TrimBot2020 Deliverable D8.6

Wikipedia articles, popular science and presentation events

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Contributors: Bosch, WUR, UEDIN, ETHZ, ALUF
Dissemination: PU

Abstract: This deliverable reports about activities for dissemination to a general public audience and participation to popular scientific events where we presented the results of TrimBot2020.

Deliverable due: Month 48

1 Presentations and exhibitor booths

We presented the project results (partial and final) at various occasions and at a number of events. In the following we list the relevant presentations and exhibitions of the TrimBot2020 project to general public and targeted audience.

1.1 AgriFoodTech 2017

The WUR team presented partial achieved results of the TrimBot2020 project at the AgriFoodTech 2017 Dutch fair on technological progress in the agricultural production field. The robotic arm for bush trimming was presented, among the results and prototypes developed for other projects of the WUR team. In Figure 2, we show two pictures from the demonstration booth.

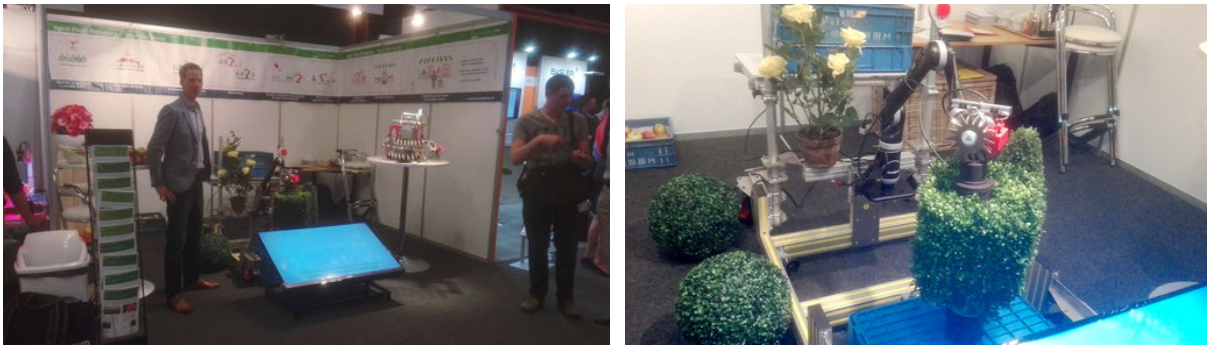


Figure 1: Booth at AgriFoodTech 2017.

1.2 ETH Zurich Scientifica 2017 and 2019

Scientifica is the yearly fair of the ETH in which research products are demonstrated to the general public, schools and people interested in scientific progress. Below, we show a picture of the TrimBot2020 demonstrated in the exhibition hall.

Figure 2: TrimBot2020 exhibited at ETH Scientifica.

1.3 APPIS 2018 and exhibition in Elder Museum

We (RUG team) organized a special session dedicated to the TrimBot2020 project at the 1st International Conference on Applications of Intelligent Systems (APPIS) 2018. The session was attended by about 50 delegates of the conference and enlarged the dissemination of the TrimBot2020 achievements also to scientists in signal processing, intelligent buildings, medical systems for non-visual data and so on.

The TrimBot2020 results achieved up to that period were presented with videos streamed on the TV screens of the Elder Museum of Science and Technology for the whole week. The project videos were watched by the attendants of the Elder Museum in Las Palmas de Gran Canaria. These are people from the general public, tourists, children on school trips, families. Pictures of the activities at APPIS 2018 are shown below (Figure 3).

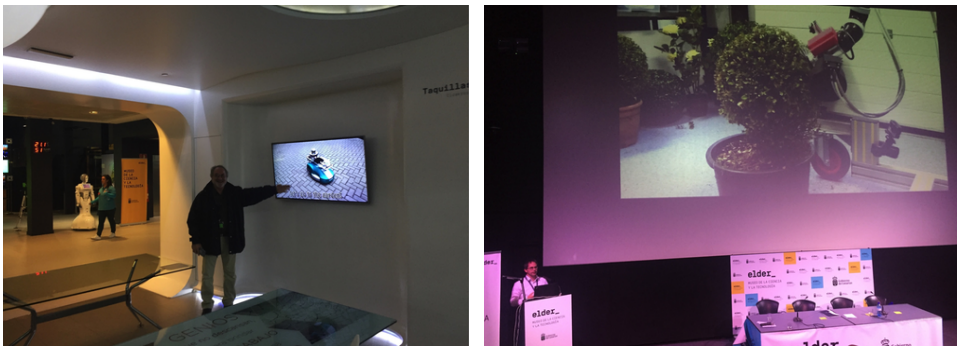


Figure 3: Photos of the dissemination at APPIS 2018 and in the Elder Museum.

