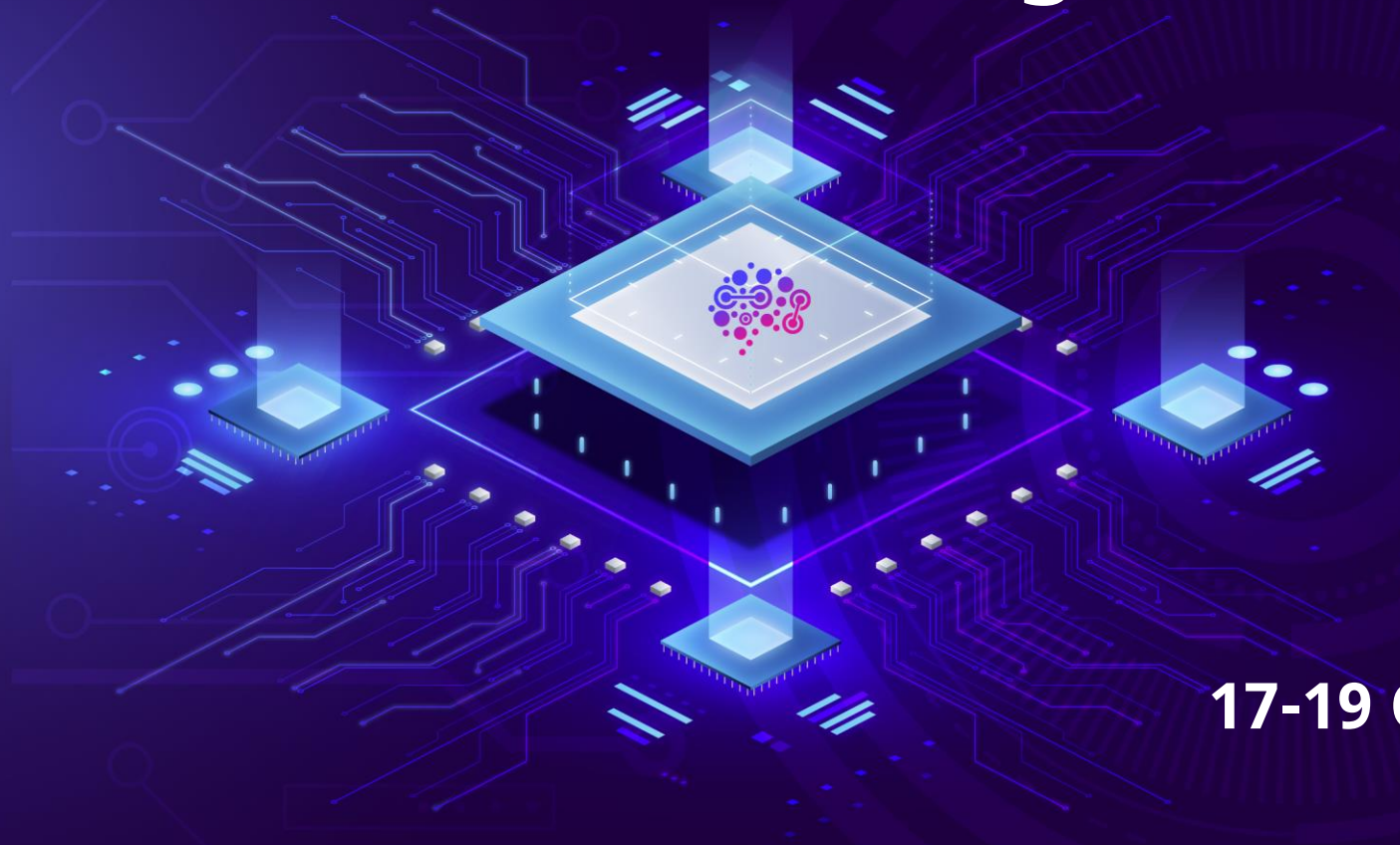
European Conference on EDGE AI Technologies and Applications - EEAI



Advancing emerging edge AI technologies and driving next generation intelligent applications.

