Title: NAVIGATION OF AN AUTONOMOUS DIFFERENTIAL DRIVE ROBOT FOR FIELD SCOUTING IN SEMI-STRUCTURED ENVIRONMENTS

Recently, the utilization of robots in agriculture environments is flourishing due to the ever-increasing manual labor costs, declining numbers of seasonal workers as well as the capability of technology. The implementation of autonomous systems for precision agriculture will have a profound impact on future orchard operations by providing low cost, meticulous inspection and also an assortment of other activities. Different sensors have been proven proficient in agrarian navigation including the likes of GPS, inertial, magnetic, rotary encoding, time of flight as well as vision. To compensate for anticipated disturbances, variances and constraints contingent to the outdoor semi-structured environment, a differential style drive vehicle will be employed as an easily controllable system to conduct tasks such as imaging and sampling. In order to demonstrate the motion control of an unmanned ground vehicle, custom-designed for strawberry farms, the navigation task is partitioned into multiple phases to regulate the over-bed and cross-bed operation needs. In particular, during the cross-bed segment an elevated strawberry bed will provide distance references utilized in a logic filter and tuned PID algorithm for safe and efficient travel. Due to the significant sources of uncertainty such as wheel slip and the vehicle model, nonlinear robust controllers are developed for the cross-bed or headland traversal, relying on external feedback in the form of machine vision. A simple image filter algorithm was formulated for strawberry row detection, in which pixels corresponding to the bed center will be tracked while the vehicle is in controlled motion. Simulation of the entire system with bounded uncertainty was subsequently completed to ensure the control capability before successful validation in multiple commercial farms. It is anticipated that with the developed algorithms the authentication of fully autonomous robotic systems functioning in agricultural crops will provide heightened efficiency of needed costly services; scouting, disease detection, collection, and distribution.

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Approved for distribution by Yunjun Xu, Committee Chair, on March 13, 2018.

The public is welcome to attend.