1.4 International Symposium on Robotics 2018

We (RuG team) presented an overview of the TrimBot2020 project activities and results achieved up to June 2018 at the 50th International Symposium on Robotics (ISR) 2018 in Munich on June 19-21. The audience was of about 150 people, with expertise in various branches of robotics, from industrial to aerospace robotics and self-driving cars. The novelty of the TrimBot2020 robotics application stimulated the interest of the audience, especially regarding technical solutions and future works. Pictures of the presentation are shown below (Figure 4).

Figure 4: Photos of the presentation at ISR.

1.5 IROS 2018

We (RUG team) presented the progress of the TrimBot2020 development with an exhibitor booth at the International Conference on Intelligent Robots and systems (IROS) 2018, held in Madrid (Spain) from 1 to 5 October. Videos of the TrimBot2020 platform navigating the garden and of the trimming action of a bush were continuously streamed on a TV screen and raised the interest of the audience of the exhibition. We also demonstrated the TrimBot2020 robotic arm with the custom trimmers.

Target audience and visitors were from academia, industry and governmental bodies. About 300 people collected advertisement flyers and leaflets about diverse aspects of the project. Below, some pictures of the TrimBot2020 booth at IROS are shown. (Figure 5)

Figure 5: Photos of the exhibitor booth at IROS 2018.

At the Industry, Kai Oliver Arras from Bosch gave a talk about **From 600 gr to 60 t: Robotics Research at Bosch** - see Figure 6. Among other research projects also the Trimbot2020 Project was presented.

Figure 6: Talk of Kai Oliver Arras (Bosch) at IROS 2018 Industry Forum.

1.6 EU Industry Days 2019

The TrimBot2020 consortium participated (RUG team) in the European Industry Days 2019 meeting, held in Brussels on 5 and 6 of February 2019. We demonstrated the achieved results in the first three years of the project with an exhibitor booth (of four squared meters) in which we showed one modified Bosch Indego mower platform, and videos of garden navigation and trimming action demonstrations, flyers, leaflets and posters. The audience of the dissemination activity was mainly composed of industry and governmental bodies representatives that expressed curiosities mostly about the marketization of the project results. Around 20 persons per day stopped at the booth to discuss the technological progress developed in the project. In Figure 7, we show few pictures of the booth.

Figure 7: Photos of the presentation at the EU Instrustry Days 2019 event.

1.7 European Robotics Forum

The Bosch team participated in the European Robotics Forum 2019 meeting in Bucharest (20 - 22 March). The complete prototype robot was presented to industrial peers in an exhibitor booth together with other Bosch robotic activities. Promotional materials (deliverable D8.5) was distributed to the audience. A particular note of importance has to be made for the great interest of children from schools, to whom we showed the results that robotics can achieve today. Below we show few photos of the event.

At the Official Opening Session, Kai Oliver Arras from Bosch gave a talk about **From 600 gr to 60 t: Robotics Research at Bosch**. Among other research projects also the Trimbot2020 Project was presented.

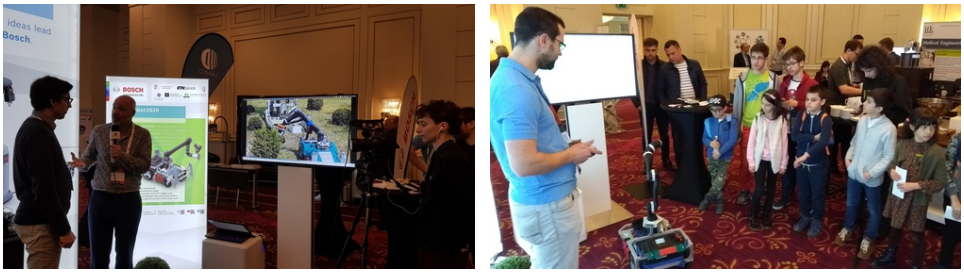


Figure 8: Photos of the presentation at the European Robotics Forum 2019.

1.8 Robotics: Science and Systems 2019 conference

Bosch participated with an exhibitor booth showing some results of the TrimBot2020 project in the Robotics: Science and Systems (RSS 2019) conference. See below few photos of the booth.

Figure 9: Photos of the booth presented by Bosch at RSS 2019.

1.9 AgriFoodTech 2019 - Final results presentation

We (RUG and WUR teams) demonstrated the final TrimBot2020 results and prototype at AgriFoodTech 2019, the annual fair of agricultural and food technology of the Netherlands, that attracts people from industry, academia, governmental and public bodies, and general public with interest in technological progress in the agricultural field. We also organized a workshop in which we discussed more technical results of TrimBot2020 and welcomed talks from delegates of other research institutions and companies with strong expertise in agricultural robotics.

We provide more details about the workshop and exhibitor booth for the final dissemination event of the TrimBot2020 results in the deliverable D8.10. Below, few pictures of the booth and the TrimBot2020 presentation are shown.

Figure 10: Photos of the exhibitor booth and TrimBot2020 presentation at AgriFoodTech 2019.