17-19 October 2023, Athens, Greece

European Conference on EDGE AI Technologies and Applications - EEAI

Using Edge AI in IoT Devices for Smart Agriculture Applications :

Autonomous Weeding of Vegetables and Vine Health Monitoring

Aymeric Deshayes, IMS Laboratory, France

17-19 October 2023 Athens, Greece

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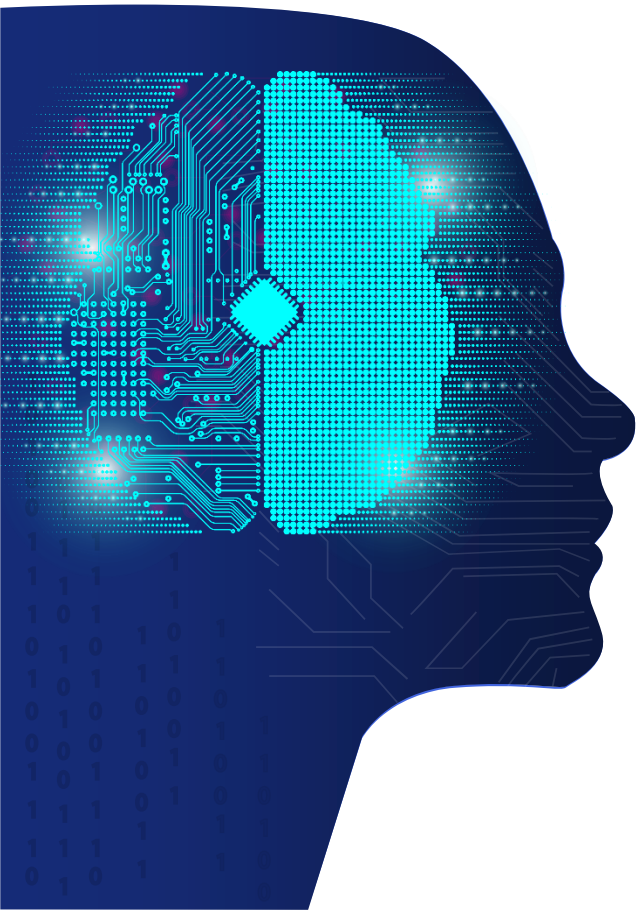
Presentation Outline



- Introduction
- State-of-the-art
- Research Goal
- Methodology
- Design and Implementation
- Experimental Results
- Future Research
- Conclusion

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Introduction

- 21st century challenge for agriculture: produce better, with less (product, surface, …)
- Precision farming
  - Improving crop management and decision making
  - Based on measurements => Sensors + data processing

