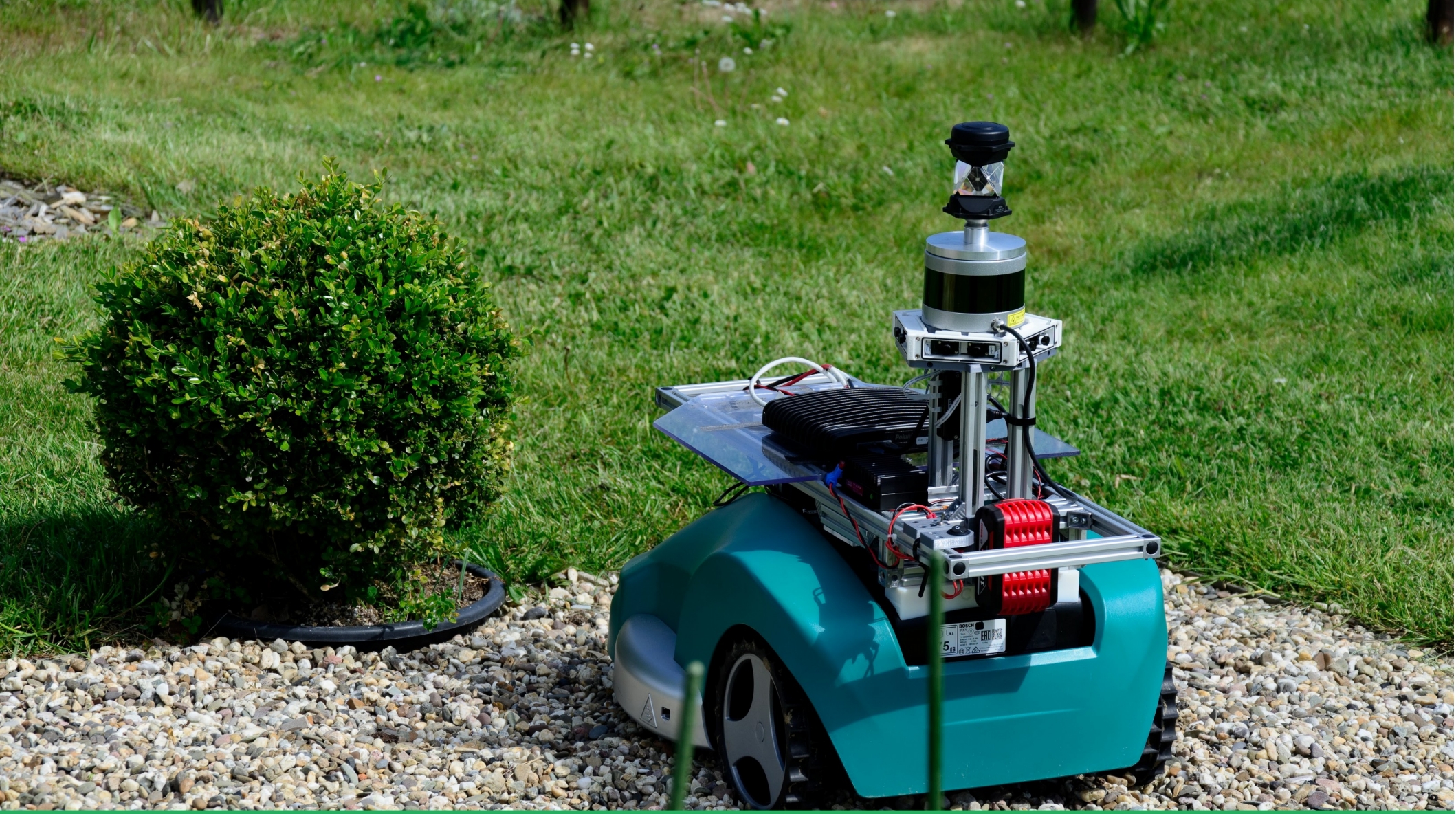

TrimBot2020: an outdoor robot for automatic gardening

Horizon 2020
European Union funding
for Research & Innovation

50th International Symposium on Robotics, 20-21 June 2018, Munich

grant no. 688007

Project Consortium

TrimBot2020 project

"to prototype the first outdoor robot for automatic bush trimming and rose cutting"