2 Project mentions

The project was mentioned and its results covered by many newspapers and online media. On the website, at the url http://trimbot2020.webhosting.rug.nl/publicity/, we maintain an updated list of the mentions (more than 40 in December 2019).

3 Scientific presentations

The results achieved in the TrimBot2020 project were presented at a number of conferences and events, of which we give a list in the following. For completeness, we also report a list of the published journal papers.

3.1 Conference presentations (posters and oral)

- Horna, L. A., Fisher, R. B. **3D plane labeling stereo matching with content aware adaptive windows** *Proc. 12th International Joint Conference on Computer Vision, Imaging and Computer Graphics Theory and Applications, 2017.*
- Luis Horna, Robert B. Fisher **Plane labeling trinocular stereo matching with baseline recovery** *The Fifteenth IAPR International Conference on Machine Vision Applications, 2017.*
- Dominik Honegger, Torsten Sattler, Marc Pollefeys **Embedded Real-time Multi-Baseline Stereo** *Proc. IEEE Int. Conf. on Robotics and Automation (ICRA), 2017, 2017.*
- Thomas Schöps, Johannes L. Schönberger, Silvano Galliani, Torsten Sattler, Konrad Schindler, Marc Pollefeys, Andreas Geiger **A Multi-View Stereo Benchmark with High-Resolution Images and Multi-Camera Videos** *Conference on Computer Vision and Pattern Recognition (CVPR), 2017, 2017.*
- Johannes Lutz Schönberger, Hans Hardmeier, Torsten Sattler, Marc Pollefeys **Comparative Evaluation of Hand-Crafted and Learned Local Features** *Conference on Computer Vision and Pattern Recognition (CVPR), 2017.*
- Eddy Ilg, Nikolaus Mayer, T. Saikia, Margret Keuper, Alexey Dosovitskiy, Thomas Brox **FlowNet 2.0: Evolution of Optical Flow Estimation with Deep Networks Conference** *IEEE Conference on Computer Vision and Pattern Recognition (CVPR), 2017.*
- Benjamin Ummenhofer, Huizhong Zhou, Jonas Uhrig, Nikolaus Mayer, Eddy Ilg, Alexey Dosovitskiy, Thomas Brox **DeMoN: Depth and Motion Network for Learning Monocular Stereo** *IEEE Conference on Computer Vision and Pattern Recognition (CVPR), 2017.*
- Torsten Sattler, Radim Tylecek, Thomas Brox, Marc Pollefeys, Robert B. Fisher **3D Reconstruction Meets Semantics – Reconstruction Challenge 2017** *ICCV Workshop Venice, Italy, 2017.*
- Anil S. Baslamisli, Hoang-An Le, Theo Gevers **CNN based Learning using Reflection and Retinex Models for Intrinsic Image Decomposition** *IEEE International Conference on Computer Vision and Pattern Recognition (CVPR), 2018.* Johannes L. SchÃ¶nberger, Andreas Geiger, Marc Pollefeys, Torsten Sattler **Semantic Visual Localization** *IEEE International Conference on Computer Vision and Pattern Recognition, 2018.*

- Nicola Strisciuglio, Maria Leyva Vallina, Nicolai Petkov, Rafael Munoz Salinas **Camera Localization in Outdoor Garden Environments Using Artificial Landmarks** *IEEE International Work Conference on Bioinspired Intelligence , 2018.*
- B.A.J. van Tuijl, A.P.M. Tielen, A. Mencarelli, J. Hemming **Structured design of a novel end-effector for a bush trimming robot** *European Society of Agricultural Engineers (EurAgEng) Conference, Ageng 2018, 2018.*
- Nicola Strisciuglio, Radim Tylecek, Nicolai Petkov, Peter Bieber, Jochen Hemming, Eldert van Henten, Torsten Sattler, Marc Pollefeys, Theo Gevers, Thomas Brox, Robert B. Fisher **TrimBot2020: an outdoor robot for automatic gardening** *50th International Symposium on Robotics, VDE Verlag GmbH - Berlin - Offenbach, 2018.*
- Hoang-An Le, Anil Baslamisli, Thomas Mensink andTheo Gevers. **Three for one and one for three: Flow, Segmentation, and Surface Normals.** *British Machine Vision Conference, BMVC 2018, 2018.*
- Can Pu, Nanbo Li, Radim Tylecek, Bob Fisher **DUGMA: Dynamic Uncertainty-Based Gaussian Mixture Alignment** *3DV 2018, 2018.*
- Nektarios Lianos, Johannes L. Schönberger, Marc Pollefeys, Torsten Sattler **VSO: Visual Semantic Odometry** *European Conference on Computer Vision, ECCV 2018 , 2018.*
- Anil Baslamisli, Thomas Tiel Groenestege, Partha Das, Hoang-An Le, Sezer Karaoglu, Theo Gevers **Joint Learning of Intrinsic Images and Semantic Segmentation** *European Conference on Computer Vision, ECCV 2018 , 2018.*
- Huizhong Zhou, Benjamin Ummenhofer, Thomas Brox **DeepTAM: Deep Tracking and Mapping** *European Conference on Computer Vision, ECCV 2018 , 2018.*
- Eddy Ilg, Özgün Çiçek, Silvio Galesso, Aaron Klein, Osama Makansi, Frank Hutter, Thomas Brox **Uncertainty Estimates and Multi-Hypotheses Networks for Optical Flow** *European Conference on Computer Vision, ECCV 2018 , 2018.*
- Eddy Ilg, Tonmoy Saikia, Margret Keuper, Thomas Brox **Occlusions, Motion and Depth Boundaries with a Generic Network for Optical Flow, Disparity, or Scene Flow Estimation** *European Conference on Computer Vision, ECCV 2018 , 2018.*
- Ian Cherabier, Johannes L. Schönberger, Martin Oswald, Marc Pollefeys, Andreas Geiger **Learning Priors for Semantic 3D Reconstruction** *European Conference on Computer Vision, ECCV 2018 , 2018.*
- Wei Zeng, Theo Gevers **3DContextNet: K-d Tree Guided Hierarchical Learning of Point Clouds Using Local and Global Contextual Cues** *Workshop Geometry Meets Deep Learning, ECCV, 2018, 2018.*
- Nicola Strisciuglio, George Azzopardi, Nicolai Petkov **Brain-Inspired Robust Delineation Operator** *European Conference on Computer Vision Workshops 2018, Springer, 2018.*

