

Highlights of ROS in Agricultural Domain

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Overview

- Why ROS?
- **BoniRob** a modular Robot Platform for Agricultural Applications
 - BoniRob → Phenotyping App
 - BoniRob → soil2Data App
- **eIWObot** a Robot Platform for maintenance in Orchards & Vineyards
- **Robots** for Education & Demonstration



Why ::::ROS?

- Modular
- Expandable
- Reusable
- Open Source with a huge and active Community
- Over 3000 Nodes for nearly all use cases available
- Large collection of helpful Tools i.e. Rviz
- Many companies provides ROS compatible drivers and software tools for their hardware
- Integration with other Open Source Libraries like PCL (Point Cloud Library), OpenCV, Gazebo, ROS-Industrial ...



Digital Twins

ROS & GAZEBO



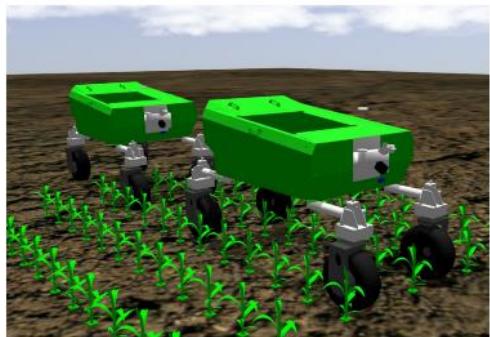
a.)



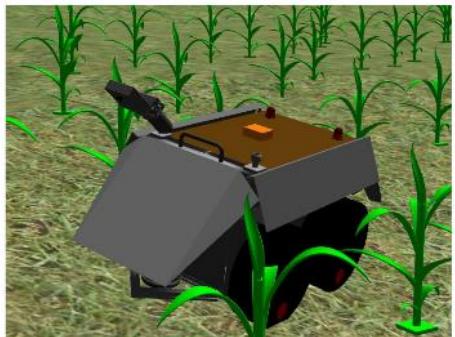
c.)



e.)



b.)



d.)



f.)



Linz, A., Hertzberg, J., Roters, J., Ruckelshausen, A. 2019. „Digitale Zwillinge“ als Werkzeug für die Entwicklung von Feldrobotern in landwirtschaftlichen Prozessen. In GI Edition Proceedings Band 287 Informatik in der Land-, Forst- und Ernährungswirtschaft. 39. GIL-Jahrestagung 18.-19. Februar 2019 Wien, Österreich, S.125–130, ISBN: 978-3-88579-681-7.



BoniRob a modular Robot Platform for Agricultural Applications

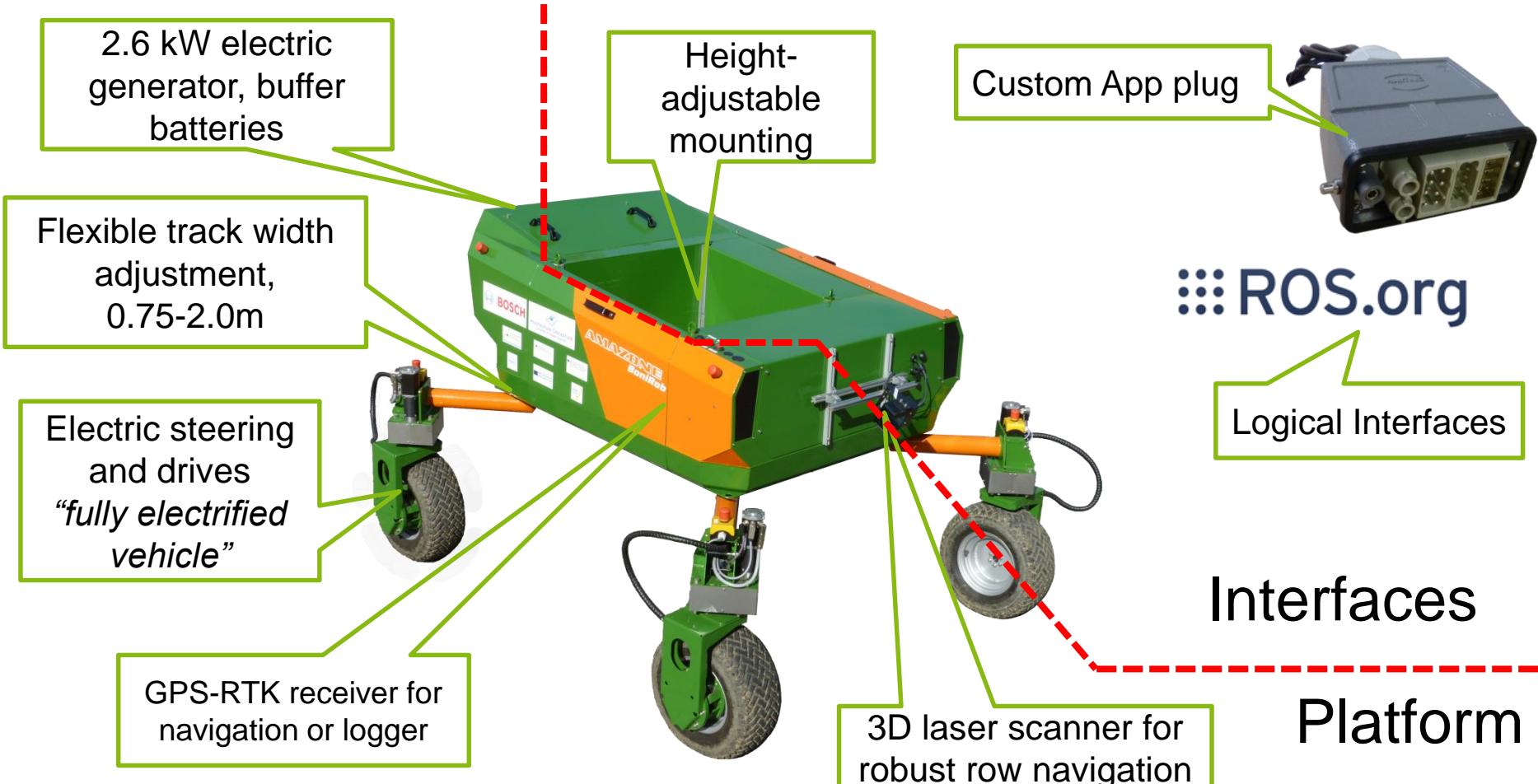


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BoniRob a modular Robot Platform for Agricultural Applications

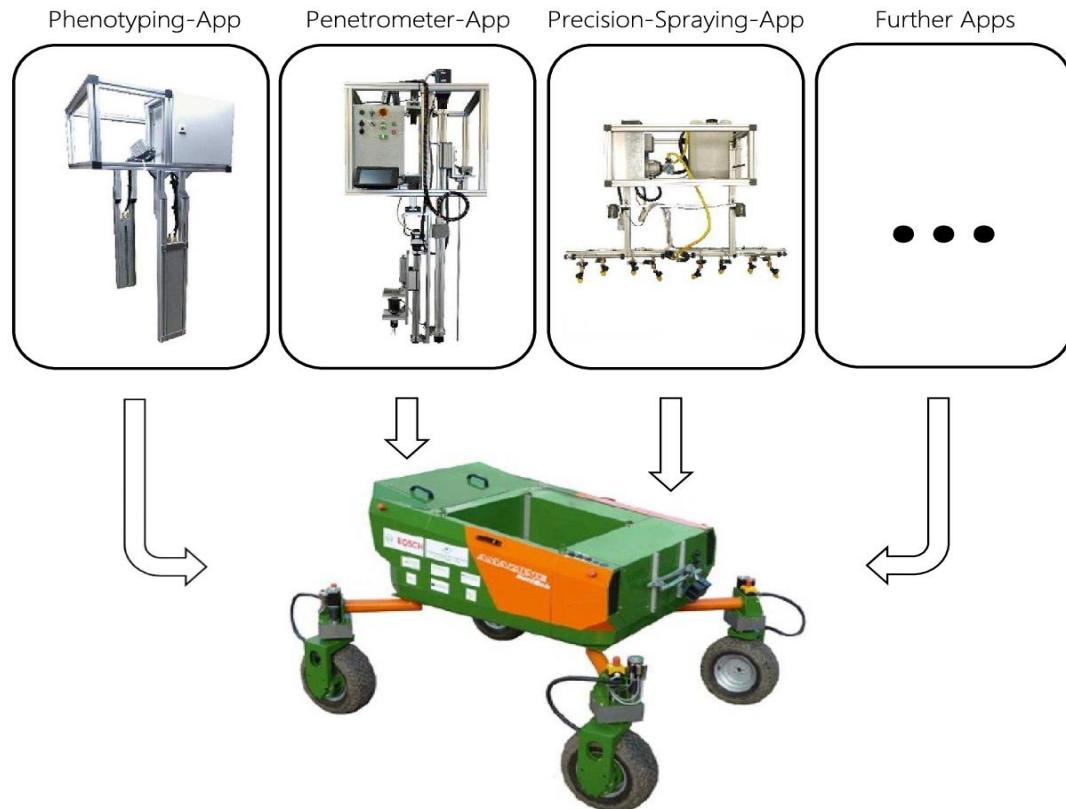




BoniRob a modular Robot Platform for Agricultural Applications

App-Concept:

- BoniRob-Apps are modules with different purposes
- Defined mechanical, electrical and logical interfaces allow an standardized integration



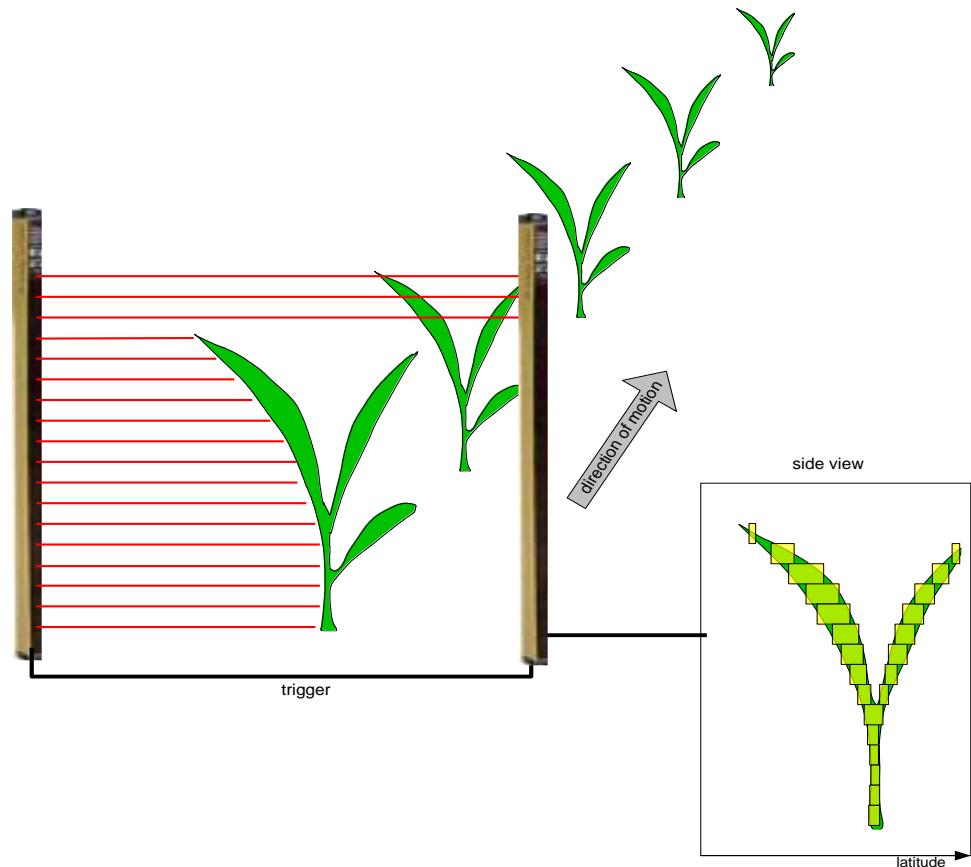
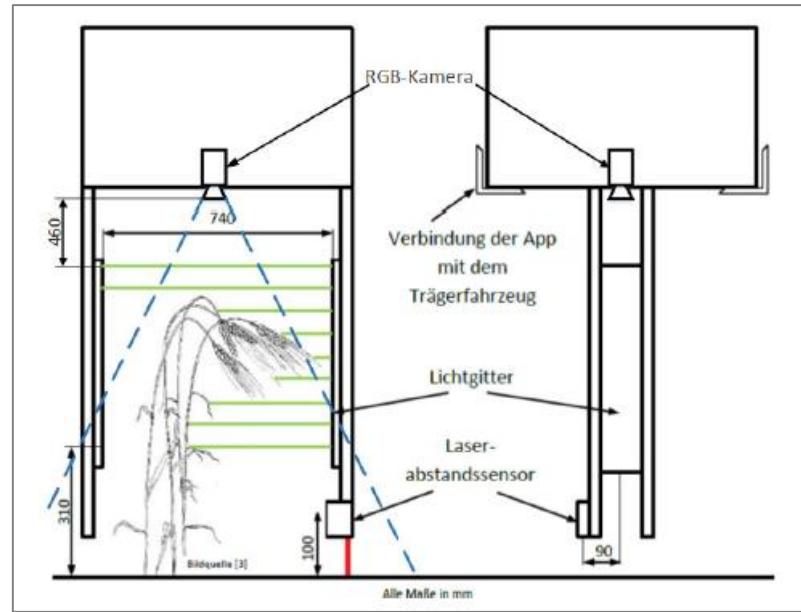


BoniRob → Penetrometer App (Soil property measurement)





BoniRob → Phenotyping App (Light Curtain & Camera)





BoniRob → Phenotyping App (Light Curtain & Camera)

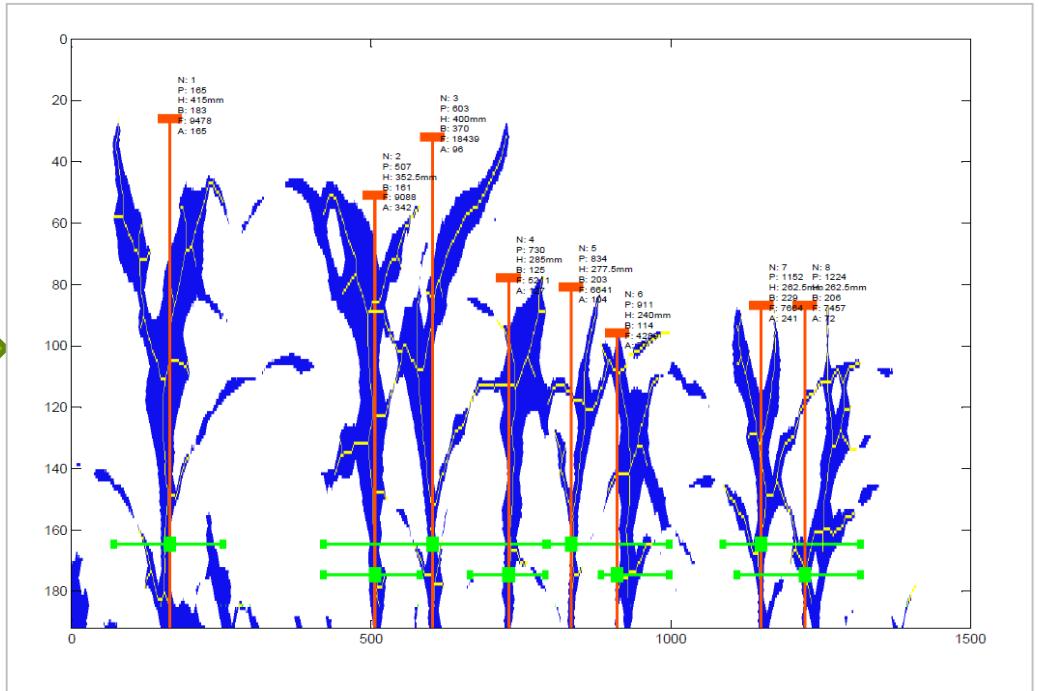


Phenotyping App – Light Curtain Output

BoniRob with Phenotyping App



BoniRob → Phenotyping App (Light Curtain & Camera)



BoniRob with Phenotyping App



BoniRob → Phenotyping App (Light Curtain & Camera)

