Combined Proceedings IPPS 74:446-454. 2024.

Drone Applications in Nursery Production

James Robbins[1] and Joe Mari Maja[2]

[1]Ornamental Hort Solutions, 300 N Pine St, Little Rock, Arkansas 72205 USA

[2]Center for Applied Artificial Intelligence for Sustainable Agriculture, South Carolina State University, 810 Goff Ave., Orangeburg, South Carolina 29117 USA

jrobbins4930@gmail.com

Keywords: small unmanned aircraft systems (sUAS), unmanned aerial vehicle (UAV), object based image analysis software (OBIA), marketing/sales, asset tracking & management, plant inventory management, chemical/nutrient applications, crop monitoring, radio-frequency identification tags (RFID), remotely piloted aerial application systems (RPAAS)

Summary

Small Unmanned Aircraft Systems (sUAS) or 'drones' are a technology that can be used to automate or augment certain operations in open field nursery production. They may be used for a variety of activities including: 1) marketing and sales, 2) asset tracking and management, 3) plant inventory, 4) application of chemicals and nutrients, and 5) crop monitoring. Today users have the option to perform these tasks in-house or use an outside provider.

INTRODUCTION

Drones are currently accepted as a safer and more economical solution for various situations. Non-agricultural applications such as law enforcement, utility inspection, bridge inspection, wildfire monitoring, construction and news reporting are commonplace. Agriculture is also benefiting from these affordable and technologically advanced aerial systems (Robbins, and Maja, 2021a,b).

We have identified at least five applications for drone use in open-field nursery production. Each application can be evaluated for its likelihood of being adopted by nurseries from immediate to long-term. Businesses also need to evaluate whether the process they want to automate with drones can be accomplished in-house, by an outside provider, or by a hybrid of those options. Today it is common for outside companies to provide images, image processing, and aerial application services.

The first application for drones in nursery production, considered low hanging fruit, is for **marketing and sales**. Nurseries of any size can immediately use a small drone outfitted with a camera to capture needed aerial photographs of the nursery or crops (**Fig. 1**). Still images or videos taken by the nursery can immediately be used for their website, social media, catalogs or trade show marketing. Alternatively, a local 3rd party provider could provide the same material for a fee.

Figure 1. Drones can be used to capture images for marketing and sales

The second application, **asset tracking and management**, can also be immediately adopted by most nurseries. Examples of this application include safe inspection of gutter connected and retractable roof structures, estimation of bark pile volume, and inspection of other infrastructure, i.e. fences, buildings, etc. (**Fig. 2**). Routine inspection of general infrastructure can be accomplished in-house using an inexpensive small drone with a camera (**Fig. 3**). Estimation of bark pile volume is a bit more complicated. In this case, still images taken by either the nursery or an outside provider would require software processing by an outside provider, which includes fees.

Figure 2. Using drones for asset tracking and management.

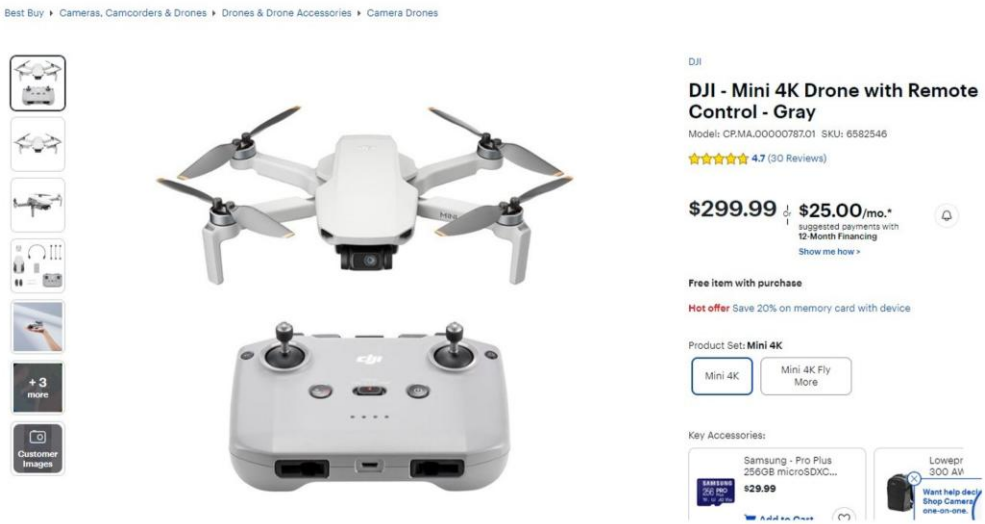

Figure 3. An inexpensive, entry-level sUAS/ drone with remote control.

