Assessing the navigational accuracy of an autonomous orchard robot equipped with 2D laser scanner and particle filter

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Abstract

Statement of the Problem:

A challenge faced when growing fruit in orchards is efficient weed control. Weed control is often done with tractors and mowing devices. The labour intensive nature of this operation causes that the frequency of mowing is limited to a minimum. An autonomous platform that can carry out this operation without human intervention would allow farmers to regularly tackle weeds in their orchards without the large labour requirement. In the design of an autonomous orchard robot, a combination of sensors and navigation algorithms need to be chosen which provides similar or higher navigational accuracies compared to current mowing with manual steering. The objective of this study is to investigate the accuracy of a sensor and algorithm combination for autonomous in-row navigation of an orchard robot.

Methodology & Theoretical Orientation:

A Clearpath Robotics Husky A200 robot was equipped with a 2D laser scanner, a three-axis IMU, wheel odometry and an RTK-GNSS sensor. A navigational algorithm was built based on the particle filter. Experiments were done in a Dutch apple orchard to assess the navigational accuracy, by tracking the robots trajectory between two tree rows with RTK-GNSS and to calculate the lateral and angular deviation from the optimal AB-line.

Results:

The particle filter guided the robot through the orchard path with an average lateral deviation of 0.07m and an average angular deviation of 2.57° from the AB-line at a speed of 0.25 m/s and respectively 0.08m and 1.73° at 0.5 m/s.

Conclusion & Significance:

The selected sensor layout and navigational algorithm proved to be suitable for autonomous in-row navigation in fruit orchards as an alternative for manual driving. Headland detection and obstacle avoidance were not taken into account in this study, and are part of the further development of the autonomous orchard navigation.

Image

Recent Publications

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2. Bergerman, M., Maeta, S. M., Zhang, J., Freitas, G. M., Hamner, B., Singh, S., and Kantor, G. 2015. Robot Farmers: Autonomous Orchard Vehicles Help Tree Fruit Production. IEEE Robotics & Automation Magazine 22(1):54-63.
3. Thrun, S., Fox, D., Burgard, W., and Dellaert, F. 2001. Robust Monte Carlo localization for mobile robots. Artificial Intelligence 128(1):99-141.
4. Vroegindeweij, B. A., Ijsselmuiden, J., and van Henten, E. J. 2016. Probabilistic localisation in repetitive environments: Estimating a robot's position in an aviary poultry house. Computers and Electronics in Agriculture 124:303-317.
5. Zhang, J., Maeta, S., Bergerman, M., and Singh, S. 2014. Mapping orchards for autonomous navigation. In 2014 Montreal, Quebec Canada July 13–July 16, 2014, 1. American Society of Agricultural and Biological Engineers.

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Biography

Pieter Blok is a scientific researcher at Wageningen University and Research. He is specialized in agricultural robotics, computer vision, mechatronics and sensor technology, with 6 years' work experience in various national and international research projects. He is author of several peer-reviewed conference papers. Pieter graduated in 2011 as a Master of Science (MSc) in Agricultural Engineering at Wageningen University and is currently conducting his PhD entitled "Agro-robotics in open field food production".

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