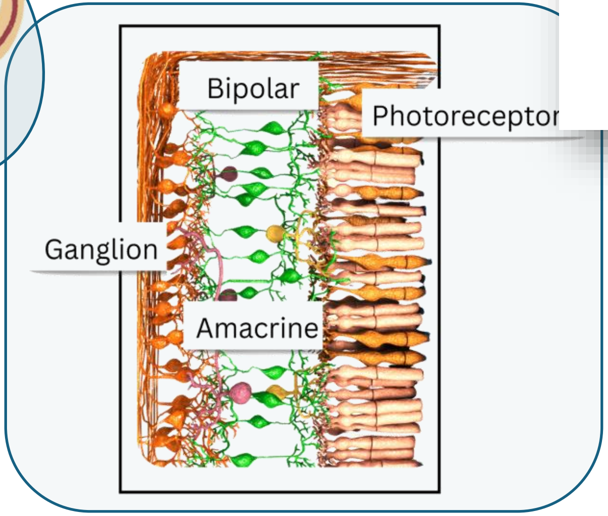
D’Angelo, G., Clerico, V., Bartolozzi, C., Hoffmann, M., Furlong, P. M., & Hadjiivanov, A. (2025). Wandering around: A bioinspired approach to visual attention through object motion sensitivity. *Neuromorphic Computing and Engineering*, *5*(2), 024019.

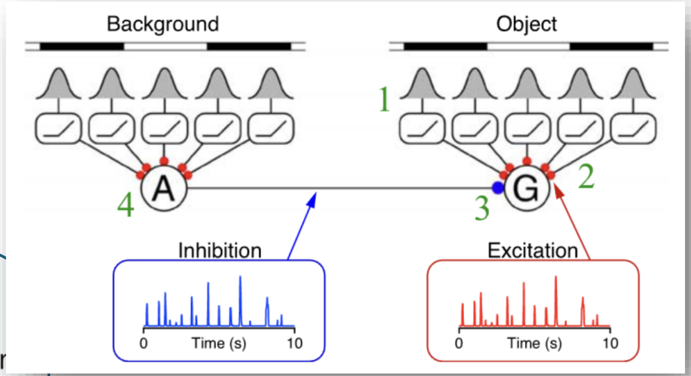
Visual attention

Trials	# Events	# sOMS Events	Percentage
10	14747.03 ± 2029.17	2189.15 ± 385.57	85.16%





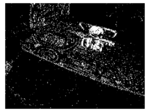
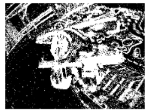
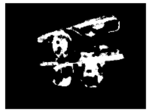
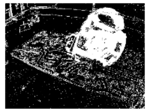


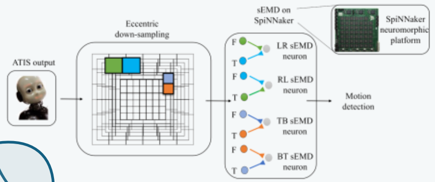


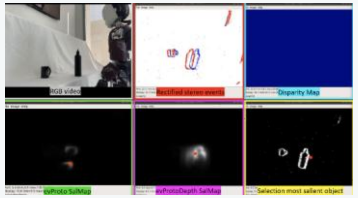
Baccus, S. A., Ölveczky, B. P., Manu, M., & Meister, M. (2008). A retinal circuit that computes object motion. *Journal of Neuroscience*, *28*(27), 6807-6817.

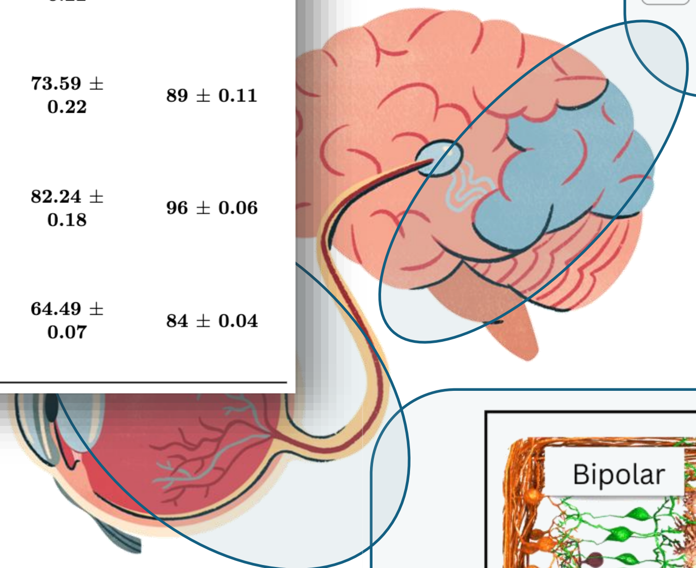
D'Angelo, G., Clerico, V., Bartolozzi, C., Hoffmann, M., Furlong, P. M., & Hadjiivanov, A. (2025). Wandering around: A bioinspired approach to visual attention through object motion sensitivity. *Neuromorphic Computing and Engineering*, *5*(2), 024019.

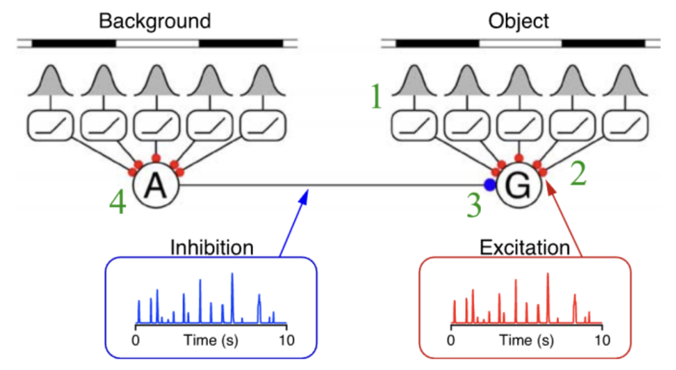
Visual attention

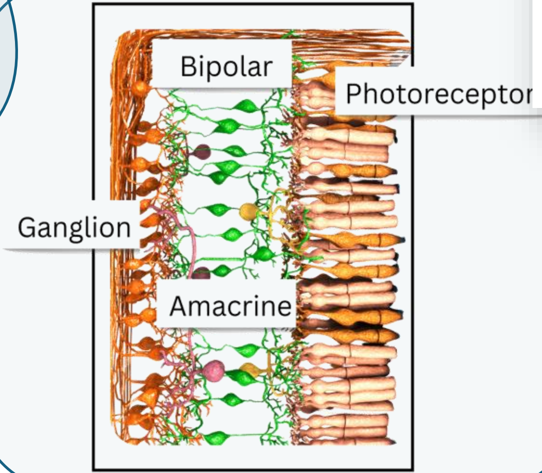
Sub-dataset	Event map [51]	Ground Truth [51]	OMS map	mean IoU % [12]	mean IoU %	mean SSIM %
Box				72 ± 16	**64.79 ± 0.02**	**89 ± 0.08**
Fast				69 ± 3	**69.85 ± 0.15**	**90 ± 0.06**
Floor				94	**63.21 ± 0.22**	**94± 0.22**
Table				88 ± 10	**73.59 ± 0.22**	**89 ± 0.11**
Tabletop				72 ± 14	**82.24 ± 0.18**	**96 ± 0.06**
Wall				82±6	**64.49 ± 0.07**	**84 ± 0.04**











Baccus, S. A., Ölveczky, B. P., Manu, M., & Meister, M. (2008). A retinal circuit that computes object motion. *Journal of Neuroscience*, *28*(27), 6807-6817.

D'Angelo, G., Clerico, V., Bartolozzi, C., Hoffmann, M., Furlong, P. M., & Hadjiivanov, A. (2025). Wandering around: A bioinspired approach to visual attention through object motion sensitivity. *Neuromorphic Computing and Engineering*, 5(2), 024019.

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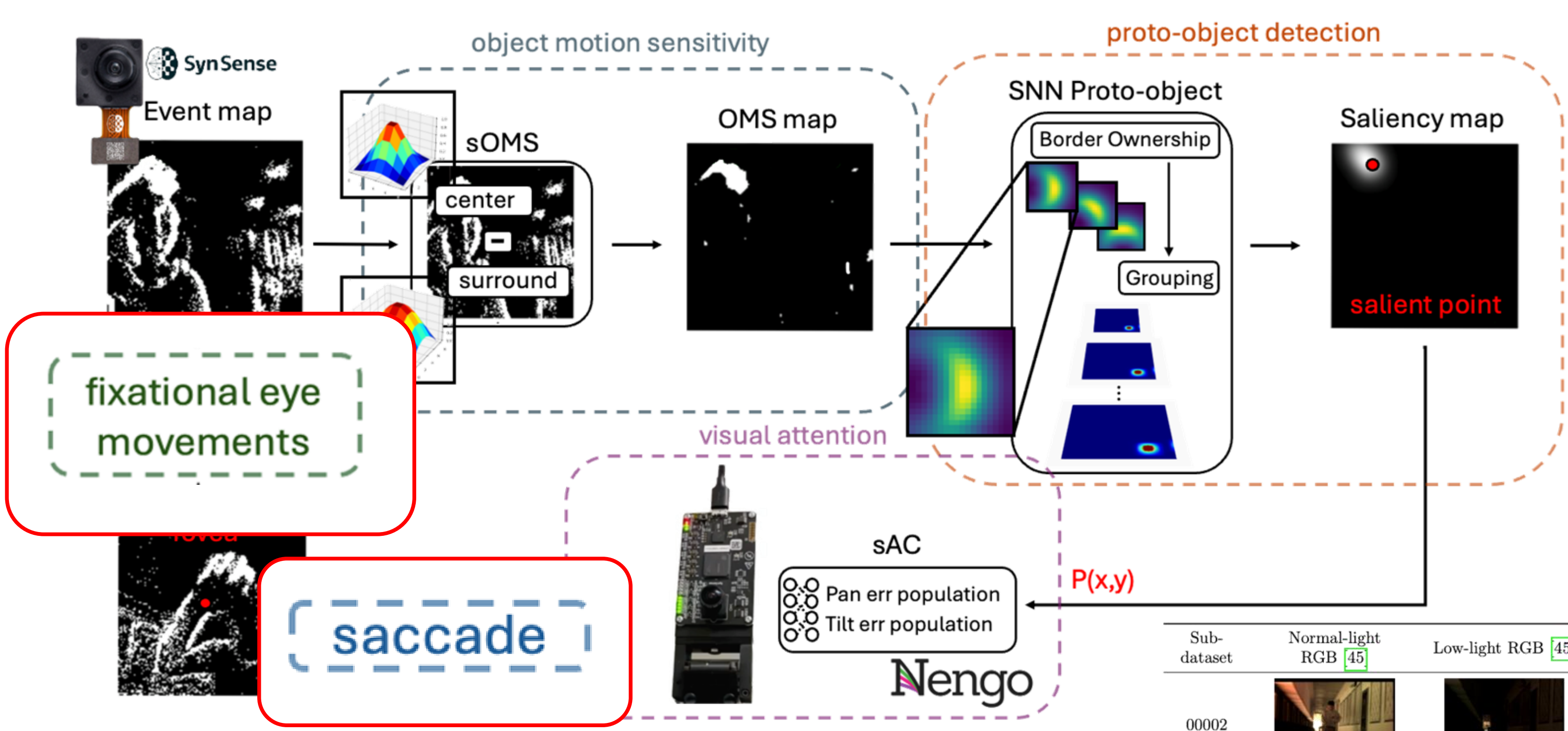

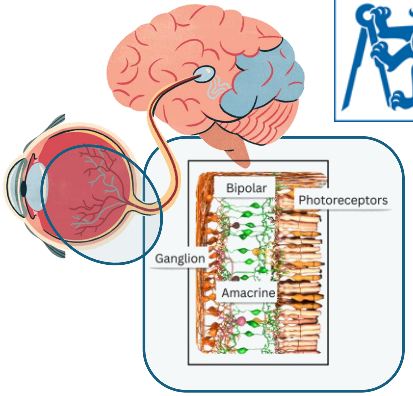

Sub-dataset	Normal-light RGB [45]	Low-light RGB [45]	Event map [45]	Annotation [45]	OMS map	Saliency map	Accuracy %
00002							84.13
00011							89.88
00064							87.47
00033							72.96
00031							55.55
00025							47.84

Embodiment refers to the concept of experiencing the world through a physical body or form.

D'Angelo, G., Clerico, V., Bartolozzi, C., Hoffmann, M., Furlong, P. M., & Hadjiivanov, A. (2025). Wandering around: A bioinspired approach to visual attention through object motion sensitivity. *Neuromorphic Computing and Engineering*, *5*(2), 024019.

