NaLamKI

Nachhaltige Landwirtschaft mit Künstlicher Intelligenz

Sustainable Agriculture with Artificial Intelligence

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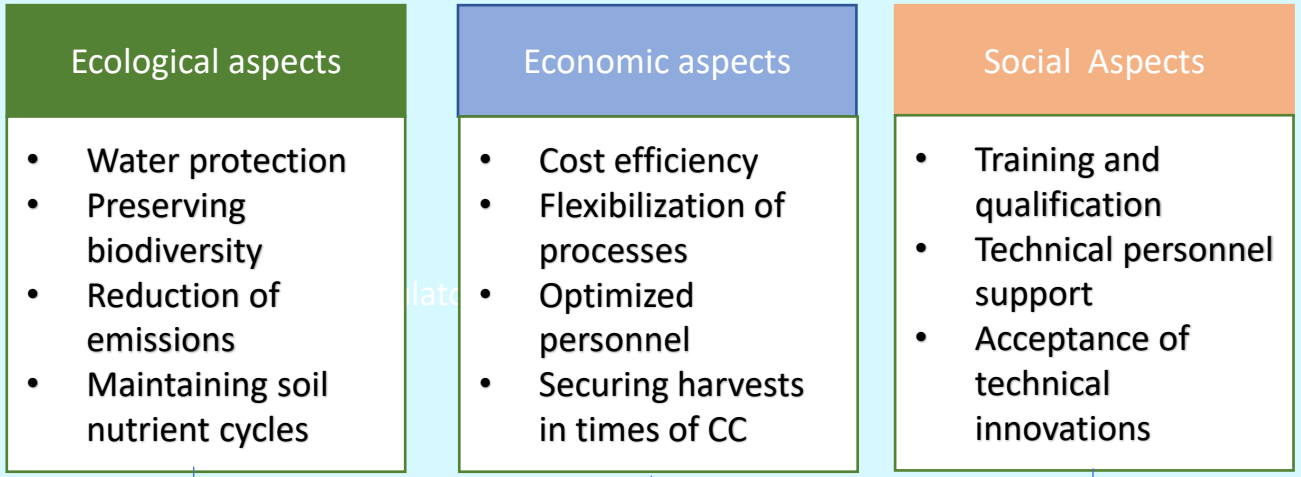
Supported by:

Federal Ministry
for Economic Affairs
and Climate Action

on the basis of a decision
by the German Bundestag

Background
Why NaLamKI

- Cloud-based
- heterogeneity and data sovereignty aware
- GAIA-X compliant
- model-based AI approach to increase agricultural sustainability and competitiveness



About NaLamKI

- AI services are being developed for use in agriculture, which evaluate data from conventional and autonomous agricultural machinery, satellites, and drones, combine them in a software service platform and make results accessible via open interfaces.

- AI methods have to be adapted to agricultural use cases

- Domain-specific data must be processed and made accessible for training the models

About NaLamKI

- Aggregating data (sensor and machine data obtained through remote sensing, soil sensing, robotics, manual data collection, and inventory data)
- Agricultural practices can be optimized in a more sustainable, efficient, and transparent manner
- By building an International Data Space for Agriculture (IDSA) and GAIA-X compliant services, the platform will act as interoperability between different centralized and decentralized cloud providers and users.