- Hanz Cuevas-Velasquez, Nanbo Li, Radim Tylecek, Marcelo Saval-Calvo, Robert Fisher **Hybrid Multi-camera Visual Servoing to Moving Target** *IROS 2018, Madrid, 2018.*
- Jose Facil, Benjamin Ummenhofer, Huizhong Zhou, Luis Montesano, Thomas Brox, Javier Civera **CAM-Convs: Camera-Aware Multi-Scale Convolutions for Single-View Depth** *IEEE International Conference on Computer Vision and Pattern Recognition (CVPR), 2019.*
- Osama Makansi, Eddy Ilg, Özgün Çiçek, Thomas Brox **Overcoming Limitations of Mixture Density Networks: A Sampling and Fitting Framework for Multimodal Future Prediction** *IEEE International Conference on Computer Vision and Pattern Recognition (CVPR), 2019.*
- Maria Leyva Vallina, Nicola Strisciuglio, Nicolai Petkov **Place Recognition in Gardens by Learning Visual Representations: Data Set and Benchmark Analysis** *International Conference on Analysis of Images and Patterns CAIP 2019, 2019.*
- Can Pu, Robert B. Fisher **UDFNET: Unsupervised disparity fusion with adversarial networks** *Proc. 26th IEEE Int Conf on Image Processing (ICIP)*
- Dejan Kaljaca, Nikolaus Mayer, Bastiaan Vroegindeweij, Angelo Mencarelli, Eldert J. Van Henten, Thomas Brox **Automated Boxwood Topiary Trimming with a Robotic Arm and Integrated Stereo Vision** *IROS 2019*

3.2 Other presentations

- Robert B. Fisher **TrimBot2020: A gardening robot for rose, hedge and topiary trimming** *European Robotics Forum, March 2016, talk and poster*
- Radim Tylecek **TrimBot2020 Project Overview** *APPIS Conference, January 2018*
- Nicola Strisciuglio **TrimBot2020: an outdoor robot for automatic gardening** *ISR 2018*
- Michael Blaich **Robotereinsatz zum automatischen Stutzen von Buchsbaum und Rosen, KTBL Fachtagung** *Robotics und Automatisierung im Gartenbau 2018 (Erfurt)*
- Kai Oliver Arras, **From 600 gr to 60 t: Robotics Research at Bosch** *IROS 2018 (Madrid), Industry Forum (Among other research projects also the Trimbot2020 Project was presented in this talk)*
- Kai Oliver Arras, **From 600 gr to 60 t: Robotics Research at Bosch**, *European Robotics Forum (ERF) 2019 (Bucharest), Official Opening Session, (Among other research projects also the Trimbot2020 Project was presented in this talk)*
- N. Petkov **Trainable COSFIRE filters for pattern detection and representation learning.** *Invited keynote talk at 18th international Conference on Computer Analysis of Images and Patterns CAIP2019, 2-6 Sept. 2019, Salerno, Italy. (TrimBot2020 in parts of the applications)*

- Radim Tylecek **Challenges in Autonomous Outdoor Gardening with a Robot Using Passive Vision** *CTU Prague 2019*
- Radim Tylecek **TrimBot2020: Autonomous Outdoor Gardening Robot Using Passive Vision** *AgriFoodTech 2019*
- Michael Blaich **Smart Agriculture at Bosch - From Farm to Fork** *AgriFoodTech 2019*

Furthermore, the ALUF team gave a DispNet demo to 5 members of the German parliament when they visited the University of Freiburg. Also, the ALUF team gave talks to politicians from the state of Baden-Wurttemberg (finance minister, and a member of the parliament), where TrimBot2020 research results were mentioned.

