



APROVIS3D



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- APROVIS3D -

Analog **PRO**cessing of bioinspired **VI**sion **Sen**sors for **3D** reconstruction

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Authors

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1. Dissemination methods and channels

1.1. Goals and Ambitions

1.1.1. APROVIS3D Vision and Mission

APROVIS3D targets analog computing for artificial intelligence in the form of Spiking Neural Networks (SNNs) on a mixed analog and digital architecture. The project includes Field Programmable Analog Array (FPAA) and SpiNNaker applied to a stereopsis system dedicated to coastal surveillance using an aerial robot.

The overall vision of APROVIS3D is to be the first real-time visual servoing algorithm implemented in an analog fashion directly integrated into a UAV system, thus, promoting open possibilities of combining analog computing with artificial intelligence and developing a demonstrable product with potential industrial/commercial applicability beyond the project time scale. Consequently, the project aims to create a multi-disciplinary research community with experts and, in the long term, such an innovative vision paradigm to open new research directions for scientific communities in developing analog machine learning.

The main ambitions of APROVIS3D are to develop a new design of event-based vision system, based on:

- (1) improved event-based vision sensors
- (2) new neuromorphic algorithms
- (3) their implementation on a mixed analog-digital architecture.

Moreover, APROVIS3D will provide some strong impacts towards European societal objectives, especially in the environment for the preservation of coastal areas. The coastal areas are subject to increased pressure by regional alterations and global changes. The project will have a direct societal impact since the targeted demonstrator will facilitate the coastal erosion monitoring allowing a better understanding regarding environment evolution. The 3-Dimensional and real-time monitoring of the environment using UAV with the proposed bio- inspired stereopsis sensing can facilitate the monitoring and interpretation process. The proposed system can also be adapted for atmosphere changes, deforestation and biodiversity surveillance and monitoring with longer operation time and accurate navigation.

1.1.2. Target Groups and dissemination/communication tools

APROVIS3D will target a variety of audiences ideally not only in Europe. Depending on the phase of the project lifetime, the priority audiences are likely to change, as in the beginning of users from the scientific, computational and even medical community will be prioritized, whereas towards the end of the project, industrial manufacturers in analog technologies and possibly also in robotics may also become targeted.

Target groups	Details	Access
Scientific communities	Peers in various scientific research domains interested in the project's outcomes	Publications, GitHub/GitLab, Events, Posters, Leaflets
End-users	SMEs and big industries interested in analog technologies	Website; bilateral exchanges Twitter
Local intermediaries	Coastal monitoring units	Website; bilateral exchanges Project documentation; YouTube channel
General public	All citizens of various ages	Website; Xperium

In addition, the dissemination, communication, monitoring & evaluation tools that the project will make use of are described below:

Dissemination plan	Page 1 of 8	APROVIS3D
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Tools / Channels	Partner in charge	Key Performance Indicator	Target values
Publications, presentations and posters	ALL	Scientific publication (refereed) related to project developments	18 (one publication per partner per year)
Events participation	UCA	Yearly event organised by CHIST-ERA	3
Website	UNIWA	Project website visits	5000+ unique visitors
Press releases / Project communications	ALL	Project's communications dissemination	4 project communication disseminated
Short videos	NTUA	Videos to promote the project and raise awareness;	3 videos 1000+ views
Social Media	ALL	Number of friends/followers/likes	100+ Friends / Followers / Likes

1.1.3 .Website

The aprovis3d.eu domain is registered for initial period of two years (with 5 years extension option) using godaddy.com LLC service. Registration period started at 28/5/2020.

<http://aprovis3d.eu/>

1.1.4. Publications, Conferences and Events

Scientific publications		
Publication Id	Multi-partners (Yes/No)	International (Yes/No)
Sotirios N. Aspragathos, George C. Karras and Kostas J. Kyriakopoulos, "A Visual Servoing Strategy for Coastline Tracking using an Unmanned Aerial Vehicle", submitted in IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2021), Sep 27 – Oct 1, Prague, Czech Republic	No	Yes
Amélie Gruel, J. Martinet. "Bio-inspired visual attention for silicon retinas based on spiking neural networks applied to pattern classification". Poster during the inauguration of Neuromod institute, 2021	No	Yes
Antoine Grimaldi, Victor Boutin, Laurent U. Perrinet, Sio-Hoi Ieng, Ryad Benosman. Event-driven Spiking Neural Networks for pattern recognition. COSYNE 2021	No	Yes
Amélie Gruel, Jean Martinet: Bio-inspired visual attention for silicon retinas based on spiking neural networks applied to pattern classification. Content-Based Multimedia Indexing (CBMI), Lille, France, 2021.	No	Yes
Amélie Gruel, Jean Martinet, Bernabé Linares-Barranco, and Teresa Serrano-Gotarredona. Stakes of foveation on event cameras. ORASIS 2021, Saint Ferréol, France	Yes	No
Amélie Gruel, Jean Martinet, Teresa Serrano-Gotarredona, and Bernabé Linares-Barranco. Event Data Downscaling for Embedded Computer Vision. International Conference on Computer Vision Theory and Applications (VISAPP 2022), Lisbonne, Portugal, Feb 2022	Yes	Yes
Amélie Gruel, Antonio Vitale, Jean Martinet, and Michele Magno. Neuromorphic Event-Based Spatio-temporal Attention using Adaptive Mechanisms. IEEE International Conference on Artificial Intelligence Circuits and Systems (AICAS 2022), Songdo Convensia, Corea, June 2022	Yes	Yes