ANDANTE

Problems

Access to internet

Access to power supply

Solution

EDGE computing

Do on board calculation

Low consumption architecture

Intra-row weeding

Vineyard fixed sensor VineLapse

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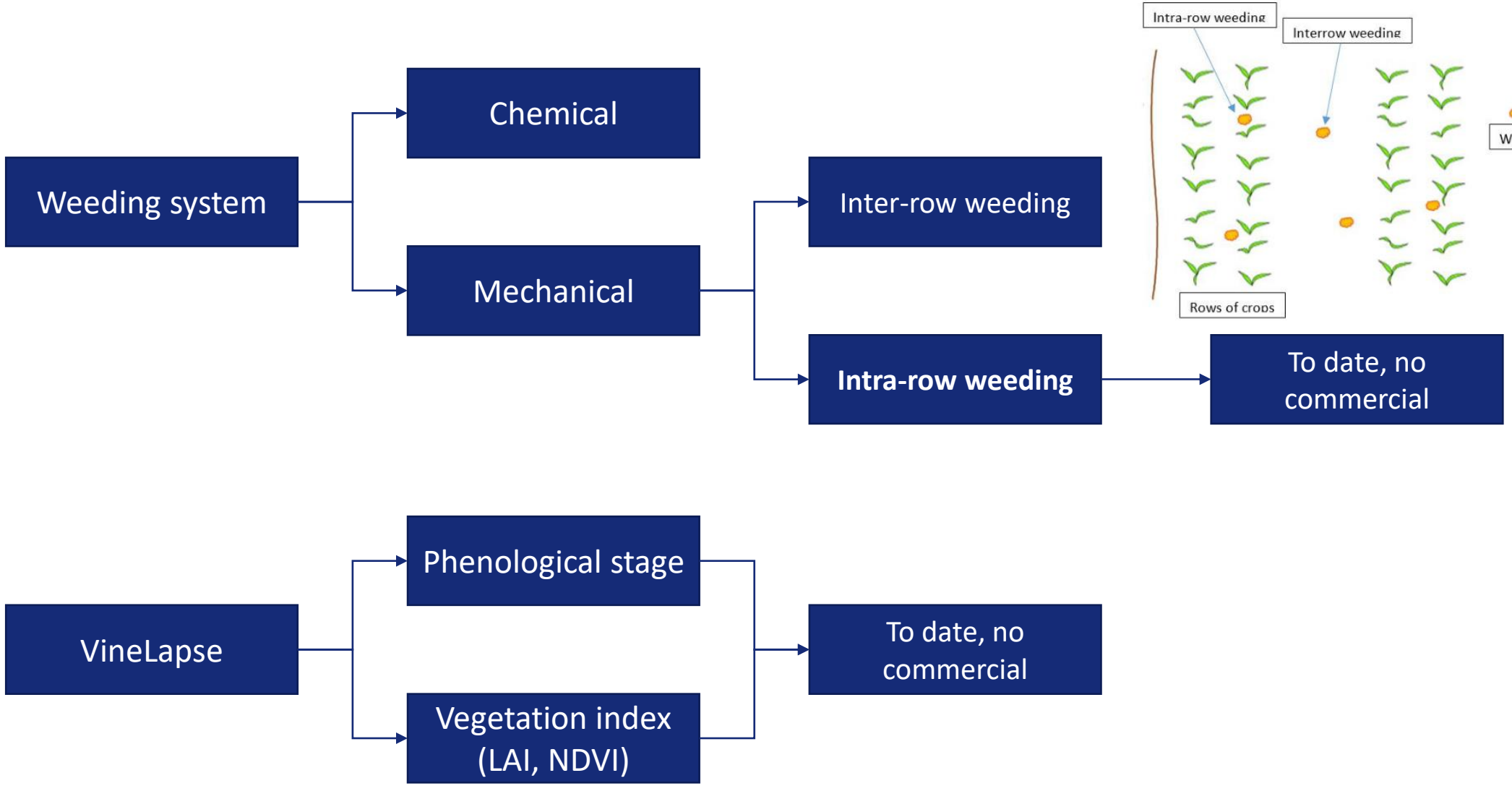
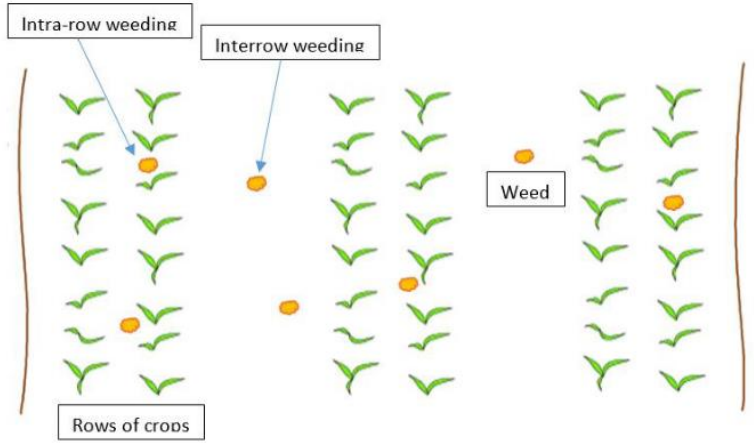
State-of-the-art





