How Soon Will There Be a ROBOT IN YOUR GREENHOUSE?

Harvesting robots for controlled environment food production may soon be the solution for growers hard pressed to find enough workers.

BY DAVID KUACK

Are you having a difficult time finding qualified workers for your controlled environment growing operation? The coronavirus pandemic has exasperated the shortage of workers as many people re-evaluate their career and job options. The Conference Board reports companies, particularly blue-collar businesses, are facing increasing critical shortages of workers.

Like other industries, commercial growers are facing some of the same challenges in regards to finding dependable workers.

"Greenhouse labor is one of the top costs for growers," says Brian Lynch, research scientist-field robotics at Vineland Research and Innovation Centre in Ontario, Canada. "Wages are continuing to go up. It is really hard to find people willing to take greenhouse jobs. Canadians don't want to do greenhouse work, which is also the case internationally. Many growers have chosen to use temporary foreign workers. But even with the use of migrant workers, it's still hard to maintain a reliable workforce that is coming in, being trained and then returning the next year to do the same job. It's difficult to find the right people and it's very costly."

Lynch says being able to have robots perform any task in a greenhouse would be very beneficial to growers. "Greenhouses are great places to implement automation and robotics. Of course, that is assuming the robots can perform as well as humans and the cost of the robot meets the return on investment schedule that growers are satisfied with."

FOCUSED ON FOOD CROPS

The top three greenhouse food crops in Canada are tomatoes, cucumbers and peppers. Researchers at Vineland Research and Innovation Centre are developing a robot for harvesting cucumbers.

"We didn't initially target tomatoes because there are already a number of companies developing robotic systems for that crop," Lynch says. "One of the reasons tomatoes have been targeted for robotic harvesting is they are round and red. The fruit is relatively easy to find on the plants and to determine if they are ripe with a computer vision system."

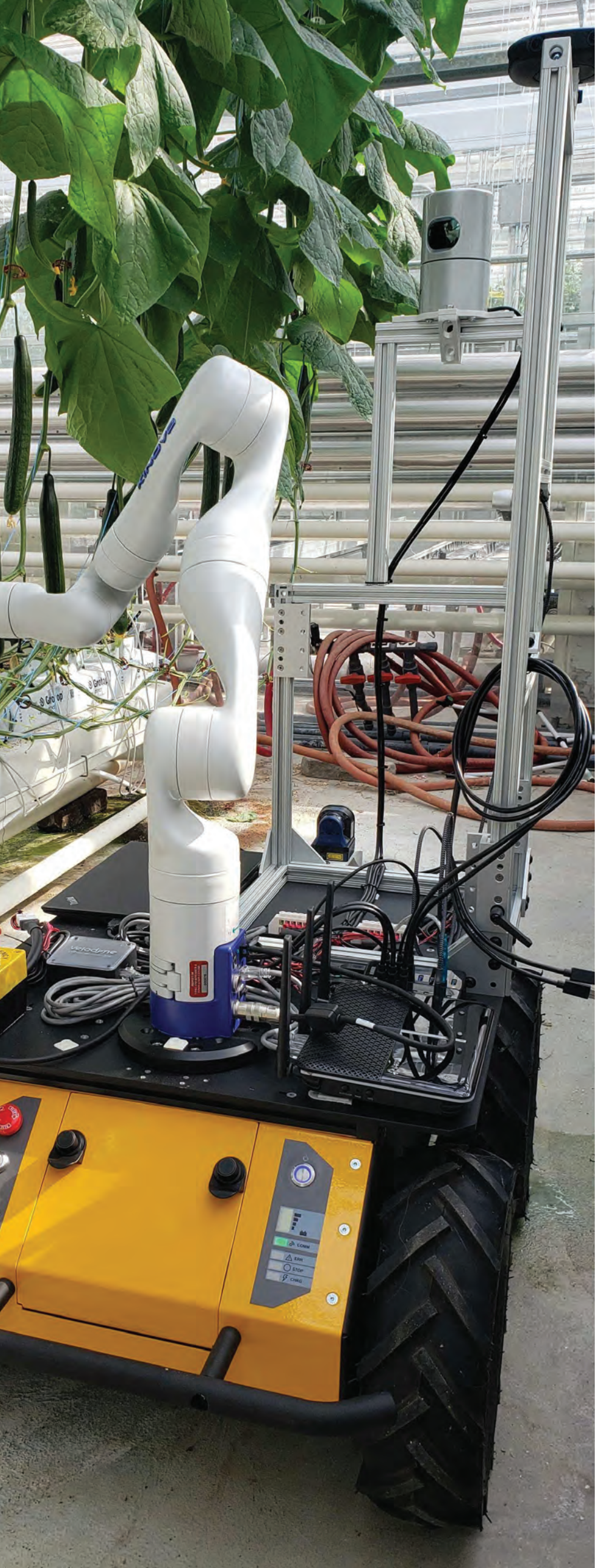
Lynch says there is a huge gap in tasks like harvesting, pruning and taking leaves off of the plants. "One reason for that gap is these tasks are big challenges for a robot. These can be difficult jobs to perform."

