CROP ANALYSIS USING DRONE TECHNOLOGY

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ABSTRACT

In the context of increasing global population and climate change, modern agriculture must enhance production efficiency. Vegetables production is crucial for human nutrition and has a significant environmental impact. To address this challenge, the agricultural sector needs to modernize and utilize advanced technologies such as drones to increase productivity, improve quality, and reduce resource consumption.

These devices, known as Unmanned Aerial Vehicles (UAV), with their agility and versatility play a crucial role in monitoring and spraying operations. They significantly contribute to enhancing the efficacy of precision farming. The aim of this review is to examine the critical role of drones as innovative tools to enhance management and yield of vegetable crops cultivation.

This review was carried out using the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) framework and involved the analysis of a wide range of research published from 2018 to 2023. According to the phases of Identification, Screening, and Eligibility, 132 papers were selected and analysed. These papers were categorized based on the types of drone applications in vegetable crop production, providing an overview of how these tools fit into the field of Precision Farming. Technological developments of these tools and data processing methods were then explored, examining the contributions of Machine and Deep Learning and Artificial Intelligence. Final considerations were presented regarding practical implementation and future technical and scientific challenges to fully harness the potential of drones in precision agriculture and vegetable crop production.

The review pointed out the significance of drone applications in vegetable crops and the immense potential of these tools in enhancing cultivation efficiency. Drone utilization enables the reduction of input quantities such as herbicides, fertilizers, pesticides, and water but also the prevention of damages through early diagnosis of various stress types. These input savings can yield environmental benefits, positioning these technologies as potential solutions for the environmental sustainability of vegetable crops.

1. INTRODUCTION

Drones Surveillance Service, Start up for farmers. Can be a game changer in agriculture for many purposes, including:

- Precision farming

  Drones can help with land typography scans, crop health monitoring, irrigation scheduling, fertilizer application, yield data estimation, and weather analysis.

- Crop monitoring using (NDVI)

  Drones can monitor crops, detect storm damage, and measure plant growth, crop numbers, and thickness.

- Weather prediction

  Drones can reach high altitudes in harsh environments to provide accurate weather forecasts.

- Other applications.

  Drones can also be used for infrastructure inspection, photogrammetry, & Increase Production, Reduce snake bites in farm.

2. LITERATURE REVIEW

Table 1. Summary of the discussed related work.

Ref	Methodology	Pros	Cons
M. Istiak *et al.* (Istiak et al., 2023) (2023)	Determination of the impact of imaging modalities and imagery datasets in relation to agricultural applications, categorical evaluation of UAV configuration, and the feasibility assessment of UAVs in precision agriculture. In addition, the worldwide taxonomy of crops for which unmanned aerial vehicles are used is documented.	Perform a meta-analysis of recent studies on the use of UAVs for applications based on visual imagery in agriculture.	NA
Qin *et al.* (Qin et al., 2023) (2013)	They examine the impact of downwash airflow produced by a plant protection drone's flight altitude on the powdery mildew spores' horizontal, vertical, and ground distribution in wheat. Spore traps are used to track the evolving dynamics of airborne powdery mildew conidia.	The study offers a basis for scientific and reasonable spraying and control by agricultural drones, as well as for more in-depth research on the dissemination of powdery mildew spores and enhanced pest management.	The impact of airflow disturbance is closely linked to the release of powdery mildew pathogen spore numbers. The drone's rotor airflow has less of an impact on spore release in the early stages, when spore release is minimal.
Torres-Sanchez *et al.* (Torres-Sá et al., 2015) (2015)	An inventive Otsu-based thresholding Object-based Image Analysis (OBIA) algorithm was used to find vegetation in remotely sensed photos that were taken.	The classification error decreased as the object size increased until an optimal value was attained.	Once the ideal value was reached, increasing the size of the object led to larger errors, while the other parameters, like shape and compactness had little bearing on the classification accuracy.
Wang *et al.* (Wang et al., 2020) (2020)	To improve the prediction of grain yield, structural and spectral data taken from UAV-based images during the rice growing season is used.	Improving the accuracy of grain yield predictions and gaining effective crop growth monitoring.	NA
L. Li *et al.* (Li et al., 2018) (2018)	The half-Gaussian fitting method for FVC estimation (HAGFVC) is a novel approach for breaking down the Gaussian mixture strategy and estimating FVC.	The outcomes show that the HAGFVC approach can be applied correctly and effectively.	The prevalence of mixed pixels in LARS images, particularly at high altitudes above ground level or in the case of moderate vegetation coverage, caused other methods they tested to perform poorly.
J. Enciso *et al.* (Enciso et al., 2019) (2019)	A method for utilizing UAV data to measure crop height, canopy cover, and NDVI values in relation to time and space for three different tomato varieties during the growing season.	There was no discernible difference between the estimated UAV and manually measured crop heights, according to the computed paired t-test statistic.	Enhancements should be made to UAV crop growth and NDVI monitoring.
D. Stroppiana *et al.* (Stroppiana et al., 2018) (2018)	An unsupervised clustering algorithm was used to classify a multispectral orthomosaic that was created from images.	The most appropriate inputs were spectral indices, and SAVI and GSAVI produced the best results, with OA exceeding 94%.	NA

