



Report on Research

College of Agricultural, Consumer and Environmental Sciences

U of I Robots Go Solar; New System Could Drastically Reduce Herbicide Use

A solar-powered robot with 20/20 vision, on a search-and-destroy quest for weeds, soon will be moving up and down the crop rows at the experimental fields at the University of Illinois. What's more, this robot has the potential to control weeds while significantly reducing herbicide use.

"The robot uses GPS for navigation, and two small cameras mounted on a frame on top of the machine to give the robot depth perception, just like a human," said Lei Tian, agricultural engineer at the U of I. "If he sees a weed, he can actually tell how far away it is."

An on-board computer offers access to information that provides the morphological features of plants, to help the robot determine just what is and isn't a weed. Once a weed is identified, a robotic arm attached to the front of the machine engages a device the researcher calls "a custom-designed end effector."

There are two layers to the device, according to Tian. One layer cuts the weed, while the second layer applies herbicide to the cut weed.

"This type of application is extremely effective," said Tian, "because it applies herbicide directly to the plant, instead of broadcasting uniform rates across a field."

With this level of precision, Tian said the system has clear environmental benefits. In addition to cutting herbicide use, chemicals do not drift off-target when placed directly on the plants.

The original inspiration for this robot came several years ago, when Tian and two graduate students were working on remote-sensing systems for a C-FAR (Council on Food and Agricultural Research) project.

"We were collecting field data from satellite imagery, such as soil moisture and plant conditions, but we needed to have ground reference data to validate that information," said Tian.

"But that kind of data is tedious to collect," he continued, "and it's very hot work. The grad students who collected this information stayed in the field most of the day, and one of them was fainting from the heat."

At the time, Tian was working on a robot that could go into the field and continuously collect data, but the battery that powered the system required charging about every two hours.

"So I thought, what if we had a system that could collect data but could also convert the heat of the sun into an energy source?" said Tian. "We could replace the grad student worker with a robotic system."

That system evolved into today's model, and two other graduate students worked with Tian to present a paper on the robot at the Annual International Meeting of Agricultural and Biological Engineers this July in Portland, Oregon.

Hong Young Jeon, a PhD candidate in agricultural and biological engineering, and Nathanael Gingrich, a master's student, have worked



steadily on the system design that cuts the weed and applies herbicide. They have also mounted the curved solar panel that powers the robot.

"We custom-built a shelf that holds the solar panel," said Gingrich. "It also protects the machine from weather and gives it shade for its vision system."

Although the robot is equipped with ultrasonic sensors that go all the way around the machine, "we're going to try and use only the camera vision for navigation," said Jeon, "which makes it a lot more difficult."

The robot stands a little more than two feet tall, is 28 inches wide and almost five feet long. He can travel about three miles per hour and moves on wheels, although the researchers have treads they can put on him to give more grip.

At the current stage, the robot is used to combat weed infestation; but in the future, Gingrich and Jeon hope to place different sensors and cameras on the robotic arm that would be used to judge soil properties or plant conditions.

"It has a full-blown Windows computer with an 80-gigabyte hard drive and a wireless connection to the Internet," said Gingrich, "so the amount of information we can collect is virtually unlimited."