Among the labor tasks in a cucumber greenhouse, harvesting accounts for one third of the labor.

"With many controlled environment food crops, harvesting occurs every day," Lynch says. "It's a constant task once the plants are mature and producing fruit."

He explains, "With cucumbers, there is open space within the plants. Color is the biggest challenge because there is green fruit on green foliage. Fruit shape can also be a challenge when there are cucumbers that are straight and others can have a

Challenges for designing a cucumber harvesting robot include color similarities in foliage and fruit and irregularities in the shape of the fruit. *(Photos courtesy of Brian Lynch, Vineland Research and Innovation Centre)*



Once cucumber plants are mature and producing fruit, harvesting occurs daily, accounting for one third of the labor.

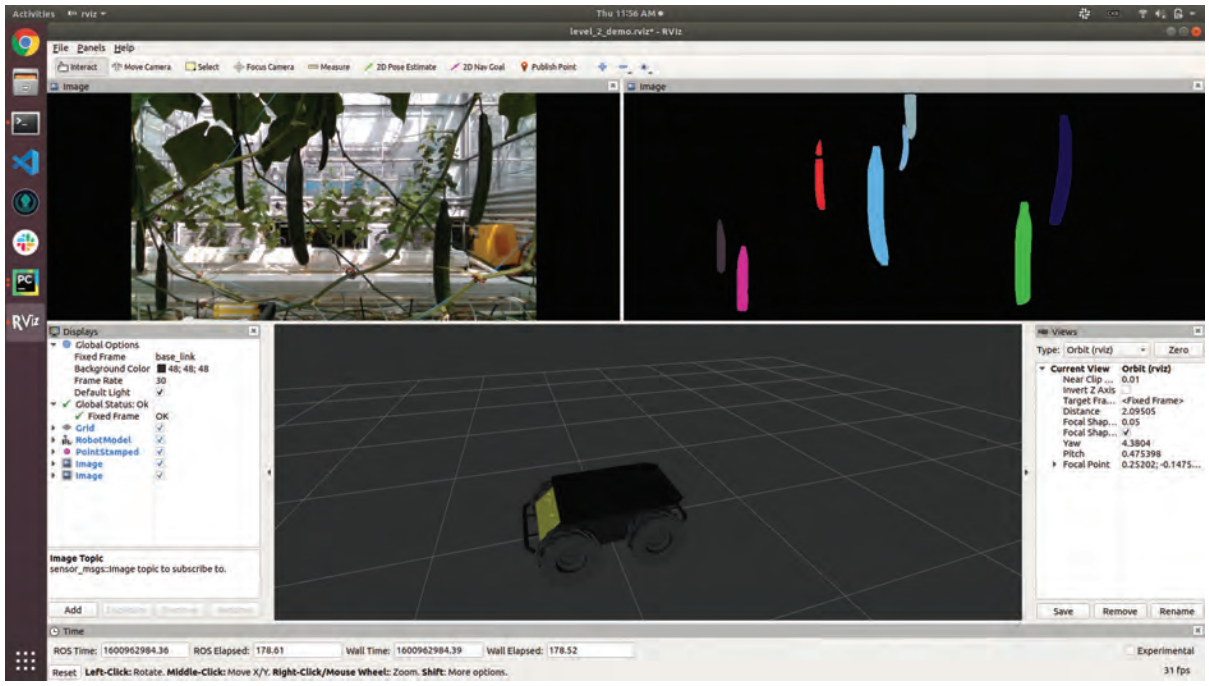
bend to them. The cucumber shape is not as predictable as a tomato. But cucumbers are easier to harvest because they are not as soft as other fruit and there is not as much concern about holding on to them."

According to Lynch, designing a robot that will drive up and down the crop rows in a greenhouse should be relatively easy to do.

"There is a lot of technology already available that is used in warehouses for automated robot systems that could be applied," he says. "The picking mechanism itself is the biggest challenge. The robot needs to be able to pick all of the cucumbers and not miss any of the fruit. The robot has to be able to maneuver to get to the right place to cut the stem of the fruit and hold onto the fruit. This has to be done accurately."

He adds, "We are working with the Institut National d'Optique (INO) in Quebec to develop a specialized vision sensor. We are also in the process of establishing a commercialization/manufacturing partner. A big part of what we at Vineland is not developing products so much as developing core pieces of the technology and demonstrating how they work. We take the core technologies and then develop them further with a partner."