Horizon 2020
European Union funding
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THE UNIVERSITY of EDINBURGH

UNIVERSITY OF AMSTERDAM

ETH Zürich

UNI FREIBURG

WAGENINGEN UNIVERSITY & RESEARCH

BOSCH

university of groningen

TrimBot2020 objectives and components

Prototype the first outdoor garden trimming robot

- Research the underlying robotics and vision
- Navigate over varying terrain
- Approach boxwood topiary, rose bushes
- Trim them to ideal shape

Robot components

- Mobile platform (base)
- Kinova Jaco robotic arm with clipper
- Multiple camera system

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Challenges

Dynamic environment

- Weather and seasonal changes
- Variable lighting conditions

Navigation over diverse terrains

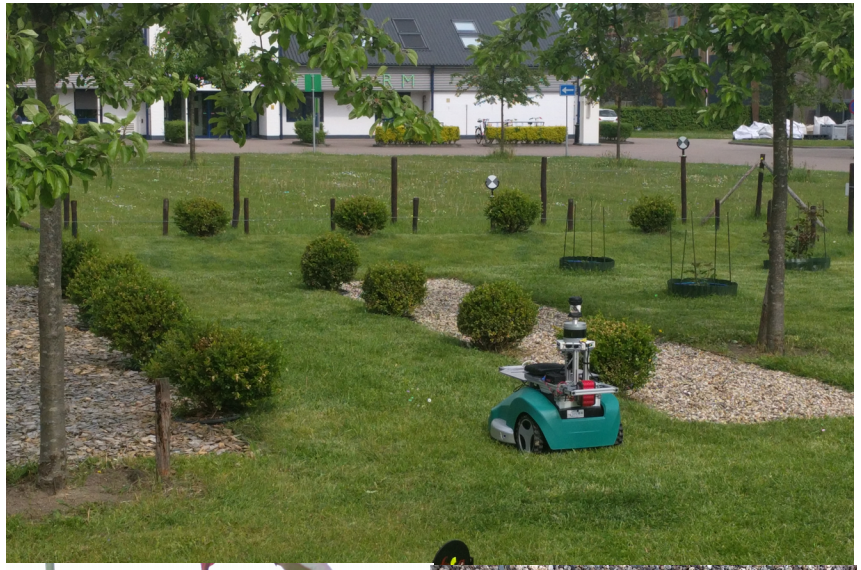
- Detection of slopes and drivable surfaces