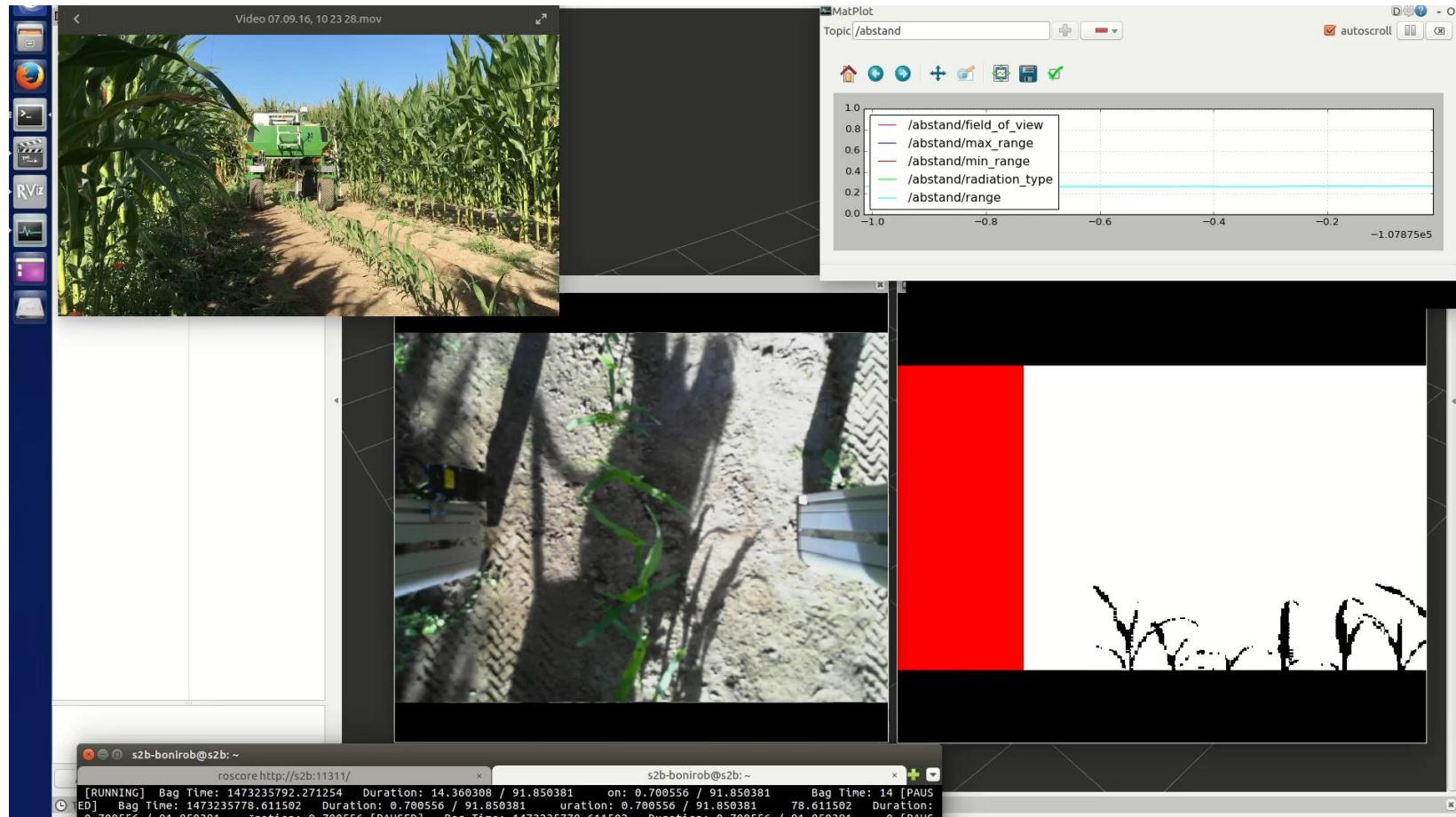


BoniRob with Phenotyping App





BoniRob → Phenotyping App (Light Curtain & Camera)



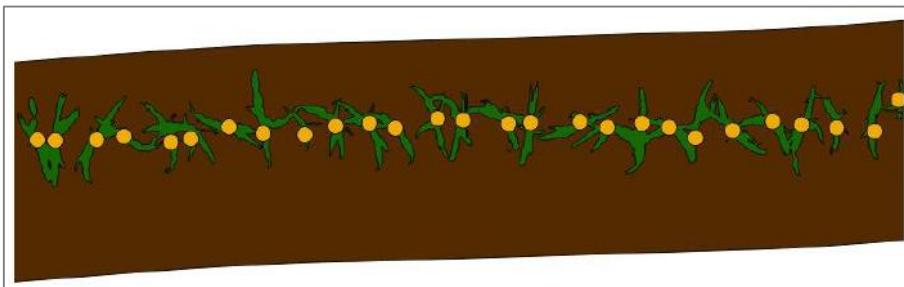


BoniRob → Phenotyping App (Light Curtain & Camera)

Application: Counting Plants



Phenotyping App – Light Curtain Output



Phenotyping App – Processed Data (Camera & Light Curtain)





BoniRob → soil2data App (on-the-go soil nutrient analysis)

ANEDO

iCotec
electronic solutions

 **LUFA**
NORD-WEST


Nietfeld

MMM
TECH SUPPORT


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BoniRob with the soil2data App



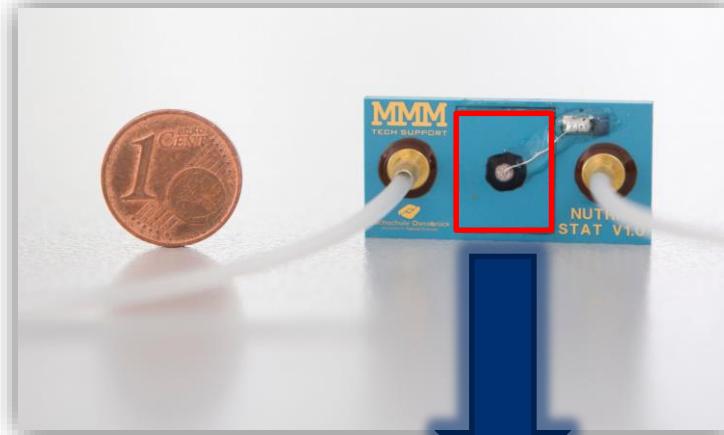
BoniRob → soil2data App (on-the-go soil nutrient analysis)

Simultaneous measurement of:

- pH value – ISFET 1
- P ($H_2PO_4^-$) Phosphor – ISFET 2
- N (NO_3^-) Natrium – ISFET 3
- K (K^+) Potassium – ISFET 4
- Electrical conductivity of the solution
- Temperature of the measurements liquid



Ion-selective field effect transistors (ISFET)



P ($H_2PO_4^-$) – ISFET 2 N (NO_3^-) – ISFET 3



pH value – ISFET 1 K (K^+) – ISFET 4

Reference electrode



BoniRob → soil2data App (on-the-go soil nutrient analysis)

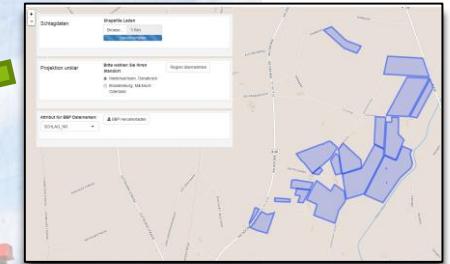
ISFET- Multisensor modul incl.
readout circuit electronic:



Soil preparation modul:



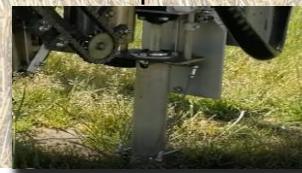
Soil sampling planning:



Electronics for process automation
and data management:



Soil sampler:





BoniRob → soil2data App (on-the-go soil nutrient analysis)





eIWObot a Robot Platform for maintenance in Orchards & Vineyards



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 KEB

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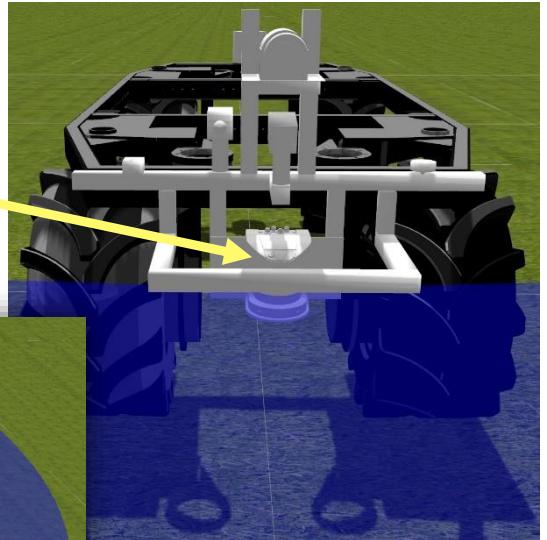
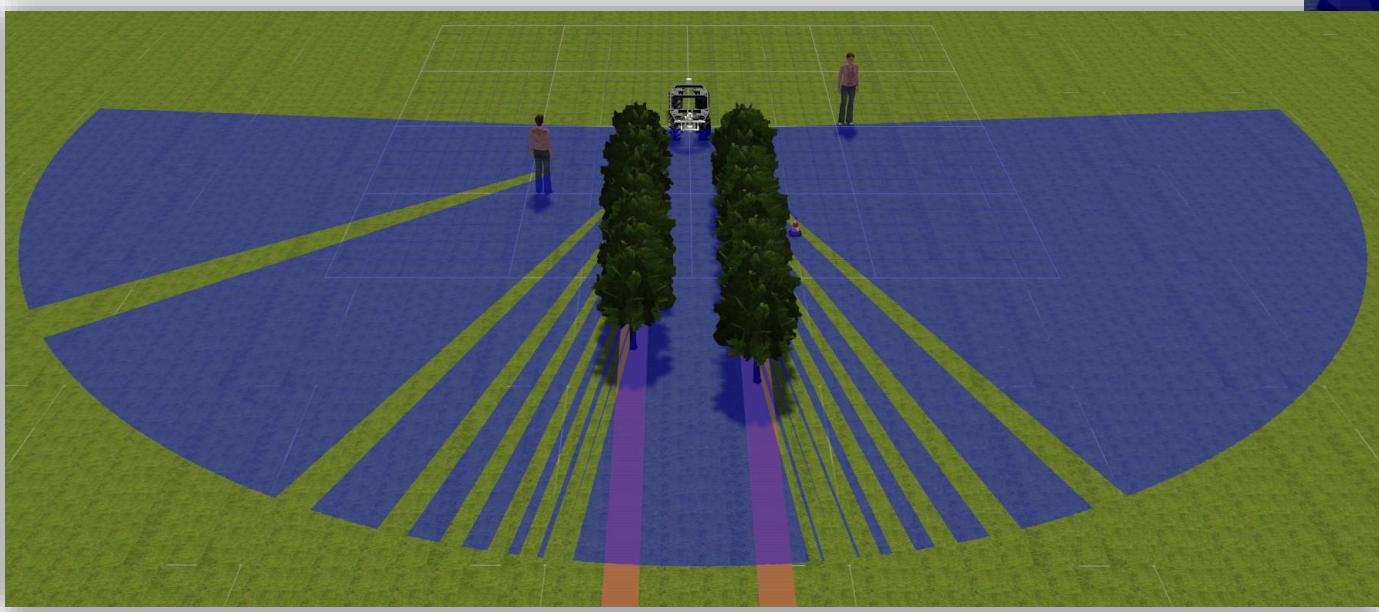
 Federal Ministry
of Food
and Agriculture



eIWObot a Robot Platform for maintenance in Orchards & Vineyards

Sensor Technology for Navigation:

- Horizontal Laser Scanner



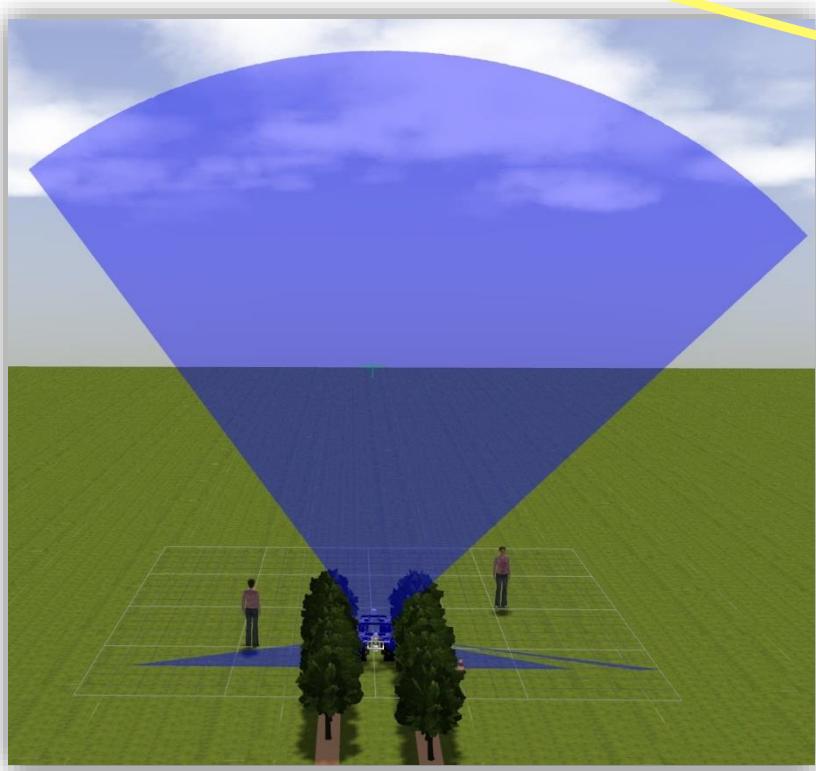
Sick Laserscanner LMS511



eIWObot a Robot Platform for maintenance in Orchards & Vineyards

Sensor Technology for Application (Plant Protection):

- Vertical Laser Scanner (scanning leaf area)

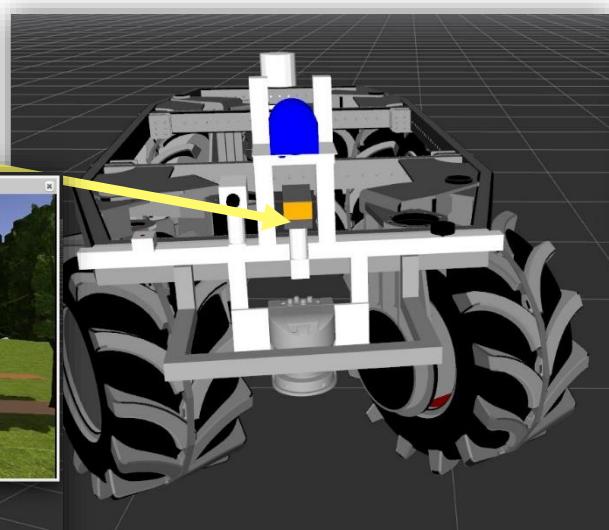
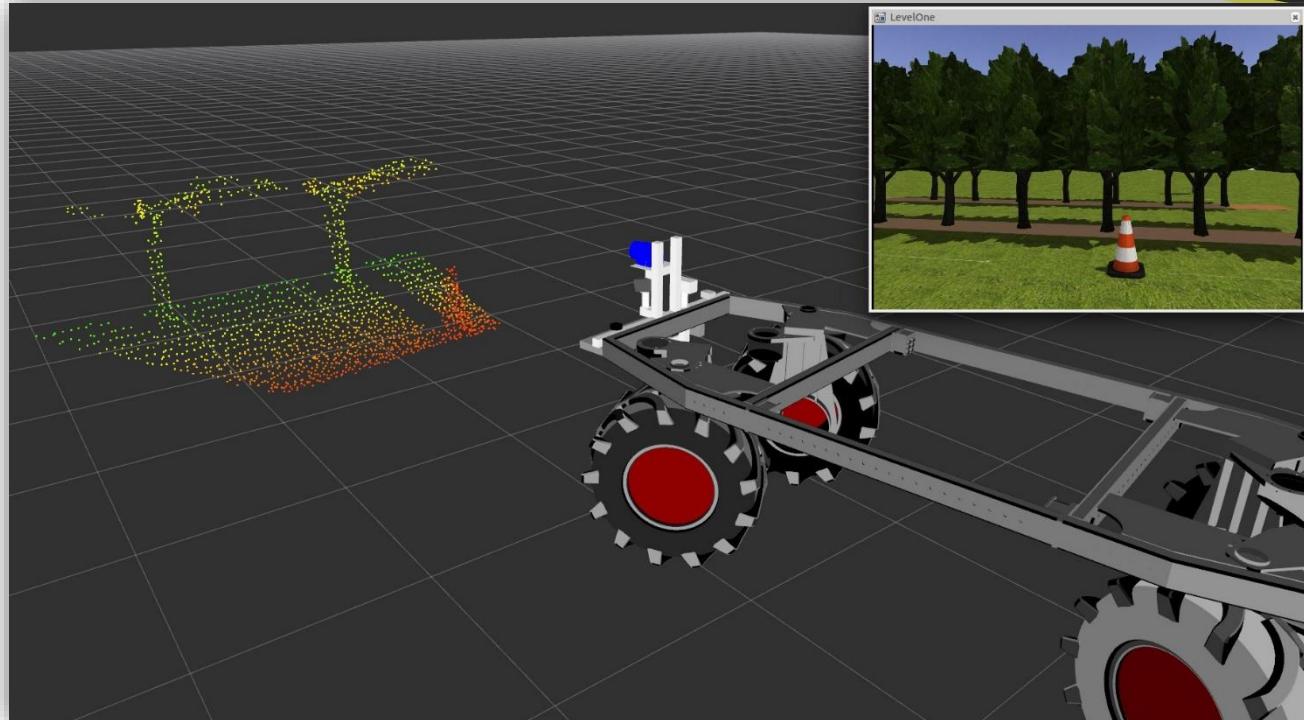