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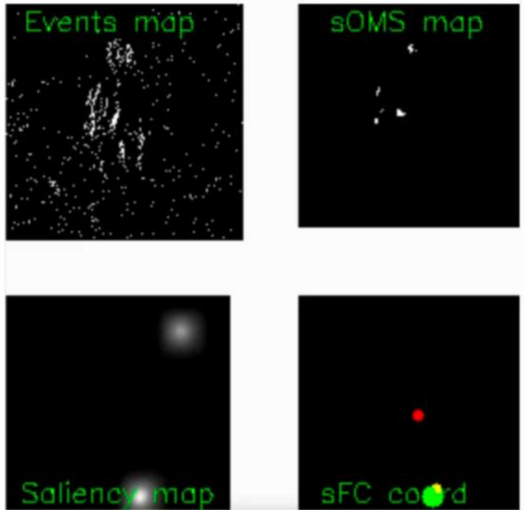
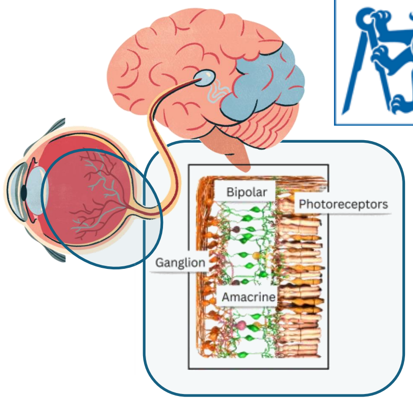
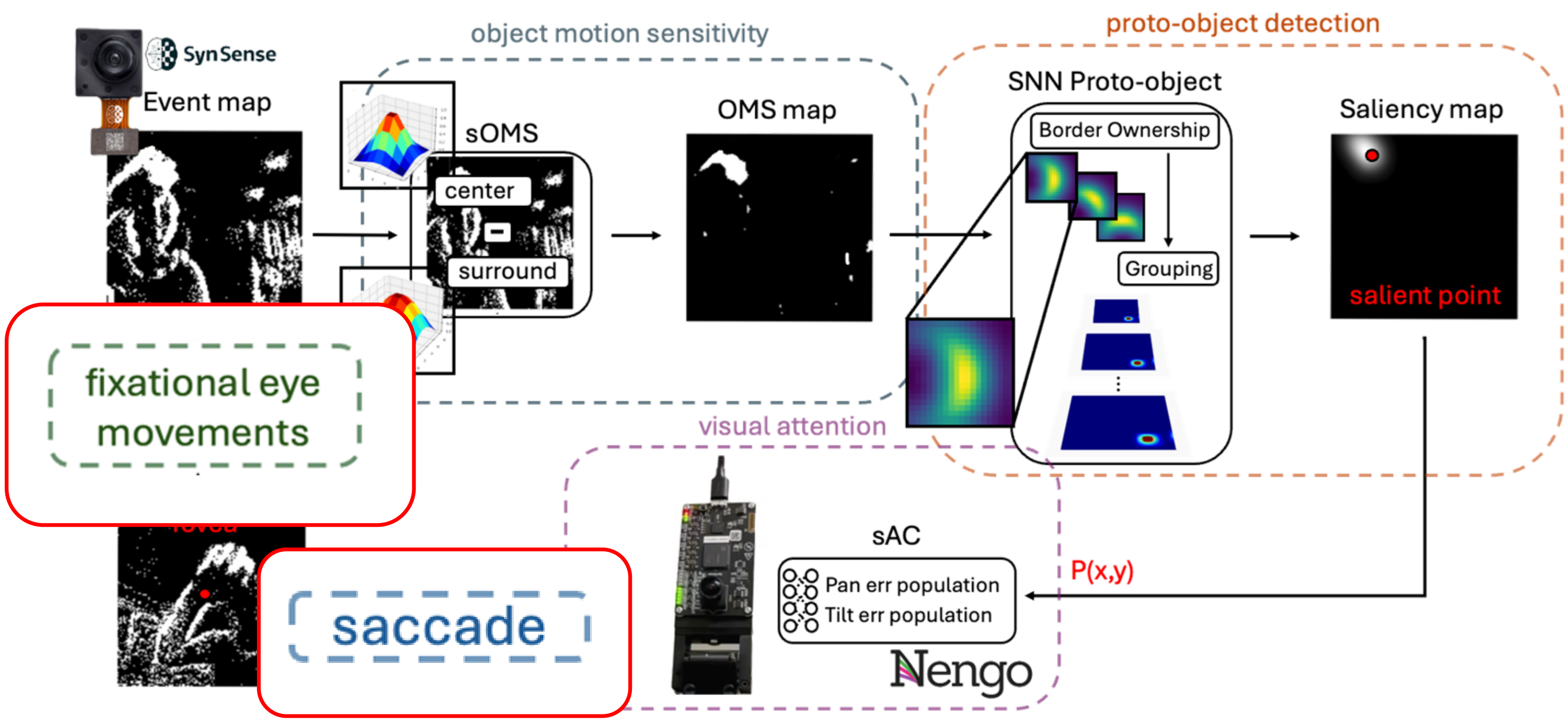
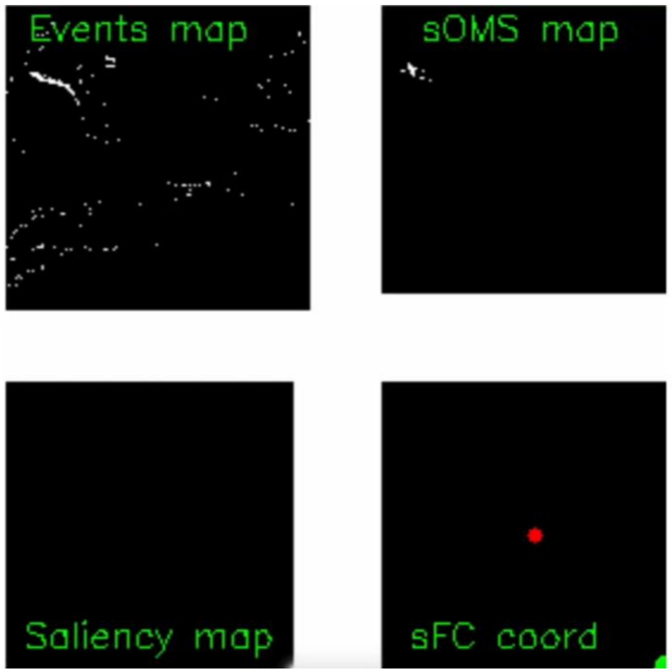
~120 ms M2

~1 ms Speck
<< 1 W

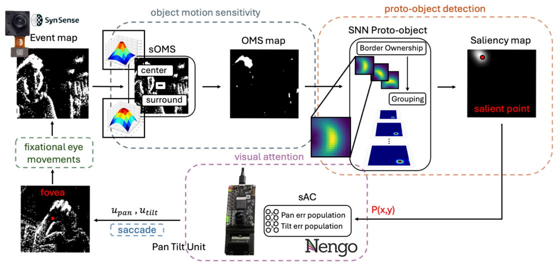


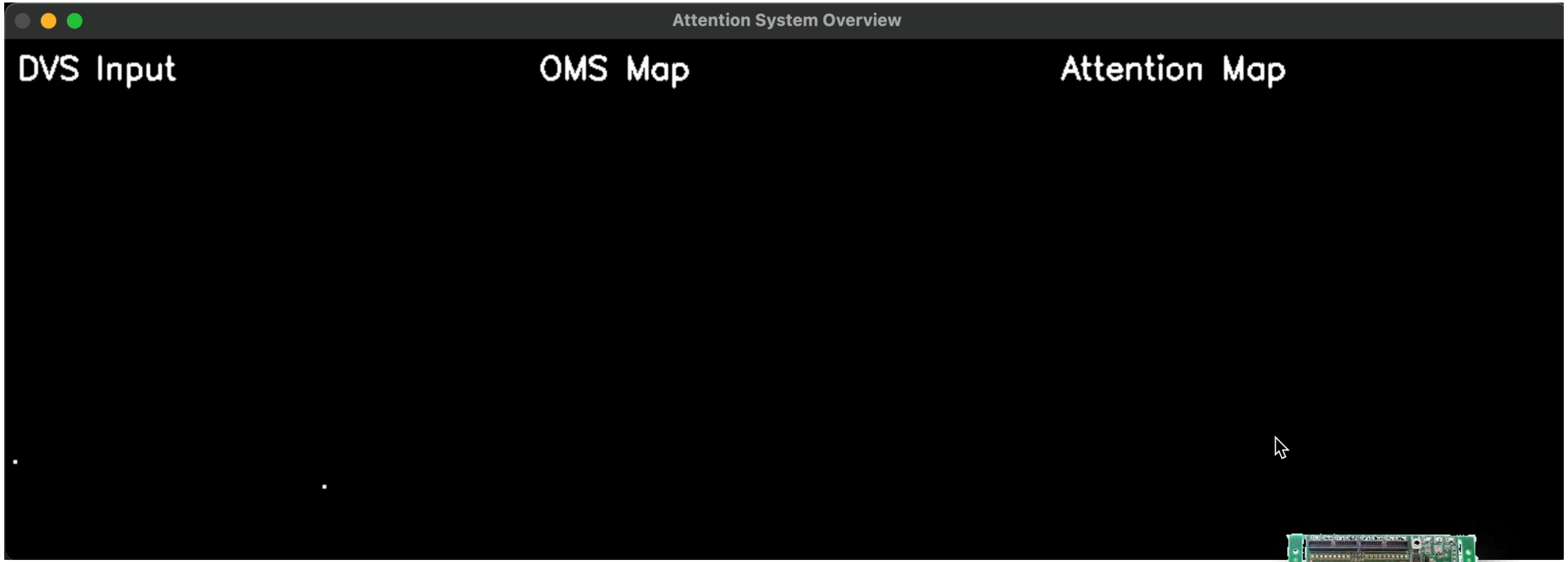


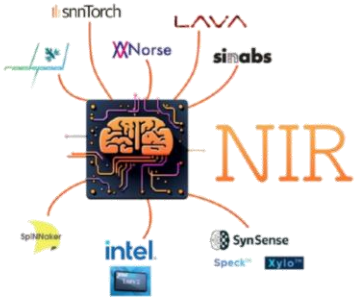


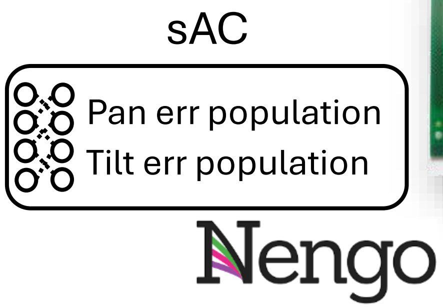


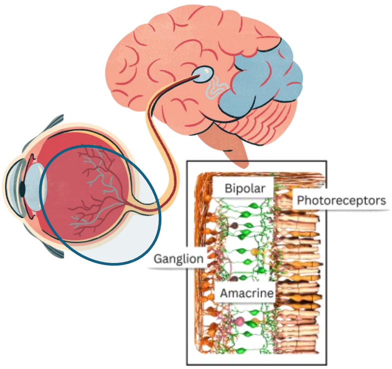
Neuromorphic working in progress...