The next drone application is **plant inventory (Fig. 4)**. Within this category, we also lump the use of simple still photographs that can be used for crop insurance purposes. Plant inventory is the application our team has worked on the longest (2010). To date, we have identified three approaches to collecting plant inventory. The first and least complex method is to take aerial images of blocks of plants and then print out your images and simply count plants captured in the image.

Figure 4. Plant inventory management utilizing drones.

An easy and inexpensive way to count is to use an inexpensive counter-pen marker which marks and counts each plant as you analyze the image (**Fig. 5**).

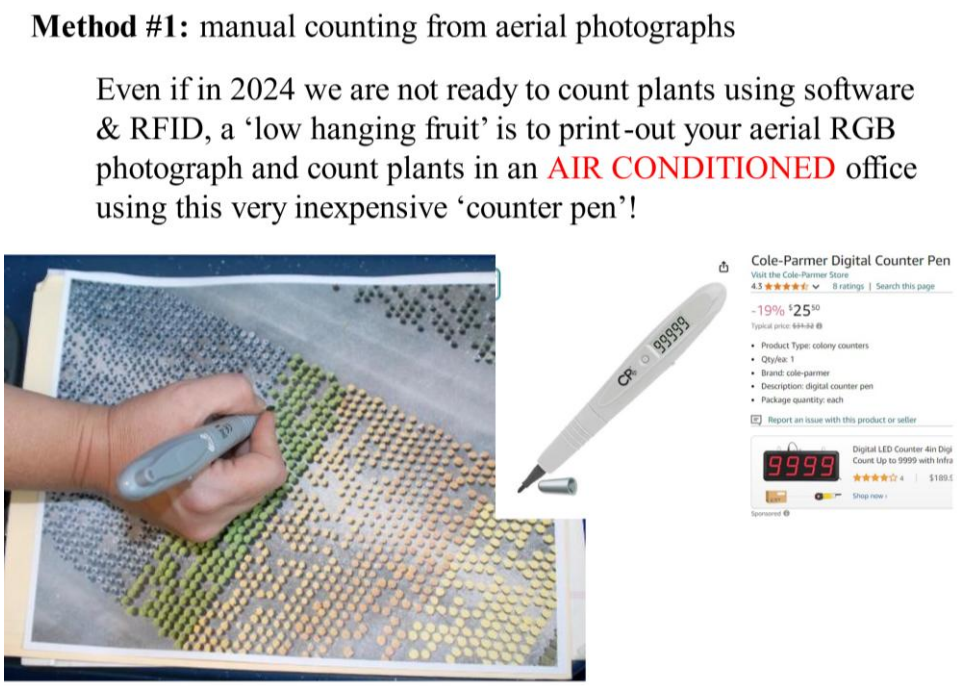

Fig. 5. Manual counting from aerial photographs.

Method #2 clearly requires advanced skill if done in-house or requires using an outside fee-based service. This method uses 'Object Based Image Analysis' (OBIA) software (i.e., Feature Analyst™, eCognition) to analyze a digital aerial image (**Fig. 6**).

