DRONES IN AGRICULTURE: A SUMMARY

ABSTRACT

Modern sustainable agricultural production trends pose a need to change production technology processes with the application of techniques, using tools that cause less environmental pollution and con-tribute to ensuring health safety in general. Precision agriculture, or precision agriculture, can be defined as an agricultural production process that includes the application of information technology and various types of sensors, satellite positioning, and monitoring of farming machinery. Aerial remote sensing is regarded as one of the most crucial technologies for smart and precision agriculture (PA). Drones are used in aerial remote sensing, which measures vegetation indices and uses images of various wavelengths to identify various crop conditions. In order to obtain the necessary images for precision agriculture, manned aircraft or satellites have been utilized in recent decades. Drone surveillance systems help farmers observe aerial images of crops. The use of drone-borne sprayers in the field has increased coverage, increased chemical effectiveness, and made spraying operations easier and faster.

Keywords: Drone, UAV, Crop monitoring, Pest management, Precision agriculture, Digital technologies, Smart agriculture

Introduction

As agricultural scale and production reach new world records, society's environmental consciousness fortunately also increases [1]. The demand for producing high-quality food free of pesticide residues and other harmful substances is rising in contemporary, environmentally conscious societies. The use of renewable energy sources and the preservation of the environment and natural resources are also motivated by ecological concerns. Current trends in sustainable agricultural production necessitate a shift in production technology procedures through the use of methods and instruments that reduce environmental contamination and help to ensure overall health and safety [1]. Many studies and social initiatives call for a transition to more sustainable agricultural methods due to their favorable impacts on ecosystems, biodiversity and human health [2]. The idea of precision agriculture, or agricultural management based on the use of information technology in agriculture, is one strategy that backs such initiatives [3]. An agricultural production process that incorporates the use of information technology, different kinds of sensors, satellite positioning, and farming machinery monitoring is known as precision agriculture. work, data analysis, and decision-making procedure.

Aerial remote sensing is regarded as one of the most crucial technologies for smart and precision agriculture (PA). Drones are used in aerial remote sensing, which measures vegetation indices and uses images of various wavelengths to identify various crop conditions [4]. In recent decades, manned aircraft or satellites have been used to capture desired images for precision agriculture [5]. The cost of taking pictures with manned aircraft is high, and the issue with satellite imagery is that, in most cases, the spatial resolution is not as good as one would like. Additionally, weather conditions affect image quality and availability [6], [7]. Advances in unmanned aerial vehicle (UAV) technology and the reduction in weight of payloads have transformed the use of remote sensing of crops using this technology. This technology is less expensive, saves time, and obtains high-resolution images without destruction [8], [9]. Drone surveillance systems help farmers observe aerial images of crops. This provides information regarding water systems, soil varieties, pests and fungal infestations. Crops of images collected by drones contain information in the infrared and visual spectrum ranges. Various features from these images can be extracted, providing information about plant health in a way that is invisible to the naked eye. Another important feature of this technology is the ability to monitor performance regularly, i.e. weekly or even hourly. Regularly available crop information helps farmers take corrective measures for better crop management [10], [11].

Applications of drones in precision agriculture can be studied based on payloads. The actual payload is the weight that the drone can carry. Concerning the payloads two main categories are described in this review viz. crop health monitoring and spraying [12].

UAVs and Drones

Nowadays, the application of small unmanned aerial vehicles (UAVs) is growing at a very fast pace in the agricultural industry [13], [14], [15]. Drones are semi-autonomous devices that are continuously evolving into fully automated devices. These devices have great potential for agricultural planning and the collection of related spatial information. Despite some inherent barriers, this technology can be used for effective data analysis [16].

Drones were originally radio-controlled aircraft that pilots operated from the ground. Modern drones, on the other hand, are GPS-based, self-governing aircraft. The drone's intended use determines the kinds of cameras, sensors, and control systems that are used. Fixed wings, helicopters or VTOL, and multicopters are the three primary categories of UAVs. The size of different payloads has decreased as a result of advancements in drone technology, leading to more compact and effective drones. These drones can now carry out tasks like applying pesticides thanks to AI integration, which gives them the ability to make wise decisions.

Drones for crop monitoring

For small installations, there are limitations to using satellite imagery for data analysis. Additionally, weather and lighting conditions affect the availability of satellite imagery. Because unmanned aerial vehicles (UAVs) can automatically take pictures of the desired location at the desired altitude and frequency, they offer a better option for gathering image data. Furthermore, drone-based technologies can be used as a fully automated tool for weed and pesticide analysis and can analyze data instantly. Camera-equipped drones use advanced image data analysis tools to identify diseased or defective plants [17], [18]. Drones are primarily used in agriculture to map fields and monitor crops.

