**Progress in precision spraying**

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Current research at Cornell University is to develop methods to allow adjustment of both the airflow and liquid flow for an orchard sprayer. In both cases this adjustment is made using the information provided by one sensing system. A scanner senses vegetation by means of a multiple array of ultrasonic sensors. This project follows the principles of variable rate technology (VRT).

**Adjusting airflow**

Previous research at Cornell University, lead to the development of an adjustable louvre to control the air leaving the sprayer. The adjustable louvre on the air outlet of a traditional axial fan or tower air blast sprayer reduced drift by as much as 63% in orchards during field trials in early to mid season when canopies are developing. When drift is reduced, deposition within the canopy or on the fruit should increase, the spray has to go somewhere.

In the original louvre design, the sprayer operator manually adjusted the louvre position so the spray plume doesn't pass through the canopy. The adjustable stroke length of the actuator moves the louvre, thus matching airflow to canopy size. Unfortunately in tall trees and heavy canopies it was a challenge to see how far the spray cloud passed through the canopy (the sprayer is one side of the target row and you wish to see the spray cloud on the other side of the row). A sensor system adjusts the stroke length of the actuator and subsequently controls the position of the louvre. The first sprayer we used was a conventional air-assisted sprayer, Berthoud S600EX (Berthoud, Cedex, France) equipped with the Cornell louvre system for adjusting the outlet of air from the axial-fan.

**Adjusting liquid flow**

The canopy of fruit trees changes in size and density as the growing season progresses. The amount of spray needed to adequately cover the target is often a point of discussion, but all agree that good coverage is essential and the amount of spray required varies due to many horticultural factors such as variety, trellis design and growth stage. As many orchards have different size crops, growth stages and row widths, so changing liquid flow rate to match the varying parameters is very important. In order to adjust liquid flow rate for the canopy, current practice is to change tractor forward speed, adjust sprayer pressure or change nozzles. Changing forward speed is simplest but also affects air penetration. Changing pressure only has a minor effect on output so changing nozzles is the preferred method. Unfortunately changing nozzles is time-consuming, exposes the operator to potentially dangerous pesticide residues and is regarded as a chore by most operators.

We fitted an air-assisted sprayer, John Bean Redline 5284781 Tower sprayer (Durand Wayland, La Grange, GA, USA), with a Lechler VarioSelect® system for proportional liquid application. The mounted system is based on thirteen blocks (at five different

heights or manifolds) each with space for four nozzles. The system is equipped with three flat fan nozzles (Position A:110-01 Orange, Position B: 110-015 Green, and Position C: 110-02 Yellow). Every manifold and combination of nozzle is activated in groups by a pneumatic system mounted on the sprayer. These nozzles can be operated individually or in groups.

**Vegetation sensing**

For vegetation detection the sensing system we developed is based on an array of ultrasonic sensors that are capable of detecting canopy vegetation. For this study, one array of 6 sensors for orchard characterization was mounted on a vertical mast. The distance between the sensors is 27 inches for orchard characterization, enough space to ensure that we don't have interference between the sensors. With this configuration the system can detect 10 foot trees in the case of the orchard sprayer.

The sensors send signals to a control board that in turn selects the correct number of nozzle blocks/manifolds. The nozzles can then emit spray according to the tree canopy. The sensors/controller is also able to position the actuator and then control the position of the louvre. These functions were tested in the field in 2013 to study better air and liquid adjustment. Every one of these functions is related to the increment or decrement the quantity of air that the system will apply depending on the Tree Row Volume detected by the sensors. Results of the 2013 season trials will be presented at the Fruit and Vegetable Expo, Syracuse, 2014.

**Conclusions**

The ultrasonic sensors are mounted and configured for an accurate reading of vegetation in fruit crops. The electronic system is based on an Arduino board that is able to control the different sectors and nozzles of the Lechler VarioSelect system. The same system is able to operate the position of the actuator on the louvre system. The electronic system can register data from all the systems via a serial port operating at a frequency of 3,33 Hz. This system is ready to conduct field trials this coming summer 2013.

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