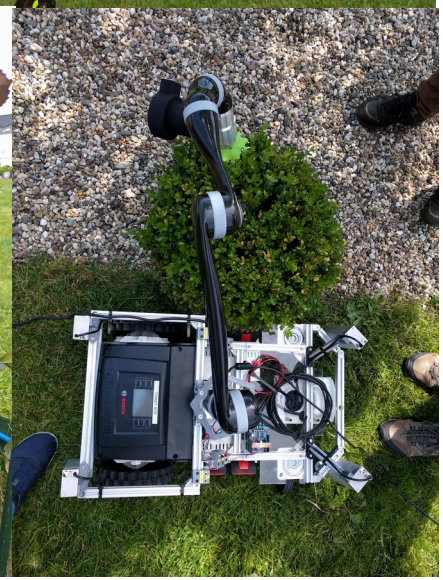
Plant shape representation

- Where to cut and how much?
- Target vs. observed shape

Accuracy of trimming

- Bend, flex, wind
- Visual servoing to bushes





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Mobile platform

Based on Bosch Indego lawn mower

+ Retractable stabilizers

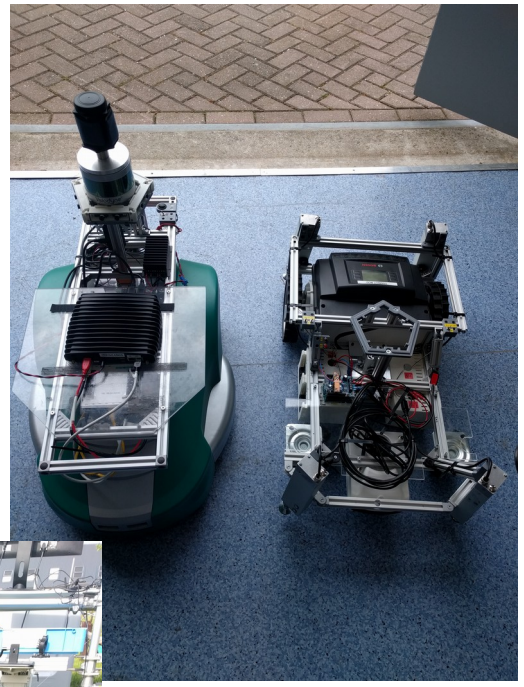
Carries control computers

Pokini Mini PC

2x RazorBlade notebooks

Camera system + IMU

Robotic arm with trimming tools



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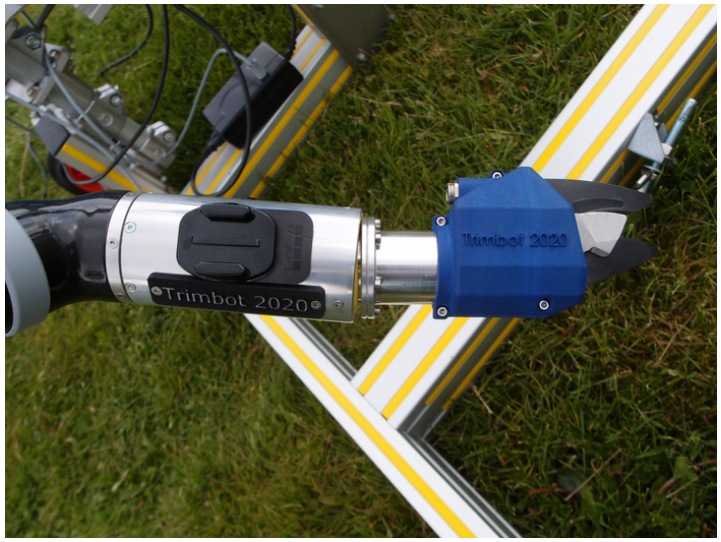
Custom trimming tools

Bush trimmer

- Counter-rotating blades
- Omni-directional cutting
- Visual servo to desired surface