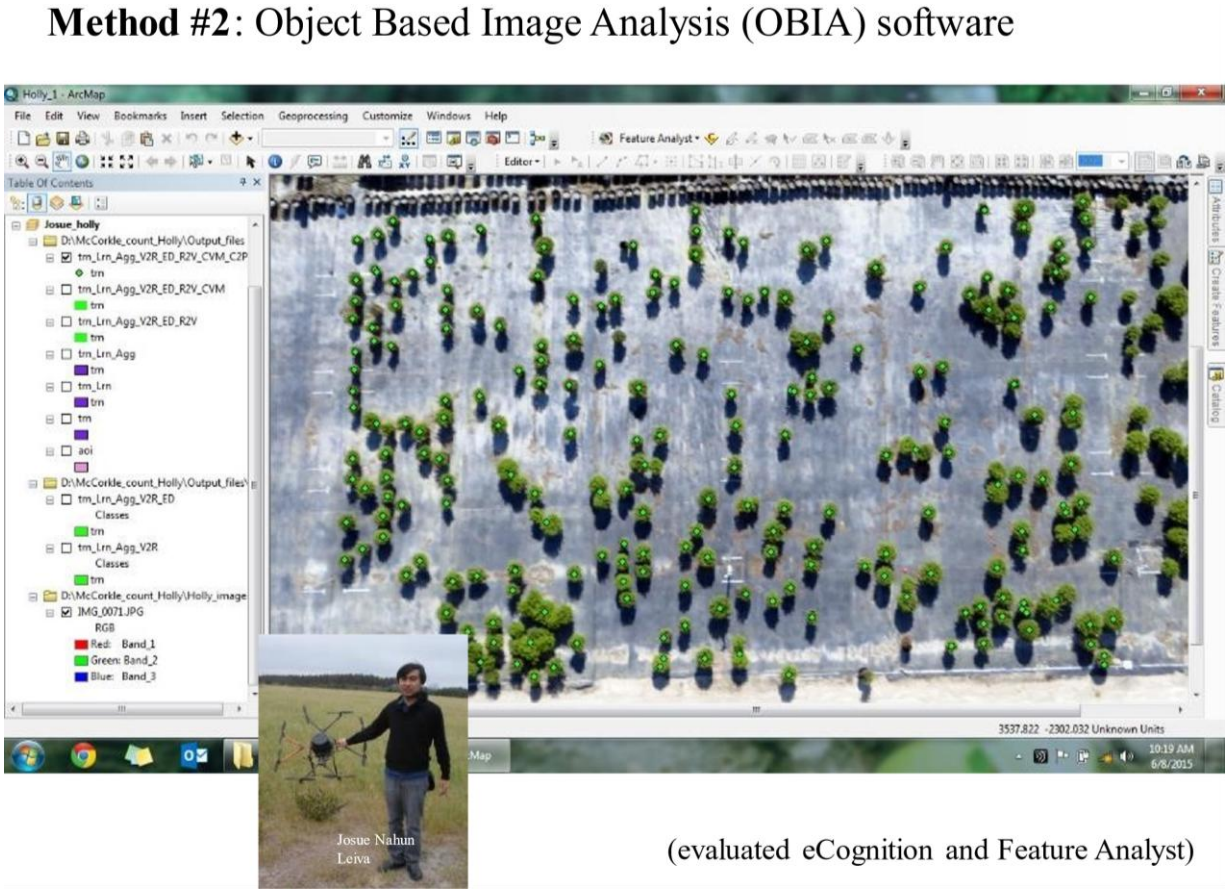

Figure 6. Object based image analysis (OBIA) software.

The software is 'trained' to extract geospatial features (in our case, plants). Most of these programs are tightly integrated with the EsriR ArcGISR platform, which would require additional cost and expertise for a majority of nurseries. In most cases, once you have created a training set for a specific plant, you may be able to apply it later in the production cycle. This method is a clear example of how a subscription to an outside service (e.g. Agremo, Solvi, DroneDeploy) to analyze the images may be a better business decision (**Fig. 7**). Our publication in the Proceedings of the Southern Nursery Association Research Conference (Maja et al., 2015) - would be helpful if you are interested in this approach. Method #3 to automate plant inventory involves using radio-frequency identification (RFID) tags and a hand-held or drone-based reader (**Fig. 8**). This effort, in collaboration with Dr. Tom Fernandez at Michigan State University, is simple and can be adopted by nurseries of any size almost immediately (Maja et al., 2024). Our team feels strongly that the future of fast and cost-effective plant inventory rests in merging RFID tags with a small drone. The same RFID tag used during production is being designed to pass forward to the retailer for reprogramming for their sales and inventory purposes.