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Research Goal

- Implement ANDANTE platform in our projects

- Weeding system
  - Lower the cost
  - Reduce power consumption

- Vinelapse
  - Having more computing power
  - Keep low consumption

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Methodology

- Comparison with the new circuit developed during ANDANTE
  - Precision/recall
  - Power consumption
  - Processing speed
  - Cost

- Test different algorithms on board with the fixed sensor, evaluate the autonomy and robustness
  - Operational in field during a whole season without human interventions

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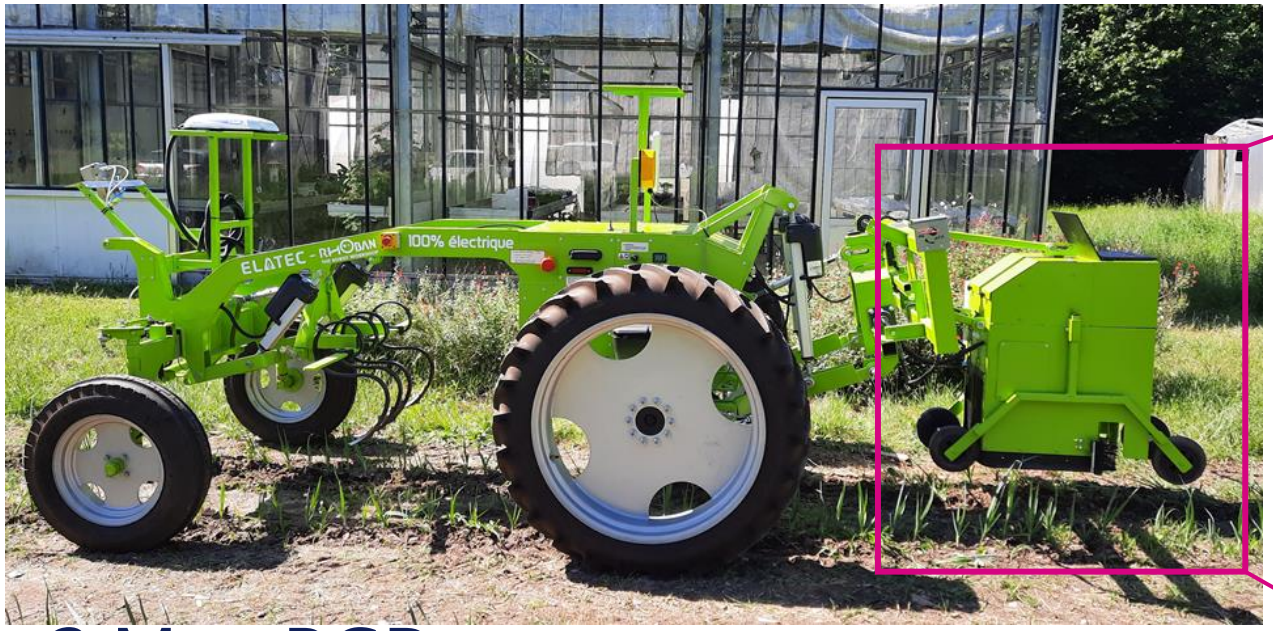
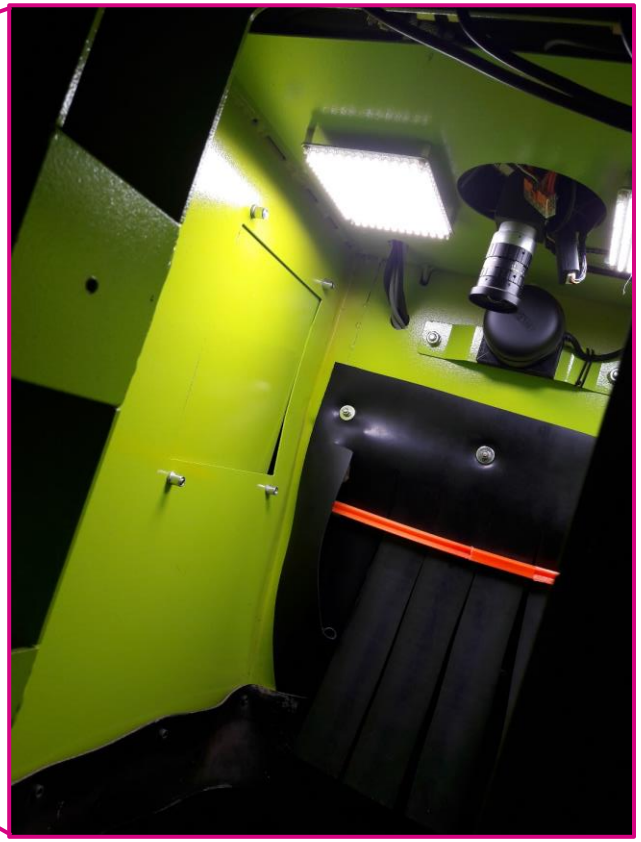
Design and Implementation: weeding system