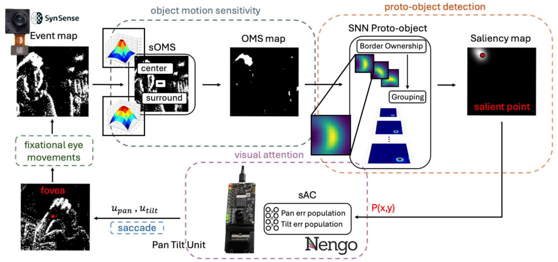


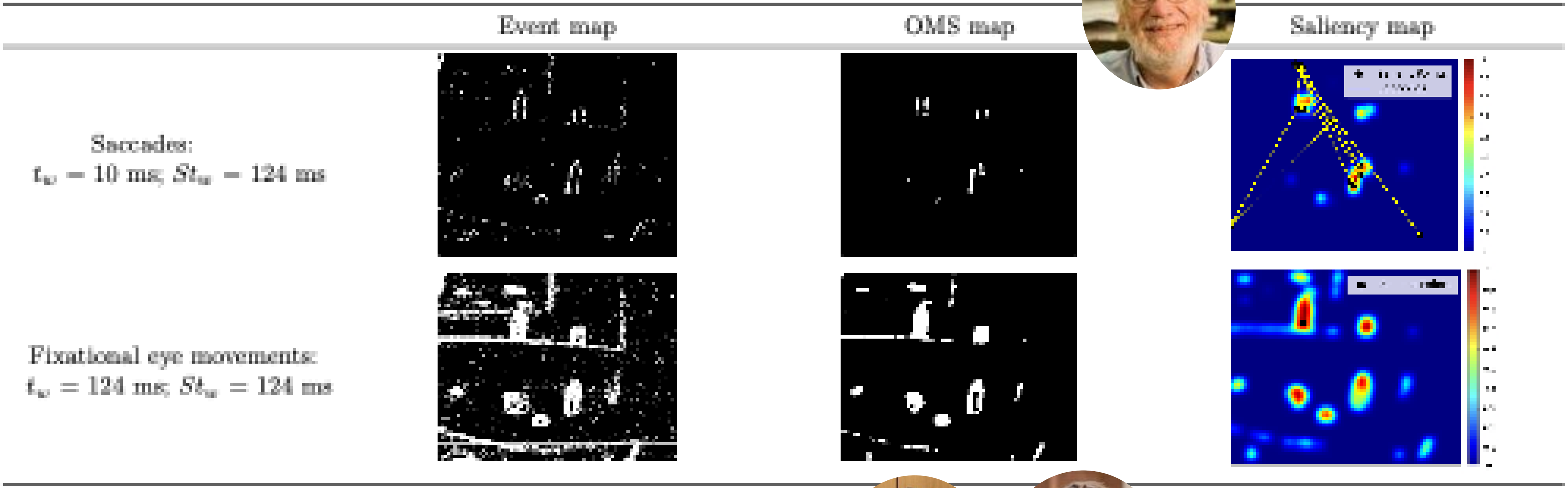






D'Angelo, G., Clerico, V., Bartolozzi, C., Hoffmann, M., Furlong, P. M., & Hadjiivanov, A. (2025). Wandering around: A bioinspired approach to visual attention through object motion sensitivity. *Neuromorphic Computing and Engineering*, *5*(2), 024019.





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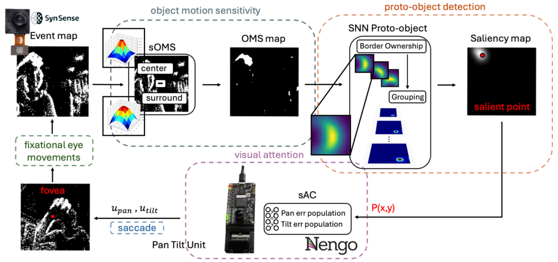
Politecnico di Torino

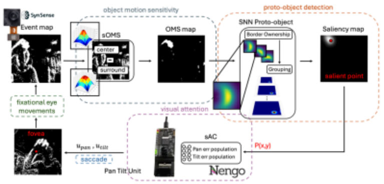
UNIVERSITY OF SUSSEX

Riccardo Pignari
PhD student - visiting 2025
Politecnico di Torino
SNNs visual attention & motion detection

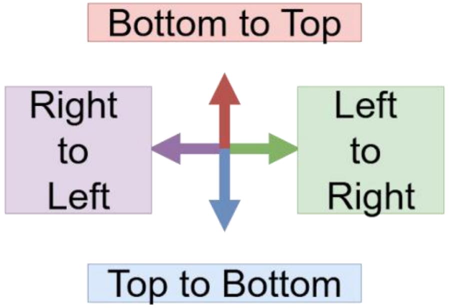


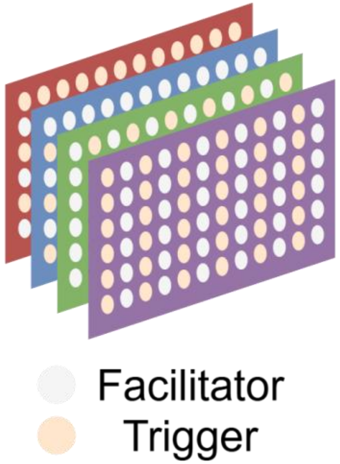
      

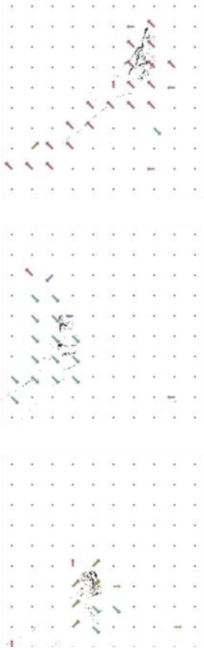
Motion direction detection though object motion segmentation



sOMS Map

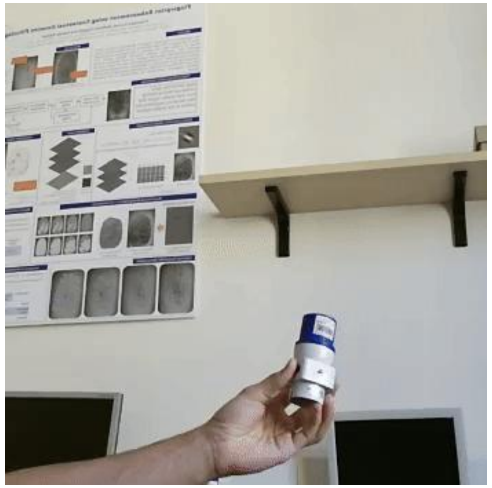




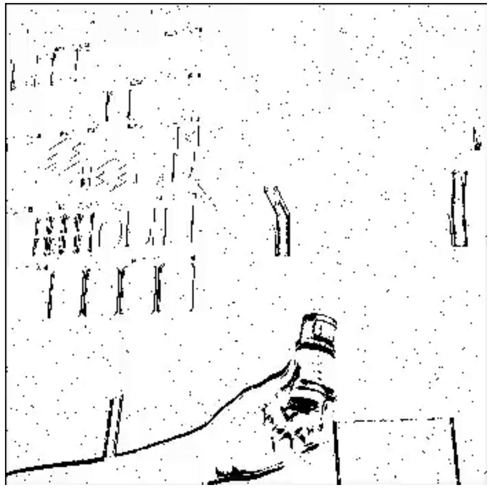


sEMD Direction Map

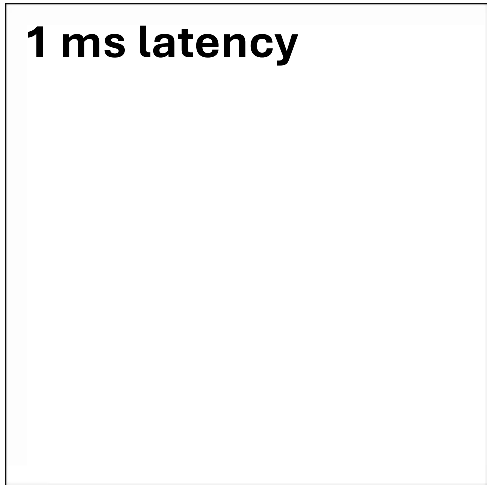
Video RGB



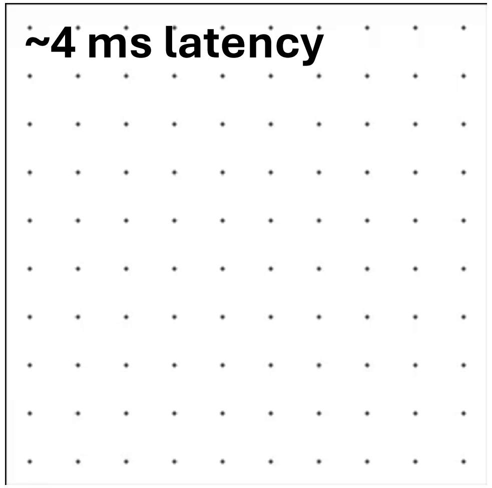
Event-camera

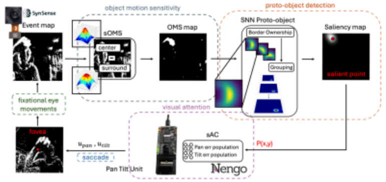


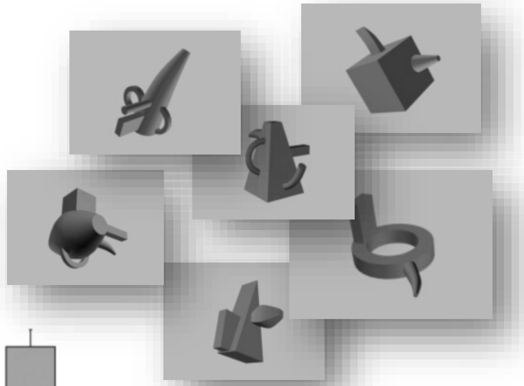
spiking OMS



spiking EMD



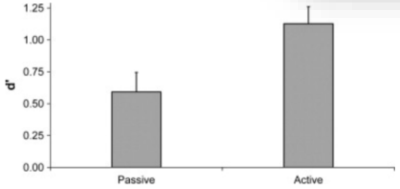




“Often you do not need to store a complete internal model of the world”

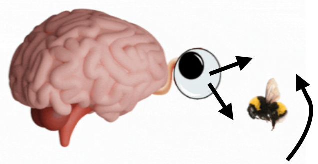
Ballard, Dana H., et al. "Deictic codes for the embodiment of cognition." *Behavioral and brain sciences* 20.4 (1997): 723-742.

We use the world as a kind of external memory



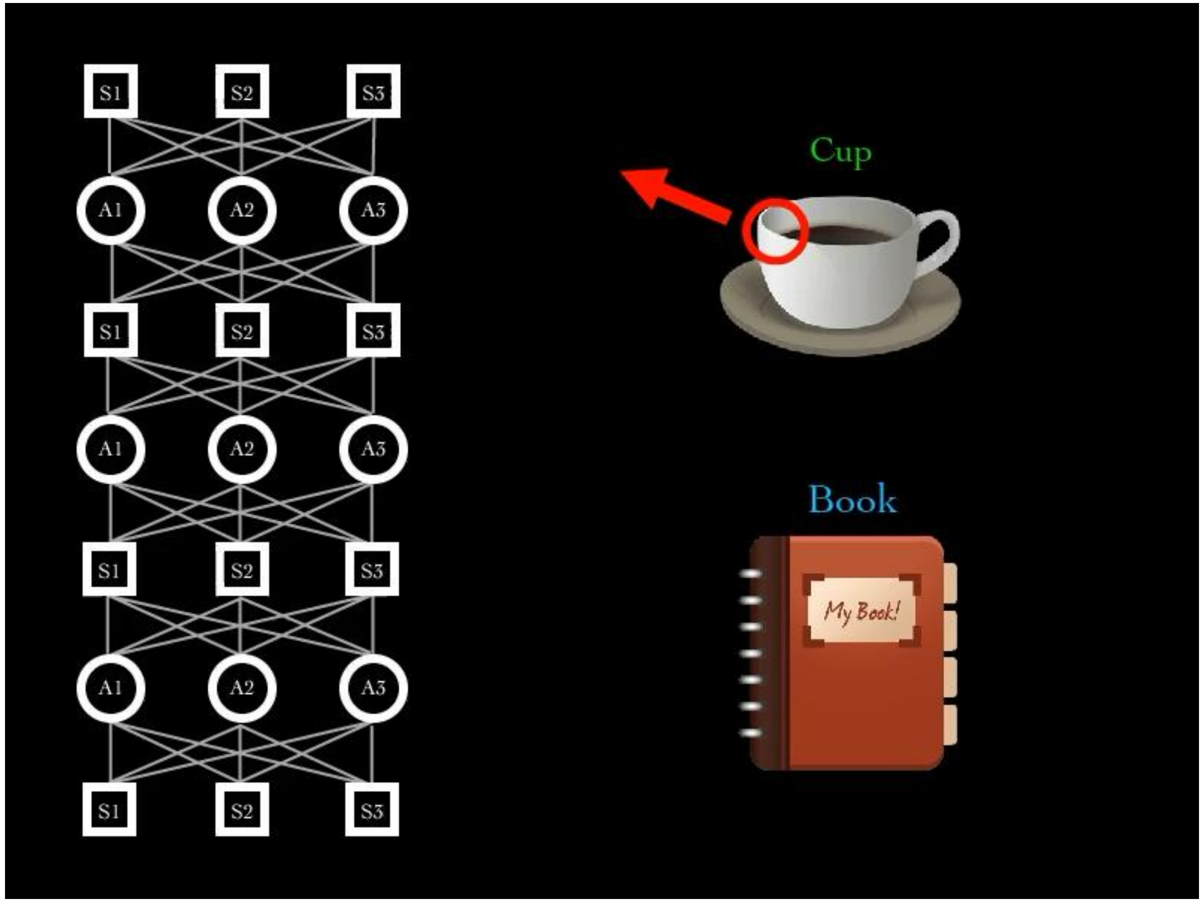
Meijer, Frank, and Rob HJ Van der Lubbe. "Active exploration improves perceptual sensitivity for virtual 3D objects in visual recognition tasks." *Vision Research* 51.23-24 (2011): 2431-2439.

