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Enabling Ultra-low Power Machine Learning at the Edge

tinyML EMEA Technical Forum 2021 Proceedings

June 7 – 10, 2021

Virtual Event

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tinyML EMEA Technical Forum 2021
June 7-10, 2021

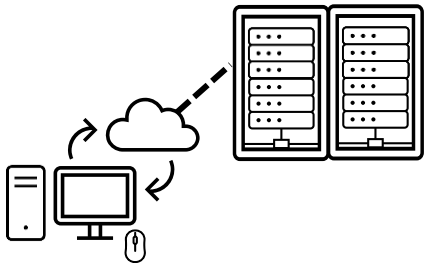
Low-Power License Plate Detection and Recognition on a RISC-V Multi-Core MCU-based Vision System

Lorenzo Lamberti , PhD student at University of Bologna, Italy

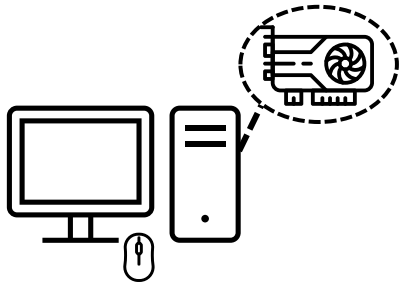
June 10, 2021

Deep Learning on Tiny Devices

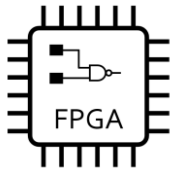
Deep Learning visual tasks are usually too computational intensive to be implemented on IoT devices



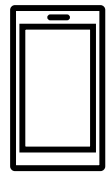
HPC servers ✓



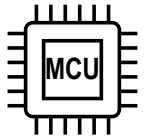
GPU ✓



FPGA ✓



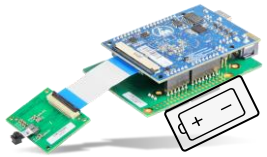
Mobile ✓



MCU ✗

<u>MCUs are the ideal IoT platform</u>:

- Low-power: IoT devices are battery-operated.
- Low-cost
- Highly-flexible: SW programmable.



<u>But, MCUs present severe limitations:</u>

- **Memory** is limited to few MB. (DL models ≳100MB)
- **Computational power** is limited:
  - Single-core Low clock frequency (≲500MHz)
  - Low inference throughput

Focus of our work: overcome these challenges.

Automatic License Plate Recognition (ALPR)

Deep Learning task chosen: Automatic License Plate recognition

ALPR challange: predicting all the license plate characters.

Why ALPR? No evidences of ALPR on low-power MCUs yet!

prediction

京QC8152

We present a HW/SW co-design flow that enable the deployment of intensive DL workloads on a 100mW budget:

1. Determination of HW and SW building blocks → **2. Optimization of the SW pipeline** → **3. In-field Testing and SoA comparison**

Hardware:

Software:

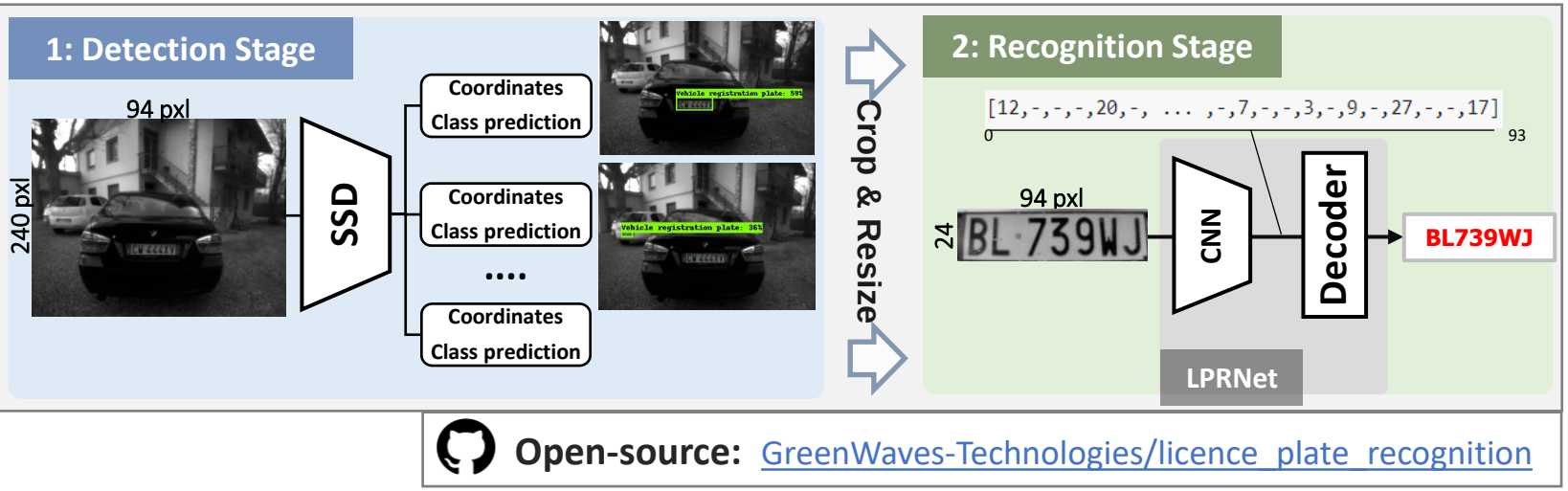
1. Detection CNN
2. Recognition CNN

- **Hand-tuned NN topology**
- **Model Compression:** 8-bit
- **GAP*flow:*** Efficient automated deployment on GAP8

We prove the accuracy of the system:
- on public datasets + in-field testing

We prove the energy-efficiency of our system
- Comparing the SoA of ALPR

Conclusions



Open-source: [GreenWaves-Technologies/licence_plate_recognition]

NEW SoA:

We achieve the most energy efficient MCU device for ALPR in literature with 117mW

73x less power consumption compared with previous SoA system [1] (**3.12W**)!

- **1.1FPS** inference @175MHz performing **687M MAC**
- **4.1MB** footprint (8-bit quantization applied)
- **Accuracy:** 39% mAP for LP detection, >99.13% for char recognition
- **Max recognition distance**: 4m for detection, 1m for recognition

[1] D. M. F. Izidio et al., "An embedded automatic license plate recognition system using deep learning," in 2018 VIII Brazilian Symposium on Computing Systems Engineering (SBESC), 2018, pp. 38–45.

Thank you for your attention !

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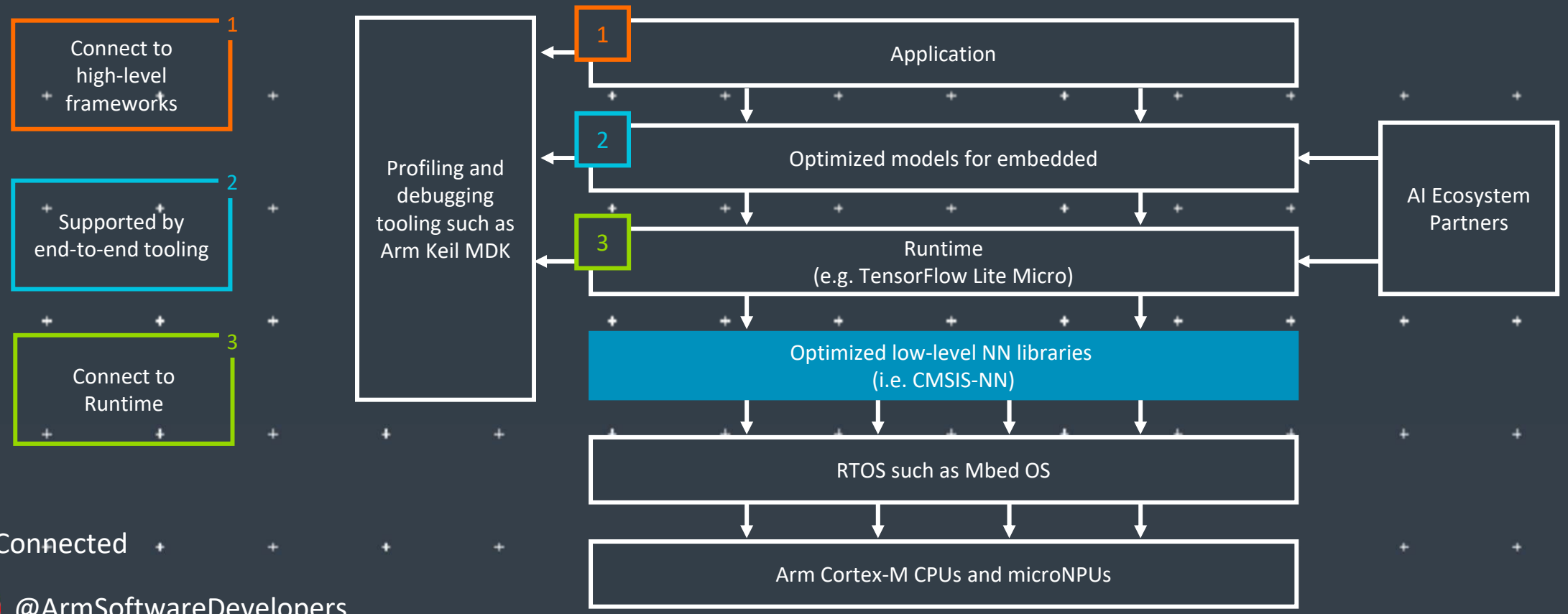