eIWObot a Robot Platform for maintenance in Orchards & Vineyards

Sensor Technology for Obstacle Detection:

- 3D-Laser Scanner

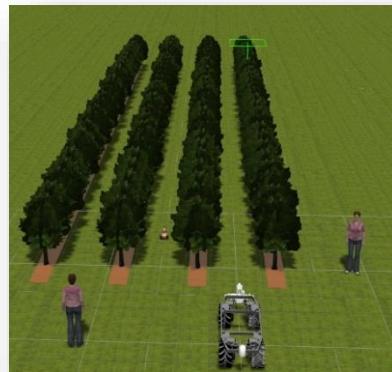


3D-Laser Scanner
FX8 Nippon Signal

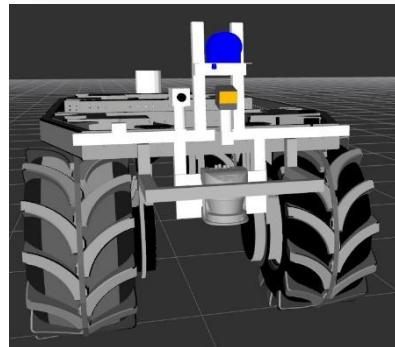


eIWObot a Robot Platform for maintenance in Orchards & Vineyards

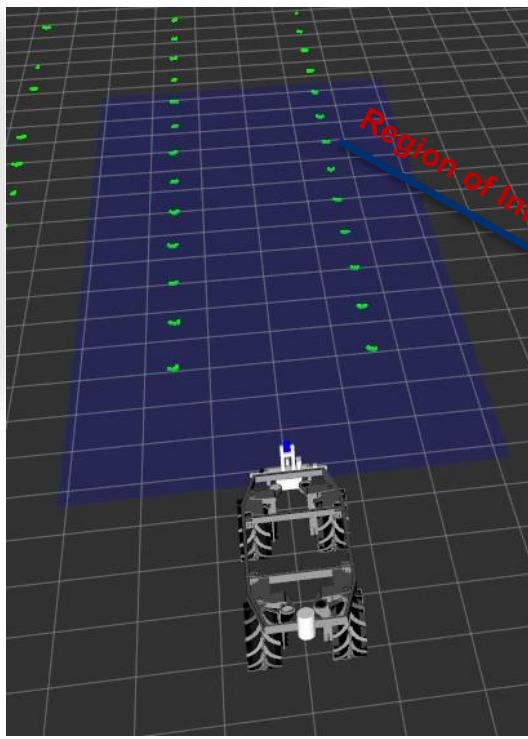
Navigation: Laserscan Data (polar) → Laserscan Data (cartesian) → Region of Interest (ROI) →
Transformation: Binary Image → Transformation: Hough Lines