sensorimotor view



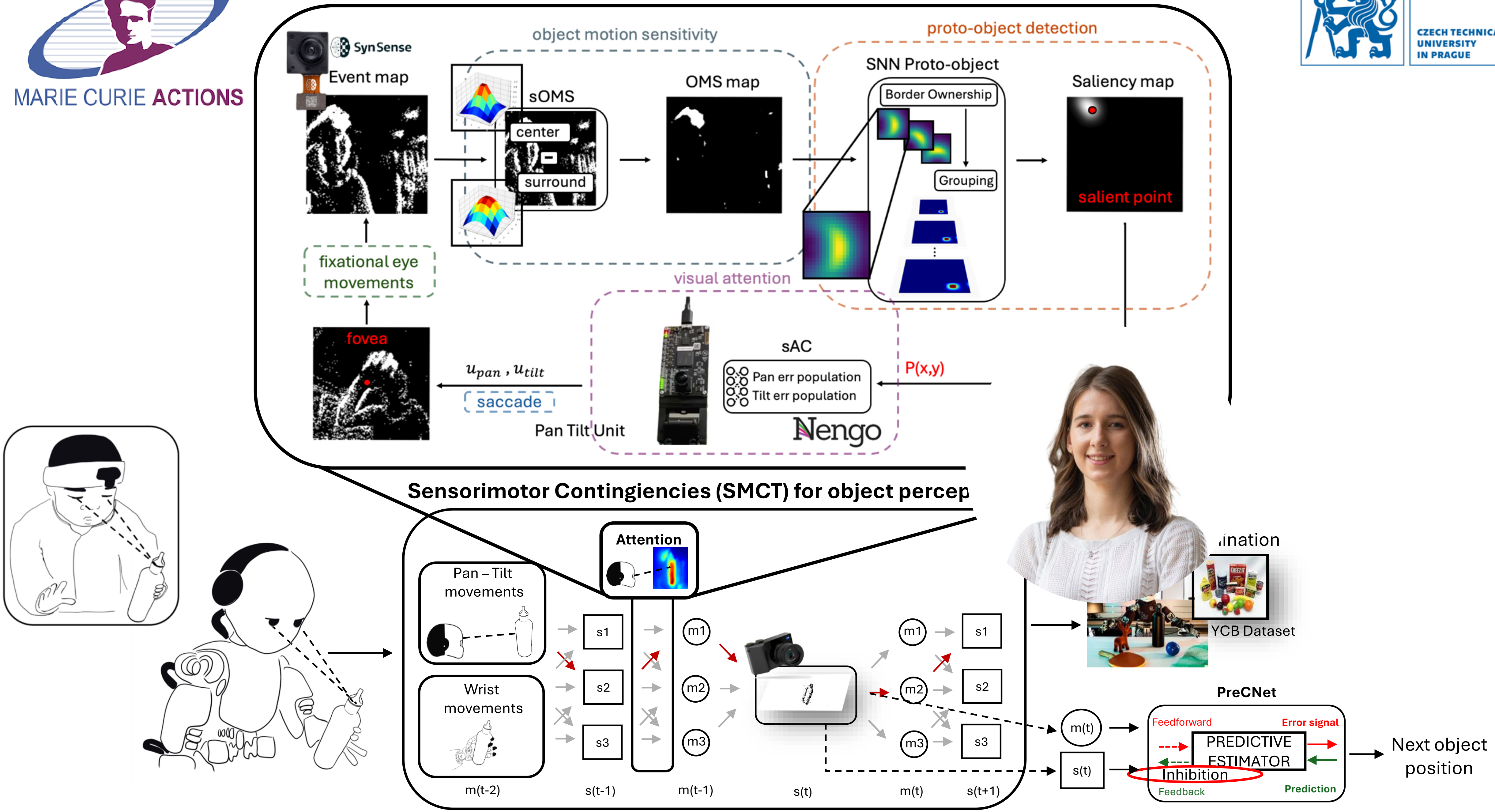
O'regan, J. Kevin, and Alva Noë. "A sensorimotor account of vision and visual consciousness." *Behavioral and brain sciences* 24.5 (2001): 939-973.

McQuillan, Maureen E., et al. "Parents influence the visual learning environment through children's manual actions." *Child development* 91.3 (2020): e701-e720.



Engel, Andreas K., et al. *Trends in cognitive sciences* 17.5 (2013): 202-209.
Maye, Alexander, and Andreas K. Engel. *IEEE International Conference on Robotics and Automation*. IEEE, 2011.

Attention



SynSense
Event map
object motion sensitivity
sOMS
center
surround
OMS map
proto-object detection
SNN Proto-object
Border Ownership
Grouping
Saliency map
salient point
fixational eye movements
visual attention
fovea
u_{pan} , u_{tilt}
saccade
Pan Tilt Unit
sAC
Pan err population
Tilt err population
Nengo
P(x,y)
Sensorimotor Contingiencies (SMCT) for object percep
Attention
Pan – Tilt movements
Wrist movements
s1
s2
s3
m1
m2
m3
m(t-2)
s(t-1)
m(t-1)
s(t)
m(t)
s(t+1)
YCB Dataset
PreCNet
Feedforward
Error signal
PREDICTIVE ESTIMATOR
Inhibition
Feedback
Prediction
m(t)
s(t)
Next object position

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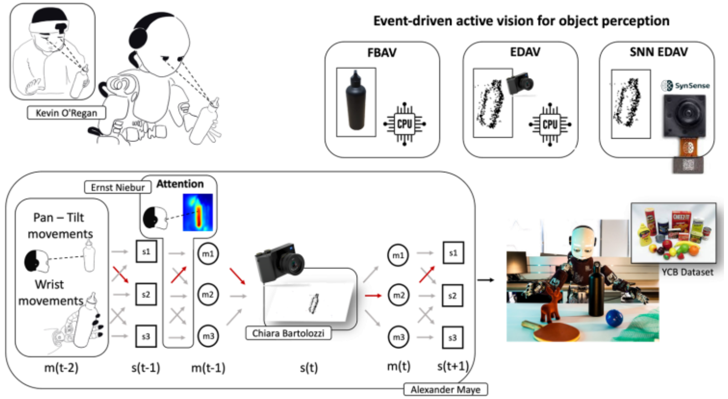
Šárka Lísková
PhD student
Czech Technical University in Prague
Computational Physics working on SNN for object learning

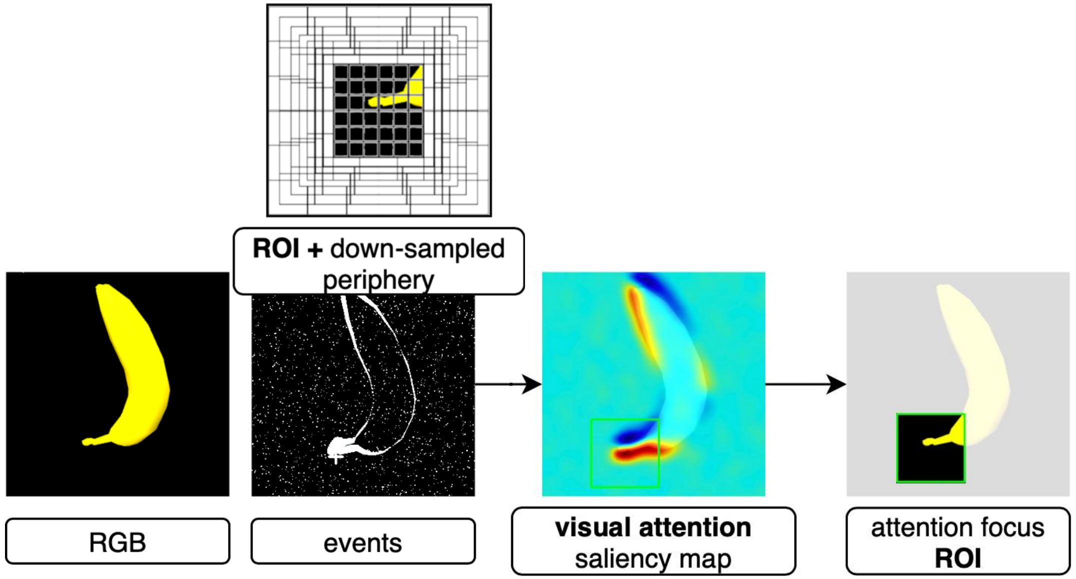


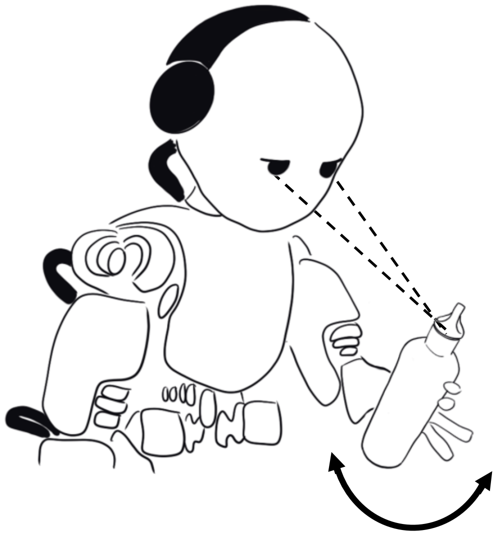


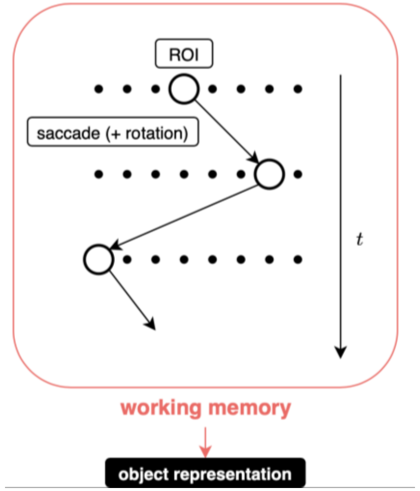


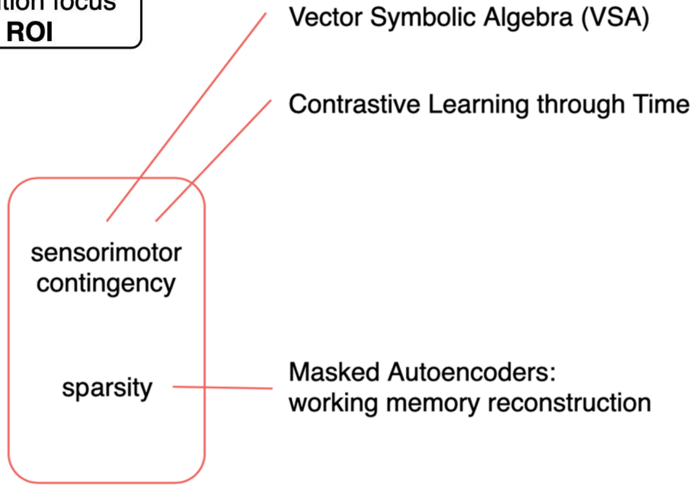


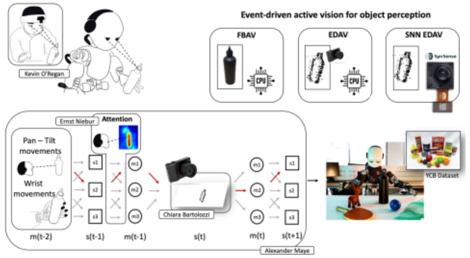
Bioinspired active vision: learning through exploration



