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High-tech scouting in citrus production

By Yiannis Ampatzidis and Tara Wade

Traditional sensing technologies in citrus production for pest and disease detection and field phenotyping rely on manual sampling, which is time consuming and labor intensive. Since availability of personnel trained for field scouting is a major problem, small unmanned aerial vehicles (UAVs) equipped with various sensors and artificial intelligence (AI) can simplify the surveying procedure, decrease data collection time and reduce cost.

UAVs equipped with RGB and multispectral sensors have recently become flexible and cost-effective solutions for rapid, precise and non-destructive field scouting. Growers are typically reluctant to adopt new technologies. However, demonstrated ease of use and cost savings can encourage widespread adoption. Precise and early detection of pests and diseases can reduce spray costs, scouting labor costs and possible fruit losses caused by pests and diseases. However, the extent to which this is offset by the increased cost of specialized labor or consultants needed to operate UAVs and interpret information needs to be carefully examined by each operation.

APPLICATIONS USING UAVS AND AI

Novel cloud- and AI-based solutions were recently introduced in citrus to process, analyze and visualize data collected from platforms such as UAVs. One example is the Agroview technology developed by the University of Florida Institute of Food and Agricultural Sciences (UF/IFAS). It comprises a machine vision algorithm (AI-based) that uses deep learning to effectively detect and assess individual plants on aerial maps.

Agroview is an automated cloud-based application that utilizes a user-friendly and interactive interphase to simplify the data processing and visualization procedures to promote adoption of UAVs and remote sensing in citrus. This application can measure tree inventory, health and fertility by:

1. Detecting, counting and geolocating trees and tree gaps (locations with dead or no trees)
2. Measuring tree height and canopy size
3. Developing tree health (or stress) maps
4. Estimating plant nutrient content and developing fertility maps

A video demonstration of this emerging technology can be found at twitter.com/i/status/1202671242647490560. Figure 1 (see page 16) shows the user interface of the Agroview application that includes multiple citrus blocks from a commercial field. Figure 2 (see page 17) presents an example of a fertility map.

This user-friendly application has great potential to provide individual tree analysis over large areas, detect stressed plants and compare phenotypic characteristics on different sets of plants. This technology can also save growers money and time.

For example, the U.S. Department of Agriculture recently developed new insurance policies that require growers to create and submit accurate tree inventories for all perennial tree policies. Traditional manual tree-counting

Figure 1. Agroview shows data for: (a) multiple blocks and (b) individual field and tree information.

techniques are very labor intensive, time consuming and expensive. These techniques can cost approximately $12 to $24 per acre and can take two to four weeks to cover 1,000 acres. The Agroview application can create accurate tree inventories in a short time and save the Florida citrus industry at least 50 percent of the data collection cost and 90 percent of the data collection time.

Furthermore, the fertility maps produced by UAVs and Agroview can be used for precision fertilizer applications. For this reason, UF/IFAS researchers are developing smart and variable-rate sprayers and fertilizers that can "read" the fertility maps produced by Agroview. These devices will optimize applications of agrochemicals by using zone nutrient information to vary application rates.

Traditional tree sprayers/fertilizers have high inefficiencies, and significant amounts of agrochemicals are lost to the environment, thus degrading natural resources and increasing growers' costs. Variable-rate applications and prescription maps (compatible with precision equipment) could lower agrochemical usage by 30 to 70 percent while reducing application costs, risk of crop damage and environmental impacts. These technologies could save millions of dollars per year for the Florida tree fruit industries.

Other industry efforts have also developed intelligent tools for perennial crops such as citrus. For example, Aerobotics provides a technology to analyze data collected from UAVs for tree detection, orchard management and stress detection (among other tools).

In order to fly a UAV for commercial use (such as data collection in commercial groves), a Remote Pilot Certificate is required from the Federal Aviation Administration (FAA). UF/IFAS offers training seminars that help participants become FAA-certified UAV pilots. Equipment costs can vary vastly. For most applications described above (e.g., tree inventory), relatively low-cost UAV equipped with an RGB camera (approximately $600 to $2,000) is needed. For estimating plant nutrient content and the development of fertility maps, an additional multispectral camera is required, which can cost from $3,500 to $10,000.

POTENTIAL ADOPTION

There is no disputing that the right cameras are better at identifying plant stress, diseases and pests than the human eye or that flying drones is less labor intensive than walking through groves. However, these devices are expensive and require specialized labor to operate, analyze data, and create usable and timely information. There is likely a steep learning curve that is beyond what most growers are prepared to do without help, making scouting services attractive.

The cost of these services, contract design and the effectiveness of the information they provide are important factors in widespread adoption. Other factors such as market prices, farm size and weather can also affect a grower's decision to adopt a new technology or service.

Cost-share programs are effective at increasing use of a practice or technology. Therefore, programs that encourage farm sustainability could consider subsidizing these services or educating growers about their benefits and challenges and helping them to determine if the technology is a good fit for their enterprises. Reducing the costs of these technologies and making them widely available may also result in reduced costs for growers and increased use.

What is still uncertain is the extent to which the technology can reduce the cost of services like scouting. Contracted services like scouting for plant stress, pests and diseases in citrus groves is time consuming and expensive. UF/IFAS estimates for citrus production costs in the Southwest Florida and Indian River areas indicate that scouting costs average $65 per hour and are reported to be as high as $80 per hour, while in Central Florida scouting costs average $27 per hour (see crec.ifas.ufl.edu/economics).

These scouting costs are in addition to what growers pay for material

Figure 2. This fertility map was developed in Agroview from data collected from an unmanned aerial vehicle equipped with a multi-spectral camera. Nutrient levels for zone development are based on University of Florida Institute of Food and Agricultural Sciences recommendations.

and application costs. For example, in Southwest Florida, insecticide, fungicide and bactericide material and application costs average $388 per acre or about 23 percent of the total cost of production. These costs will likely be higher for fresh fruit production. Therefore, at the right price and with meaningful benefits, technologies like Agroview and improved smart applicators for agricultural inputs can substantially reduce production costs.

Identifying plant stress and nutritional needs quickly and accurately can help improve tree health and fruit quality and therefore help manage some of the risks in crop production. While the plan is to make this technology attractive and available for long-term use, this technology could also prove to be particularly useful in monitoring fields when exploring new grove management strategies and reporting assets for things like insurance claims or loan applications.

Yiannis Ampatzidis and Tara Wade are assistant professors at the UF/IFAS Southwest Florida Research and Education Center in Immokalee.