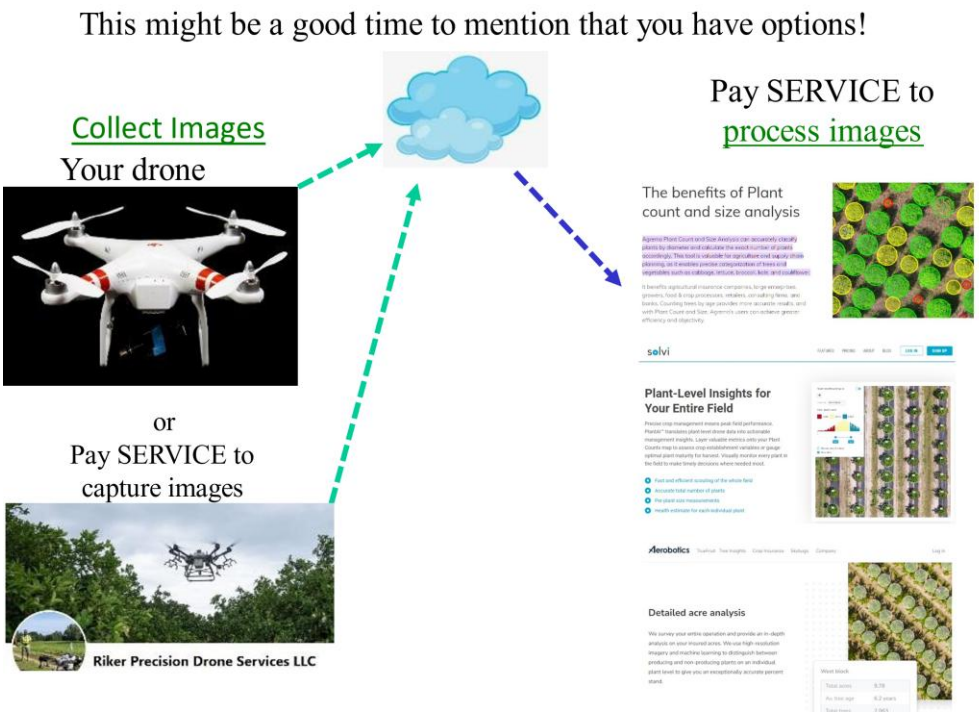

Figure 7. Options to use collect images via drones, pay outside to service to capture images – and subscription to an outside service (e.g. Agremo, Solvi, DroneDeploy) to analyze the images.

Method #3: Merging RFID tags with sUAS

Figure 8. Merging RFID tags with drones to track and manage assets and products. A microchip and antenna make up the "tag," which can be read by an RFID scanning device. The scanner turns the radio waves into digital data. RFID offers a major advantage over bar coding in that the scanning device does not need direct line of sight to read the tag.

The next nursery application is the **aerial application** of chemicals or nutrients (**Fig. 9**). Materials that can be applied using a drone can be liquid or granular (e.g., fire ant bait). Long term, this application may have the greatest impact on the nursery industry, but we are clearly in the early stages of ironing out all the details (i.e., flight regulations, pesticide label rules, application rates) (Robbins, et al., 2021). These small 'spray drones' offer tremendous potential to nurseries that grow hundreds of different crops in small blocks. A cottage industry is emerging to offer spray services to nurseries which would simplify the startup impact for a nursery trying to do this in-house. Currently, the Remotely Piloted Aerial Application Systems (RPAAS) working group is the best source for information on this specific topic.

Figure 9. Chemical and nutrient applications using drones.

The final drone application is the broad category of **crop monitoring**, which includes monitoring for nutrients, water, insects, diseases, and general plant health (**Figs. 10 and 11**). Our team has worked in this area and it is our opinion that beyond a simple survey of general plant health, this application is years off from being widely applied to the nursery industry. The sheer diversity of plant types grown at a typical nursery makes this challenging. In the short term, crop monitoring using a drone is more likely in a monoculture like turfgrass or row crops (e.g., soybean, corn, rice, wheat). Only the largest nurseries will likely try this in-house due to the technical challenges with sensors and software to collect and process images. Special training is also required to correlate changes in spectral aspects of images with a specific plant response (e.g., water stress, mite infestation) that you are interested in. While drone companies currently offer crop monitoring services to nurseries, make sure that the provider has specific experience with the types of plants you grow.