NaLamKI- platform

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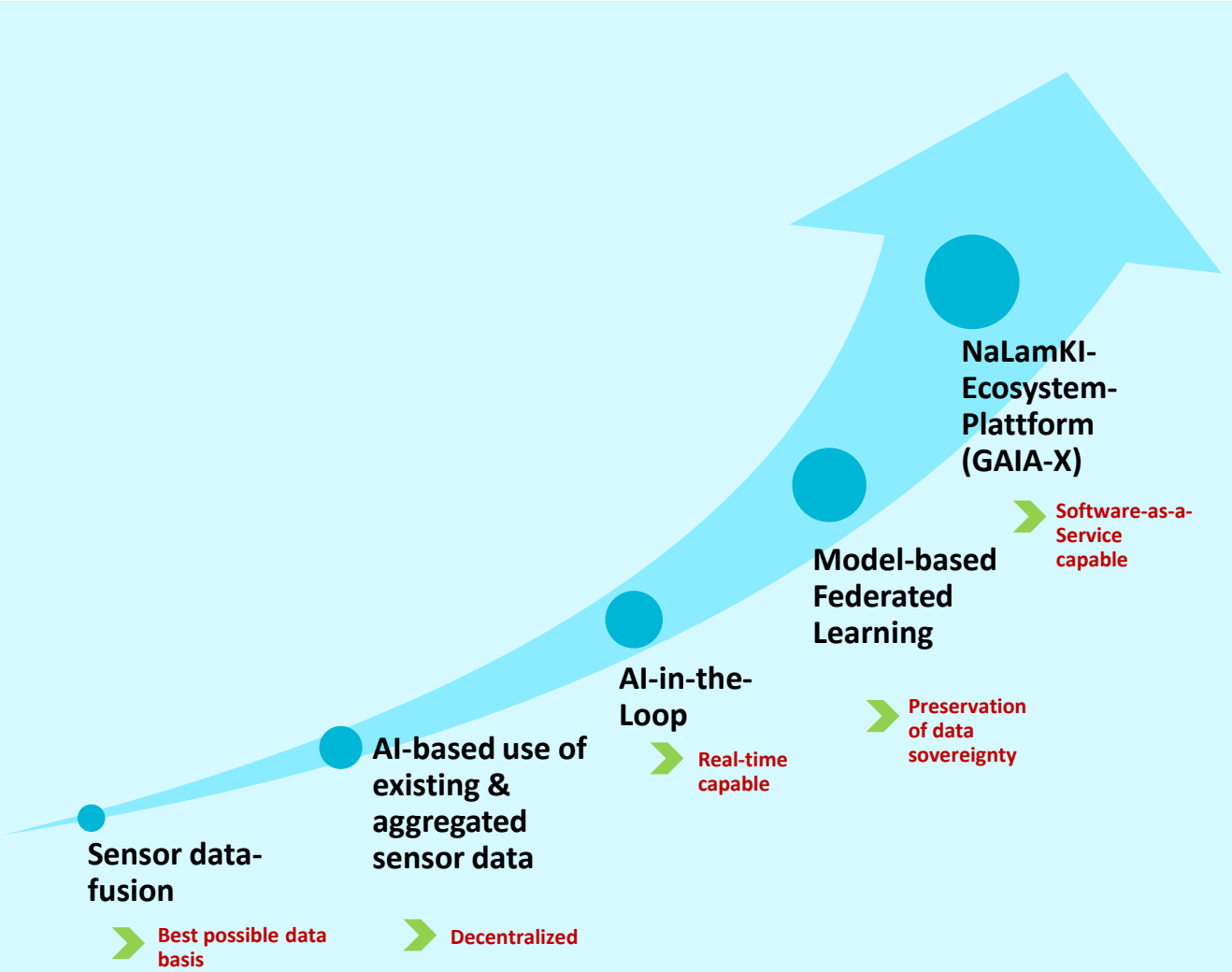
Innovation - potential

- Technical feasibility
- High-quality data basis for the learning phase of the algorithms
- Results can be individually transferred and used in the competence domains of the individual partners
- Both individual and overall solutions can be implemented



NaLamKi Application Potential

Cloud Level

- SaaS/AIaaS platform
- GAIA-X compliant architecture
- Openness to third-party providers while maintaining data sovereignty

Operational Level

- AI-based collection
- Documentation (output quantities, transparency)
- AI-based resource-optimized and cost-efficient process and application control
- Modeling of the overall "field" system

Maschine Level

- Driving strategy, autonomy, service and maintenance applications
- Remote control
- Sensor calibration

Demonstrators

1 Area-specific crop protection measures

2. Remote sensing detection of plant infections

3. Orchard inspection

4. Environment inspection by means of a (partially) autonomously driving tractor

5. GAIA-X-compliant cloud infrastructure for AI-based Software as a Service solution

6. Multi-scale information retrieval with remote sensing

7. Farmer dashboard for visualization of project data

8. 5G sideline communication between drones and ground vehicles.