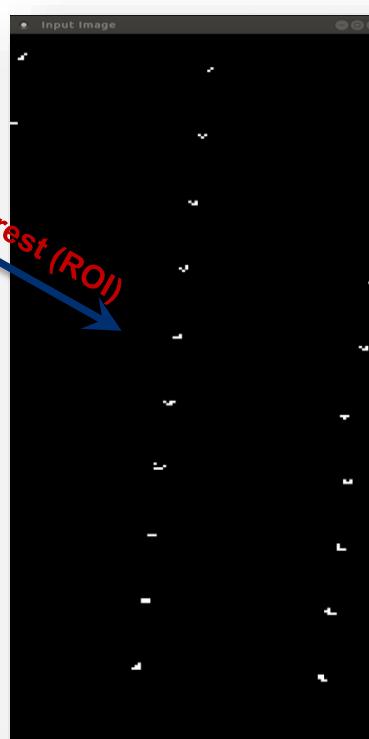
Simulation



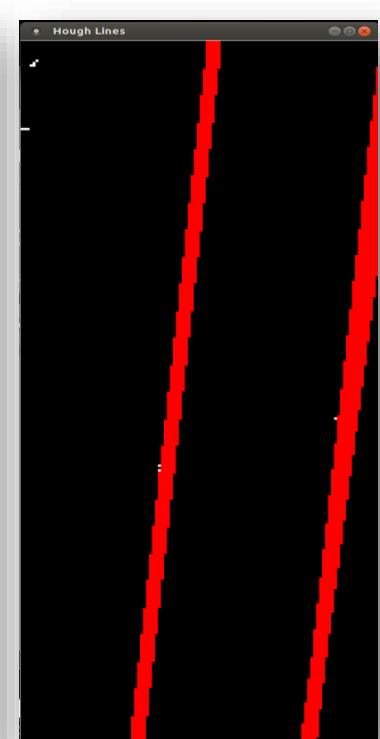
eIWObot Model with Sensors



Laserscan Data → Region of Interest



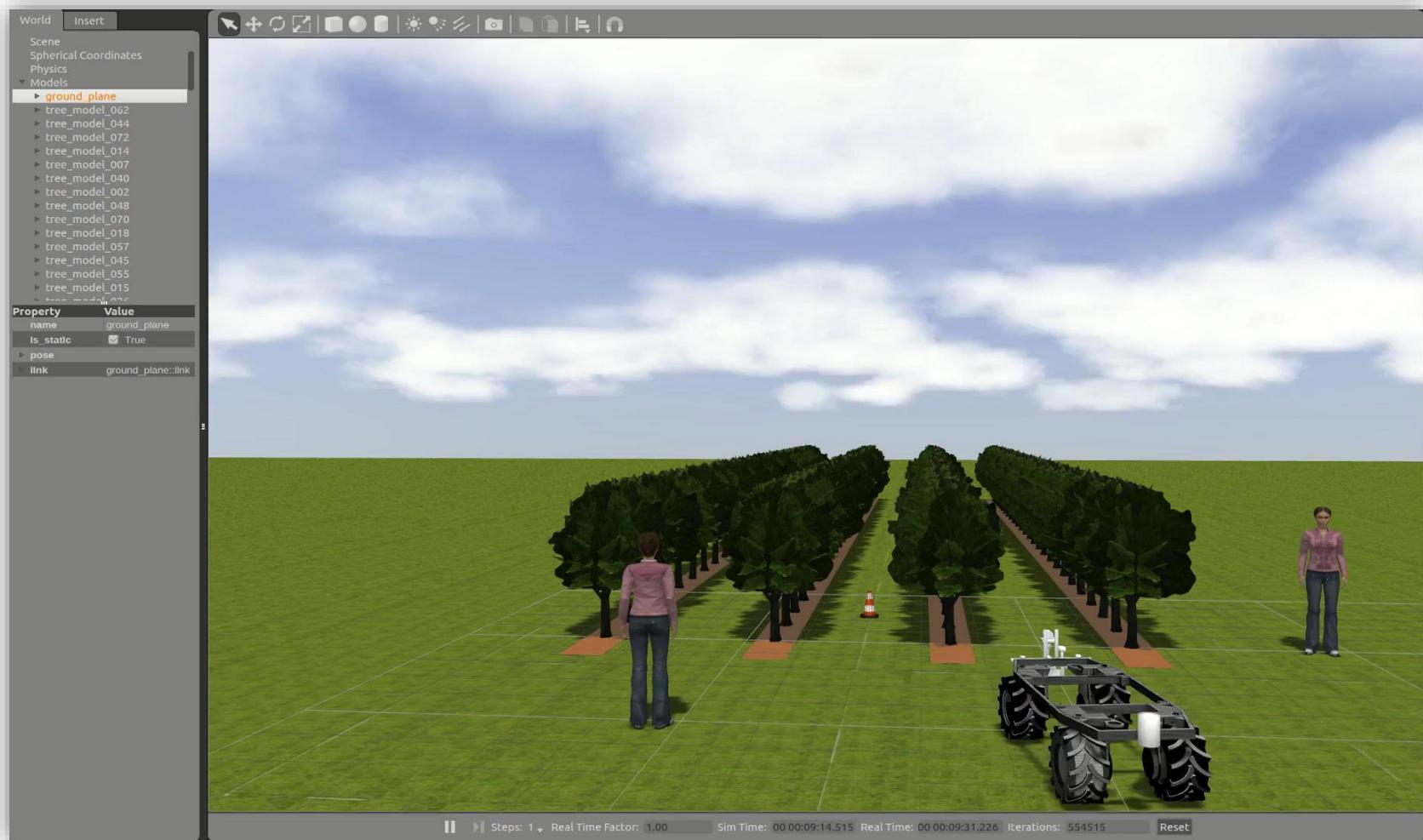
Binary Image Transformation



Hough Transformation (Lines)



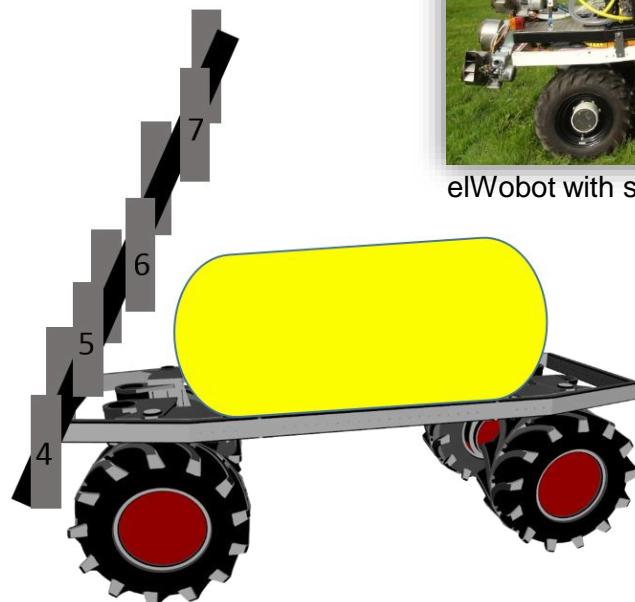
eIWObot a Robot Platform for maintenance in Orchards & Vineyards





elWObot a Robot Platform for maintenance in Orchards & Vineyards

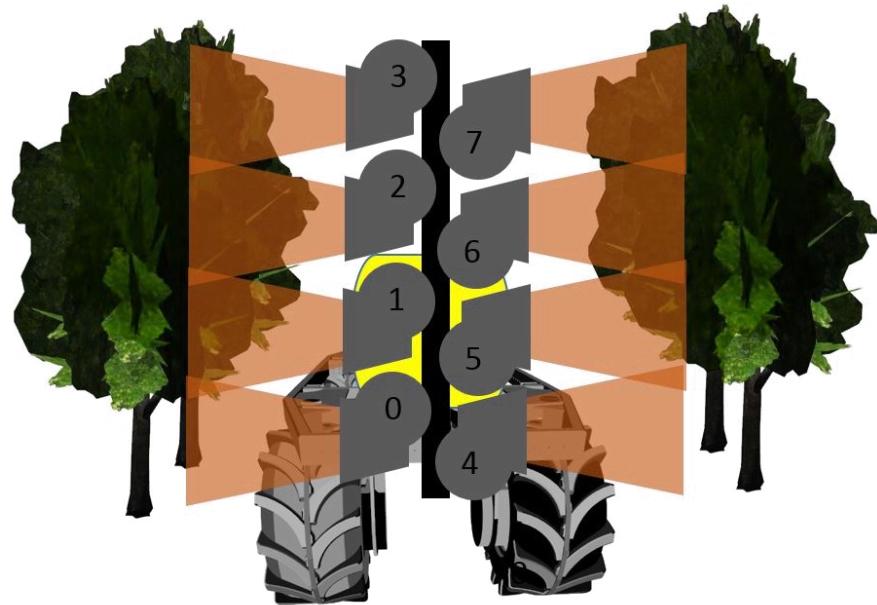
Electrical driven Sprayer



Schematically side view



elWobot with spray application

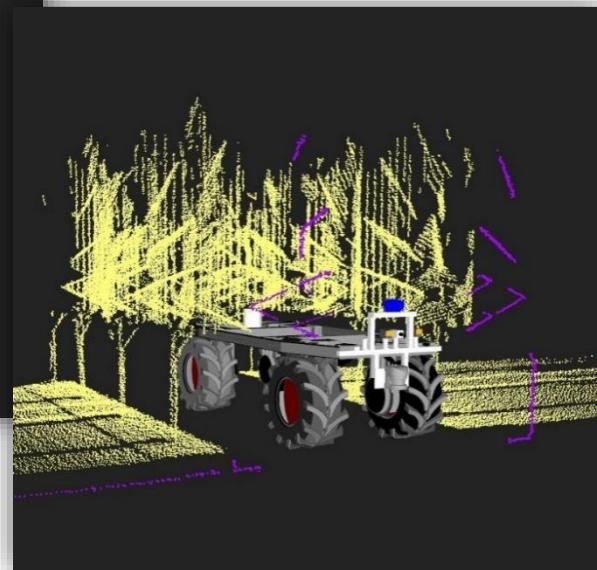
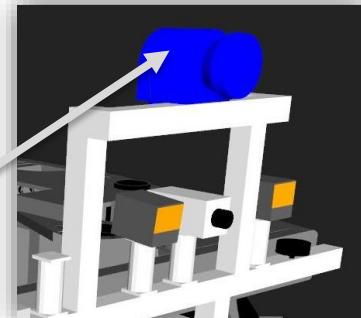
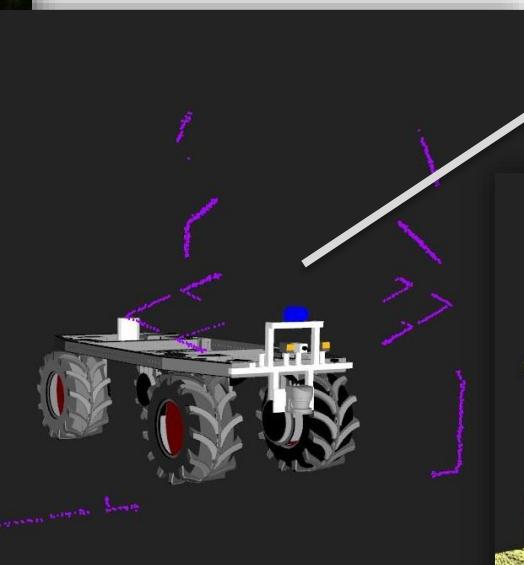