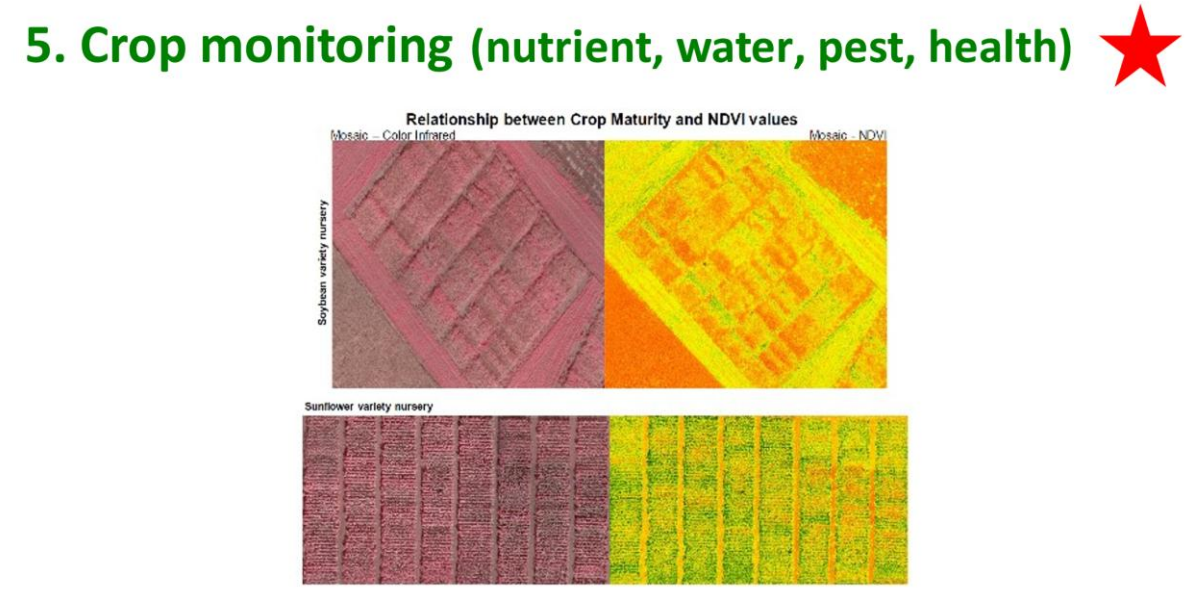

Figure 10. Crop monitoring for nutrition, water, pest, plant health.

Figure 11 An experimental approach to detect water stress in nursery crops using drones.

CONCLUSION

In summary, there is no doubt that sUAS/ drones will be a useful technology in outdoor plant production. Still, users need to carefully evaluate their specific situation to determine what the best approach is. Some users may conclude that purchasing the sUAS/ drones and software is the best option, while others may find that hiring an outside company to acquire and process the images is their best option.

The authors are certified remote pilots (Robbins: #3952601; Maja: #3952164) – and have been using sUAS/ drones for 14 years.

Acknowledgment: We wish to acknowledge the collaborative help from many people and organizations, including the J. Frank Schmidt Family Charitable Foundation, Horticultural Research Institute (HRI), J. Frank Schmidt & Son Co., McCorkle Nurseries, Greenleaf Nursery Company, Bailey Nurseries, Cherrylake, Yule Tree Farm, Woodburn Nursery & Azalea, Willoway Nurseries, Hale and Hines Nursery and R.A. Dudley Nurseries.

LITERATURE CITED

Maja, J. M., Fernández, T., Robbins, J. **(**2024). A potent combo. Research explores the viability of drones and RFID tags for nursery and garden center inventory. Nurs. Manag. *40*: 37-42.

Maja, J.M., Leivab, J.N, Robbins, J. and Chappell, M. (2015) Comparison of manual inventory counts to an automated approach using an unmanned aerial system. South. Nurs. Assoc. Res. Conf. *60*:73-77. https://irp.cdn-website.com/5d757b5b/files/uploaded/15resprosec03.pdf

Robbins, J. and Maja, J.M. (2021a). Eyes in the skies. Nurs. Manag. *37*(1): 16-17.

Robbins, J. and Maja, J.M. (2021b). Make it count with drones. Nurs. Manag. *37*:24-26.

Robbins, J., Martin, D., Reynolds, B., and Maja, J.M. (2021). Aer. Chem. Applic. *37*: 22, 24-25.