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Resources: developer.arm.com/solutions/machine-learning-on-arm

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TinyML for all developers

C++ library

Arduino library

WebAssembly

Dataset

Acquire valuable training data securely

Enrich data and train ML algorithms

Edge Device

Real sensors in real time

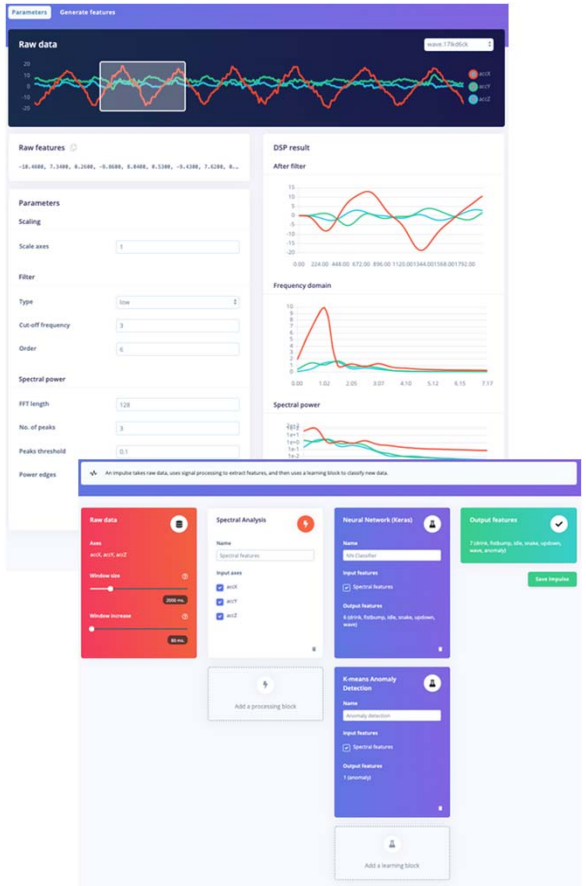
Open source SDK

Impulse

Embedded and edge compute deployment options

Test impulse with real-time device data flows

Test



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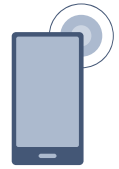
Cloud

IoT/IIoT

Automotive



Mobile

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Founded in 2017 and headquartered in Irvine, California, the company is backed by Amazon, Applied Materials, Atlantic Bridge Capital, Bosch, Intel Capital, Microsoft, Motorola, and others. Syntiant was recently named a CES® 2021 Best of Innovation Awards Honoree, shipped over 10M units worldwide, and unveiled the NDP120 part of the NDP10x family of inference engines for low-power applications.