3.3 Journal publications

- Sezer Karaoglu, Yang Liu, Theo Gevers, Arnold W.M. Smeulders **Point Light Source Position Estimation from RGB-D Images by Learning Surface Attribute** *IEEE Trans. Image Processing, 2017.*
- Nikolaus Mayer, Eddy Ilg, Philipp Fischer, Caner Hazirbas, Daniel Cremers, Alexey Dosovitskiy, Thomas Brox **What Makes Good Synthetic Training Data for Learning Disparity and Optical Flow Estimation?** *International Journal of Computer Vision, 2018.*
- Radim Tylecek, Fisher, R. B. **Consistent Semantic Annotation of Outdoor Datasets via 2D/3D Label Transfer** *Sensors, 18 (7), pp. 20, 2018, ISSN: 1424-8220.*
- Can Pu, Runzi Song, Radim Tylecek, Nanbo Li, Bob Fisher **SDF-MAN: Semi-Supervised Disparity Fusion with Multi-Scale Adversarial Networks** *Remote Sensing, 11 (5), pp. 487, 2019.*
- Maria Leyva Vallina, Nicola Strisciuglio, Manuel Lopez Antequera, Radim Tylecek, Michael Blaich, Nicolai Petkov **TB-Places: A Data Set for Visual Place Recognition in Garden Environments** *IEEE Access, 7 , pp. 52277 - 52287, 2019, ISSN: 2169-3536.*
- Manuel Lopez Antequera, Maria Leyva Vallina, Nicola Strisciuglio, Nicolai Petkov **Place and Object Recognition by CNN-Based COSFIRE Filters** *IEEE Access, 7 , pp. 66157 - 66166, 2019.*
- Nicola Strisciuglio, George Azzopardi, Nicolai Petkov **Inhibition-augmented Operator for Delineation of Curvilinear Structures** *IEEE Transactions on Image Processing, 2019. doi: 10.1109/TIP.2019.2922096*
- Huizhong Zhou, Benjamin Ummenhofer, Thomas Brox **DeepTAM: Deep Tracking and Mapping with Convolutional Neural Networks** *International Journal of Computer Vision, 2019.*
- Dejan Kaljaca, Bastiaan Vroegindeweij, Eldert J. Van Henten **Coverage trajectory planning for a bush trimming robot arm** *J Field Robotics, pp. 1-26, 2019.*

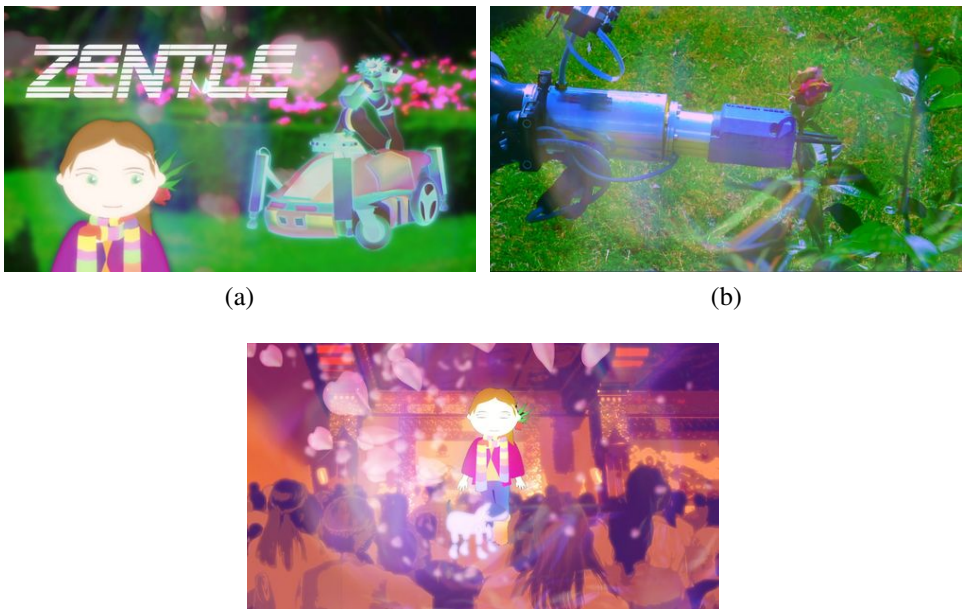
3.4 Radio interviews

The project coordinator, Prof. Fisher, had two radio interiews where he talked about the final achievements of the project. The interviews were for:

- BBC RADIO SCOTLAND - 25 October
- BBC Radio 4 Today - 26 October

4 Wikipedia page

We developed a Wikipedia page that describes the technological innovations proposed by the TrimBot2020 consortium and used to develop the first outdoor gardening robot. The page lists information about the project and the consortium, together with references to some of the project publications. We attach an export of the page at the end of this document. The page is still awaiting for approval by the Wikipedia coordinators. The URL of the draft page is: https://en.wikipedia.org/wiki/Draft:TrimBot2020



(a) (b)

(c)

Figure 11: Some of the media stills produced to advertise the Zentle movie.