Proposed Identification:

Drones are currently one of the most representative technologies in the evolution of precision agriculture in the scientific and productive world. However, their history began in other fields of application. The drone, in fact, originated as a tool to be employed in the military sector, aiming to safeguard the integrity of human personnel in reconnaissance and surveillance missions. Over time, their use has extended well beyond the military context, finding applications in various sectors, including entertainment, transportation, security, photography, and environmental exploration [14].

The most common designation is "Unmanned Aerial Vehicles" (UAV). They can also be defined by other acronyms, many of which are of Anglo-Saxon origin: in addition to "Remotely Piloted Aircraft System" (RPAS), they may be referred to as "Unmanned Aerial System" (UAS), "Aerial Robot" or simply "Drone" [15].

These terms refer to a complex system consisting of the aerial platform, one or more components and/or sensors making up the payload, and a ground station in communication with the flight controller of the platform. Within the flight controller, components dedicated to the orientation and movement of UAVs are present, including gyroscopes, magnetic compass, GNSS module, pressure sensor, and triaxial accelerometer [16].

UAVs are generally categorized based on various attributes, including aircraft types, wing types, takeoff/landing direction, payloads, flying altitude, etc. [17].

According to the classification by Watt et al. [18], they can be distinguished as MAV (Micro (or Miniature) or NAV (Nano Air Vehicles), VTOL (Vertical Take-Off & Landing), LASE (Low Altitude, Short-Endurance), LALE (Low Altitude, Long Endurance), MALE (Medium Altitude, Long Endurance), HALE (High Altitude, Long Endurance).

The most used platforms in precision agriculture fall into the LASE class and are fixed-wing systems or multirotors, such as helicopters, quadcopters, hexacopters, octocopters, etc. VTOL multirotor platforms, widely employed for crop monitoring, generally weigh less than 5 kg excluding the payload. They are equipped with interchangeable lithium batteries, and are easily transportable, facilitating transfers between different fields.

UAV platforms can be controlled by the operator through the ground station, remaining in the field of vision, or they can fly in automatic mode, following a trajectory defined by the user through waypoints during the flight plan design phase.

Payloads can include sensors and cameras for data collection or even specialized equipment for tasks such as crop spraying [Section 4.7]. Although the sensors that drones can be equipped with are numerous, the most commonly used on UAV platforms for agricultural purposes are:

-Visible cameras, RGB (Red, Green and Blue): these are the simplest cameras capable of producing grayscale or color images for characterizing the visible properties of plants and their growth [19,20].

-Multispectral cameras: capable of producing images in different bands of the spectrum. These cameras typically cover the visible (VIS) and Near InfraRed (NIR) portions of the spectrum and can be used to calculate most vegetation indices used in agriculture. Many of these indices have been used by different authors in the papers included in this review,

-Hyperspectral cameras: this type of sensor provides images in a high number of bands with very high spectral resolution, detecting a vast amount of information. The application of these cameras allows for in-depth analysis of crops, providing information on the presence of various pathogens [42,43].

-Thermal cameras: they provide images with information about the temperature of each pixel. These sensors enable thermal alterations identification on the leaf surface induced by water stress conditions, making them particularly useful for water management [44,45].