Rose cutter

- Pruning of rose bushes
- Cut stems at defined locations



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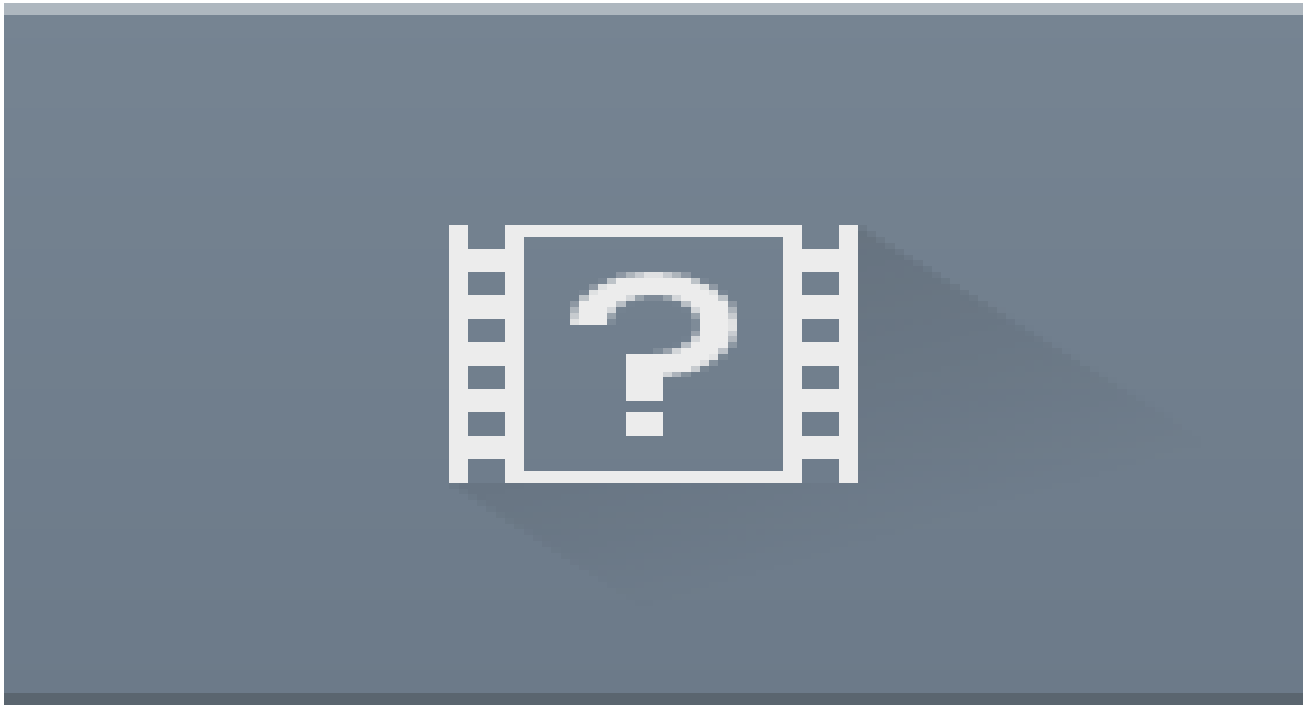
Robotic arm control

Stereo camera on the arm for bush shape fitting to 3D data

Cutter path planning and visual servoing (open loop). Multiple cutting sites around bush

Closed-loop visual servoing (future work)



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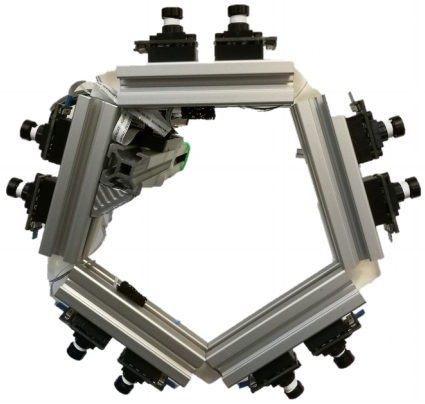
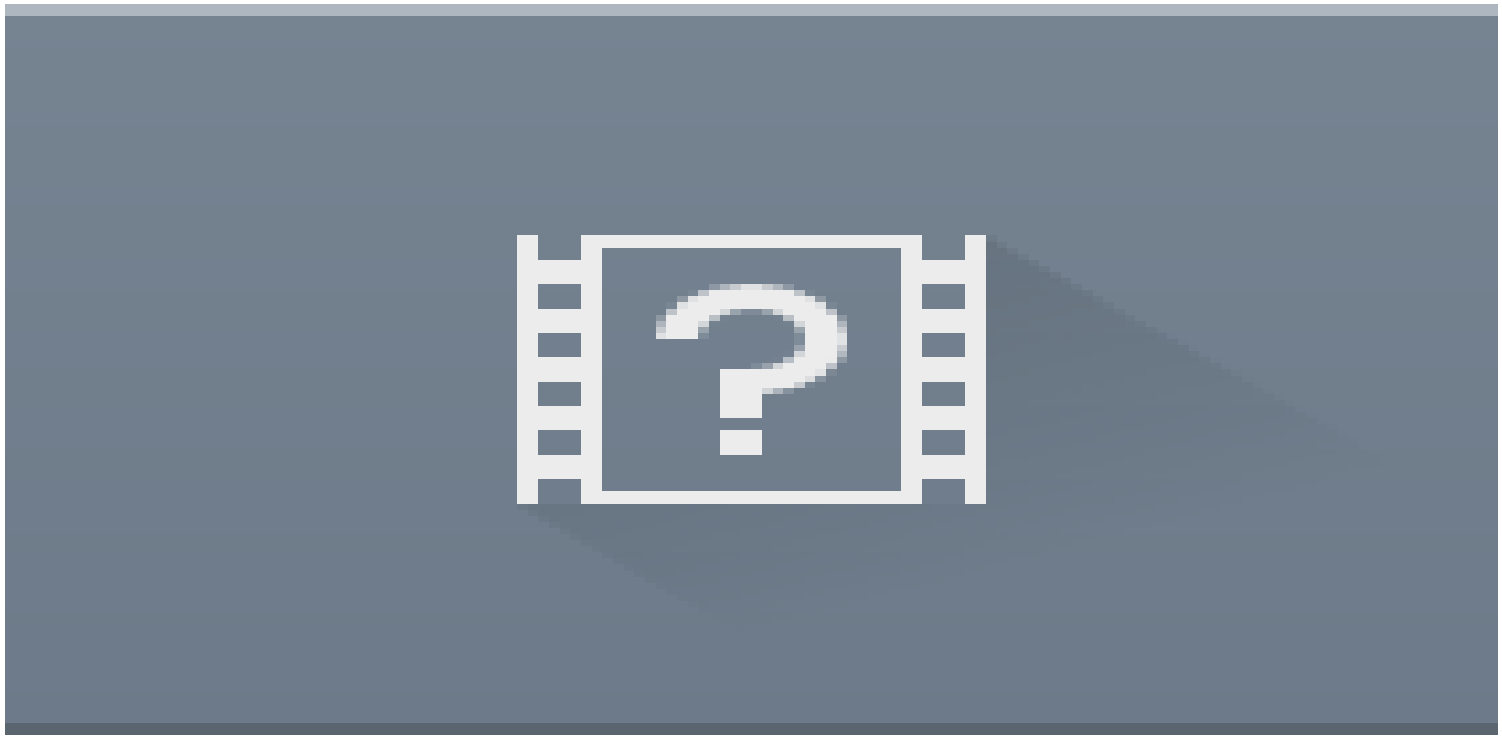
Camera sensors