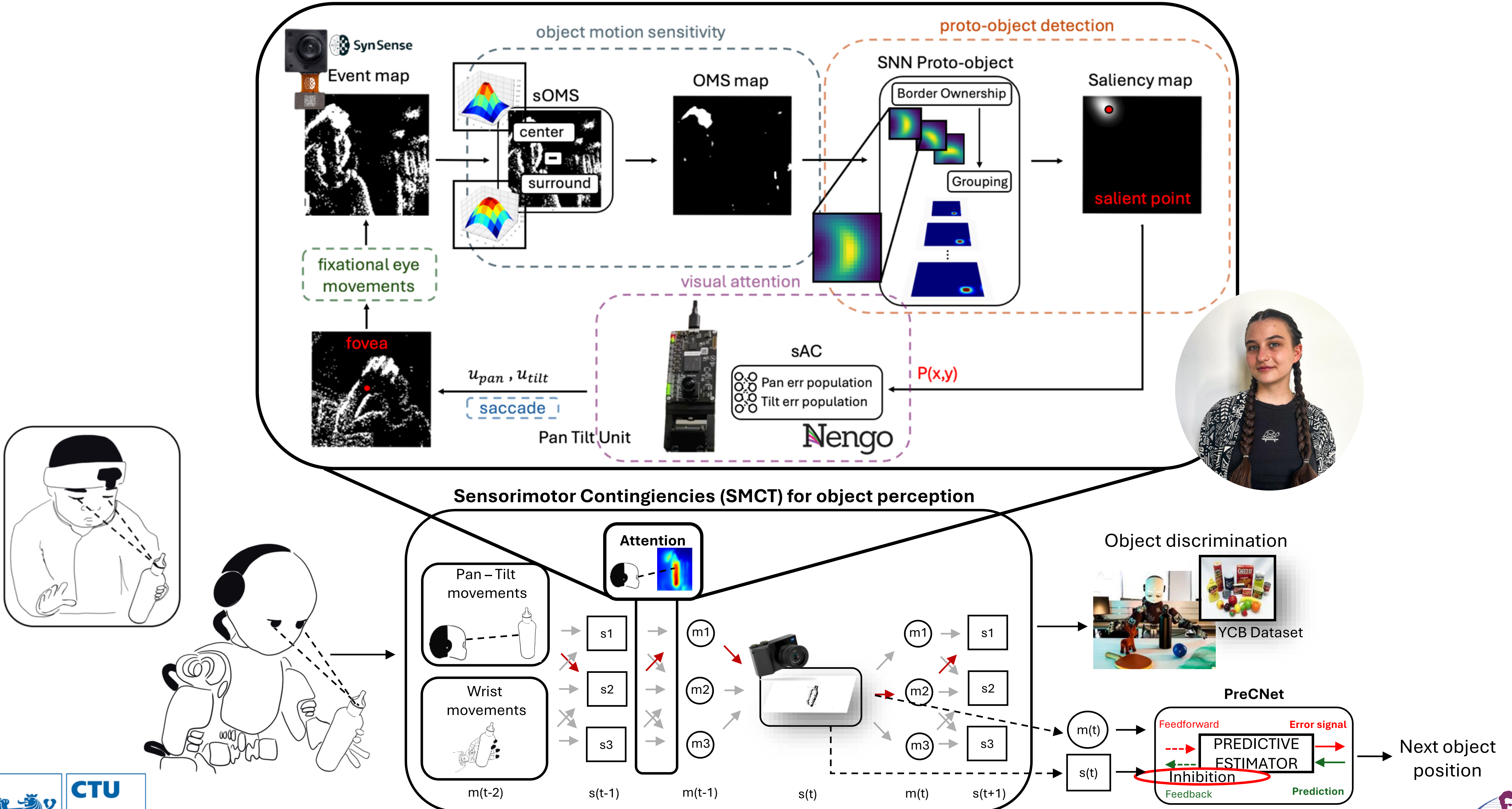








Attention



D'Angelo, G., Clerico, V., Bartolozzi, C., Hoffmann, M., Furlong, P. M., & Hadjiivanov, A. (2025). Wandering around: A bioinspired approach to visual attention through object motion sensitivity. *Neuromorphic Computing and Engineering*, *5*(2), 024019.

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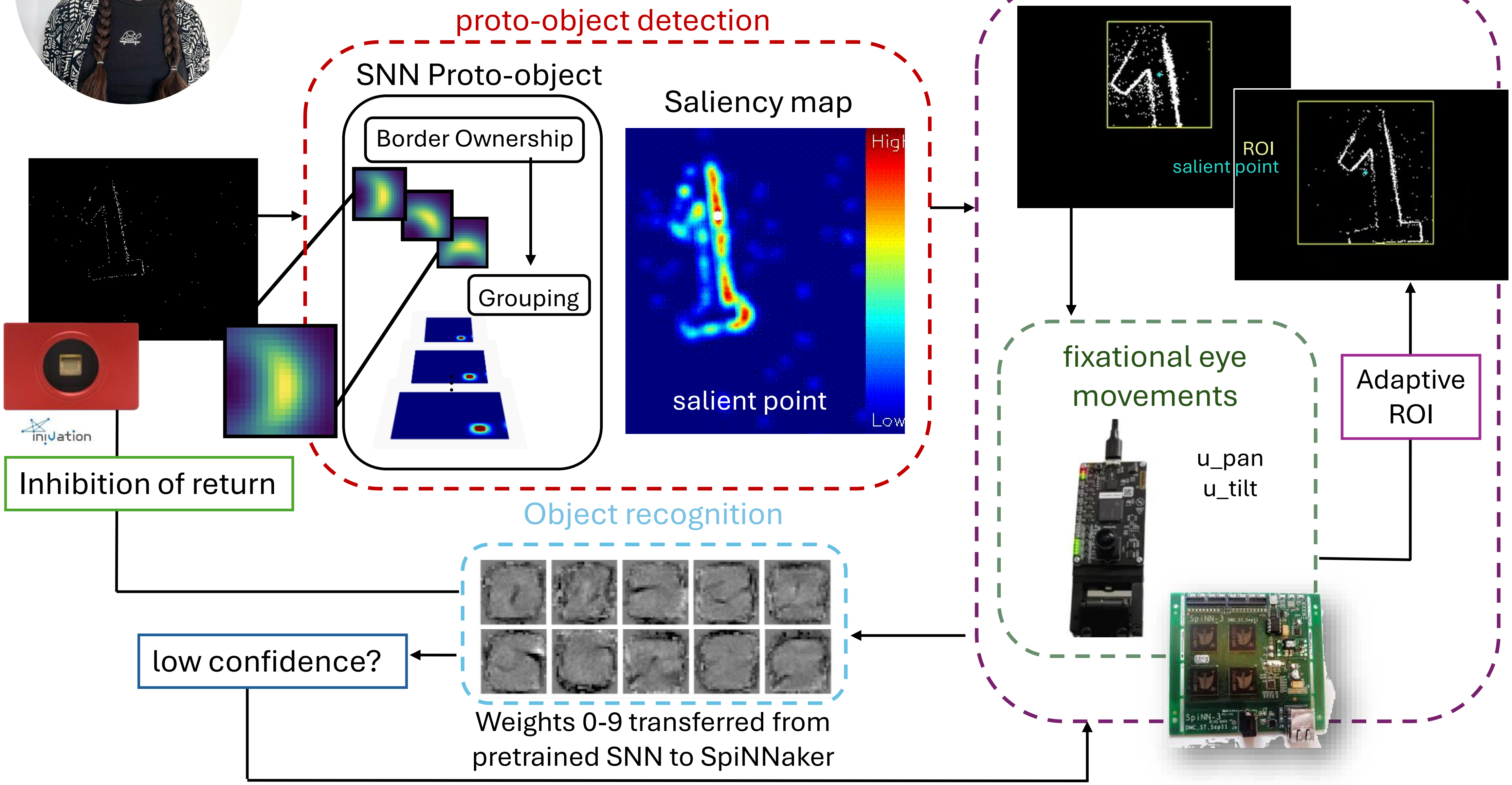
Olha Vedmedenko
Bachelor student
Faculty of Information Technology at CTU
SNNs on the SpiNNaker neuromorphic platform

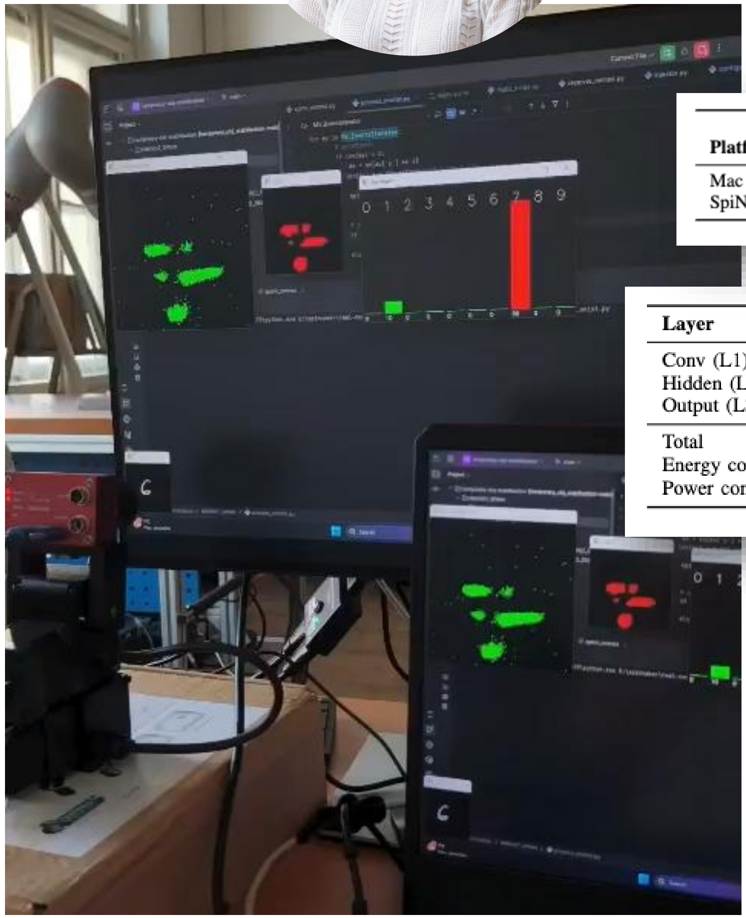
Neuromorphic active object recognition



Neuromorphic active object recognition

UNIVERSITY OF WATERLOO

CTU CZECH TECHNICAL UNIVERSITY IN PRAGUE



Platform	Accuracy SL-MNIST 35 ms	Accuracy SL-MNIST 100 ms	Accuracy ASL-DVS 35 ms
Mac (simulation)	74.61%	83.82%	92.27%
SpiNNaker	–	71.7%	83.1%

Layer	SL-MNIST Avg Spikes	ASL-DVS Avg Spikes
Conv (L1)	719.31	720.95
Hidden (L2)	2235.82	1681.92
Output (L3)	156.35	73.09
Total	3111.48	2475.96
Energy consumption	≈ 24891.84 nJ	≈ 19807.68 nJ
Power consumption	≈ 0.711 mW	≈ 0.565 mW

Neuromorphic visual attention for Sign-language recognition on SpiNNaker

Šárka Lísková[1*], Olha Vedmedenko[2*], Mazdak Fatahi[2], Matej Hoffmann[1], P. Michael Furlong[3], and Giulia D'Angelo[1]

[1]Dept. of Cybernetics, Faculty of Electrical Engineering, Czech Technical University in Prague, Czech Republic
[2]Faculty of Information Technology, Czech Technical University in Prague, Czech Republic
[3]Université de Lille, CNRS, Centrale Lille, UMR 9189 CRIStAL, F-59000 Lille, France
…ational Research Council of Canada & Systems Design Engineering, University of Waterloo, Canada

…—Sign-language recognition has achieved substantial …lassification accuracy in recent years; however, the …d power requirements of most existing methods limit their suitability for real-time deployment. Neuromorphic sensing and processing offer an alternative paradigm based on sparse, …nputation that supports low-latency and energy-…ion.

…, we introduce an end-to-end neuromorphic … American Sign Language (ASL) fingerspelling … integrates a spiking visual attention mechanism …n-of-interest extraction with a compact spiking … deployed on the SpiNNaker neuromorphic plat-…mark the proposed system against two datasets: a …erated event-based version of the Sign Language …and a natively recorded ASL-DVS dataset, whilst …prehensive overview of sign-language recognition …k.

This work yields competitive performance in simulation (92.27%) and comparable performance on neuromorphic hardware deployment (83.1%), while achieving the most energy-… …hitecture (0.565 mW) and low latency (3 ms) across all …d approaches. Despite its compact design, the system …s the suitability of task-dependent visual attention … for edge deployment.

***…ms*—Visual attention, active object recognition, Sign-…cognition, event-based sensing, and neuromorphic**

I. Introduction

…nd gestures, including Sign-language, play an …e in human communication, particularly for deaf an… …f hearing users. Recent literature focuses primarily on accuracy of Sign-language recognition [1]; however, for interaction to be effective and reactive, gesture-recognition systems must achieve low latency, low power consumption, and high robustness to environmental variability. For smooth … suitable for deployment on robotic platforms or wearable devices.

In humans, visual attention mechanisms enable selective processing of task-relevant regions of interest (ROIs), focusing perceptual resources toward salient scene elements while filtering irrelevant information [4]. This offers a bio-inspired strategy for achieving both efficiency and responsiveness. By contrast, modern, data-driven systems [5] that process the entire visual field uniformly allocate computational resources to non-informative regions of the scene, compromising both efficiency and robustness.