5 Zentle movie

We developed, together with the Akasha Production company, a cartoon movie targeted to children, for advertising the robot actions in the garden and encourage children to pursue scientific and technological innovations. The movie tells the story of a little girl, Ani. Ani lives in a Special Place where she and her dog Zinn have the very important job of looking after the gardens. When a storm in a nearby village leaves people there in desparate need, Ani

and her family decide to leave the Special Place to help. But who will look after the gardens? Oracle, the Wise One, tells Ani that he has a friend for her - Zentle the robot.

The official release of Zentle, with media campaign is scheduled for the end of January. In Figure 11, we show few media stills produced for advertising the Zentle movie. Based on feedback from a partial release of Zentle, a second version of the movie has been developed focussing more on Ani's personal initiative and removing several aspects that received criticisms. The second version is also scheduled for public release in January.

Draft:TrimBot2020

The TrimBot2020[1] is a research project funded by the EU Horizon 2020 research and innovation framework. The aim of TrimBot2020 is to investigate the underlying robotics and computer vision technologies to prototype the next generation of intelligent gardening consumer robots. The project focus is on the development of intelligent outdoor hedge, rose and bush trimming capabilities, allowing the robot to navigate over varying garden terrain, approaching hedges to restore them to their ideal tidy state, and approaching topiary-styled bushes to restore them to their ideal shape.

TrimBot2020 robot equipped with the custom bush trimmer end-effector.

Rose cutter of the TrimBot2020 robot in action

Contents

Design and technologies

The design of the TrimBot2020 robot required a combination of robotics and [[3D computer vision] research and innovation activities. Original developments in 3D sensing of semi-regular surfaces with physical texture (overgrown plant surfaces), coping with outdoor lighting variations, identifying different objects and types of surfaces, self-localising and navigating around obstacles, visual servoing to potentially moving target plants, leaves and branches are required to deliver all this on a small battery-powered consumer-grade vehicle.

TrimBot2020 is developed on top of the Indego platform, that is the Robotic lawn mower of Bosch, by adding a robotic arm and custom trimming tools. The robot is equipped with a camera rig of five stereo cameras for mapping and navigation of the garden and with three pairs of stereo cameras on top of the robotic arm for 3d reconstruction of bush surfaces and rose stems. The control of the robotic arm is performed by using computer vision feedback[2].

End effectors and arm control

The TrimBot2020 prototype platform is equipped with a 6 DOF robotic arm and custom designed end-effectors for omnidirectional trimming and rose cutting. When the robots reaches a location in the garden close to a topiary bush, hedge or rose bush, the cameras mounted on the arm are used in combination with computer vision algorithms to reconstruct the 3d shape of the target object. Subsequently, an algorithm based on an approximation of the solution to the traveling salesman problem is adopted to minimize the path to be followed by the robotic arm in order to trim the bush to the desired shape[3].

Visual servoing

An innovative development outcome of the TrimBot2020 project is the integrationg of visual information processing with robot control and the realization of a visual servoing module to approach bushes. Localization algorithms suffer from pose estimation errors, which are solved in TrimBot2020 by using a deep neural network (DeepTAM[4]) to localize the robot in proximity of bushes and support the approach to the target location[5].

Consortium

The TrimBot2020 consortium is composed of eight partner institutions spread around Europe. They are:

- University of Edinburgh, UK (coordinator)
- University of Amsterdam, The Netherlands
- University of Groningen, The Netherlands
- Wageningen University and Research (ex Wageningen University + DLO), The Netherlands
- University of Freiburg, Germany
- Bosch GmbH, Germany
- ETH Zurich, Switzerland

References

1. Strisciuglio, N. (20–21 June 2018). *TrimBot2020: an outdoor robot for automatic gardening* (https://ieeexplore.ieee.org/abstract/document/8470640). 50th International Symposium on Robotics. VDE. ISBN 978-3-8007-4699-6.
2. Kaljaca, D. (2019). *Automated Boxwood Topiary Trimming with a Robotic Arm and Integrated Stereo Vision* (https://lmb.informatik.uni-freiburg.de/Publications/2019/MB19/paper-MB19.pdf) (PDF). IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS). IEEE.
3. "Demo of automated bush trimming" (http://trimbot2020.webhosting.rug.nl/automatic-cutting-at-work-video/).
4. Zhou, H. (2018). *DeepTAM: Deep Tracking and Mapping* (https://lmb.informatik.uni-freiburg.de/Publications/2019/MB19/paper-MB19.pdf) (PDF). European Conference on Computer Vision (ECCV), 2018. Springer.
5. "Visual servoing with DeepTAM" (https://trimbot2020.shorthandstories.com/AAIFORPOSEESTIMATIONANDSERVOING/index.html).