Antoine Grimaldi, Victor Boutin, Laurent U. Perrinet, Sio-Hoi Ieng, Ryad Benosman. A homeostatic gain control to improve event-driven object recognition. Content-Based Multimedia Indexing (CBMI), Lille, France, 2021	No	Yes
Antoine Grimaldi, Victor Boutin, Sio-Hoi Ieng, Ryad Benosman, Laurent U. Perrinet. From event-based computations to a bio-plausible Spiking Neural Network. Champalimaud Research Symposium 2021	No	Yes
Antoine Grimaldi, Victor Boutin, Sio-Hoi Ieng, Ryad Benosman, Laurent U. Perrinet. A robust event-driven approach to always-on object recognition. TechRxiv 2021	No	Yes
Sotirios N. Aspragkathos, George C. Karras, Kostas J. Kyriakopoulos, " A Visual Servoing Strategy for Coastline Tracking using an Unmanned Aerial Vehicle ", published in Mediterranean Conference on Control and Automation (MED 2022), June 28 – July 1, 2022, Athens, Greece	No	Yes
Sotirios N. Aspragkathos, George C. Karras, Kostas J. Kyriakopoulos, " An Event-triggered Visual Servoing Predictive Control Strategy for the Surveillance of Contour-based Areas using Multirotor Aerial Vehicles ", published in IEEE/RSJ International Conference on Intelligent Robots and Systems, October 23-27 2022, Kyoto, Japan	No	Yes
Sotirios N. Aspragkathos, George C. Karras, Kostas J. Kyriakopoulos, " A Hybrid Model and Data-Driven Vision-Based Framework for the Detection, Tracking and Surveillance of Dynamic Coastlines Using a Multirotor UAV ", published in MDPI Drones Special Issue "UAVs for Coastal Surveying"	No	Yes
Amélie Gruel, Dalia Hareb, Jean Martinet, Bernabé Linares-Barranco, Teresa Serrano-Gotarredona. Neuromorphic foveation applied to semantic segmentation . CVPR 2022 workshop "NeuroVision: What can computer vision learn from visual neuroscience?", New Orleans, Louisiana, June 2022	Yes	Yes
Antoine Grimaldi, Amélie Gruel, Camille Besnainou, Jean-Nicolas Jérémie, Jean Martinet and Laurent U. Perrinet. Precise Spiking Motifs in Neurobiological and Neuromorphic Data . Brain Sci. 2023, 13(1), 68; https://doi.org/10.3390/brainsci13010068 . 2022	Yes	Yes
Amélie Gruel, Jean Martinet, Bernabé Linares-Barranco, Teresa Serrano-Gotarredona. Performance comparison of real time DVS data spatial downscaling methods using Spiking Neural Networks . WACV 2023, Hawai, January 2023	Yes	Yes
Dalia Hareb, Jean Martinet. EvSegSNN : Segmentation sémantique neuromorphique pour la vision événementielle . ORASIS 2023, Carqueiranne, France. May 2023	No	No
Amélie Gruel, Jean Martinet. Sélection neuromorphique simultanée d'objets saillants dans des événements . ORASIS 2023, Carqueiranne, France. May 2023	No	No
Amélie Gruel, Lucia Trillo Carreras, Marina Bueno Garcia, Ewa Kupczyk, Jean Martinet. Frugal event data: how small is too small? A human performance assessment with shrinking data . CVPR 2023 Workshop on Event-based Vision, Vancouver, Canada. June 2023	No	Yes
Hugo Bulzomi, Marcel Schweiker, Amélie Gruel, Jean Martinet. End-to-end Neuromorphic Lip-reading . CVPR 2023 Workshop on Event-based Vision, Vancouver, Canada. June 2023	No	Yes
Amélie Gruel, Alfio di Mauro, Robin Hunziker, Luca Benini, Jean Martinet, Michele Magno. Embedded neuromorphic attention model leveraging a novel low-power heterogeneous platform . IEEE International Conference on Artificial Intelligence Circuits and Systems (AICAS 2023), Hangzhou, China. June 2023.	Yes	Yes
Amélie Gruel, Jean Martinet, Michele Magno. Simultaneous neuromorphic selection of multiple salient objects for event vision . IJCNN 2023, Queensland, Australia. June 2023.	Yes	Yes
Dalia Hareb, Jean Martinet. EvSegSNN: Neuromorphic Semantic	No	Yes