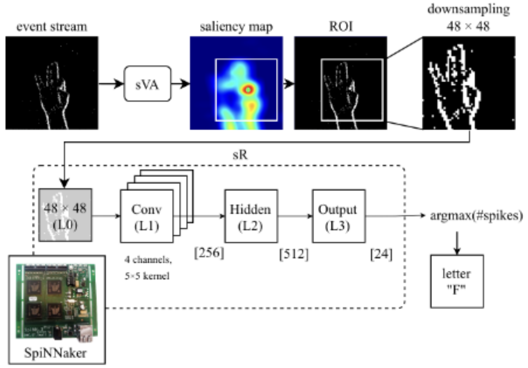
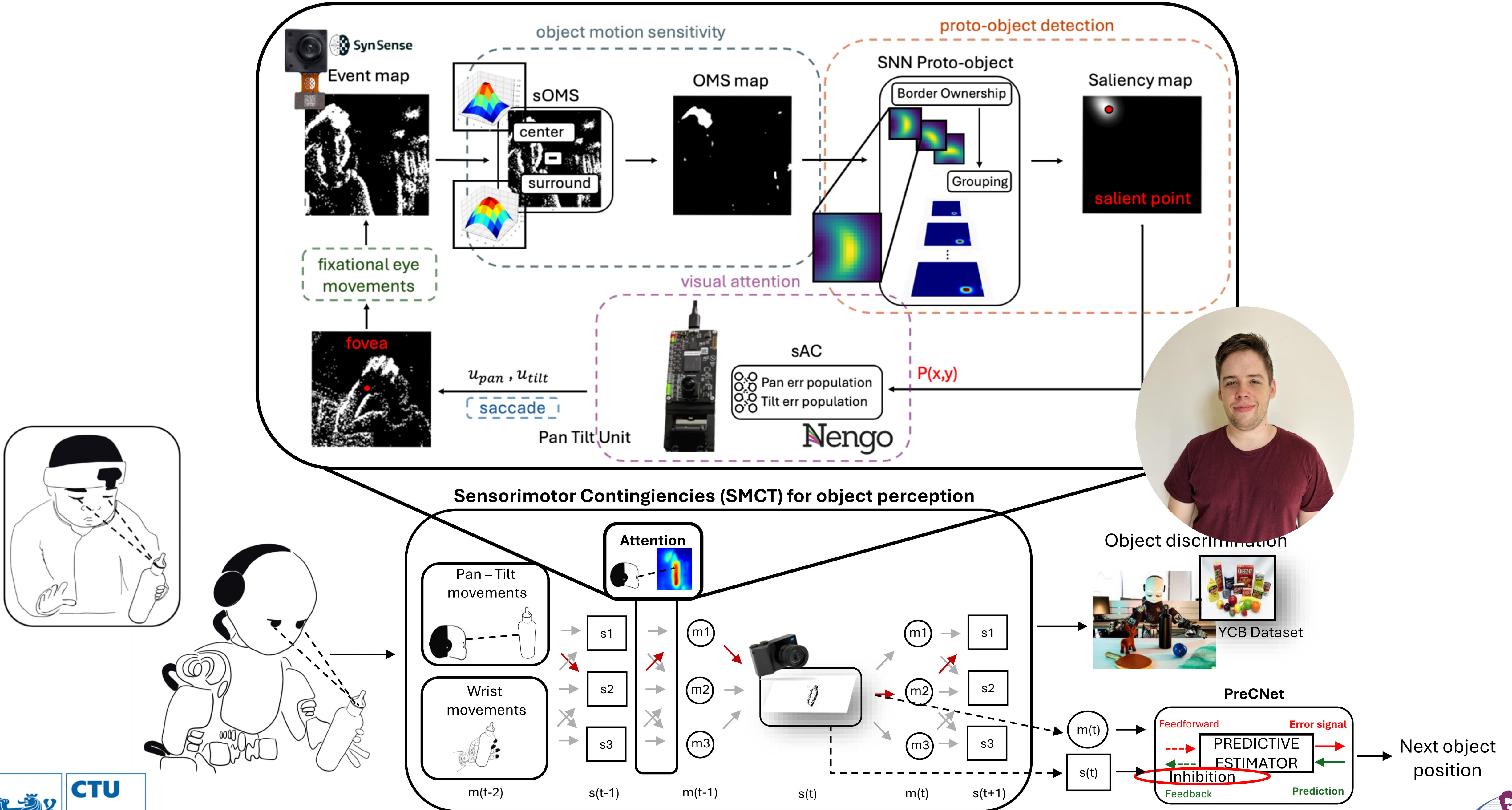


Fig. 1. **Neuromorphic Sign language recognition architecture:** Event streams are processed through the spiking visual attention (sVA) model to extract salient regions (ROIs), which are then downsampled and fed into the recognition network (sR) deployed on SpiNNaker. The network architecture comprises convolutional (L1, 256 neurons, 4 channels, 5 × 5 kernel), hidden (L2, 512 neurons), and output (L3, 24 output neurons) layers.

Attention



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Lukáš Bartůněk
Master student
Czech Technical University in Prague
SNN solutions for eye blinking detection and classification








Event-based eye blinking and eye tracking

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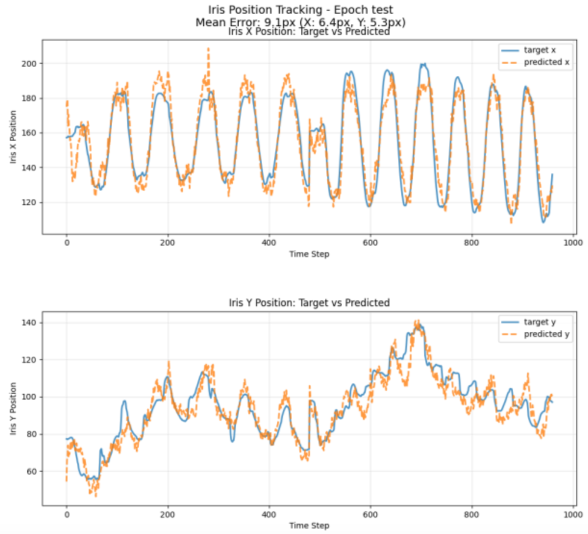
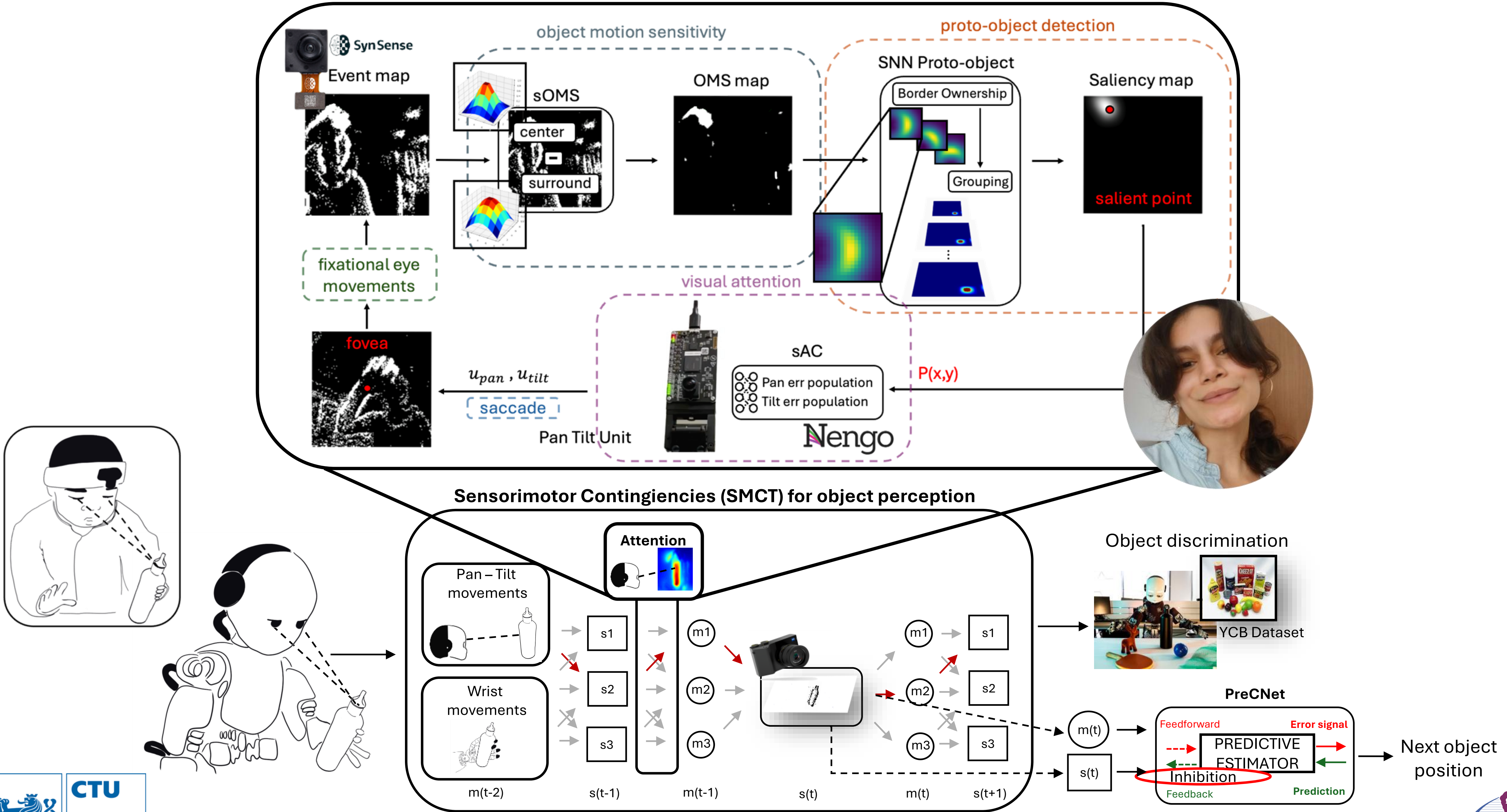


Model	Paradigm	Params	Window	Error (640×480)	NME (%)
		Non-Causal / Offline			
MambaPupil [9]	Dense ANN	8.59M	10 ms	∼1.60 px	0.20
E-SpikePT [13]	Hybrid SNN+ANN	N/A	10 ms	1.56 px	0.19
		Causal / Real-Time			
3ET ConvLSTM [10]	Dense ANN	417K	10 ms	∼17.60 px	2.20
JaneEye [11]	Light ANN	17.6K	10 ms	19.60 px	2.45
		Neuromorphic SNNs (Causal)			
Ours (Valid / No Blinks)	**HTC SNN**	**49.3K**	**3 ms**	**24.06 px**	**3.01**
Ours (All Frames)	**HTC SNN**	**49.3K**	**3 ms**	**25.34 px**	**3.16**
Retina [12]	LIF SNN	63K	10 ms	28.64 px	3.58
AIS SNN Conversions [14]	LIF SNN	107K	10 ms	32.64 px	4.08

Table 6.1: Quantitative comparison of eye-tracking architectures. Temporal Resolution indicates the event integration window. Errors are reported as Mean Euclidean Distance scaled to the 640×480 sensor and Normalized Mean Error (NME).

Attention



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Rayane Rocha
Bachelor student - visiting 2026
Universidade Federal da Paraıba (UFPB)
SNNs language-based visual attention