External links

- TrimBot2020 website (http://www.trimbot2020.org)

- TrimBot2020 on EU H2020 CORDIS portal (https://cordis.europa.eu/project/rcn/199850/factsheet/en)
- Media related to Agricultural robots at Wikimedia Commons

Horticulture and gardening

Gardening	Allotment · Arboretum · Butterfly · Community · Forest · French intensive · Garden · Garden design (computer-aided) · Garden tool · Green wall · Guerrilla · Historic conservation · History · Landscape · Native · Parterre · Raised bed · Square foot · Sustainable · Xeriscaping
Types of gardens	Alpine · Ancient Egypt · Back · Baroque · Biblical · Bog · Botanical · Bottle · Butterfly · Byzantine · Cactus · Cantonese · Chinese · Colonial · Color · Communal (Garden square) · Community · Container · Cottage · Dutch · English · Fernery · Floating · Flower · French (formal · landscape · Renaissance) · Front · German · Greek · Greenhouse · Hanging · Hügelkultur · Islamic · Italian · Japanese · Keyhole · Kitchen · Knot · Korean · Market · Mary · Monastic · Mughal · Orchard · Indonesian home garden · Persian (Bāgh · Charbagh · Paradise) · Philosophical · Physic · Pleasure · Pollinator · Rain · Rock · Roji · Roman · Roof · Rose · Sacred · School · Scottish · Sculpture · Sensory · Shade · Shakespeare · Spanish · Tea · Therapeutic · Trial · Tropical · Victory · Walled · Water · Wildlife · Winter · Zen · Zoological
Horticulture	Agriculture (stock-free · sustainable · urban) · Arboriculture · Botany · Companion planting · Crop (most valuable) · Flora · Floriculture · Fruticulture · Genetically modified tree · Hydroculture · Indigenous · Intercropping · Landscape architecture · Oenology · Olericulture · Plant (breeding · propagation · drought tolerance · hardiness) · Pomology · Postharvest physiology · Tropical · Urban (agriculture · horticulture · forestry · reforestation) · Viticulture · Monoculture
Organic	Biodynamic agriculture · List of organic gardening and farming topics · Vegan organic gardening
Plant protection	Fungicide · Herbicide · Index of pesticide articles · List of fungicides · Pesticide · Plant disease forecasting · Pruning · Weed control (Aquamog weed remover)
Related articles	Garden tourism

Category · Commons · WikiProject

Mobile robots and unmanned vehicles

Aerial		Unmanned aerial vehicle (UAV) · Aerobot · Helicam · List of unmanned aerial vehicle applications · Unmanned combat air vehicle (UCAV) · Ornithopter
Ground	**Walking**	Humanoid · Android · Hexapod (list)

	Other	Unmanned ground vehicle (UGV) · Automated guided vehicle (AGV) · Self-driving car · Automatic train operation (ATO) (list)
Underwater		Unmanned underwater vehicle (UUV) · Autonomous underwater vehicle (AUV) · Intervention AUV (I-AUV) · Remotely operated underwater vehicle (ROUV) · Underwater glider
Surface		Unmanned surface vehicle (USV)
Space		Uncrewed spacecraft · Robotic spacecraft (list) · Robotic telescope · Space probe · Cargo spacecraft (spaceflights to the ISS)
Other		Domestic · Military · Rescue · Medical · Disability · Agricultural · BEAM robotics · Microbotics · Nanorobotics · Robotics · Robot locomotion · Autonomous robot · Autonomous logistics · Radio-controlled model · Remote control vehicle · Remote control animal

Categories · Radio control · Unmanned vehicles

Robotics

Main articles	Outline · Glossary · Index · History · Geography · Hall of Fame · Ethics · Laws · Competitions · AI competitions
Types	Anthropomorphic (Humanoid · Android · Cyborg) · Claytronics · Companion · Animatronic (Audio-Animatronics) · Industrial · Articulated (arm) · Domestic · Educational · Entertainment · Juggling · Military · Medical · Service · Disability · Agricultural · Food service · Retail · BEAM robotics · Soft robotics
Classifications	Biorobotics · Unmanned vehicle (aerial · ground) · Mobile robot · Microbotics · Nanorobotics · Robotic spacecraft (Space probe) · Swarm · Underwater (remotely-operated)
Locomotion	Tracks · Walking (Hexapod) · Climbing · Electric unicycle · Robot navigation
Research	Evolutionary · Kits · Simulator · Suite · Open-source · Software · Adaptable · Developmental · Paradigms · Ubiquitous
Related	Technological unemployment · Terrainability · Fictional robots

Category · **Outline**

Robot Category:Agricultural revolutions Category:Emerging technologies -

Review waiting, please be patient.