Drones in the agriculture perform many activities that assist in crop monitoring, some of which are:-

1. Crop scouting

2. Crop health monitoring

3. Yield monitoring

4. Biotic and abiotic stress assessment

5. Disease classification

6. Plant height, canopy estimation

In 2012, Jacopo Primicerio et al. We have developed an unmanned aerial vehicle (UAV) called VIPtero. [19]. This allowed us to manage the vineyards appropriately depending on their location. This was an autonomous hexacopter that could operate based on location using a multi-spectral camera. In 2015, Hassan-Esfahani et al. [20] proposed a remote sensing technology called “AggieAir” for agricultural applications. We were able to capture images in the RGB (red, green, blue), near-infrared (NIR), and thermal spectra. It provided high-quality multispectral imaging data for monitoring plant health. In 2016, Santesteban et al. used a drone system to investigate water conditions in vineyards [21]. Aerial thermal images taken by drones were used to estimate current and seasonal water status of crops. Plant health status was analyzed using the Crop Water Stress Index (CWSI). In 2018, Arnab Kumar Saha et al.

proposed an IOT-based real-time drone system for crop data monitoring [22]. Real-time data analysis was done using intelligent sensors and modules. In 2019, Jack and colleagues used a Raspberry Pi 3B module to incorporate the suggested solution into a drone. suggested a method for estimating soil properties that uses the visible atmospheric resistance index (VARI) squared [23]. In 2020, Su et al. proposed an automatic yellow rust monitoring system using UAV [24]. To gather data, a multispectral camera was employed. RGB, Extra RedEdge, and NIR were the five distinct spectral bands that were recorded. For semantic segmentation, the suggested system used U-Net.

Drones for pest management

Manual mechanical sprayers are the most common tools for traditional pesticide application. Manual pesticide application can affect the human body and cause diseases such as cancer, hypersensitivity, asthma, and other disorders [25]. In addition, traditional methods also have other drawbacks, such as: For example, additional use of chemicals, shortage of agricultural labor, less uniform application, environmental pollution, and reduced land coverage. These traditional methods have high pesticide application costs and are less effective in controlling pests and diseases. To address these drawbacks, drone-borne sprayers are used. The use of drone-borne sprayers in the field has increased coverage, increased chemical effectiveness, and made spraying operations easier and faster. Currently, drones carry pesticide tanks with a capacity of up to 40 liters and can spray crops according to requirements according to premapped routes. Drones have shown great potential in covering fields that are difficult to access with tractors or aircraft. The first UAV (unmanned helicopter) for pesticide spraying was developed in 1983 by Yamaha Motor Co., Ltd. in Shizuoka Prefecture, Japan. The stability and controllability of this helicopter was not suitable for use in the field.

Recent years have seen many changes in both drone flight controls and spray systems. The spray system has been upgraded from a semi-controlled device to an AI-based fully automated system. The fully automatic pesticide spraying system analyzes real-time data and is capable of spot spraying. Chemical spraying requires no human effort, making it a safer and more economical system of choice.

It is crucial to stress that there is no direct human activity present when using a drone for spraying. The impact of pesticides on people is greatly lessened in practice since the drone pilot is safely away from the surface to be sprayed [26]. Current research focuses on improving the spray coverage to enable the large-scale use of drones for pesticide spraying [27]. When used in conjunction with precise monitoring, pesticides can be applied less frequently, which may lead to decreased pesticide use and resistance development as well as a rise in natural enemies [28]. The use of drones in agriculture heralds a new era of efficiency and precision in crop protection. The use of drones, especially for supplementary biological control, requires the large-scale release of natural enemies to immediately combat pests [29]. Natural enemies can be distributed precisely where they are needed, potentially increasing the effectiveness of biological control agents and reducing distribution costs.

Conclusion

Since 2017, the application of drones in precision agriculture has rapidly increased. This is due to the reduced weight, reduced cost, and increased payload capacity of UAVs. By using drone surveillance technology, the data collected is processed instantly, allowing for active processing and decision-making in real-time. Currently, the practical use of drones is spreading faster than in other industries. There are several reports highlighting the successful use of drones in agriculture, both in the use of pesticides and the introduction of natural enemies**.**

The (UAV) market is constantly changing, with improved technology now shifting the use of fixed-wing drones and helicopters to smaller multicopter-based drones, accounting for almost 50% of the UAV models currently available. covered [38]. Each type of UAV has its performance drawbacks, such as high operating and maintenance costs, limited flight range, time, and payload capacity, but with accelerating technology development and the systems integrated into drones, Engine innovation will overcome most of these problems. in the near future

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