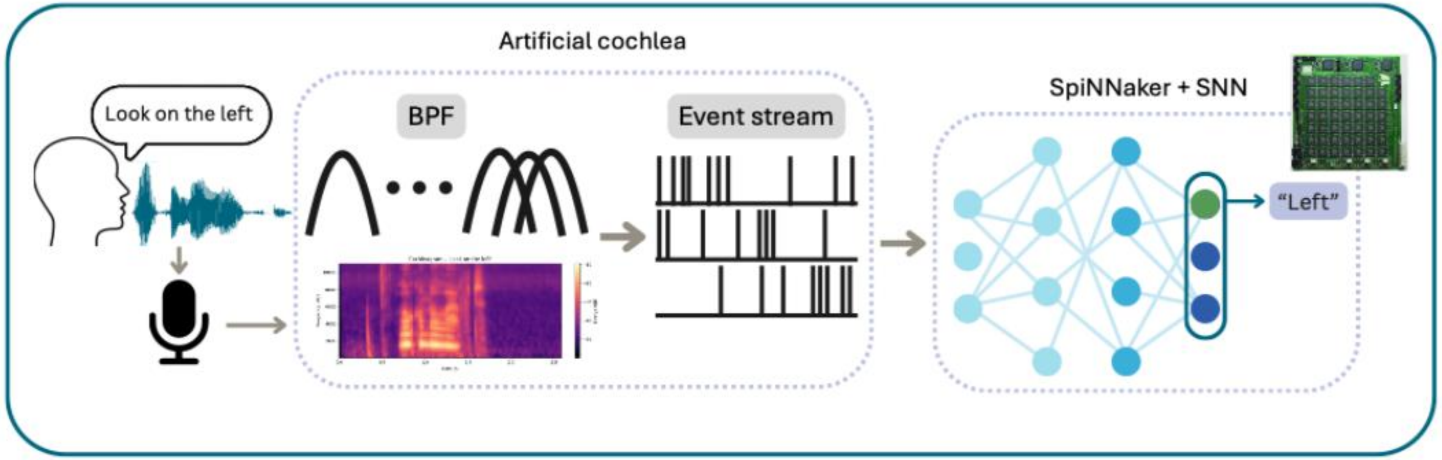




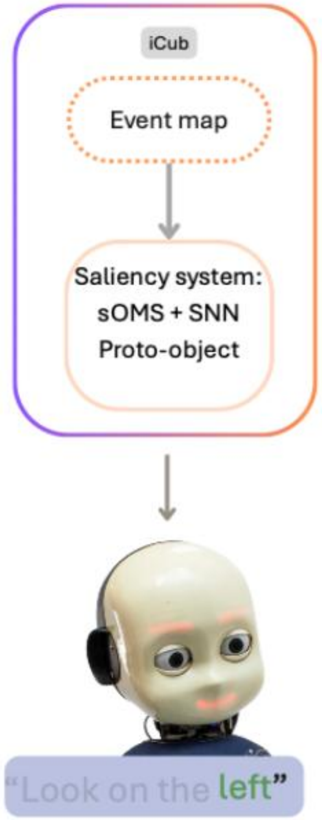


Talk to look: visual attention influenced by spoken commands

Keyword spotting

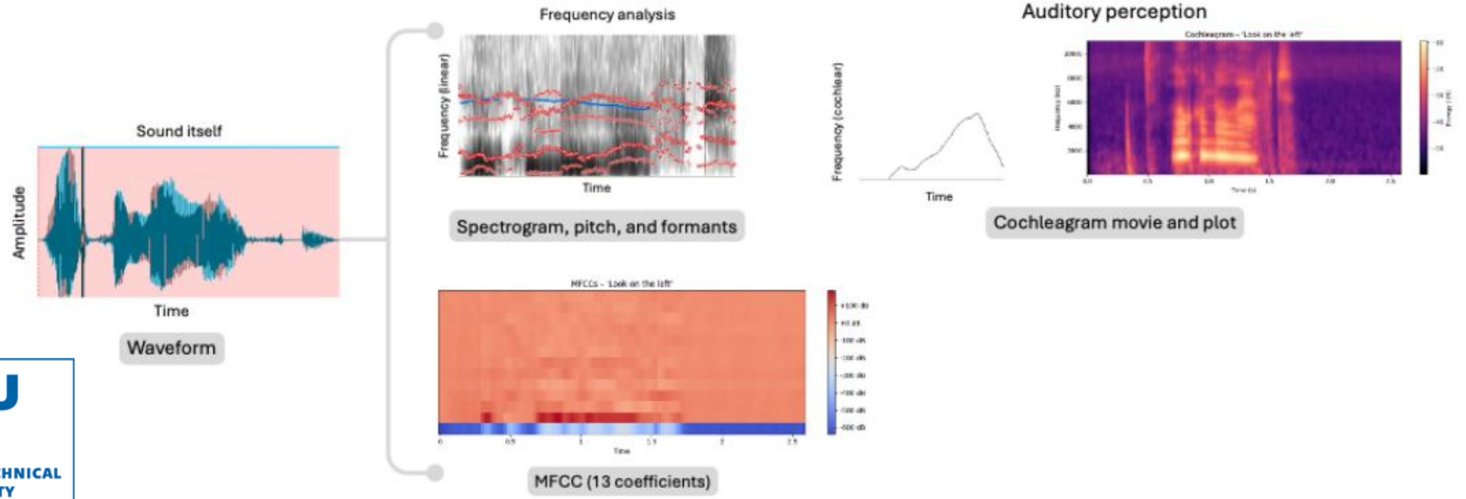


Visual attention model



Why a cochlear model?

Raw data and different FEx for the sentence "Look on the left"



Less power consuming than LLMs and effective for short commands

Only the signal of one word is sufficient to drive attention

AGH

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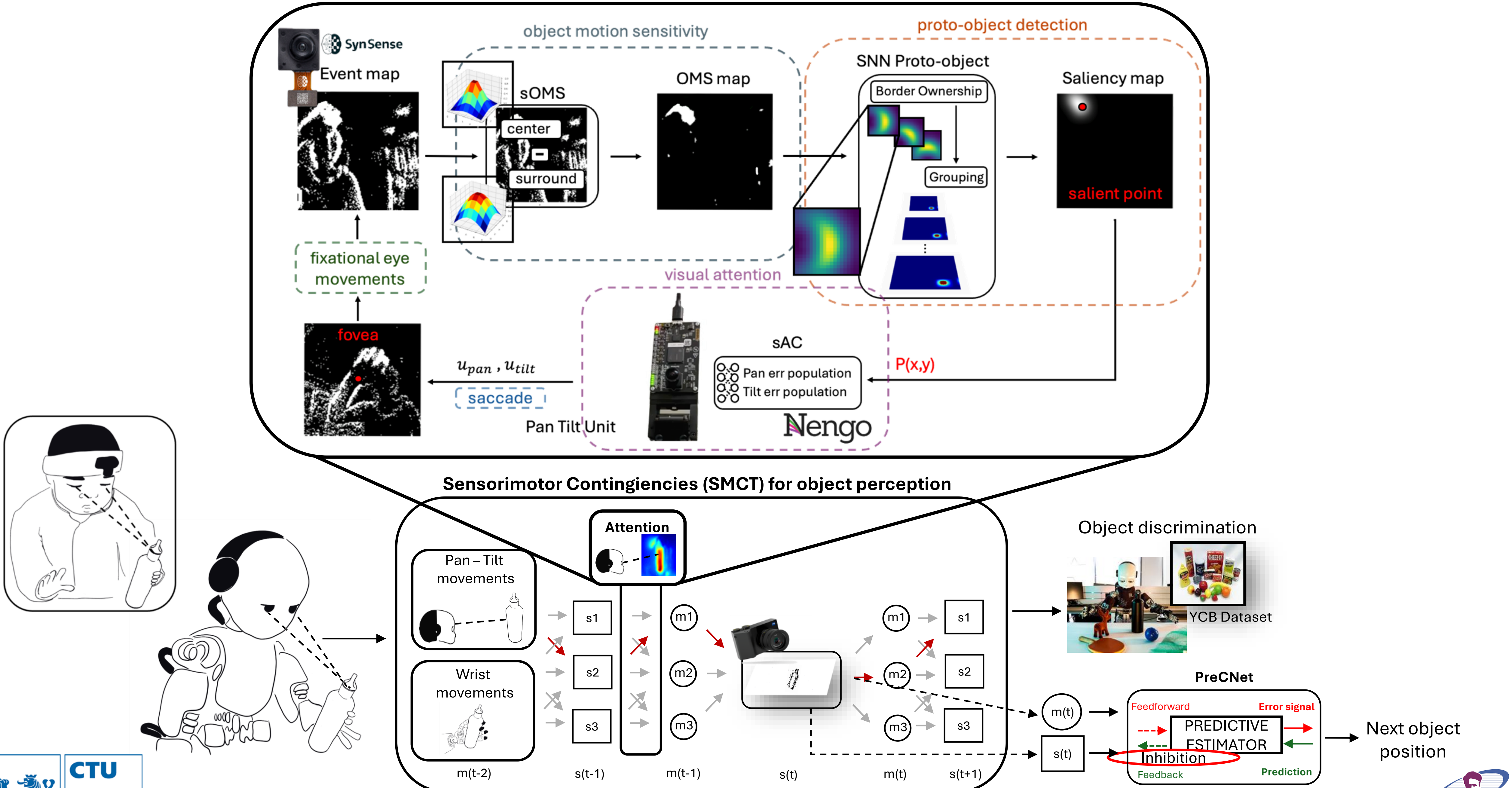
Attention



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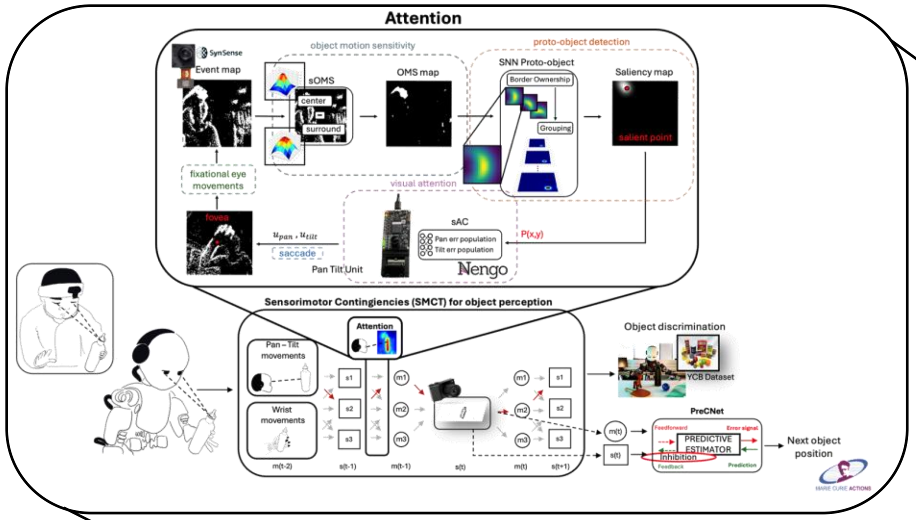
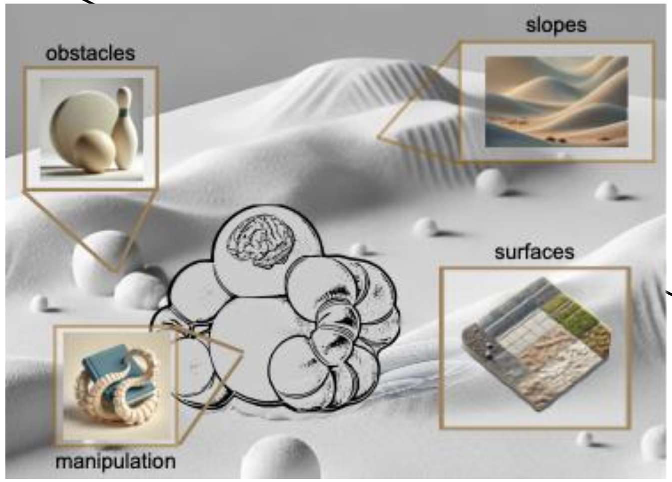
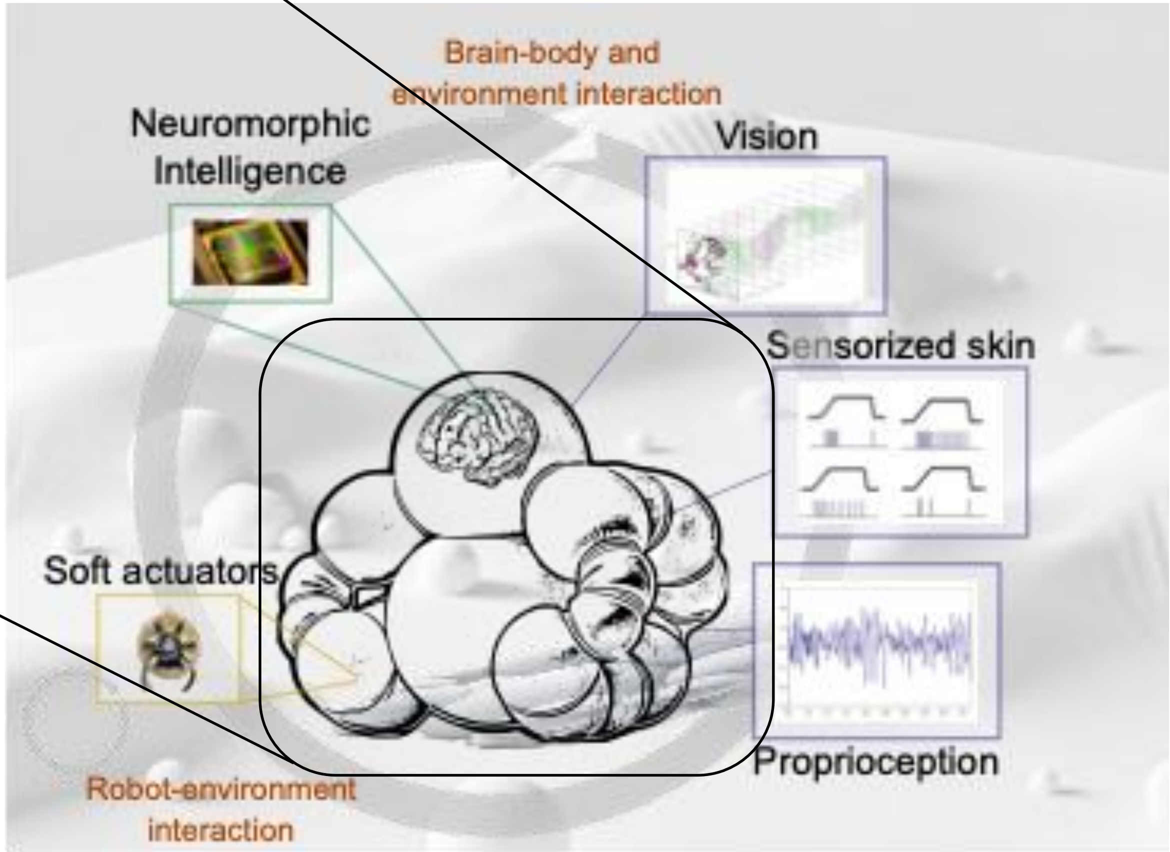


