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Applications of Unmanned aerial vehicles in agriculture

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Abstract : Unmanned aerial vehicles (UAVs) are unmanned flying robots. The term UAV usually includes drones, micro, and nano aircraft. In most cases, the UAV consists of the main control unit with one or more fans or propulsion systems that lift the UAV and push it into the air. Originally developed and used by the military, UAVs are now used in surveillance, disaster management, firefighting, border security, and courier services. This chapter is of particular interest to the agricultural application of UAVs and focuses on their use in livestock and crop management. This chapter describes different types of UAVs, pest control, plant irrigation, health surveillance, livestock, geofence, and their use in other agricultural activities. Beyond the application, we will discuss the benefits and potential uses of UAVs in agriculture, as well as business-related and other open issues that impede the spread of UAVs in agriculture.

***IndexTerms* – UAVs, smart agriculture, remote sensing.**

I. INTRODUCTION

Unmanned aerial vehicle (UAV) an aircraft operates without human intervention. There are different types of UAVs that are used for different purposes. This technique was originally used by the military for anti-aircraft targeting exercises, intelligence gathering, and surveillance of some enemy areas. However, this technology goes beyond its original purpose and has been attracting attention in various areas of human effort in recent years. Advances in technology have made unmanned aerial vehicles more and more adaptable to a variety of purposes. If no pilot is on board, the UAV can be remotely controlled by a ground station pilot or autonomously through a pre-programmed flight plan.

There is great potential for the use of UAVs in agriculture. One of the applications can be product forecasting with accuracy using data collected by remote sensing. Farmers can observe their farms remotely with UAVs. This skyscape can reveal many problems on the farm, including problems related to watering, soil changes, and the spread of fungi and pests. Detailed information on water access, climate change, wind, soil quality, the presence of weeds and insects, changes in vegetation period, etc. can be monitored on the UAV. From a livestock perspective, UAVs are used to count populations, monitor animals, and study dietary and health-related patterns. With the information gathered, farmers can provide quick and efficient solutions to identified problems and problems, make better management decisions, improve agricultural productivity, and ultimately more. You can achieve high profits. This chapter describes the various uses of UAVs in agriculture in both commercial livestock and crop production. This chapter also introduces some of the open challenges for applying UAVs to agriculture.

An unmanned aerial vehicle (UAV) is a type of aircraft that operates without a human pilot on board.NS Overview of the "2050 Agricultural Project", The world population will reach about 10 billion by 2050. As a result, food production needs to be increased by 70% [1]. Agriculture requires automation, robotics, information services, and intelligence to speed up food production Connecting information and communication technology (ICT), robotics, artificial intelligence (AI), big data, Internet of things. Smart agriculture Creates new opportunities for the future. At the center of smart agriculture expansion Agricultural robots including unmanned aerial vehicles (UAV) are widely used [2]-[4]. Having a UAV Significantly reduce working hours, thereby increasing Stability, measurement accuracy, productivity. UAV Not only is it cheaper than most other agricultural machines, it's also easy to use. Besides, their applications are contributing to the expansion of many areas of Agriculture including pesticide and fertilizer search and spraying, sowing, weed detection, childbirth Evaluation, mapping, harvest forecast [5]. The agricultural UAV market is growing rapidly [7], And several venture companies were born. handle PricewaterhouseCoopers Market Research, Market Agricultural UAV sizes are expected to grow to about $ 32.4 billion by 2050, which is the Global UAV market. Major UAV company Includes DJI, Parrot, PrecisionHawk, AGEagle, Trimble navigation. UAV needs to address for advanced agricultural solutions. Key technologies include precision positioning, navigation, control, imaging, communications, sensors, materials, batteries, circuits, and motors. Depending on the application of Characteristics of UAV and agricultural sector, various Technology (device development, nozzle control, And big data). Providing information about all UAV technologies is a challenge. Research and Development. Agriculture, like any other industry Innovation through the use of convergence technology. Have a UAV It has been shown to be frequently used throughout the industry. However, Agricultural UAVs have many technical limitations, including B. Battery efficiency, short flight time, communication range, payload. Requires technical restrictions Resolved to provide the right approach to the next generation

Agricultural solution. So planning and system Future development should be decided through the first discussion Latest technology, upgrades, precision equipment, Diversification. In this post, we will look at trends, conditions, the latest technology, and agricultural uses. Provides UAVs and instructions, perspectives and problem solving for the future.