NaLamKI - Partners

Application Partner & Manufacturers	Data Providers	Service Provider & Software Development	Research Partner
John Deere robot makers Opto Precision	planet.	NT.AG	Fraunhofer HHI JKI Julius Kühn-Institut Universität Hohenheim Technische Universität Kaiserslautern DFKI Deutsches Forschungszentrum für Künstliche Intelligenz GmbH
Förderverein Digital Farming e.V. hofgut neumühle Kompetenz in landwirtschaftlicher Tierhaltung DLG		gravity&storm	

Project Partner

Associate Partner

Subcontracted Partner

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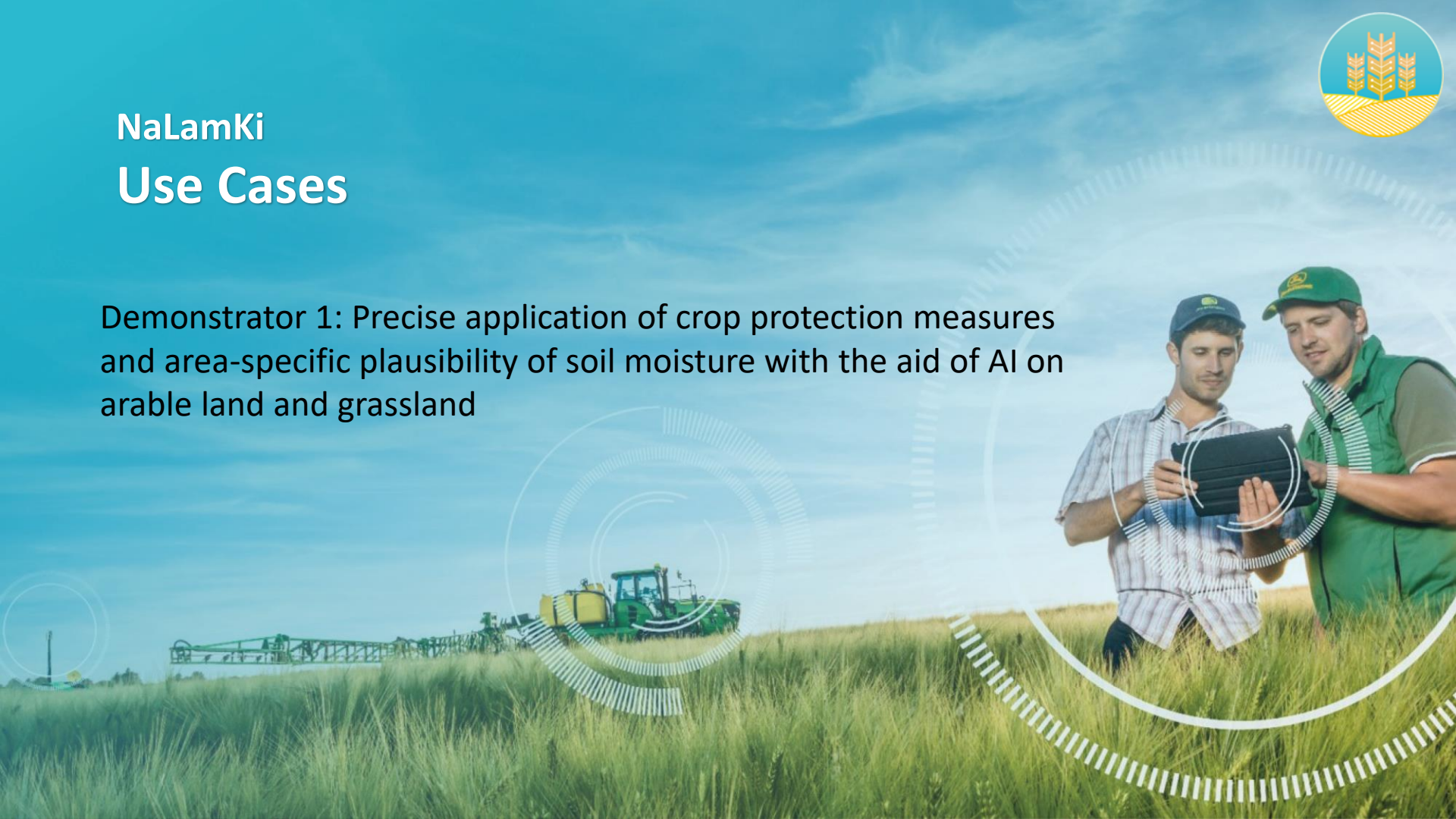
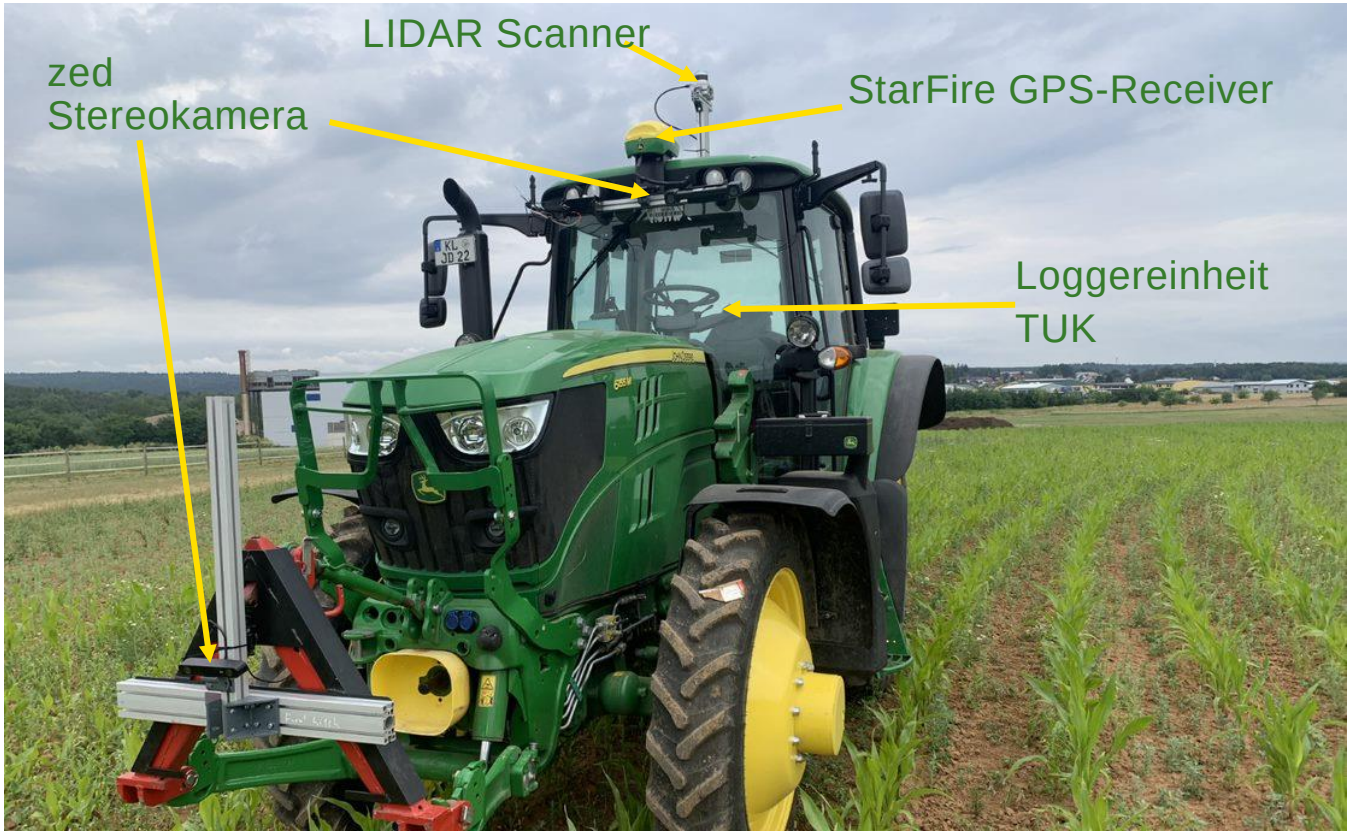
Use Cases