The cucumber harvesting robot is expected to provide a 90 to 95% savings for harvesting labor. This translates to around $24,000 to $28,000 per acre annually.



Vineland Research and Innovation Centre is working with Institut National d'Optique (INO) to develop a specialized vision sensor for the cucumber robot.

REAL WORLD EXPERIENCE, NUMBERS

Lynch says the research center will also be looking to incorporate the harvesting robot into commercial greenhouses for testing.

"Vineland does have large greenhouse areas where we can grow a cucumber crop and test the robot," he says. "However, we want to demonstrate the robot in a commercial greenhouse environment where it would be deployed. Early on, we made the decision that this harvesting robot should be stand alone and able to move between the rows of crops. Once it is turned on it should start harvesting. We are looking to find growers who we can work with to trial the robot."

The robot was designed to work with high wire cucumber production. This cucumber production method is very similar to the technique used to grow tomatoes on the vine.

"We are at the point with the robot where we have proof of concept and know it works. Now we are trying to make it run faster. I expect that we will have a commercial robot ready to use within the next 18 to 24 months."

While developing the picking mechanism was the biggest challenge, Lynch says he is looking at other tasks the robot can do, including pruning and deleafing.

"If a grower already has the robot for harvesting, what will have to be done to develop other tools that can be attached to the robot arm? Being able to use the robot to prune the plants would also make a considerable dent in labor costs. Everyone that is working on this technology recognizes that growers don't want to have to buy one robot for harvesting and one to do other tasks, including applying fungicides or pesticides. We want to package as much as possible with one robot."

Lynch says some companies manufacturing robots for greenhouse applications advertise that they will save growers 50% on their labor costs.

"We are aiming for around 90 to 95% savings for harvesting labor," he shares. "That translates to around $24,000 to $28,000 per acre annually. For a 10-acre greenhouse, that adds up to $240,000 to $280,000 growers are spending annually on harvesting labor alone."

Another consideration when incorporating a harvesting robot, Lynch says, is missed fruit. If a

robot is 95% successful at picking fruit, a worker is going to have to go in and pick the remaining 5%. At this point with the robotic technology available, there isn't a greenhouse that doesn't have humans doing some harvesting. There is a skeleton crew that has to go in and pick missed fruit. We're hoping that robots will be able to identify areas where fruit has been found, flag it and indicate that it can't be reached because it could damage the plants or fruit."

OVERCOMING LIMITATIONS

One of the capabilities of the robot that Lynch is looking to improve is the speed of picking the cucumbers.

"We are looking to make some changes that will drop the rate of picking from 15 to 10 seconds," he says. "We want to bring the picking rate down even lower to around 8 seconds per piece of fruit. But if we can develop a robot that is half the cost, then growers can afford to have a slower robot, but they could employ more of them."

Lynch says another aspect they are considering is developing a robot with multiple arms, but that increases the cost of the robot unless the cost of each arm can be lowered. "We think that can be done," he says. "If we can speed up the robot and reduce its cost, then it becomes a more favorable purchase for growers. We use a three-year payback period in regards to return on investment. Looking at the math, we consider how much growers are spending on harvesting labor and how much they can afford in terms of a robot. We want to make it faster and more cost effective."

Some growers have the misconception that since it's a machine, a robot can run 24 hours a day.

"A robot's battery needs to be charged and there is time dedicated to maintenance," Lynch says. "Some fruit — cucumber is one of them — when it is harvested it has to be sent to the packaging line quickly or it is going to dehydrate. Cucumbers are filled with water and once they are harvested from the plant if they don't get wrapped in plastic quickly enough they are going to lose that water. A grower could have a robot harvester picking all night, but there is also going to have to be a crew available to process and package the cucumbers."

LOOKING BEYOND CUCUMBERS

Lynch says the technology being developed for the cucumber harvesting robot will be used as much as possible for other crops.

"We will be looking at peppers next, as well as tomatoes," he says. "In doing this research, we are learning more about vegetable crops in greenhouses that enables us to address harvesting problems related to picking berries or peaches in an orchard. Some of the technology will have applications to harvesting other crops, but also performing other tasks including pest and disease detection.

"If a robot is traveling up and down rows of crops for harvesting, there is the potential to include other tasks that can be added to the robot. It might be possible to add a sensor to detect stress in the plants or collect other data that can be analyzed. The robot could collect information regarding fruit size and where the fruit is located on the plants. This data could be analyzed to determine if one area of the greenhouse consistently has smaller fruit. The robot might also be used to sort the fruit by size to meet the quality standards of the growers' customers."

For more information: Contact Brian Lynch, Vineland Research and Innovation Centre, brian.lynch@vinelandresearch.com; www.vinelandresearch.com; https://www.youtube.com/watch?v=fbJzuCIZO14. gpn

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