II. TYPES OF UAVS

UAVs can be categorized by use, some for photography, aerial maps, surveillance, photography, and more. However, you can make a better classification based on those features. Vroegindeweij et al. In the paper [1], we outlined the different types of UAVs used in agriculture and categorized them into three major groups: fixed-wing, vertical takeoff, and landing (VTOL), and birds/insects. The authors have identified VTOL with its mobility, superior mobility, and levitation capacity as the most suitable for agricultural applications. However, in [2], the author proposes a fixed-wing UAV because it is more suitable because it has a relatively short flight time and a longer flight time and speed compared to a slower VTOL. bottom. In other words, the author has spoken in favor of unmanned helicopters such as monocopters and single-rotor UAVs [3, 4]. These types of UAVs have long flight times, can fly at different altitudes, and have excellent hovering capabilities. However, the flight is much more complicated. A comprehensive study of various UAVs was also conducted in [5]. From this document, four major types of UAVs have been identified. That is,

multi-rotor UAV,
fixed-wing UAV,
single-rotor helicopter,
fixed-wing multi-rotor hybrid UAV.

Figure 1.
Multi-rotor UAV [6]

Figure 2.
A fixed-wing UAV.

Figure 3.
A single-rotor UAV

Figure 4.
A hybrid fixed-wing-multi-rotor UAV

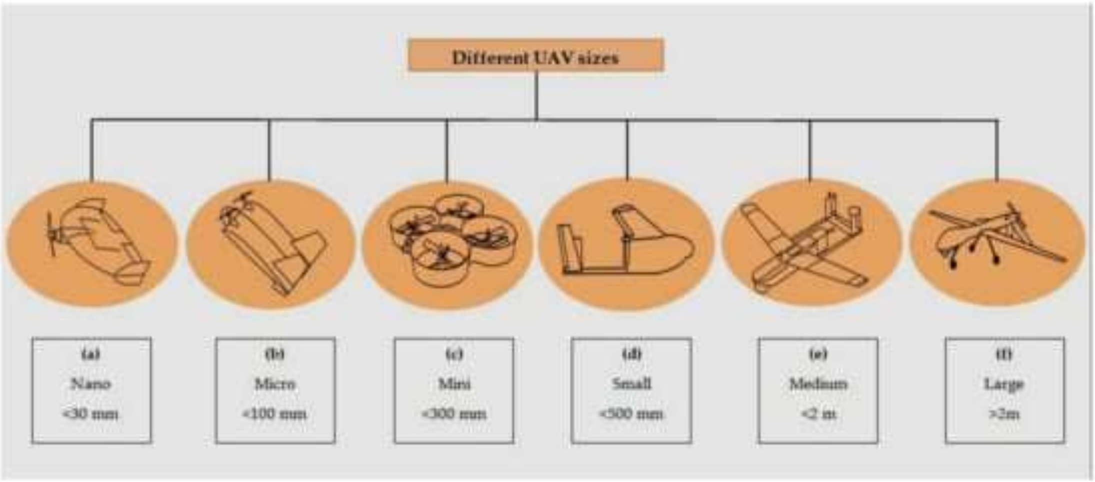

Figure 5.
Types of UAV- based on size (Source:Fahlstrom, P.G.; Gleason, T.J. (Eds.) *Introduction to UAV Systems*, 4th ed.; John Wiley & Sons, Ltd.: West Sussex, UK, 2012; Chapter 2; pp. 17–31)

III. UAVS IN FARMING

3.1 Farm Analysis

Gathering soil information using UAVs can help at the beginning of the crop cycle. The data collected will be useful for early soil analysis and for planning sowing patterns. This data also helps farmers to develop irrigation plans and determine the amount of fertilizer needed after planting in soil or fields. Using a data-driven approach, farmers can improve total produce yields while significantly saving fertilizers and pesticides. All this is made possible by the analysis of remote images captured by the UAV. UAV images also have great potential for the development of site-specific weed control treatments. High-resolution images allow farmers to detect weeds quickly and accurately as they germinate, and contain the weeds with minimal pesticides. The author of [12] has developed an object-based image analysis (OBIA) of a series of UAV images using a 6-band multispectral camera in a cornfield in Spain. [13] provided technical specifications and configurations for UAVs that can be used to capture remote images for site-specific early weed management (ESSWM). The study also evaluated the spatial and spectral imaging properties required to distinguish weed seedlings. They deployed a UAV with a multispectral camera, analyzed the UAV's technical specifications and configuration, and generated images at various flight positions. It has the high spectral resolution required to detect and locate weed seedlings in sunflower fields. The results of the survey will help you select the right sensors and configure your ESSWM flight mission.