5 pairs of stereo cameras (WVGA)
360° field of view
FPGA synchronization @10Hz
On-board stereo @10Hz





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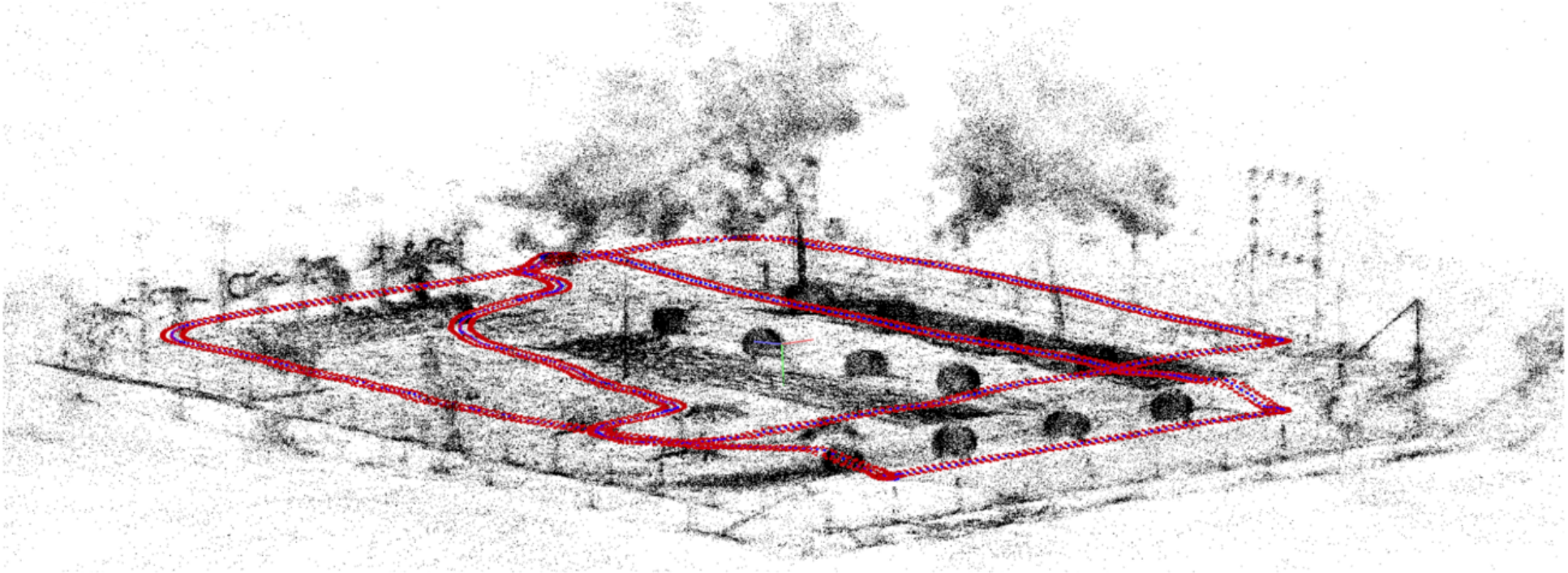
Localization and Mapping