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- Help:Wikitext – how to use the markup
- Help:Referencing for beginners – how to include references
- Wikipedia:Article development – how to develop your article
- Wikipedia:Writing better articles – how to improve your article
- Wikipedia:Verifiability – make sure your article includes reliable third-party sources

You can also browse Wikipedia:Featured articles and Wikipedia:Good articles to find examples of Wikipedia's best writing on topics similar to your proposed article.

Editor resources

- *Find sources:* Google (https://www.google.com/search?as_eq=wikipedia&q=%22TrimBot2020%22) (books (https://www.google.com/search?tbs=bks:1&q=%22TrimBot2020%22+-wikipedia) · news (https://www.google.com/search?tbm=nws&q=%22TrimBot2020%22+-wikipedia) · newspapers (https://www.google.com/search?&q=%22TrimBot2020%22+site:news.google.com/newspapers&source=newspapers) · scholar (https://scholar.google.com/scholar?q=%22TrimBot2020%22) · free images (https://www.google.com/search?safe=off&tbs=sur:fmc&tbm=isch&q=%22TrimBot2020%22+-site:wikipedia.org+-site:wikimedia.org) · WP refs (https://www.google.com/custom?hl=en&cx=007734830908295939403%3Agalkqgoksq0&cof=FORID%3A13%3BAH%3Aleft%3BCX%3AWikipedi

a%2520Reference%2520Search&q=%22TrimBot2020%22)) · FENS (https://en.wikipedia.org/wiki/Wikipedia:Free_English_newspaper_sources) · JSTOR (https://www.jstor.org/action/doBasicSearch?Query=%22TrimBot2020%22&acc=on&wc=on) · NYT (https://www.nytimes.com/search/%22TrimBot2020%22) · TWL (https://wikipedialibrary.wmflabs.org/partners/)

- *Easy tools*: Citation bot (https://tools.wmflabs.org/citations/process_page.php?edit=automated_tools&slow=1&page=Draft:TrimBot2020) (help) **|** *Advanced:* Fix ambiguous links (https://dispenser.info.tm/~dispenser/cgi-bin/dab_solver.py?page=Draft:TrimBot2020&commonfixes=yes&client=Dablinks) · Fix bare URLs (https://tools.wmflabs.org/refill/result.php?page=Draft:TrimBot2020&defaults=y) · Fix broken links (https://dispenser.info.tm/~dispenser/cgi-bin/webchecklinks.py?page=Draft:TrimBot2020#view:0.0.0.1.1.1)

Reviewer tools

- Instructions · ⋈ · TrimBot2020 (talk: + (https://en.wikipedia.org/w/index.php?title=Talk:TrimBot2020&action=edit&editintro=Template:AFC_submission/banner_editintro&preload=Template:AFC_submission/banner_preload) bio (https://en.wikipedia.org/w/index.php?title=Talk:TrimBot2020&action=edit&editintro=Template:AFC_submission/banner_editintro&preload=Template:AFC_submission/banner_preload_(bio))) · (log (https://en.wikipedia.org/w/index.php?title=Index.php&title=Special:Log&page=TrimBot2020)) · Copyvios report (https://tools.wmflabs.org/copyvios?lang=en&project=wikipedia&title=Draft:TrimBot2020&url=) · reFill (https://tools.wmflabs.org/refill/result.php?page=Draft:TrimBot2020&defaults=y) · Citation Bot (https://tools.wmflabs.org/citations/process_page.php?edit=toolbar&slow=1&user=&page=Draft:TrimBot2020) · (Search: Google (https://www.google.com/search?&q=TrimBot2020), Bing (https://www.bing.com/search?q=TrimBot2020), Wikipedia (https://en.wikipedia.org/w/index.php?title=Special:Search&search=TrimBot2020&fulltext=Search)) · Submitted 22 days ago by Nicstrisc (talk: H (https://en.wikipedia.org/w/index.php?title=User_talk:Nicstrisc&action=edit&editintro=Template:AFC_submission/user_talk_editintro_(hold)&preload=Template:AFC_submission/user_talk_preload_(hold)&preloadtitle=Your+submission+at+%5B%5BWP%3AAFC%7CArticles+for+creation%5D%5D&section=new) D (https://en.wikipedia.org/w/index.php?title=User_talk:Nicstrisc&action=edit&editintro=Template:AFC_submission/user_talk_editintro_(declined)&preload=Template:AFC_submission/user_talk_preload_(declined)&preloadtitle=Your+submission+at+%5B%5BWP%3AAFC%7CArticles+for+creation%5D%5D&section=new) + (https://en.wikipedia.org/w/index.php?title=User_talk:Nicstrisc&action=edit&editintro=Template:AFC_submission/user_talk_editintro&preload=Template:AFC_submission/user_talk_preload&preloadtitle=Your+submission+at+%5B%5BWP%3AAFC%7CArticles+for+creation%5D%5D&section=new)) · Last edited 22 days ago by Nicstrisc