3.2. Planting

Crop cultivation is an expensive and laborious endeavor that traditionally requires a lot of human resources. UAVs can cover vast lands in a short period of time with the highest accuracy and accuracy, making it easier for farmers to grow their crops. The reduction in planting costs is due to the ability of the UAV to perform multiple tasks at the same time. The

UAV has become increasingly popular in agricultural research applications in recent years. Agriculture has shown that it is possible to take pictures with high spatial and temporal resolutions. Factors such as leaf area index (LAI), sorted vegetation (FC), and yield was taken into account. The evaluation was carried out using a fixed-wing UAV equipped with a multispectral sensor, images were collected during the growing season of 2016, and a flight mission was carried out 50 days after planting. The flight mission provided data on the various growing seasons of the Great Millet hybrid. The authors conclude that UAV-captured high-resolution images can be effectively used to collect data from fields during the season. The results obtained confirm the relationship between the Normalized Difference Vegetation Index (NDVI) and LAI, and between NDVI and fc. This makes it possible to determine/estimate LAI and fc from the NDVI values derived from the UAV. Images taken during the flow phase have also been shown to be a better indicator of yield than NDVIs obtained early in the growth phase of sorghum crops. In addition, early NDVI measurements have proven to be useful indicators for estimating the population densities of sorghum plants. The author of

[15] sought to develop a new method for field-scale quantification of distances between maize plants using UAVs. The distance between the roots and the plant is important in determining the final grain yield when copying to the row. A UAV-based imaging algorithm has been developed to calculate the distance between corn plants. Knowing the exact number of plants per square meter is essential and can help improve yields by deriving the use of fertilizers and pesticides based on the needs of the plant. Determining plant populations is essential for several other processes such as soil-plant balance, nutrient cycle, and resource efficiency. This study demonstrated the ability to quantify distances between maize plants, quantified variability between plants, and provided an innovative approach by expanding crop yield estimates.

3.3. Spraying

Spraying plants is usually a difficult and difficult task for farmers and agricultural producers. It is to cover a very large area extensively to ensure proper growth of the plant. Agricultural UAVs have made it easier for farmers to spread their crops. This is because it can cover a wide range in a very short time. With the help of sensors, the UAV can automatically adjust its height when spraying on uneven fields. This improves spray accuracy and saves resources. The advantage of using a UAV for plant spraying is that it saves farmers time and money, sprays efficiently because it can reach both the plant and the soil beneath it, and is a potentially harmful chemical that has existed for some time. It is to protect farmers from long-term exposure to substances. Manual spray. Agricultural UAVs use state-of-the-art terrain scanning technology to distribute the optimum amount of liquid needed for proper plant growth. This ensures low waste and uniform coverage. Lv et al. The deposit density decreases with airspeed, the droplet diameter (ie, the uniformity of the particle size distribution) decreases with increasing airspeed, and as a result, the uniformity of the sprayed droplets decreases, etc. Therefore, the authors provided theoretical support for optimizing the spray parameters of crop protection UAVs with the aim of improving crop yields. The point spray is similar to the plant spray but is intended for weeds. With a high-resolution camera, the UAV can detect weeds and accurately spray a jet of herbicide. Point sprays can save up to 90% on chemical herbicides.

3.4. Monitoring

The combination of large farmland and the efficiency of inadequate crop monitoring systems is some of the biggest challenges in agriculture. Monitoring challenges are exacerbated by unpredictable weather conditions, increasing risk, and on-site maintenance costs. Agricultural UAVs help farmers overcome some of these challenges. UAVs with infrared cameras allow farmers to monitor their operations. Farmers can see not only the condition of the crops on the farm but also the areas that require urgent attention. The result is higher yields and higher profits. Showed the possibility of using UAV images to create the following quantitative mapping products: In this study, we developed a framework that uses a single-rotor UAV (monocopter) with multiple spectral cameras to process UAV images and generate mosaic images that can be aligned with maps for GIS integration at a later date.

3.5 Irrigation

Agricultural UAVs equipped with thermal cameras can provide a great deal of insight into specific problem areas within the farm. Infrared cameras allow farmers to identify areas of low soil moisture, identify dry crops, identify flooded areas, and generally capture the overall health of the crops in the field. Such accurate and concrete monitoring is inefficient or very expensive as it was not possible with traditional agriculture or had to hire specialists to perform tasks and provide appropriate solutions. was. UAVs now offer farmers the option to do this themselves. A rain-irrigated commercial Tempranillo vineyard water quality assessment was conducted and it was concluded that UAVs could be used to assess vineyard water quality and map variability within the vineyard. Gonzalez Dugo, et al. considered assessing the non-uniformity of water conditions in commercial orchards as a prerequisite for precision irrigation. A high-resolution aerial thermal image was used. A UAV equipped with an infrared camera flew over a commercial orchard three times a day. Indicators obtained from thermal images represent the spatial variability of the water state of the plant and allow tree-by-tree mapping in the orchard. Therefore, it is becoming a valuable tool for water management in precision agriculture.

