Development of an Automated Weeding Machine for Precision In-Row Weed Control

Desert Ag Small Grants Program - Final Report

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Due to the lack of effective selective post-emergence herbicides, lettuce crops are hand weeded following cultivation to remove weeds close to the crop plants. Finding labor to perform the task has become increasingly difficult and costs are escalating. To address these issues, we propose to develop an innovative high-speed, high-precision automated weeding machine. The machine will utilize an artificial intelligence (AI) based imaging system to identify weeds and a precision sprayer to spot spray targeted weeds at the 1-cm level of resolution. In a separate project, the 1-cm resolution spot sprayer was developed and successfully tested in a laboratory setting. The aim of this seed grant project is to initiate development of the AI-based imaging system and obtain preliminary data to strengthen proposals submitted to granting agencies to obtain the funding necessary to fully develop a prototype high-precision automated weeding machine.

An AI-based imaging system was developed and tested. First, images of lettuce crop plants and weeds were captured in-situ with a specialized, high-resolution machine vision digital RGB camera mounted on a frame attached to a ground following linkage assembly. As the assembly is pulled through the field, a high-performance microcontroller coordinated camera operation with the tractor movement by orchestrating the image acquisition at regular time/distance intervals. Images at 'mm' level resolution and accuracy were georeferenced and will be used to drive the spray nozzle array. The AI algorithm operated in real-time to: 1) identify crop plants, 2) establish a user-defined crop safety zone/buffer distance (~ 1 cm) around each crop plant, 3) identify the weeds using a training approach that relied on features that included weed location relative to the crop row, shape, size, color, plant height, and 4) created a weed targeting map at 1-cm scale resolution. Evan McGinnis developed the AI algorithm as part of his Ph.D. program. Results for separating green plant material from background non-plant material (soil) and identifying weeds for targeting weeds were very promising in some trials, approaching 95% detection with <5% false positives.

These proof of concept data were incorporated into a $100K proposal submitted to the Arizona Specialty Crop Block Grant Program to fully develop a prototype high-precision automated weeding machine. The project was selected for funding and the project is in progress.

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