An Autonomous Mobile Multipurpose Platform for use in Kiwifruit Orchards

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Abstract

Other uses may be mechanical weed removal, targeted spraying, and crop scouting.

Keywords:

1. Introduction

Short-term labor requirements within the New Zealand kiwifruit industry peak twice a year corresponding pollination and harvesting cycles (Timmins, 2009). These spikes in short-term labor requirements can make it difficult to source workers, occasionally leading to labor shortfalls. Being New Zealand's largest horticultural export, kiwifruit lends itself well to automation; primarily in the areas of pollination and fruit harvesting (Statistics New Zealand, 2015). Previous work on automated harvesting of kiwifruit was carried out in (Scarfe, 2012). In that work, an kiwifruit harvesting robot was built that demonstrated the capability of harvesting kiwifruit. That prototype Stress robustness required of vehicles designed for in-field use. High cost associated with conversion of a tractor to an autonomous vehicle.

It has been stated that "since the robot development already includes a high complexity, the application itself should be of comparably low complexity" (Ruckelshausen et al., 2009).

"The implementation of additional mechatronic systems, such as weeding or seeding, will increase the complexity due to technical and logistical aspects and thus reduce the probability for the development of a robust system." (Ruckelshausen et al., 2009).

2. Mechanical design

Skid steering inappropriate for orchard environments due to soft ground. Pivoting front axle used to maintain three points of contact at all times; no suspension. Limited to $10\,\mathrm{km\,h^{-1}}$ by the choice of motor and gearboxes on the drive-system. Ackermann steering geometry with the ability to pivot about the centre of the rear wheels.

(Åstrand & Baerveldt, 2002) have used an ackermann steering system actuated by a single DC servo motor for their robotic beet-crop weeding platform. They have only two driving wheels placed at the rear of the system.

3. Hardware and sensors

GPS has proven to be unreliable when used under the dense canopy of a kiwifruit orchard. (Pedersen et al., 2006) shows the economics of using an GPS-RTK system, as seen in other agricultural systems (Bak & Jakobsen, 2004; Ruckelshausen et al., 2009), has considerable ongoing costs in the form of yearly fees. Forward and upwards facing LiDAR have been used for navigation and detection of the row and canopy.

4. Safety

Relay modules connected to the main computer via the system's CAN bus give a means of shutting down Both front drive motors are fitted with electromechanical brakes which engage when the power is cut. A wireless safety-rated controller, designed for use with cranes, has been adapted for use with driving robot platform. The controller provides the operator with a way of entering the platform into autonomous mode, manual control, triggering an emergency stop, or enabling/disabling auxiliary systems.

5. Software architecture

The control software is comprised of individual nodes, writen in either C++ or Python, linked together using Robot Operating System (ROS) for interprocess communication. The system runs on Ubuntu Server 16.04 on an Intel NUC, a compact x86 based PC. A model of the robot platform has been depeloped for use with Gazebo simulation software. Such a model provides a way to test steering and movement strategies before deploying them on the hardware.

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