



LEASARD

Low-Energy deep neural networks for Autonomous **Search-And-Rescue Drones** Oct. 2022 - Nov. 2024





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SAR missions need drones with more autonomy!

Why? To operate in unstructured and hostile environments during many hours over a wide area

no (stable) network access + no GNSS-based positioning,

excessive energy cost of a live video feed to a human operator,

- one drone = one operator : too limiting!
- How? With smart artificial vision
 - Simultaneous Localization And Mapping (SLAM)
 - and obstacle-avoidance algorithms,
 - best in class : Deep Neural Networks
- But ? The energy bottleneck : need for efficiency!
 - heavy processing requires lots of energy while
 - resources are strongly limited in embedded systems!

Energy-efficient low-latency sensors: event cameras

- **Dynamic Vision Sensor**
 - 1 pixel = 1 sensor of intensity change (+/-1).
 - **Asynchronous** event:
 - triggered pixel position + timestamp.
 - Tens of µs latency for a few mW.
 - **High dynamic range** (90-120 dB vs. 50-80 for frame cam) + **no blur**.
- Binary, sparse, asynchronous information :
 - How to process it? Is it hardware-friendly?
 - Can be coupled with RGB frame cameras! YoloV7 benefits from Event-RGB fusion as shown by Hajer Fradi:







mAP@0.5 = 0.36



DVXplorer Mini (21g (pl.) / 46g (Al) without lens, 640×480 res)

/ideo by University of

Zürich. Robotics and

ProbEn fusion

Energy-efficient DNN co-processors: custom DNNs on SoC/FPGA

- Reconfigurable logic with hard-wired interfacing / processing / controling units
 - Same job as embedded GPUs but with 1/2-1/3 of the energy.
 - How to exploit binary events + sparse information? jointly design algorithms, neural networks and processors

First step in progress:

Yolov5 with quantized layers (8bits) trained on an event-based dataset and embedded on an embedded GPU Jetson Orin Nano by Ismail A.

Then to be ported on FPGA thanks to FINN

(https://xilinx.github.io/finn/)

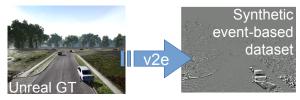


Experiments at IMT Atlantique

Aldec TySOM-3A-ZU19EG

A novel drone control to design, test and explore !

- Successive Proofs of Concept:
 - design of a new platform with an adapted control and simulation with HIL
 - with AirSim / Unreal Engine / UnrealGT,
 - to test the system and to train DNNs with v2e as conversion tool



experiments with a first prototype based on a Crazy2fly frame with a Jetson Orin Nano and a DV Mini associated to a ROS2 node to store events.



First prototype on ROS2 with an event camera and a Jetson board



Test session on the first LS2N prototype equipped with an event camera by Kojo A.-B.

Steps toward a new open drone platform