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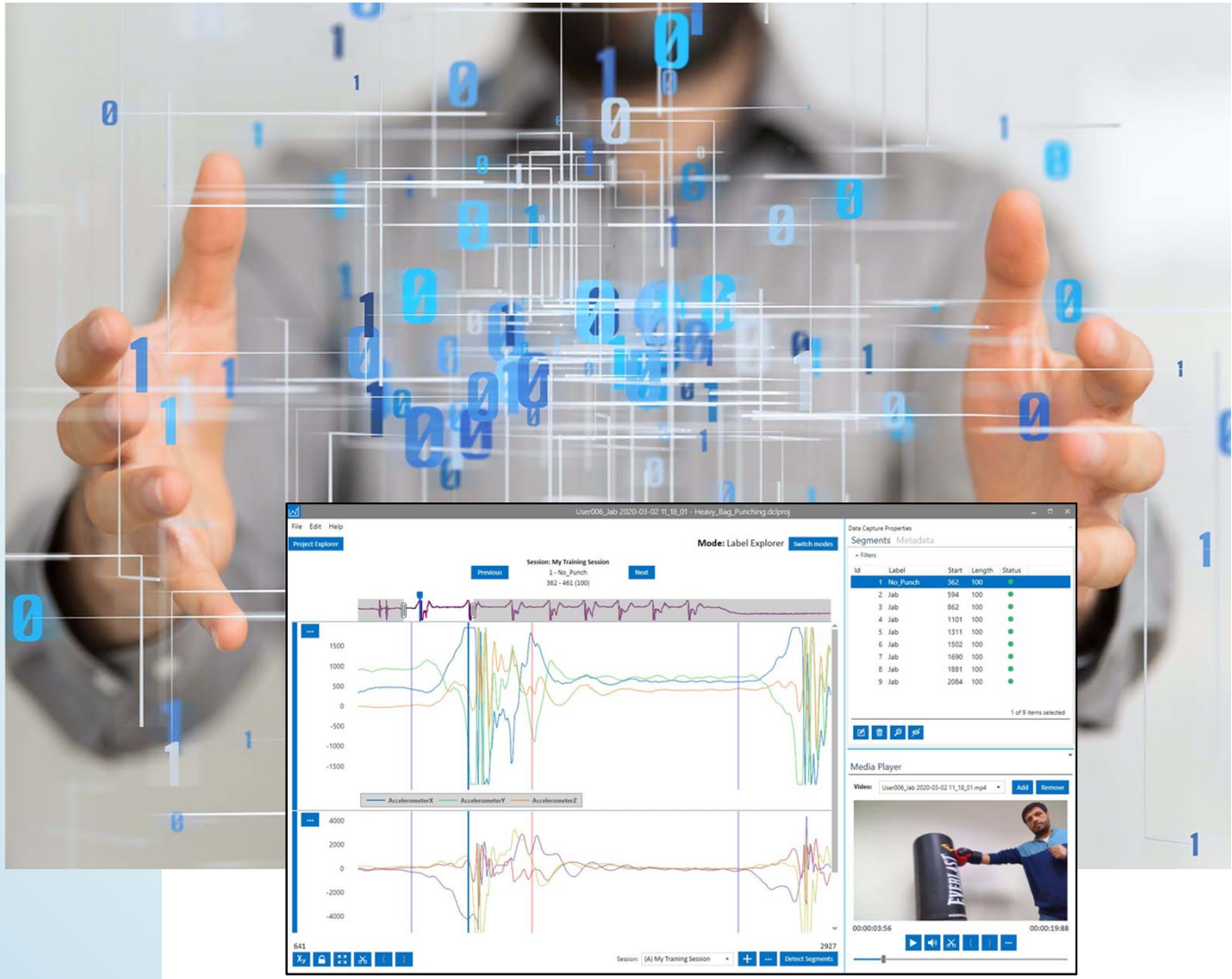

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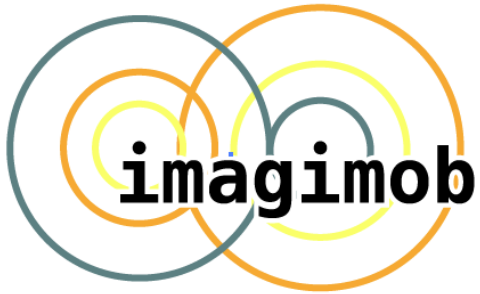

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