Schematically rear view



eIWObot a Robot Platform for maintenance in Orchards & Vineyards

Spraycontrol → Principle



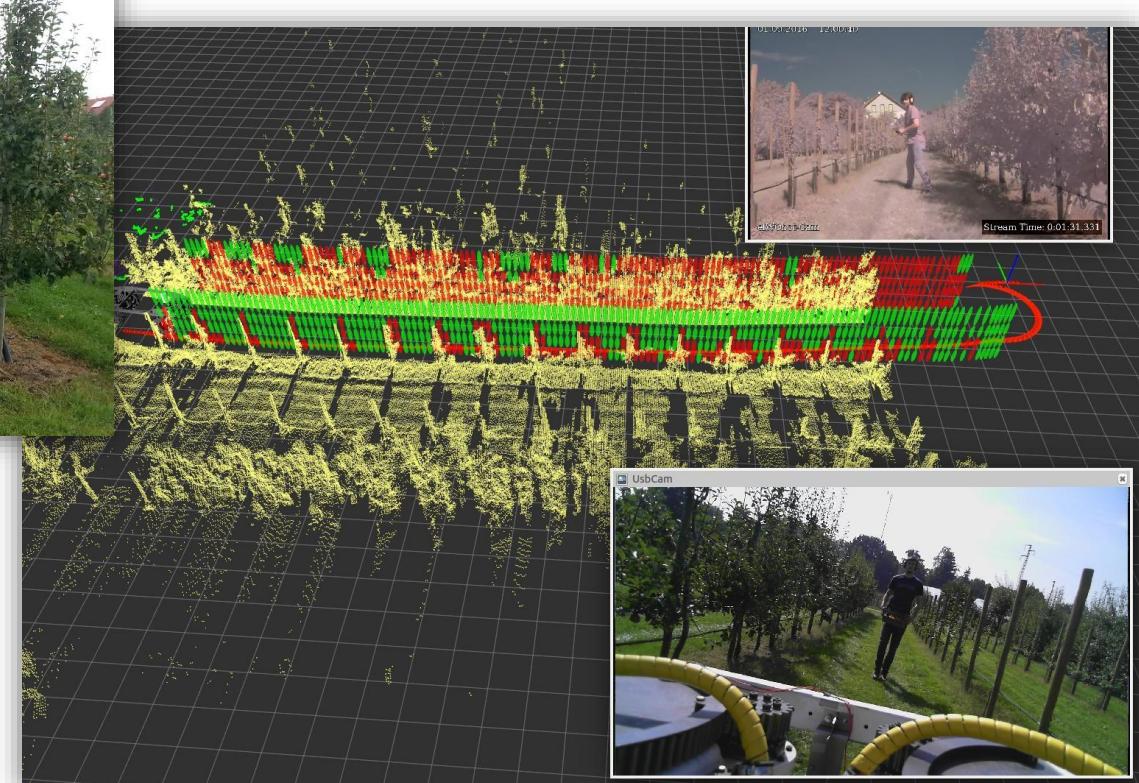


elWObot a Robot Platform for maintenance in Orchards & Vineyards

Spraycontrol → Fieldtests



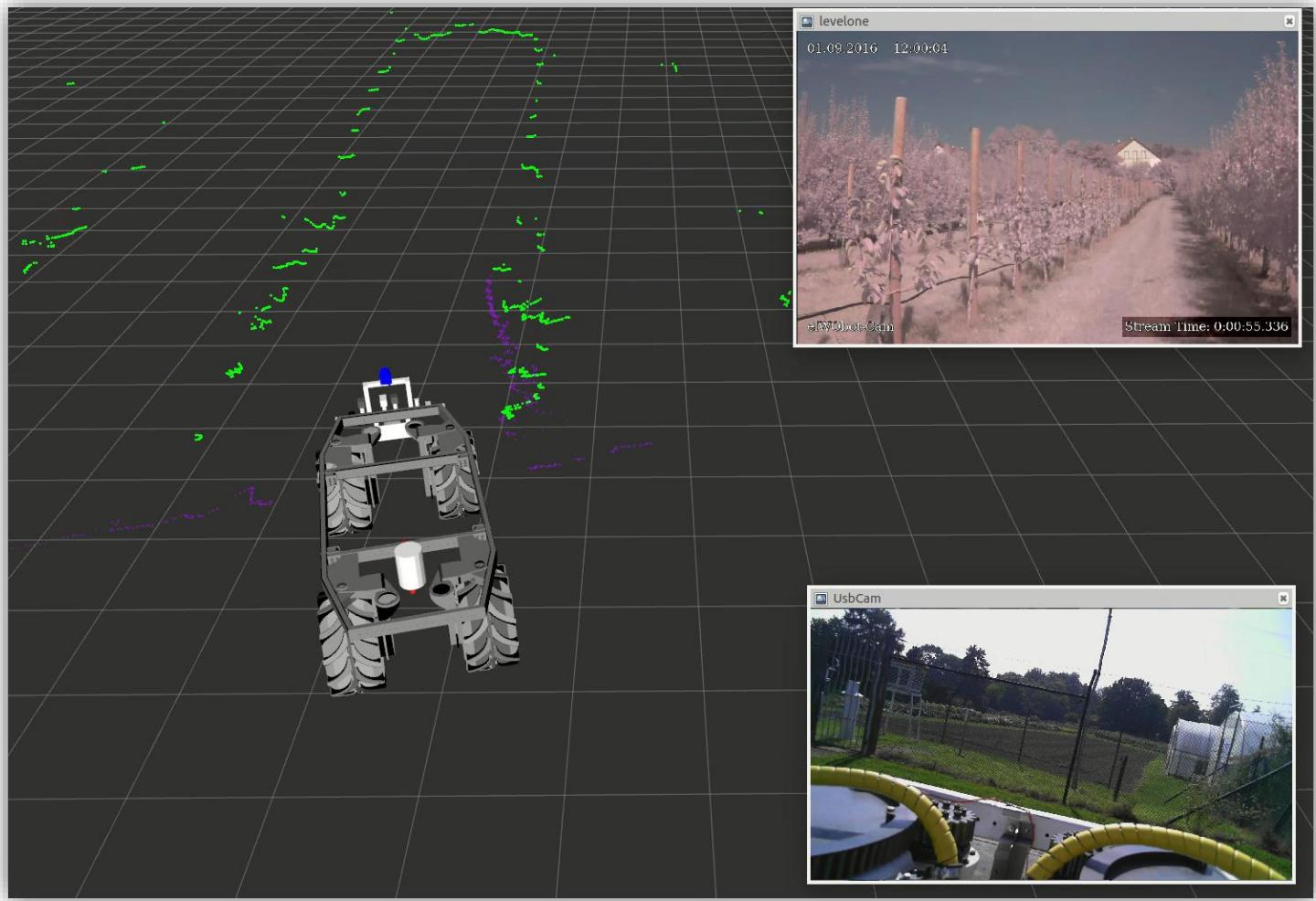
Trees with less leafs (left side) and more leafs (right side)



elWObot Spraycontrol with spray markers and point cloud



eIWObot a Robot Platform for maintenance in Orchards & Vineyards





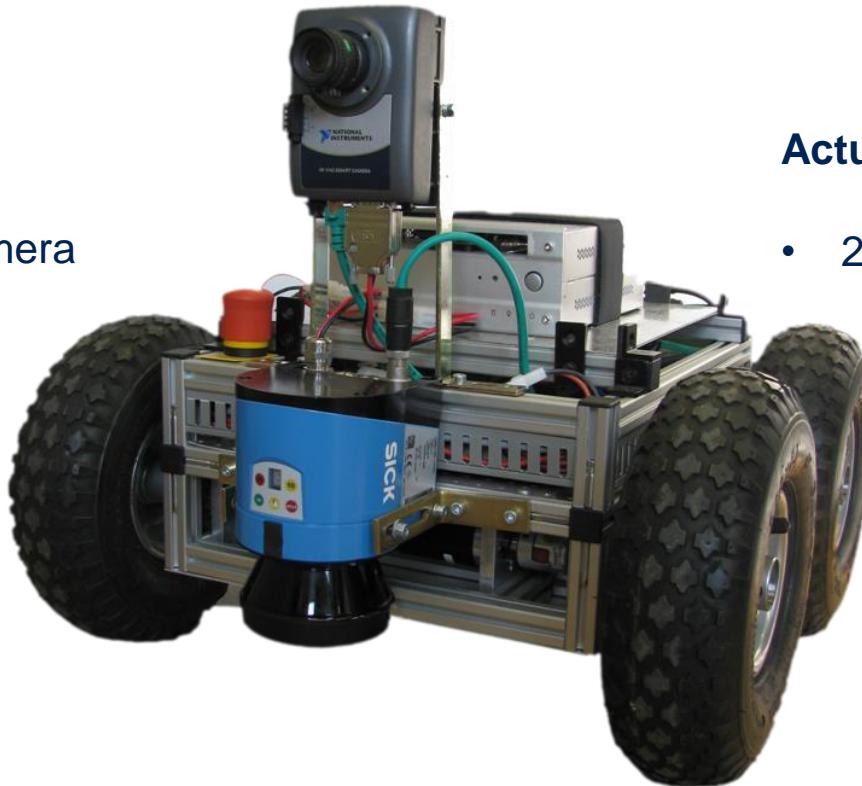
Robots for Education & Demonstration

Sensors:

- 3D Time of Flight Camera
- Laser Scanner
- Smart Cam

Actuators:

- 2 Motors (Differential Drives)