Demonstrator 1: Precise application of crop protection measures and area-specific plausibility of soil moisture with the aid of AI on arable land and grassland



Physical setup

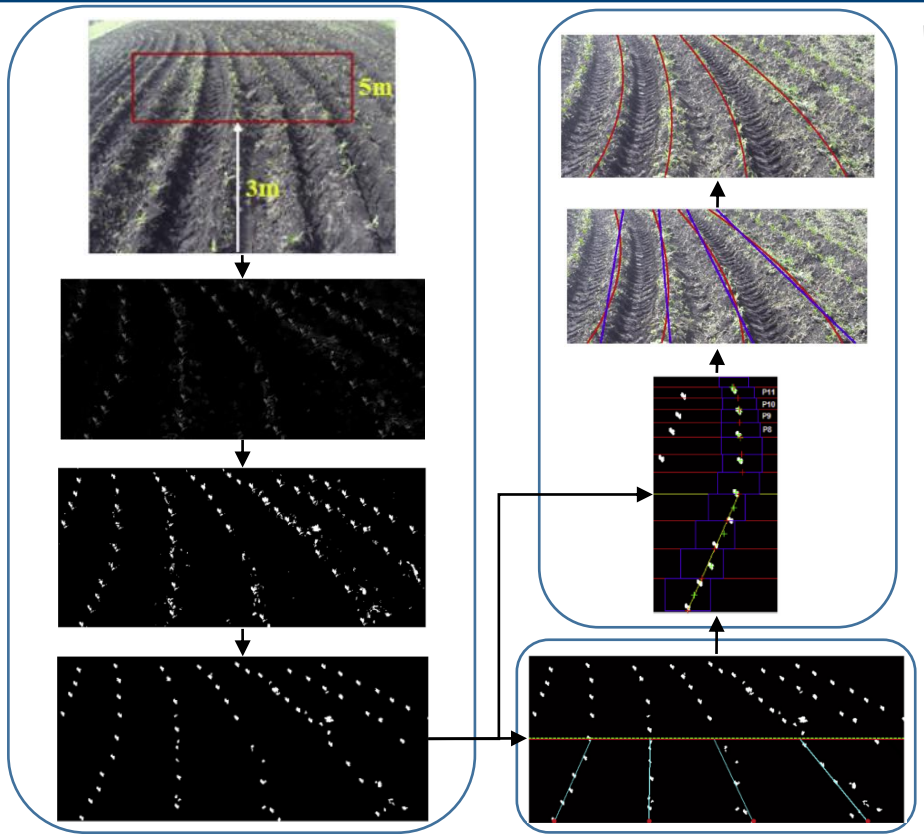


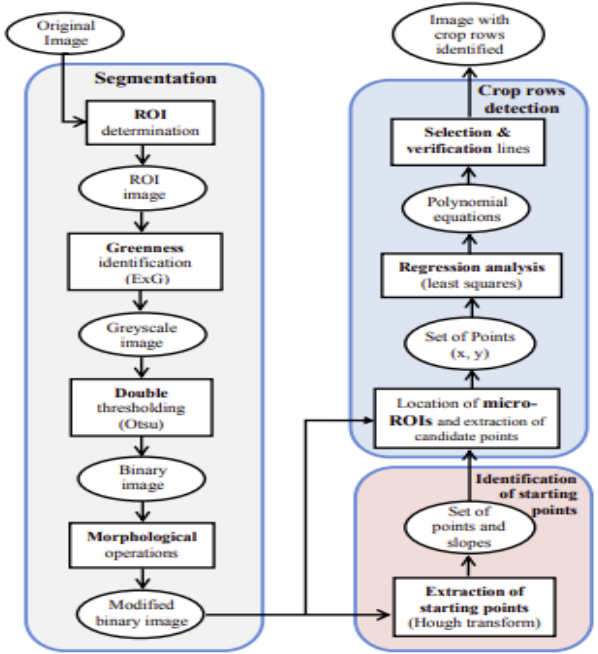
- Ground penetrating radar in planning
- Expandable with further sensors