A Benchmarking Framework for Embodied Neuromorphic Agents

Co-designing “**brain**” and “**body**” unlocks new levels of *efficiency*, *resilience*, and *adaptability*





Set of **Tasks** and **Metrics** for evaluation and benchmark

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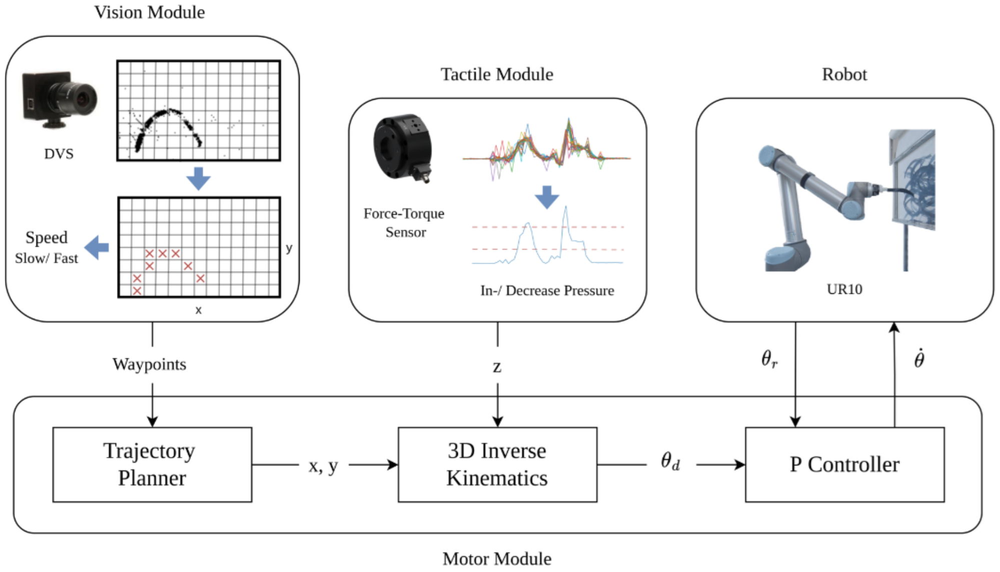
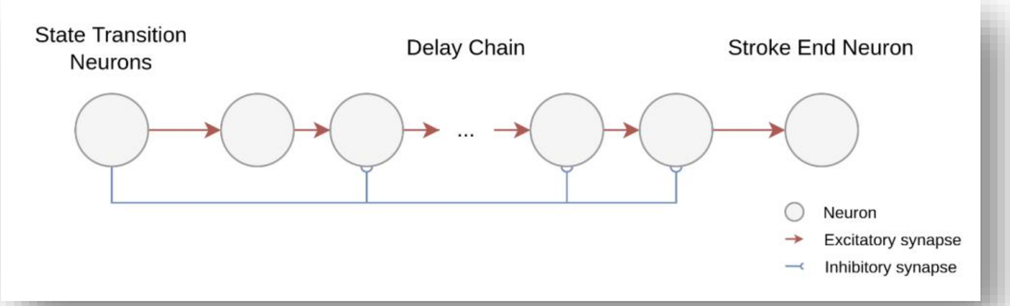
D’Angelo, G., Pedersen, J. E., Hassan, T., Cianchetti, M., Bongard, J., Iida, F., ... & Donati, E. (2026). A benchmarking framework for embodied neuromorphic agents. *Nature Machine Intelligence*, 1-13.

A neuromorphic electronic artist for robotic painting





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Schürmann, L., D'Angelo, G., Grayver, L., Bartolozzi, C., & Indiveri, G. (2025). A neuromorphic electronic artist for robotic painting. Scientific Reports, 15(1), 19561.

Ev

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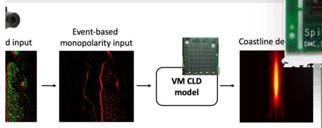
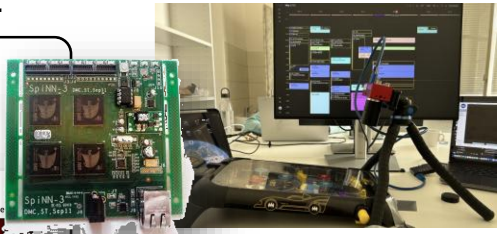
ction on SpiNNaker

Université de Lille





20 ms is 0.3756 mW

Bioinspired active vision: learning through exploration

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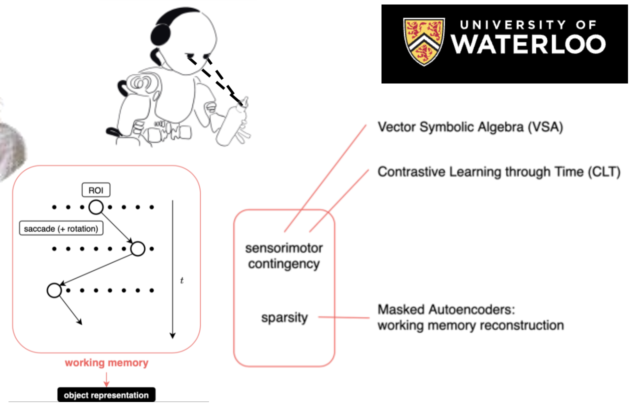
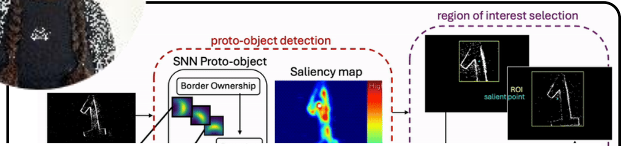
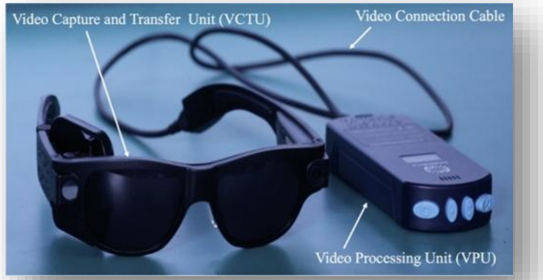


Visual stabilization for object recognition



Visual prosthesis



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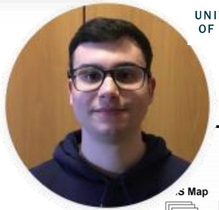
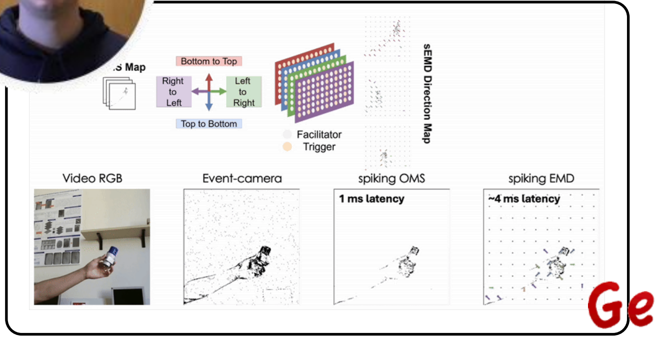
Politecnico di Torino



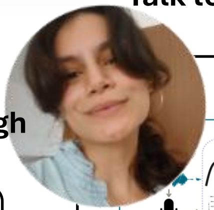
Motion direction detection though object motion segmentation

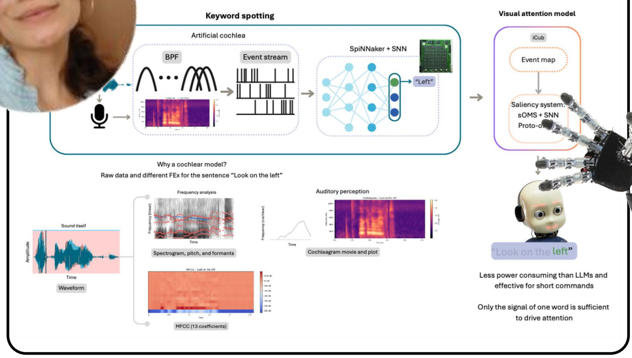


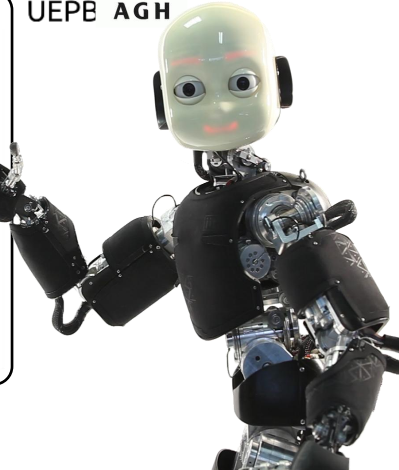
GeNN

Talk to look: visual attention influenced b spoken commands

UEPB AGH







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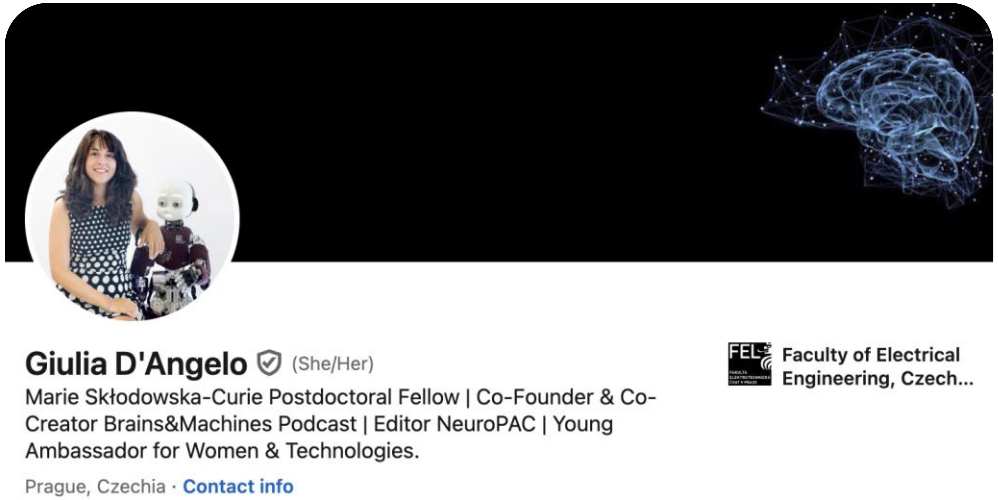
SynSense



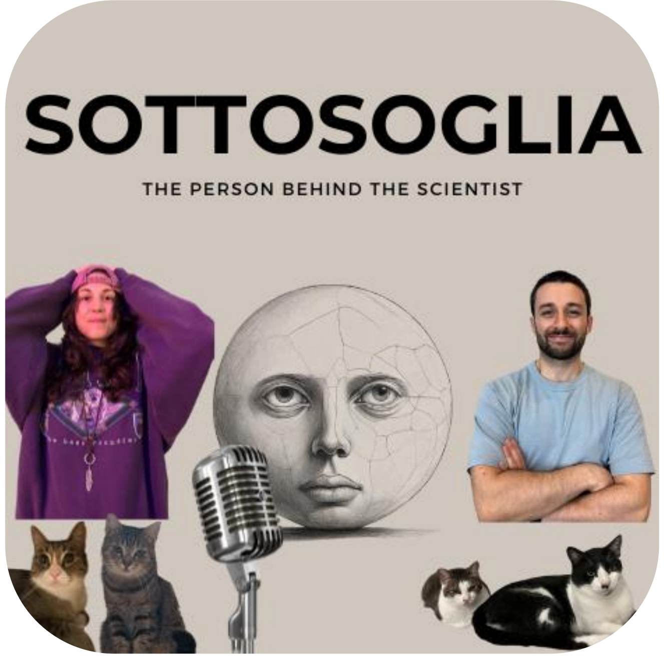
Do you want to work with me?

BRAINS & MACHINES

A podcast about neuromorphic engineering and bio-inspired technology

NEURO PAC

ONM



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