- 3 Mpx RGB camera
- LED lights
- Enclosed in a “dark chamber”
- Looking at the soil
- Nvidia Jetson Xavier

- Challenges:
  - Image processing in real-time
  - High precision needed to differentiate crops and weeds

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Design and Implementation: weeding system

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Design and Implementation: VineLapse

- 8 Mpx camera
- Take 2 pictures per night
- LED lights (white and IR)

⇒RGB and Infra-Red images

- On board image processing

=> Send only results via LoRa Network

- Challenges:
  - Autonomy
  - Low power on board processing

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Design and Implementation: VineLapse

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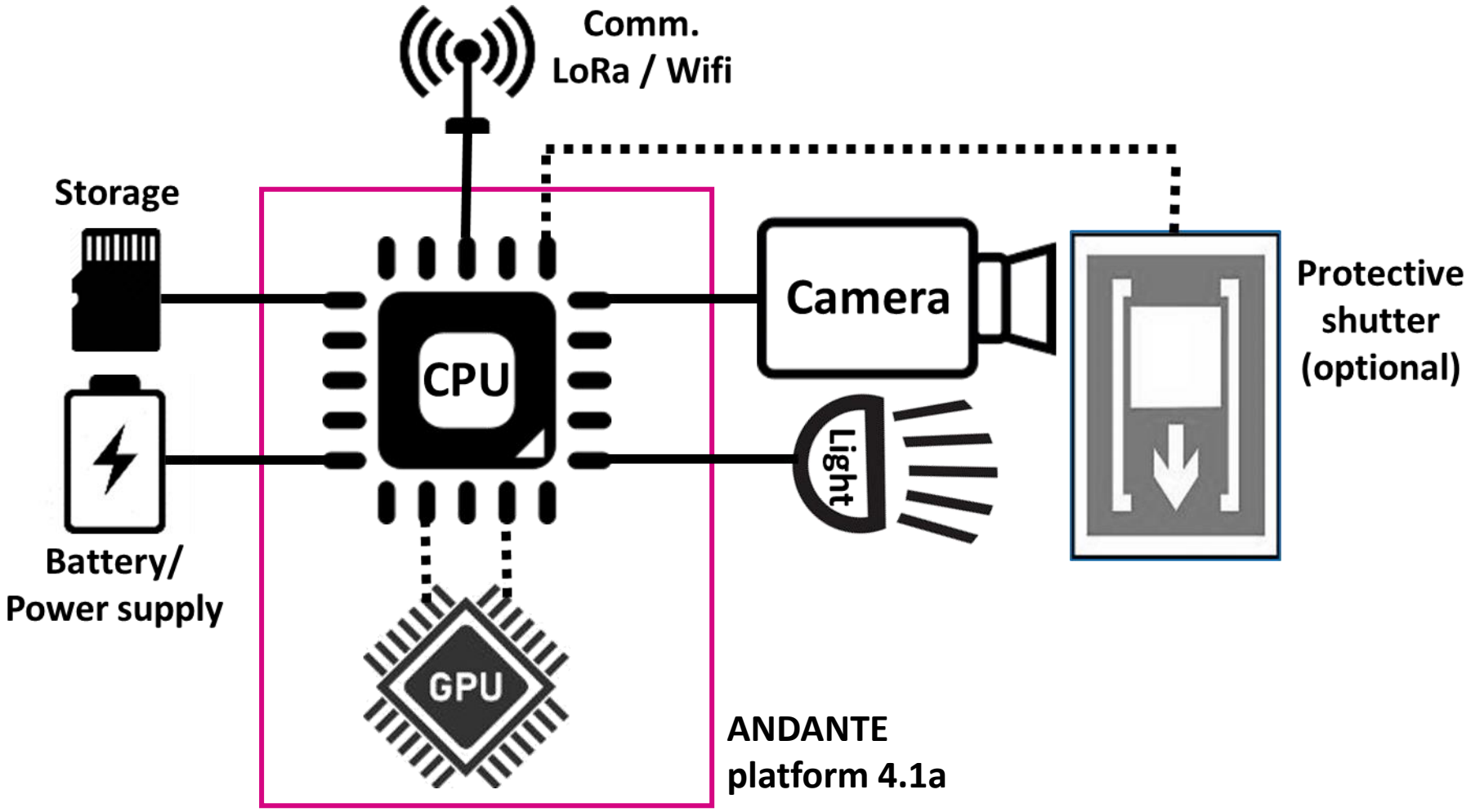
Design and Implementation