Public

UNIVERSITÄT HOHENHEIM

Methods for computer-visual row recognition - DBMR





Quelle: Automatic detection of curved and straight crop rows from images in maize fields (García-Santillán et al. 2017)

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Use Cases

Demonstrator 2:

Remote sensing detection of plant infections

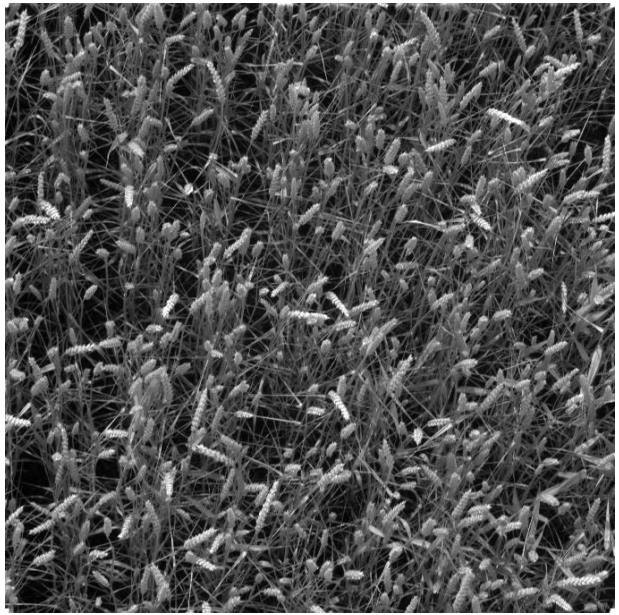
Drones

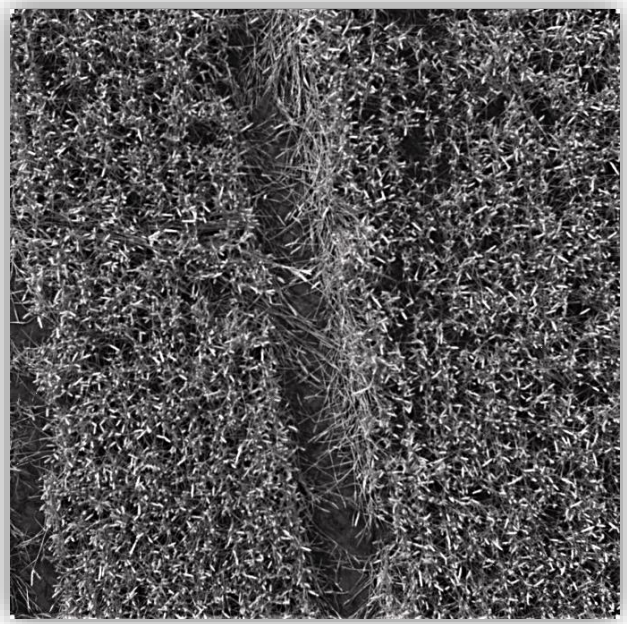
Flight Planning

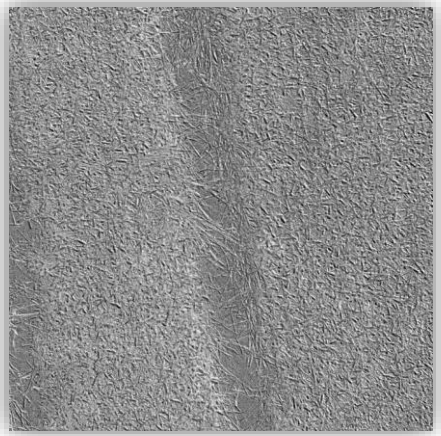
3200 Bilder und
10GB Daten pro Flug
Alle 0,2s ein Foto