- Visual SLAM for 6DOF pose estimation based on local features
- 10 cameras are modeled as a generalized camera
- @5Hz



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3D sensing of the environment

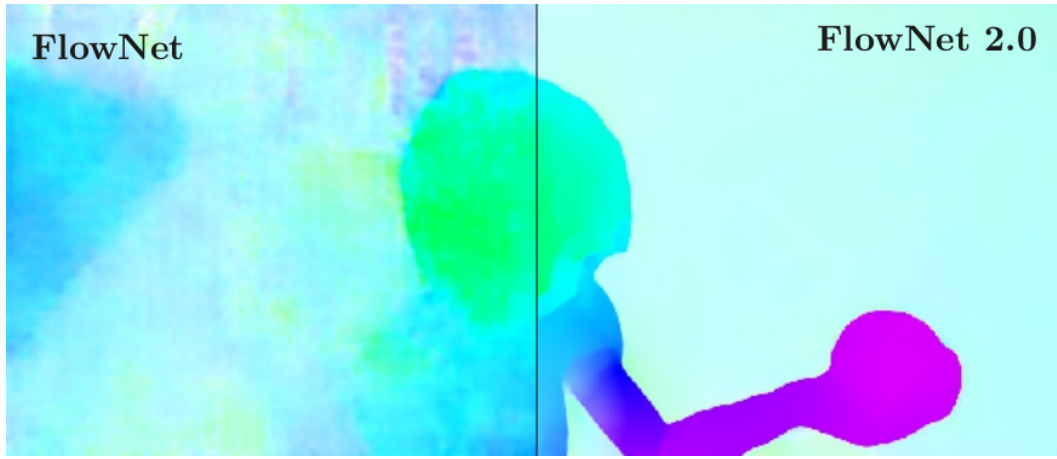
Passive sensors only

Stereo pairs

- 5 pairs for navigation (FPGA)
- 1 pair for visual servoing (DispNet)