Our lab sensors global architecture



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Experimental Results: weeding system

- Weeding system
- 90% AP50 on our own crop detection database
- 40% AP50 on COCO with YOLO v4 Tiny (a real time model)
- 65.7% AP50 on COCO with YOLO v4 (more accurate but slower model)

AP50: designate the precision of the network, this indicator is obtain with this formula:

AP=true positive/(true positive + false positive)

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Experimental Results: weeding system

Before

After

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Experimental Results: VineLapse

- VineLapse

- Several cameras deployed in the vineyard (Chateau Luchey Halde, Bordeaux area)
- 3-4 months autonomy with a 5Ah lead battery
- Robust, can resist to outdoor conditions
- Follow the vine plant development and phenological stages

- But only light computing (vegetation index and leaf area)
- Hope to do more with embedded AI circuit, with low consumption

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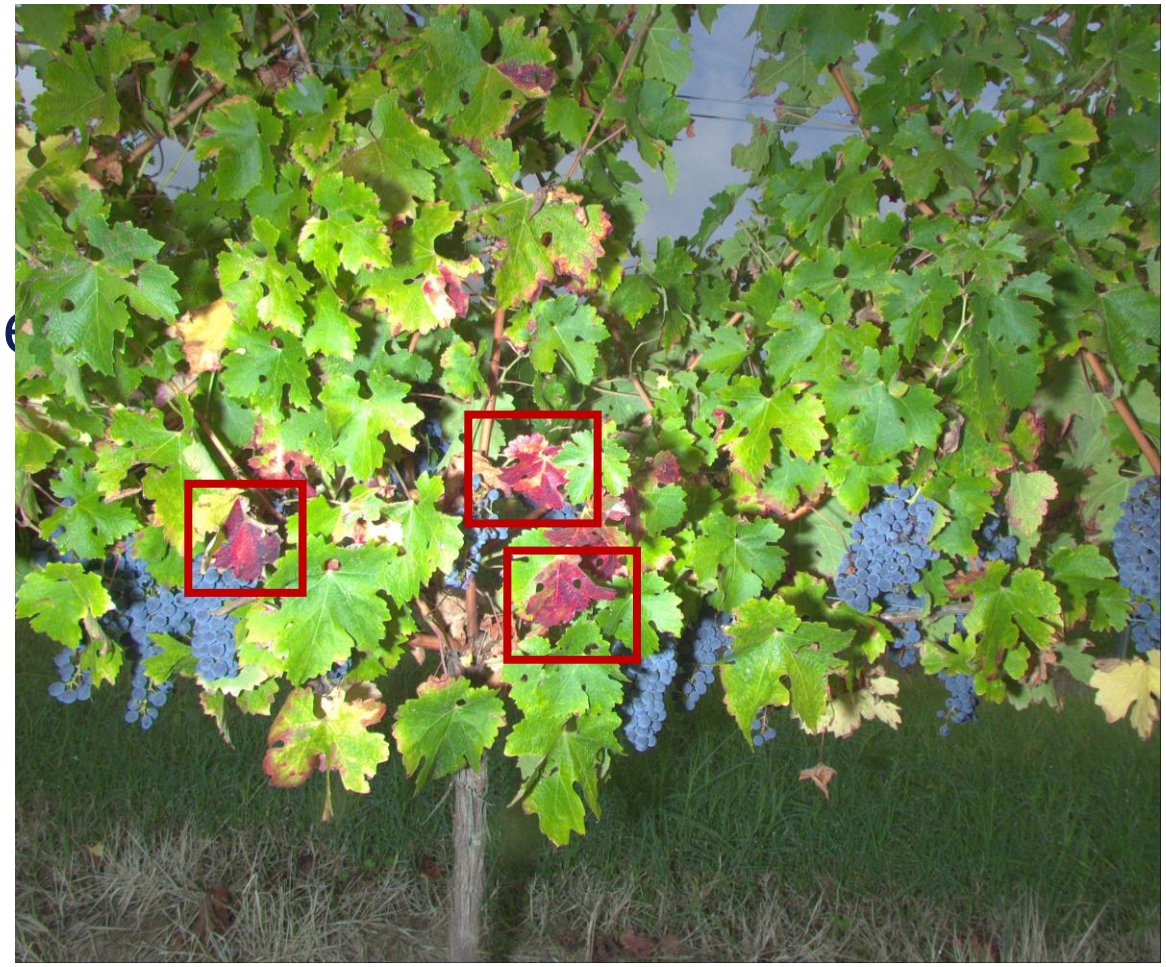
Future Research

- Implementation of the ANDANTE circuit in both systems
  - Test the performance
  - Test the impact on the autonomy
- Extended this circuit in other use case
  - Vine disease detection
  - Yield estimation
  - Etc…



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Conclusion

- We developed two systems for plant detection and characterization
- Integration of ANDANTE board in progress :
  - Empowering Edge architectures in our devices
- Edge AI computing will help to expand the use precision farming
  - Less dependencies to network availability
  - Power efficient system and sensors

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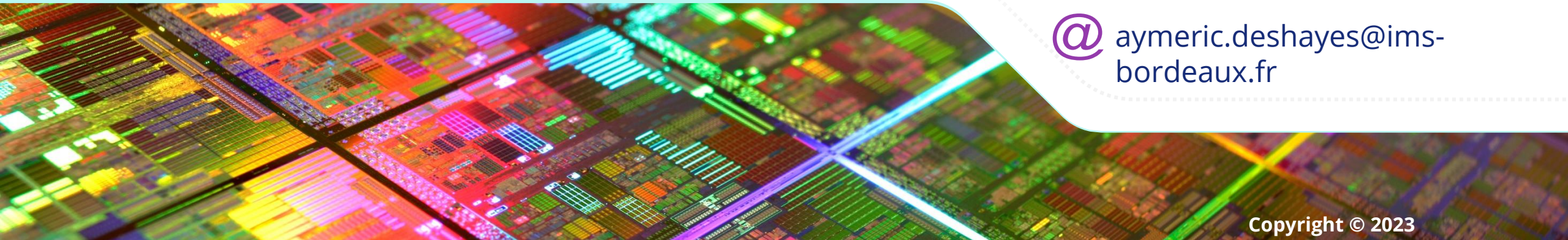
EDGE AI

Thank You

For your attention



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