Precision spraying: using fine tuning and electronics

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Introduction

In the spray application process the key factor is to know the location and volume of the target. With this knowledge it is possible to make precise adjustments to the quantity of product being applied in relation to the size of the target vegetation. The new technologies of precision spraying allow growers to apply pesticides only to the target canopy or fruit, to apply the correct quantity according to canopy size, density, growth stage and also apply products in an economic and environmentally sound manner. At the same time, if we know where the target is, we can adjust the two basic systems in one spraying machine. The first system is the liquid spray and the second and, very important for tree crop applications, is the airflow.

Current research at Cornell University is to develop methods to allow adjustment of both the liquid flow and the air flow for an orchard sprayer. In both cases this adjustment will be made using the information provided by one sensing system for scanning the vegetation comprising a multiple array of ultrasonic sensors. In general this project aims to follow the principles of variable rate technology (VRT).

The problem with the vast majority of traditional axial fan sprayers used in fruit canopy spraying is that there is too much air volume and speed, particularly whilst spraying in early to mid-season when the canopy is still developing, The result of excess air is spray drift resulting in off-target movement of spray droplets which results in environmental pollution to water courses, neighboring properties and damage to susceptible crops. Spray drift also means that pesticide is not going onto the target crop resulting in an economic waste.

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 an 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 increases.
The sprayer operator manually adjusts the louvre position so as 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 is a challenge to see how far the spray cloud is passing 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 which adjusts the stroke length of the actuator and subsequently controls the position of the louvre is required. The first sprayer we are using is 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 (Figure 1).

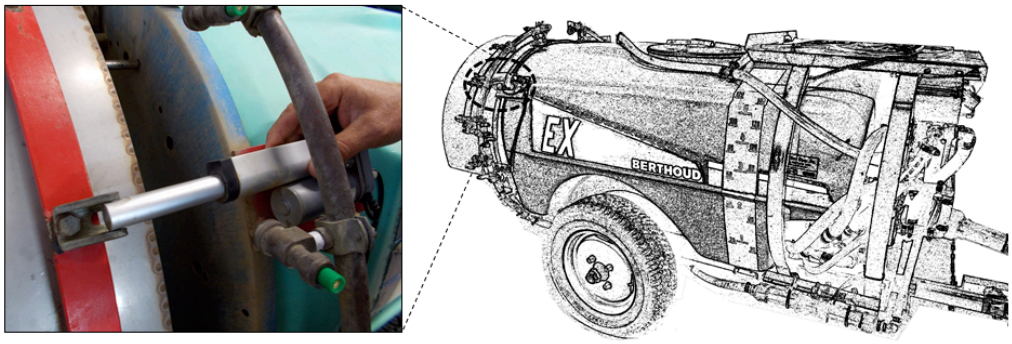

Figure 1. Louvre system mounted on conventional axial-fan sprayer.

Adjusting liquid flow

The canopy of fruit trees is changing 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.

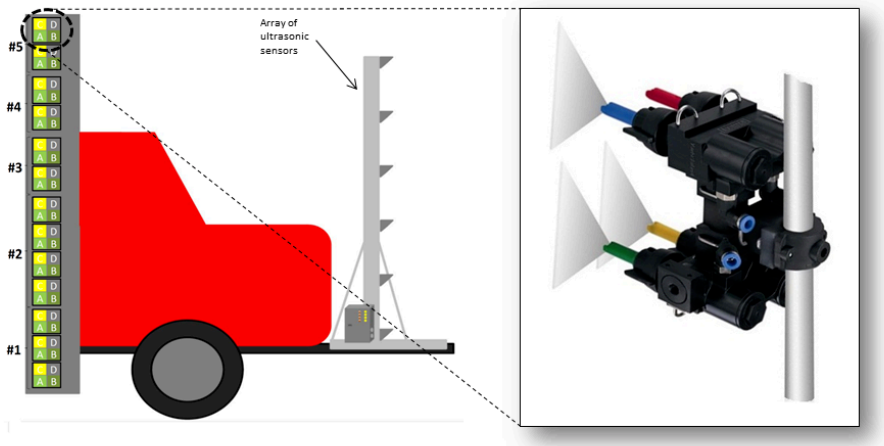

Figure 2. Tower sprayer with detail of mounted Lechler VarioSelect® unit.

We have fitted an air-assisted sprayer (Figure 2), 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 being used is based on an array of ultrasonic sensors that are capable of detecting vegetation. For this study, one array of 6 sensors for orchard characterization are mounted on a vertical mast. The distance between the sensors is 50 cm for orchard characterization enough to not have interferences between the sensors. With this configuration the system can detect 3 m of height of vegetation in the case of 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 will be tested in the field for 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.

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.

Acknowledgements

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