IV. ADVANTAGES AND DISADVANTAGES OF UAVS

4.1. Advantages

Restrictions: As it is carried in the air, it is not hindered by physical constraints such as road and ground terrain, uneven routes, and obstacles. You can scoop them all up.

Movement shorter than : The shortest distance between two points is known to be a straight path. UAVs are ideal for this because they can fly straight in a straight orbit. This is not always the case with land vehicles.

Flying in the Dark: For autonomous UAVs, the UAV can be programmed to fly in total darkness or when there is little visibility that is difficult for humans to manually control.

Time and effort savings: Activities such as staff counting, monitoring, and drafting often require the use of more helpers. These are labor-intensive and time-consuming. UAVs can significantly reduce the number of additional workers required and at the same time save time. Similarly, in crop production, UAVs can be sprayed onto crops about 40-60 times faster than human workers.

Cost: In addition to saving time, reducing staff directly leads to cost savings. However, high-performance UAVs are not cheap and have additional costs in the form of electricity to recharge the battery. The cost savings and benefits of UAVs clearly outperform traditional/raw farming manual and labor-intensive processes.

Aerial Photos: UAVs allow farmers to quickly obtain aerial images of the entire farm or selected areas of interest. This helps determine when the fruit is germinating, or when pests and weeds are choking the crop.

4.2. Disadvantages

UAVs have experienced a wide range of applications in smart cities, all of which have contributed significantly to the development of smart cities. Challenges can be broadly divided into business and technology.

Cost: Due to the technical nature of UAVs, this technology is perceived as expensive. Deployment, integration, and training can be very expensive. Similarly, the author took a project management perspective and emphasized cost as an important factor to consider when deploying UAV-related projects. It was also pointed out that various methods should be used to make appropriate estimates before embarking on such a project.

License and regulatory issues: For UAVs, this is still a gray area. Either unregulated or loosely adapted to aviation laws that are not fully compliant with UAVs. Therefore, legislation needs to be developed to regulate the new possibilities and areas of application of UAVs. Countries such as the United States, United Kingdom, Germany and Spain are moving in this direction by developing guidelines for the use of UAVs and flight areas. But the rest of the world is still a little behind.

Corporate Recruitment: From a business perspective, justifying the adaptation of UAVs to agriculture may not be easy. It can be argued that it could be a cost savings in the long run, but it argues about the actual cost of the UAV, insurance / replacement of the crashed UAV, and the purchase of high-resolution cameras for imaging and related software solutions. can. Other ongoing costs. Adding all of this makes it difficult to sell to farmers and farmers.

Technical Challenges: These are middleware services and UAV system integration, high performance systems for data analysis, machine learning / computation where all members of the team control UAV and use image and sensor information in real time. Use intelligence to identify and retrieve useful knowledge from large data pools.

Ethics and Privacy: Some believe that using a UAV for surveillance and surveillance violates privacy. The lack of standardized operational and technical procedures required for the safe operation of UAVs is a major challenge. GPS jamming and hacking can be caused by weaknesses in performing and controlling UAV operations.

V. CONCLUSION

Unmanned aerial vehicles (UAVs) are essentially flying robots. Originally designed for military use, it is now used in a variety of areas such as recreational sports, firefighting, flight simulation/training, and children's toys. This chapter introduced UAV applications in commercial agriculture. We have covered four major types of UAVs. Multirotor UAVs appear to be suitable for agriculture because they can hover in place and take off and land vertically, but their limited flight time is a major limitation. Hybrid fixed vane motor rotors may be more suitable. In addition, detailed insights into UAV applications in crop production and livestock were given. A key requirement of most agricultural UAV applications is an integrated camera that allows image capture. Images are used, among other things, for weed detection and control, soil analysis, animal surveillance, animal head counting, geofence, and patterning. Like most machines, UAVs have the advantage of performing repetitive and monotonous tasks more appropriately and efficiently than humans. Several benefits of using UAVs in agriculture were presented, including limited route restrictions, time savings, and reduced manual labor. However, there are many challenges that constrain UAVs, the most important of which is cost. UAVs suitable for agricultural use are expensive. There is a charge for operation and maintenance. As a result, it is often difficult to convince farmers and farmers to incorporate UAVs into their businesses. Cost aside, battery limitations, safety, and legal issues are major hurdles that UAVs must overcome before they can build a foothold in the agricultural sector.

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