Dynamic reconstruction

- Optical flow (FlowNet 2.0) – tracking of branch movements



Scene Understanding

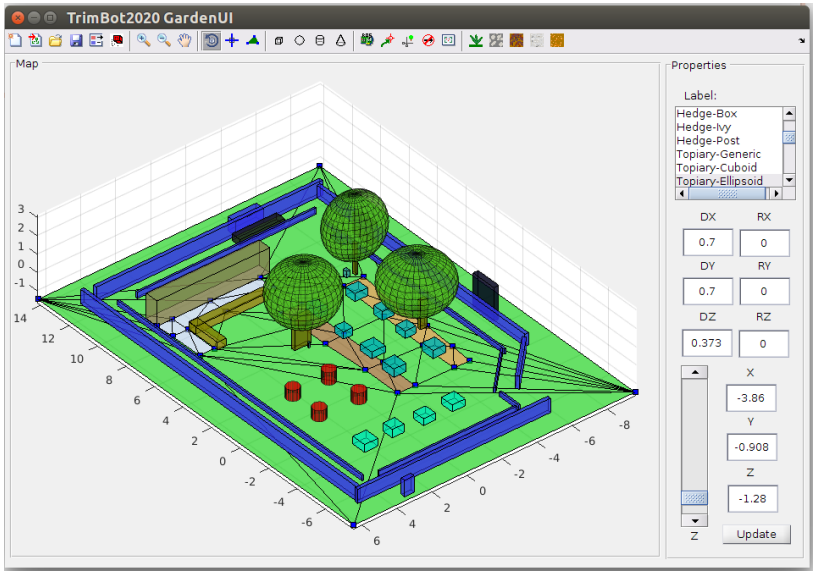
Image segmentation

Image intrinsics decomposition

Input RGB | Albedo GT | Our Albedo Prediction | Shading GT | Our Shading Prediction

Navigation

- Rough user drawn sketch map
  - Surfaces
  - Bushes
  - Obstacles, slopes
- Indicate the target bush to trim and obstacles to avoid
- Integrated-visual representation (on going/future work)



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Test gardens: Wageningen and Renningen

Workshops, Challenges, Exhibitor's booths

3D Reconstruction meets Semantics (3DRMS) workshop

1st edition @ICCV 2017, Venice

2nd edition @ECCV 2018, 9th September 2018, Munich

Challenge on **combining 3D and semantic information in complex scenes**

http://trimbot2020.webhosting.rug.nl/events/3drms/

https://gitlab.inf.ed.ac.uk/3DRMS/Challenge2018

Paper submission (full papers and exdended abstract) deadline – July 10th

Challenge deadline – **August 31st**

Upcoming

EU project exhibitor's booth at IROS 2018 (1-5 October, Madrid)

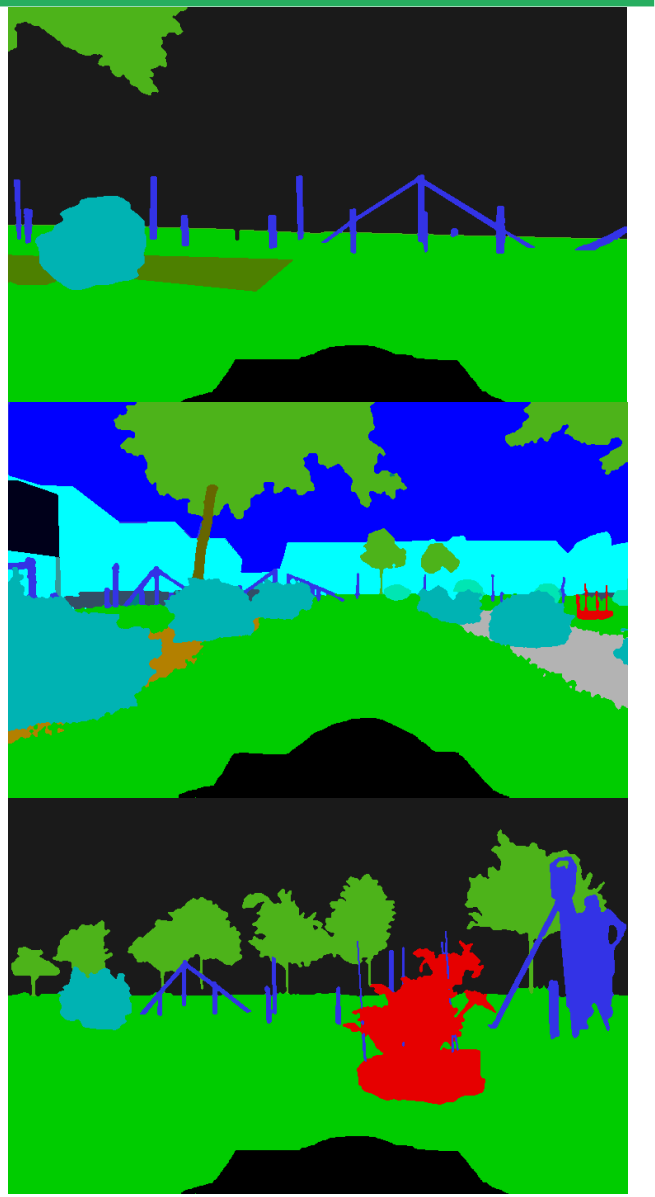
Data sets

Real data recorded in the garden

- Camera streams (with pixel-wise gt)
- 3D Point clouds (semantically annotated)
- https://gitlab.inf.ed.ac.uk/3DRMS/Challenge2017
- (Place recognition benchmark coming soon)

