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Agriculture Drones and Their Applications

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ABSTRACT

The world is getting bigger day by day which mean there are many mouths to feed and the main source of food is farming. And farming is not a simple process it needs more time and investment but with the help of the modern technology the forming process may get much easier. And the technology that we are going to use in agriculture is known as UAV's (unmanned aerial vehicles) which are also called Drones. The drones have many uses and application, with drones help we will be able to reduce the water waste and also reduce the farm waste. This paper is about how the drones are used and different applications of drones in the agriculture sector, and also to know whether the drone technology is being used in Indian society. And at the end the paper concludes with recommending the drones usage in the modern farming practice.

Keywords: UAV's, Drones, IOT, Agriculture.

Introduction

Drones in agriculture represent a technological leap, revolutionizing farming practices. These unmanned aerial vehicles offer precision in crop monitoring, spraying, and mapping, enhancing efficiency, and maximizing yields while minimizing resources. They've become a crucial tool in modern farming, fostering sustainability and innovation in the agricultural landscape. It emphasizes how these aerial devices gather data efficiently, offering real-time insights into crop health, soil conditions, and irrigation problems. Precision of drones in applying resources like fertilizers and pesticides minimizes waste and environmental impact while maximizing crop output. They enable precision farming by detecting issues early, allowing prompt intervention. The data collected can also be used in conjunction with AI and machine learning for predictive analysis, promising continual advancements in sustainable farming practices. Drones in farming help by using cameras and sensors to check on crops, soil, and water. They take lots of information fast so farmers can make quick decisions. These machines don't just observe they also spray stuff like fertilizers or pesticides very precisely. This helps crops grow better while using less and being kinder to the environment. Overall, drones are great because they're flexible, save money, and cover big areas, making farming better and more eco-friendly. Drones speed and coverage provide detailed insights into crop conditions, pests, and nutrient issues, empowering farmers to make decisions backed by data. This advancement streamlines farming practices and promotes sustainability by minimizing chemical use and optimizing resource allocation. As drones continue advancing and merging with advanced tech, they're expected to profoundly transform farming, enhancing efficiency, productivity, and environmental friend.

Literature Review

S. Ahirwar, R. Swarnka, S. Bhukya, G. Namwade (2018), have stated that the drones the inputs like water, pesticides and cost can be reduced where output will be same. The low cost drones also have good imaging sensor for crop control. The multispectral images track the changes in plants and health of crop and also concluded that the use of drones will change future of the Indian agriculture.

John Loewen, Niyom Suwandej (2018), have stated in their paper that the use of drones in agriculture have reduced overall cost and time for forming a crop. And the waste produced from forming had reduced. Drone usage will grow to 35.9% & will reach 5.7$ billion by 2025.

They have also mention in their paper that efficiency of production have increased while the cost is decreased.

Vijay Rana, Mahima (2020), they have stated in their paper that The UAV is combination of Information, Robots, AI and IOT. The use of drones and AI in farming is more & hurdle in early stages. With the help of new AI tools and UAV's show much profit in forming. They have concluded that the using AI tools in farming with help of drones will make agriculture much easier and faster production.

Pornima Rathod, Gopal Shinde, Ravi Kumar Kalloji (2022), they have discussed in their paper that the utilization of drones gives a large advantage in economy and time due to their features. The paper had presented the best drone manufacturers like DJI, Parrot etc. There are many other areas where we can use drones like satellite amassing, providing reports, physical support etc.

J P Sinha (2019), In this paper it stated that with drones we can achieve accuracy, resolution, precision, sensitivity, linearity etc. The UAVs have many disadvantages as well as advantages, in fields we need good internet connectivity and battery backup. With efficient & professional assistance the losses can be redeemed.

