GPS-Guided Mobile Robot Platform Featuring Modular Design Elements for Agricultural Applications

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Abstract

The agricultural industry has not seen significant innovation in development of low-cost automated farming solutions, with current systems costing several thousands of dollars to implement. Currently these automated solutions are primarily implemented around crop planting and harvesting, and the large implementation cost of these systems makes them unfeasible for small-scale operations. Within many agricultural industries, workers expend a considerable amount of time undertaking simple tasks that are labour intensive. Many of these tasks could instead be completed using a self-driving robotic platform outfitted with the appropriate devices required for the tasks.

This thesis covers the research work aiming to produce a solution that could turn an existing farming vehicle into a multipurpose low-cost agricultural platform, to act as the platform for an autonomous vehicle capable of performing pre-programmed tasks within an agricultural environment. A quad bike was selected as the vehicle platform for this research in which the control modules would control the speed and direction of this farm bike.

Four modules were developed to control the vehicle components that would normally be operated by a human operator. These modules are comprised of mechanical actuators coupled with a microcontroller control system and includes some specific designs to maintain the user's ability to manually control the pre-existing systems. A gear-changing module controls the vehicles manual gearbox, providing a method to detect and control the vehicles current gear. A speed control module was developed to control the vehicles throttle and braking system and detects the vehicles speed. A steering module controls the vehicles steering system, allowing for accurate control of the vehicles direction. Finally, a vehicle controller module provides a central command interface that ties the previous three modules together and controls the vehicles electrical components and engine.

Development of a low-cost differential GPS (DGPS) system was also undertaken to reduce the implementation cost of the system. Due to inconclusive results in relation to the positional accuracy of this system is was decided that a standard GPS system would be used for the vehicle prototype with further development on the DGPS system would be undertaken in future development of the research.

The successful development of a farm automated vehicle platform was achieved through this research. With further improvement on software, intelligent control and the development of a low-cost differential global positioning satellite (GPS) system, a fully autonomous farm platform that can be outfitted with different tools or devices for the required farm tasks is feasible and practical.

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List of Abbreviations

Global Positioning Satellite - GPS

Differential Global Positioning Satellite - DGPS

Universal Time Coordinated - UTC

Land Information New Zealand - LINZ

Earth centred Earth fixed - ECEF

Antilock Brake Systems - ABS

Defence Advanced Research Projects Agency - DARPA

Light Detection and Ranging - LIDAR

Ohio State University's - OSU

A-Star - A*

Infrared - IR

Pulse Width Modulation - PWM

Ground - GND

Transmit Line - TX

Receive Line - RX

Programmable Logic Device - PLD

Uninterruptible Power Supply - UPS

General-Purpose Input-Output pins - GPIO

Most Significant Bit - MSB

Proportional-Integral - PI