Synthetic data

- Rendered from virtual garden
- Varied lighting conditions
- https://gitlab.inf.ed.ac.uk/3DRMS/Challenge2018



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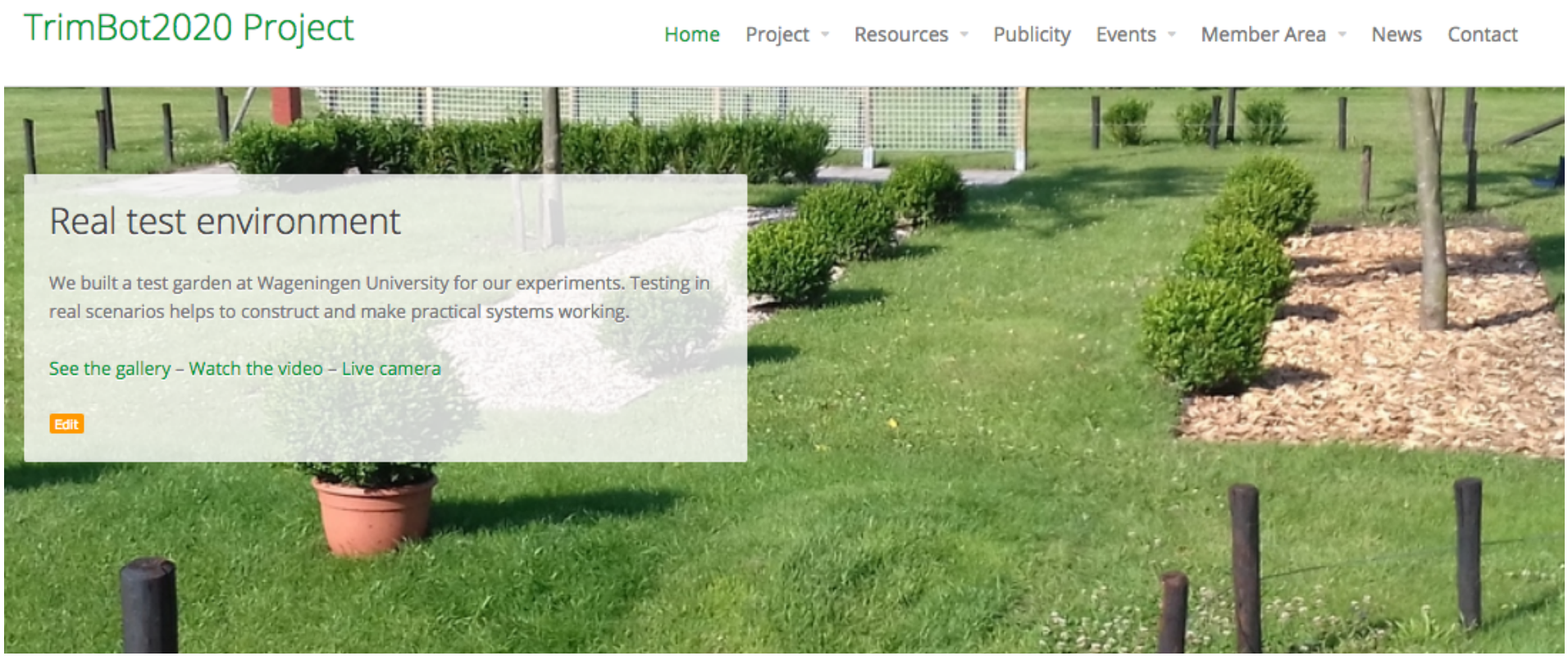
Project Website

www.trimbot2020.org



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Thank you

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