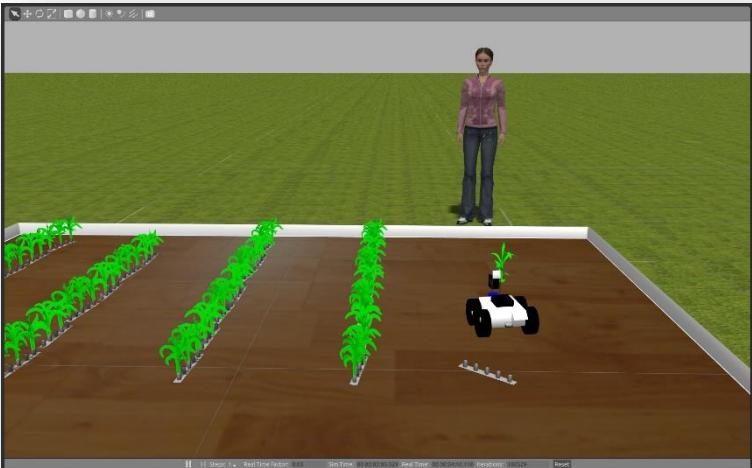
Educational robotic platform "**Zero2Nine**" for autonomous navigation and tracking
based on imaging sensor systems



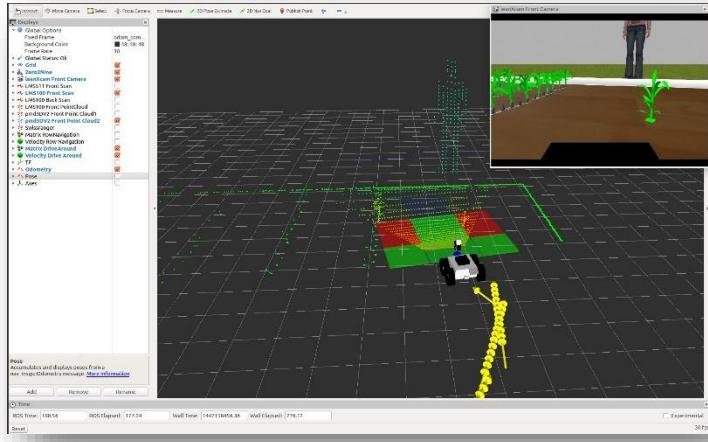
Robots for Education & Demonstration



Demonstration October 2011 – Ideen-Expo Hannover

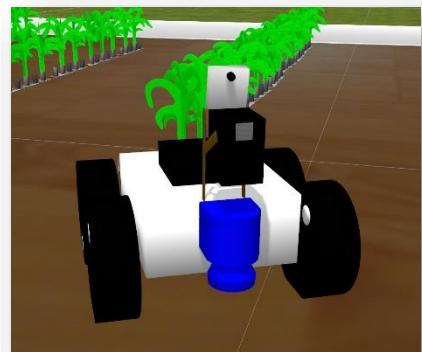


Zero2Nine in Gazebo



Zero2Nine in RViz

32

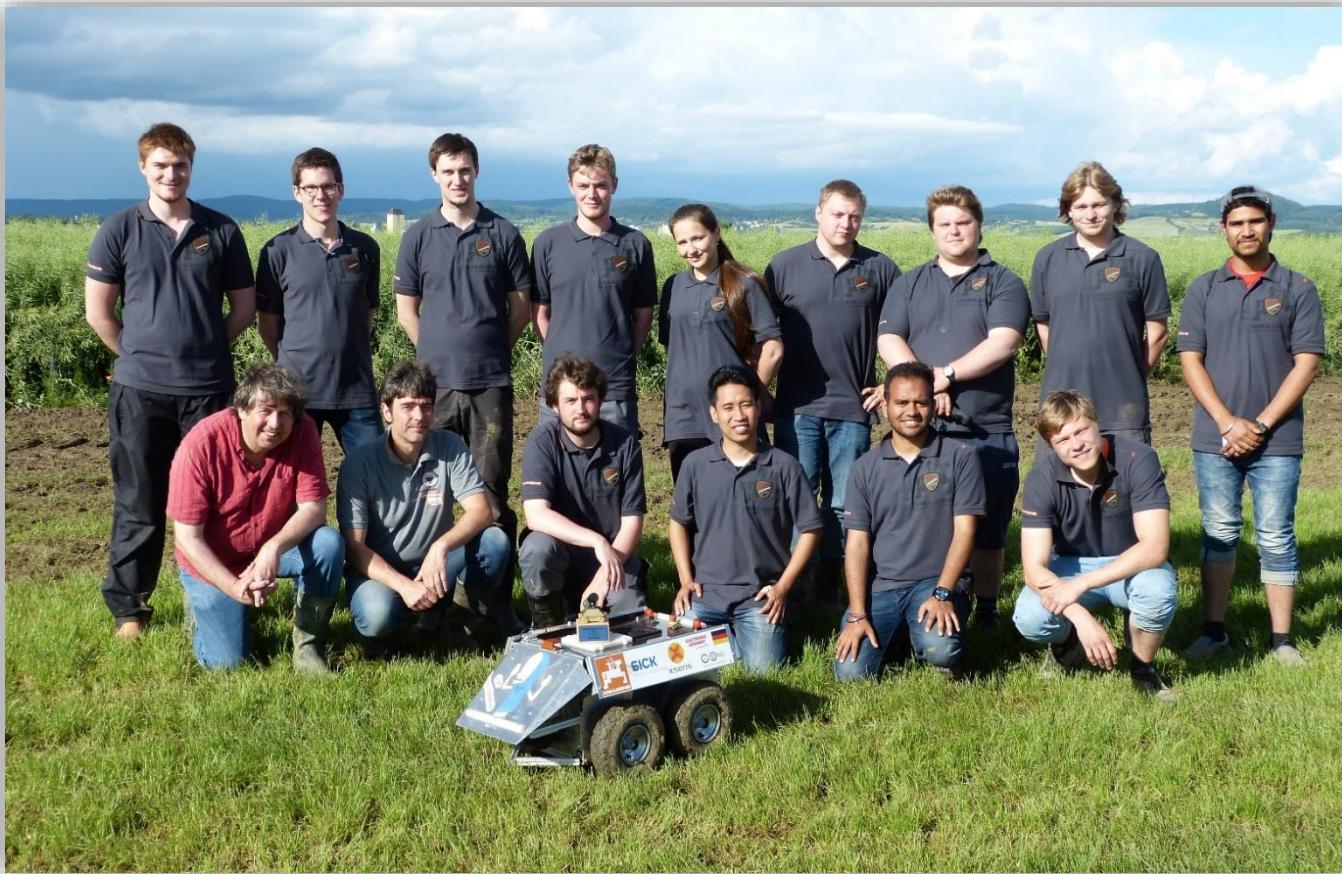


Zero2Nine in Gazebo



Robots for Education & Demonstration

International Field Robot Event – a Students Contest



Team Field Robot – world champion 2016

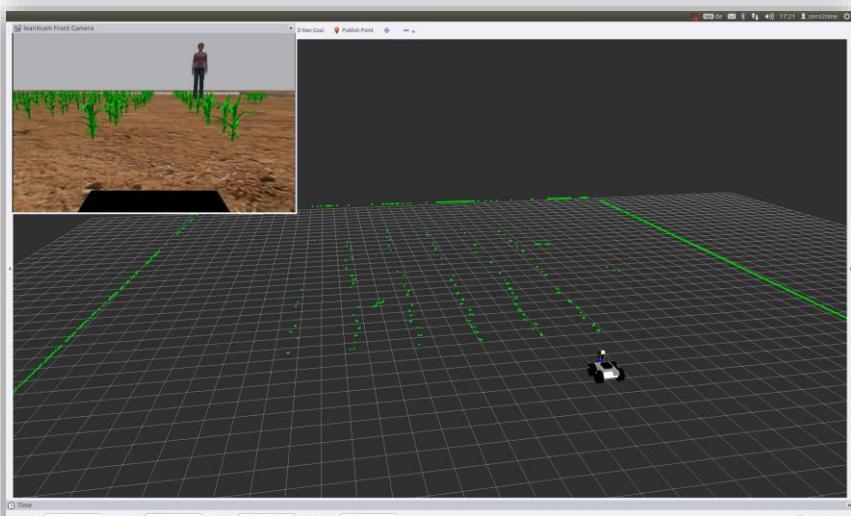


Robots for Education & Demonstration

International Field Robot Event – a Students Contest



Field Robot Event 2016



Simulating Maize-Rows (Zero2Nine)