Segmentation for Event Data. IJCNN 2023, Queensland, Australia. June 2023.		
Amélie Gruel, Dalia Hareb, Antoine Grimaldi, Jean Martinet, Laurent Perrinet, Bernabé Linares-Barranco and Teresa Serrano-Gotarredona. Stakes of Neuromorphic Foveation: a promising future for embedded event cameras. Biological Cybernetics Special Issue: What can Computer Vision learn from Visual Neuroscience? 2023.	Yes	Yes
Sotirios N. Aspragkathos, Evangelos Ntouros, George C. Karras, B. Linares-Barranco, T. Serrano-Gotarredona, Kostas J. Kyriakopoulos. An Event-Based Tracking Control Framework for Multirotor Aerial Vehicles Using a Dynamic Vision Sensor and Neuromorphic Hardware. IEEE/RSJ International Conference on Intelligent Robots and Systems, October 01-05 2023, Detroit, USA	Yes	Yes
S. T. P. Gupta, P. Linares-Serrano, B. Sen Bhattacharya and T. Serrano-Gotarredona, " Foveal-pit inspired filtering of DVS spike response ," 2021 55th Annual Conference on Information Sciences and Systems (CISS), Baltimore, MD, USA, 2021, pp. 1-6, doi: 10.1109/CISS50987.2021.9400245.	No	Yes
C. Chiplunkar <i>et al.</i> , " A Reduced-Scale Cortical Network with Izhikevich's Neurons on SpiNNaker ," 2021 International Joint Conference on Neural Networks (IJCNN), Shenzhen, China, 2021, pp. 1-8, doi: 10.1109/IJCNN52387.2021.9534244.	No	Yes
T Serrano-Gotarredona, F Faramarzi, B Linares-Barranco, " Electronically foveated dynamic vision sensor ," 2022 IEEE International Conference on Omni-layer Intelligent Systems (COINS)	No	Yes
T Serrano-Gotarredona, B Linares-Barranco, " System Architectures for Electronically Foveated Dynamic Vision Sensor ," 2022 37th Conference on Design of Circuits and Integrated Systems (DCIS)	No	Yes
I.Ortiz-Ramirez, L. Camuñas-Mesa, B. Linares-Barranco, and T. Serrano-Gotarredona, "Study of foveation mechanism in Dynamic Vision Sensors," 2023 Conference on Design of Circuits and Integrated Systems (DCIS'2023)	No	Yes

1.1.5. Main events/Workshops / Demonstrations / Exhibitions

- Contact was made with the [SpiNNaker project](#) at Manchester, to get access to remote SpiNNaker machines (for development) and to borrow the SpiNN-3 boards and SpiNNaker chips (for deployment in the demonstrator). Sample boards and chips have been received and dispatched to INT, ETHZ, and NTUA/UNIWA.
- INT initiated the installation and maintenance of a data-sharing infrastructure on a privately owned server and domain name [Spik.xyz](#).
- UNIWA proposed a study case of mapping the coastal zone with the APROVIS3D UAV set-up. The proposed area is a small pocket-beach located in the South-eastern Attica in Greece, it is easily accessible for repeatability of experiments, and it offers considerable seasonal changes of its coastline. Furthermore, HCMR (Hellenic Center for Marine Research) is located onsite, offering the possibility of static monitoring event camera setup to capture extreme weather events (beach before and after a sea storm)
- INT presented algorithm in the form of a Spiking Neural Network at [CBMI conference \(Content-Based Multimedia Indexing\) 2021](#).
- Participation in the CHIST-ERA project seminar on March 28-30, 2022
- The project final event took place at IMSE on September 14-15, 2023. The consortium has organised an industrial session with several companies (Inivation, Sony, Yumain, IMRA Europe, Renault Software labs, Synsense, Ucan drone) that came for two online sessions: one session where the companies have been offered the opportunity to pitch their products, and one session where the consortium did advertise the main project results to the companies.
- Organization of interactive local conference "Mind Yourself! How does computer science interact with neuro- sciences?" during the Brain week 2022 at UCA by A. Gruel at Learning Centre

- SophiaTech (approx. 40 participants).
- IMSE: <http://www2.imse-cnm.csic.es/neuromorphs/index.php/Projects>, organization of a special session on [Bio-inspired circuits, systems and algorithms for multimedia during CBMI'2021](#), Lille, France.

1.1.6. *Social media*

UCA has coordinated the edition of [short video advertising APROVIS3D](#)

<https://twitter.com/JeanMartinet/status/1528756314029137920>

<https://www.facebook.com/central.ntua.gr/photos/a.2112027999110747/2758352431144964/?type=3>