Programming a Thorvald robot to count grape bunches in a vineyard

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*Abstract*—Accurately counting fruit in a farm has always been a job only human beings could do. Now with emerging technologies robots can do this much more accurately and faster than human beings can. The aim of this project is to demonstrate this capability using a Thorvald robot in physics simulation called gazebo (citation required) in conjunction with RVIZ. This report documents the findings of using the Thorvald robot to count the number of grape bunches in a variety of vineyard structures. As this model of robot has 3 cameras, all of them were used to increase the efficiency of the counting while reducing the time taken. The algorithm allows the robot to work with minimal user input in a variety of environments and for different fruits. This is possible due to the use of 3 core python scripts. The result demonstrated that the robot can accurately count the number of a given grape bunch in a test environment. However, it needs ample time to count the grapes and this time is provided by using a wall following algorithm to make the robot loop around grape vines in a circle until counting is done. The number of times this looping occurs can be hard coded or simply moving the robot to another location for it to continue a count is also possible at runtime. Along with the wall following algorithm, a grape searching algorithm was also created. This allows the robot to actively seek out and move to grape bunches. These two algorithms combined using a state machine would make a highly autonomous and efficient fruit counting robot. Unfortunately, the current state of the project has the two algorithms working separately as when they are launched without a state-machine, conflicting parameters result in the robot getting stuck at times around corners and moving oddly at others.

Keywords—counting, maximize, model, cameras, simulation (key words)

# Introduction (*Heading 1*)

At the University of Lincoln, the Thorvald robot, supplied through a partnership with SAGA robotics is the base model robot spearheading scientific research throughout farms for the purpose of moving towards a robotics centred farming future. Through applying ROS techniques to simulate how the real Thorvald robot would be capable of counting fruit bunches in the real world and by using clever computer vision techniques and effective positioning the robot is able to autonomously provide an accurate count of any fruit the cameras are tuned to detect. On key objective of this project was to stand out from the rest and make effective use of all the features of the robot that were available, namely using front, right and left cameras so the robot could count regardless of which way it was facing. This project is significant because it allows the robot to have a high level of autonomy due to its obstacle avoidance and ability to actively detect, seek out grape clusters and position the robot next to them but also because of the use of 3 cameras, enabling the robot to count multiple rows when active. This is NOT done in parallel but rather sequentially by allowing each camera to access the counting algorithm with a filtering algorithm called message filters (citation required).

# Related work

## Selecting a Template (Heading 2)

Robots come in all shapes and sizes, and this means they can come with all sorts of sensors and actuators. But the one thing that remains the same in simulation is that robots all have a way of interacting with objects around them. There are a variety of ways robots can be used to map fruits in simulated environments. This is demonstrated in “Fruit mapping mobile robot on simulated agricultural area in Gazebo simulator using simultaneous localization and mapping (SLAM)” (N.Habibie et al.). Which makes use of SLAM “by generating grid-based/volumetric map using fine-tuned SLAM-Gmapping algorithm and combine it with properties/ information obtained from each detected crops/plants using fruit detection with visual sensor and tree location detection using 2D laser scanner sensor”. This research paper takes a very similar task and utilises a different approach, the benefit of which is that it does not require the use of a depth camera and yet still boasts a good result with good accuracy. This accuracy comes from generating a 2D volumetric map of agricultural area which is enriched with infor-mations/properties for each tree.

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8. M. Young, The Technical Writer’s Handbook. Mill Valley, CA: University Science, 1989.

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