Canadian Agri-Science Cluster for Horticulture 3

Update to Industry

Final Report – 2018 – 2023

Activity title:
Reduced production cost and enhanced labour efficiency using the Guelph Intelligent Greenhouse Automation System

Name of Lead Researcher:
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Names of Collaborators and Institutions:
University of Guelph, Ontario Greenhouse Vegetable Growers Association, BC Greenhouse Vegetable Growers association, AMCO farm

Activity Objectives:
The overall objective of this project is to develop, and field test an autonomous integrated prototype for a harvesting/de-leafing robot in vegetable greenhouses.

The specific objectives are:
• Large scale field testing of a plant monitoring and labour quality assurance system
• Large scale field testing of tomato and pepper fruits detection and localization under occlusion and various environmental conditions.
• Large scale field testing of harvesting operations. This will focus on beefsteak tomato and sweet pepper and expand later to cucumber and cluster tomato.
• Large scale field testing of de-leafing operation in tomato greenhouses
• Knowledge transfer and commercialization of the technology.

Research Progress & Results:
The research plan suffered from two years of COVID restrictions where access to commercial greenhouses impacted our ability to field test new technology even while the sector needed harvesting automation the most. In the last year we somewhat recovered conducted three field trials including testing of new harvesting grippers, new machine vision algorithms, and finally overall system integration. We can report that the current system prototype is able to detect a ripe tomato, confirm its location in 3D, plan a picking operation using different harvesting modes, and finally execute the plan leading to a successful harvesting. The results are promising with 50% success rate overall but can reach 80% for beefsteak.

There are three factors that will impact the commercialization of this technology in the short term: Cycle time, efficiency, and cost. The current cycle time is too slow to be deployed in a commercial greenhouse for harvesting beefsteak or cluster tomato. It takes around 15 seconds on average to complete a harvesting operation. Efficiency is also impacted where only target tomatoes that are easily reachable can be harvesting successfully. Yet the efficiency and cycle time can be greatly improved with additional sensors and higher number of robotic stations that enable

parallel operations. The main bottleneck remains the final stage of the operation where the gripper must be able to perform delicate maneuvering operation to cut or remove the target without damaging nearby tomatoes or the plant. Towards this challenge, we are exploring the deployment of additional sensors and advanced planning algorithms that can plan final stage in real-time and with high accuracy.
Cost remains a significant barrier to adoption. Yet with advancement in AI technology and the increase of usage of intelligent robotics in many sectors, the cost of hardware continues to decrease while at the same time the cost of labor continues to increase. At some point in the next 5 years, the cost will no longer be a barrier for adoption assuming that efficiency and cycle time improves to meet operational demands.

Key Message(s):

This project was able to make progress towards having a harvesting robot a reality for greenhouse operations. We estimate this technology to be at TRL6 stage now. Future work will focus on reaching TRL 9 leading to first deployment of a commercial prototype. Automation will reduce greenhouse expenses by up to 20% while enhancing safety and traceability.

Overall benefit to industry:

Harvesting remains one of the most labor-intensive tasks in a vegetable greenhouse. Most of the work force employed are temporary foreign workers who had several travel and work restrictions during COVID resulting in significant losses to greenhouse growers. Developing a robotics system for tomato harvesting has been the goal of many research projects in Europe, US, Japan, and Canada. Yet there is no commercially available system as of today. This project aimed at bridging the jap to commercialization by field testing several new technologies. While COVID restrictions delayed the overall project, we can report that the current system was field tested several times during the last 2022-2023 year. The current system is estimated to be between TRL6 and TRL 7.

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