



LEASARD

Low-Energy deep neural networks for Autonomous Search-And-Rescue Drones

Oct. 2022 – Nov. 2024

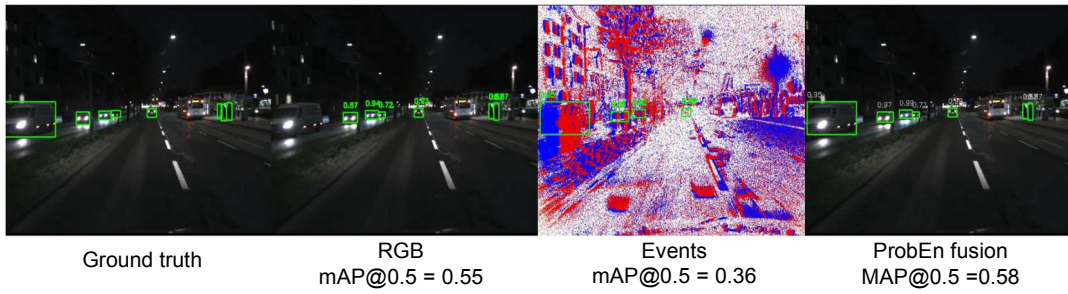
SAR missions need drones with more autonomy !

- 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 !



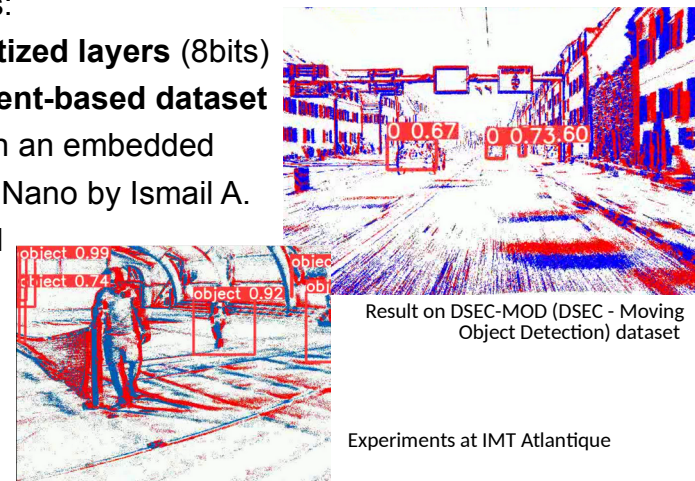
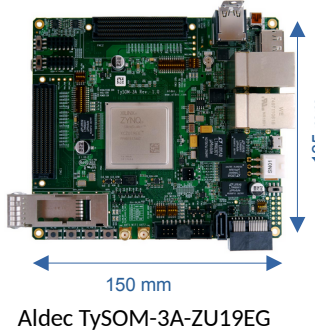
Energy-efficient low-latency sensors : event cameras

- Dynamic Vision Sensor**
 - 1 pixel = 1 sensor of **intensity change (+/-1)**.
 - Asynchronous event** :
 - triggered pixel position + timestamp.
 - Tens of μ s 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 :



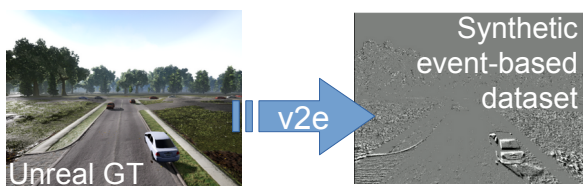
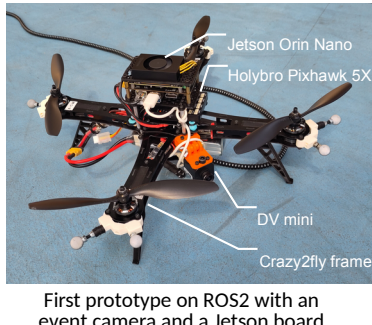
Energy-efficient DNN co-processors : custom DNNs on SoC/FPGA

- Reconfigurable logic with hard-wired interfacing / processing / controlling 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/>)



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.

Steps toward a new open drone platform