-Laser Imaging Detection and Ranging (LiDAR): these are active sensors that leverage the physical operating principle of Radio Detection and Ranging (RADAR). In particular, these sensors emit a light pulse (laser, in the case of LiDAR) or microwaves (RADAR) and measure the return of the pulse reflected by the target using a detector, calculating the time [46,47]. These sensors provide physical measurements of the geometry and volumes of canopies [48].

Flowchart:
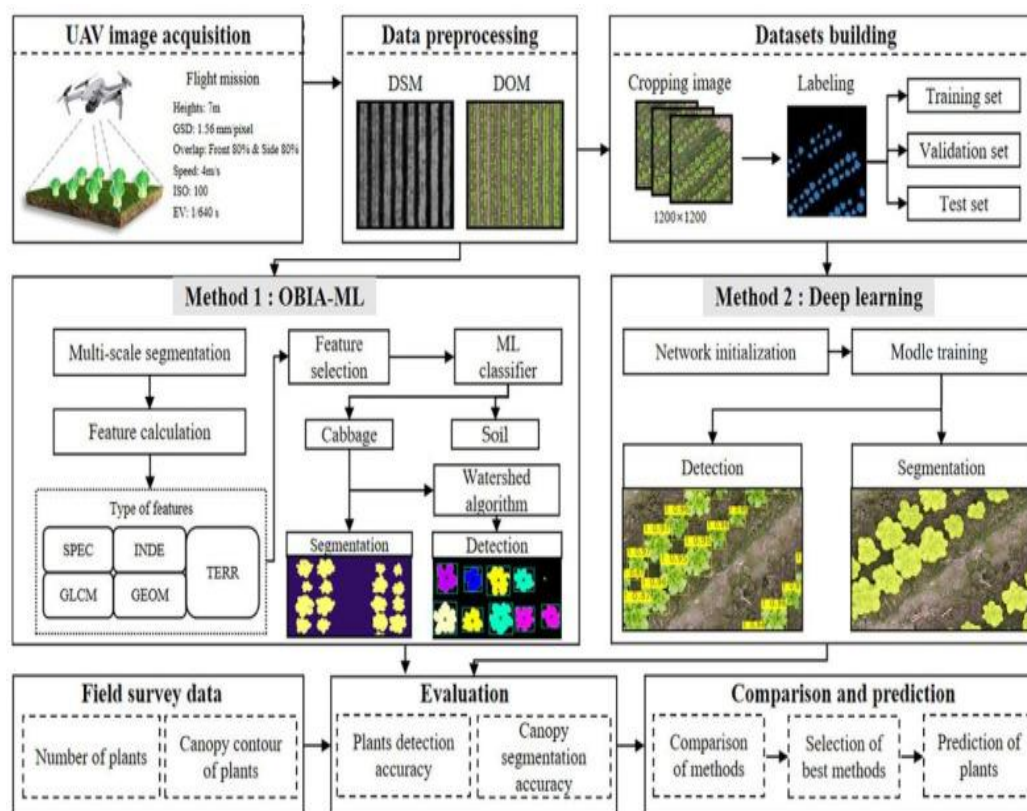
3. CONCLUSION

The review points out the significance of drone applications in vegetable crops and the immense potential of these tools in enhancing cultivation efficiency. Drone applications in vegetable crops in the literature are increasing more and more, with the number of dedicated papers on this subject growing year by year.

The scientific knowledge in this field, combined with the array of information that drones can provide, will be employed by agronomists, agrotechnicians, and specialized consultants in precision agriculture. These professionals will be capable of offering farmers increasingly informed and precise operational guidance, thereby contributing to the optimization of agricultural management practices and yielding economic and environmental benefits.

From an economic standpoint, drones can provide a dual advantage. Their utilization enables the reduction of input quantities such as herbicides, fertilizers, pesticides, and water but also the prevention of damages through early diagnosis of various stress types. Additionally, input savings can yield environmental benefits, positioning these technologies as potential solutions for the environmental sustainability of vegetable crops [64,104].

However, it is imperative to continue research and development to face technological challenges and make these tools increasingly accessible and effective for the agricultural sector where tradition is strong, and innovations are gradually accepted and adopted.

4. REFERENCES

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