Ground Resolution: 0,06cm
Footprint: 1,1m x 1,1m
Flight Time 12min
Area 1800m² bei 2,5km

Temporal images of wheat multispectral camera - 5m and 40m







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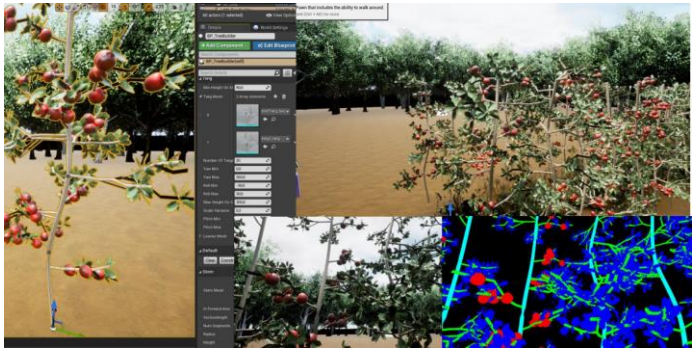
Use Cases

Demonstrator 3: Inspection of orchards

Inspection of Apple plantations

- The autonomous vehicle from Robot Makers was developed by TU Kaiserslautern with sensors for data acquisition (currently two stereo camera systems and a 360° LIDAR).



Detection of fruits (MinneApple dataset): Comparison of Models

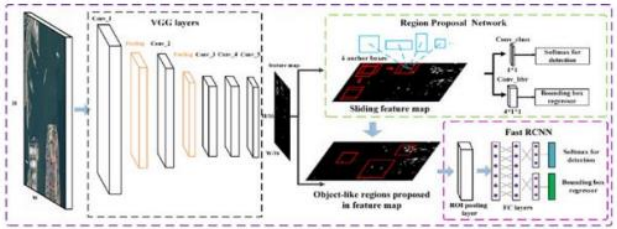
- Models:
  - Faster RCNN (Baseline Network for MinnieApple dataset)
  - YOLO v5
- Speed/Computational Cost
  - YOLO v5 model runs about 2.5 times faster
- Mean Average Precision:
  - Faster RCNN: maP .82
  - YOLO v5: maP .79

→ Beide Modelle haben eine vergleichbare mAP und funktionieren gut (see left side).

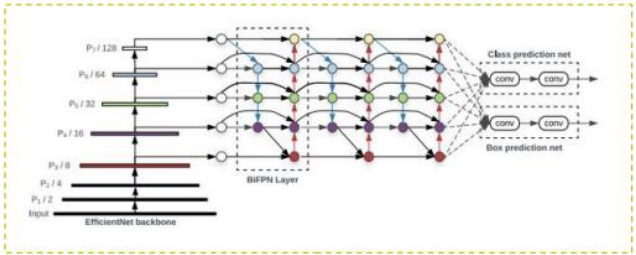
→ Generell ist YOLO schneller und erkennt auch sehr kleine Objekte gut

→ YOLO v5 is advantageous over Faster RCNN.

Faster RCNN relies on VGG



Yolo v5 has an EfficientNet as backbone

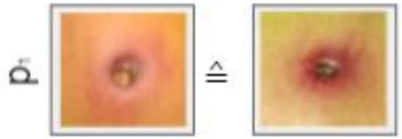


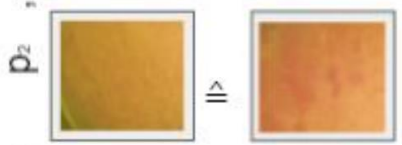
Open question: How well do models that are trained on MinneApple perform on our future data?

Prediction: Ripe Apple with Defect

ANN
(encoder)

Classification head





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defect(p_1)?

ripe fruit(p_2)?

defect(p_3)?

ripe fruit(p_4)?

yes / no

Defect incorrectly detected
(actually pistil cavity)

emerald green background used for classification
(confounding variable of "ripe fruit" in data)

image

image patches & look-alikes (prototypes)

human in the loop

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Use Cases

Demonstrator 8: 5G sideline communication between drones and ground vehicles

Thank you

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