

PhD Position : *Joint design of compression techniques for deep neural networks and low-energy processors for event-based computer vision.*



1 - Context and funding

IMT Atlantique/Brest (France) and IRL Crossing / Adelaide (Australia) collaborate on a research project to design new solutions of computer vision adapted to energy-driven embedded systems as autonomous drones and cars. This project is funded by [AI@IMT](#) (French National Research Agency PhD program) and Région Bretagne.

2 - Research project

This project aims at increasing the decision autonomy of systems as Search-An-Rescue drones or autonomous cars by embedding computer vision with powerful deep neural networks (DNN) while preserving their energy autonomy. Towards this goal, we advocate the enhancement of sensing and processing tasks through low-energy hardware such as event cameras and Field-Programmable Gate Arrays (FPGAs) and the design of neural networks that are adapted to this new hardware. This project will prototype such an integrated system that will be tested and made available to the scientific community to allow further investigations. First, sensing with event-cameras allows for a reduction of latency and energy consumption as they can capture intensity changes observed in the scene at micro-second latency with a few milli-Watts [G22], as opposed to conventional cameras that constantly capture intensity frames. Thus, deep learning solutions were proposed for autonomous car driving based on such cameras [M18] as well as for drones [V21] with implementations on CPUs, GPUs and Intel's neuromorphic research chip Loihi [L18]. Since robotic systems can greatly benefit from FPGAs [W21] and DNNs are increasingly being ported to these targets [Z20; B18], we want to seek for a match between event-sensing, DNN-processing and FPGA implementation. This approach will allow us to reach a compromise between processing performance, energy efficiency, flexibility and cost that is of prime interest for an autonomous drone or car.

3 - Team supervision and PhD registration

[Matthieu ARZEL](#), professor at IMT Atlantique,

[Jean-Philippe DIGUET](#), director of Crossing

[Mathieu LÉONARDON](#), associate professor at IMT Atlantique

The PhD student will be registered at the Doctoral School [MATHSTIC](#), work at IMT Atlantique and spend a period with the Crossing team at Adelaide.

4 - Candidate profile

- Practical skills in AI algorithms and associated tools (eg. Pytorch)
- Knowledge and Experience (previous projects) in design of Hardware architectures on FPGAs.
- Good background in Computer vision

5 - How to apply

Send CV and motivation letter (if possible with reference letters) to matthieu.arzel@imt-atlantique.fr .

6 - References

[B18] Michaela Blott et al. "FINN-R: An end-to-end deep-learning framework for fast exploration of quantized neural networks". In: ACM Transactions on Reconfigurable Technology and Systems 11.3 (2018), pp. 1-23.

[G22] Guillermo Gallego et al. "Event-Based Vision: A Survey". In: IEEE Transactions on Pattern Analysis and Machine Intelligence 44.1 (2022), pp. 154-180.

[M18] Ana I Maqueda et al. "Event-based vision meets deep learning on steering prediction for self-driving cars". In: IEEE Conf. on Computer Vision and Pattern Recognition. 2018, pp. 5419-5427.

[V21] Antonio Vitale et al. "Event-driven Vision and Control for UAVs on a Neuromorphic Chip". In: IEEE International Conference on Robotics and Automation (2021), pp. 103-109.

[W21] Zishen Wan et al. "A survey of fpga-based robotic computing". In: IEEE Circuits and Systems Magazine (2021), pp. 48-74.

[Z20] Xiaofan Zhang et al. "DNNExplorer: a framework for modeling and exploring a novel paradigm of FPGA-based DNN accelerator". In: Int. Conf. on Computer-Aided Design. 2020, pp. 1-9.