Amit Kumar, Vibhu Pandey, Shalini Singh (2022), they have concluded in their paper that how hard it is to establish drone set up. This say by 2020, 900 businesses would be using over 2900 UAVs • With the help of drones the health of farmers will better. The paper says that the government should also take part and start adding program for use of drones

Karim Rejeb, Alireza Abdollahi horst (2022), they have stated in their paper that the use of drones had changed the perspective of the farming process in the agriculture sector. In this paper they have reviewed different experiments and paper and made a chart on how well the drones can be useful. They have concluded that the use of drones had only benefited the farmer every aspect as per the results of the survey.

Manish, D Mahale Mrunal, S Thakur, Chaitali V Wagh (2021), have discussed about the different types of drones and methods used by the drones. It states that the UAVs have already started to make big changes in the agriculture sector. The cost of the drones will also get decreased in the future where a farmer with small can also use them.

Sabia Kouser, V Ramya Doddamani (2020), The paper talks about major applications and uses of drones. And the technologies used to guide the drones like sensors, GPS, etc. they also had presented the works during flight like planning, imaging, post processing etc. UAVs are expected to play a crucial role in water saving cause of it precision spraying and sensing ability.

Payal Kasar, B D Deore, Megha Bhamare, Mayuri Sahame (2018), This paper is about using drones for spraying pesticides. The processes followed are detect presence of pest, spraying pesticides, spraying of UREA. The time and cost for spraying is reduced a lot with the help of UAVs. The crop health will be increased cause of precision spray. And due to the precision spraying the land will not get pollutant cause of the pesticides.

Application of drones
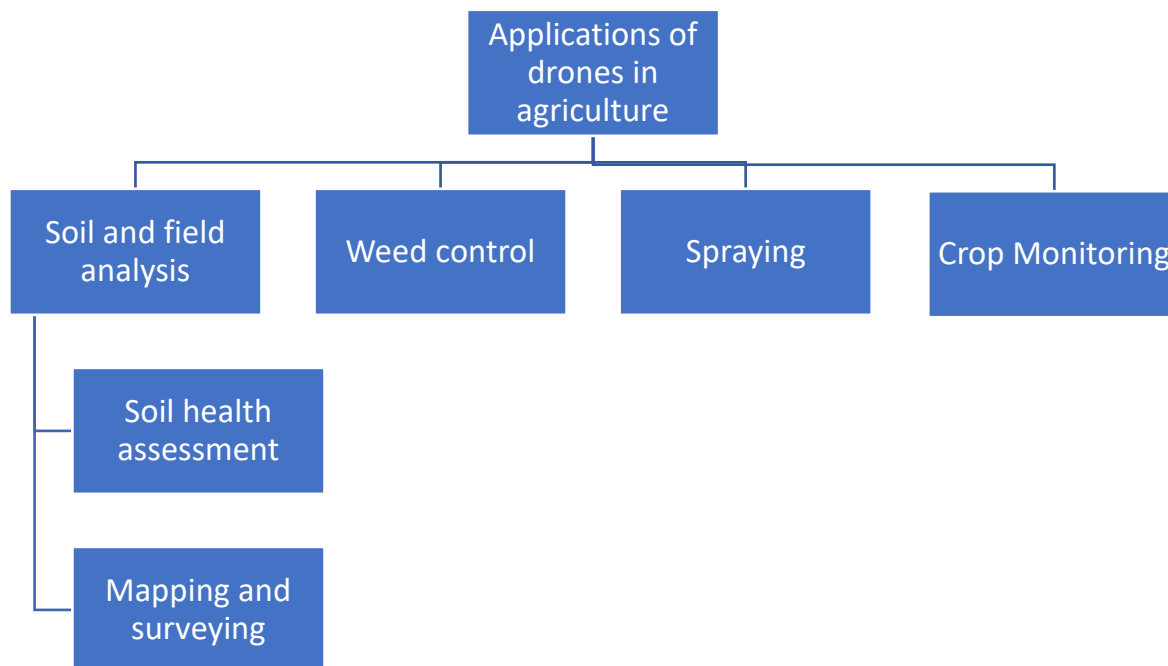
Soil and Field analysis

Soil and field analysis is the process of using the drones in agriculture which involves the use of UAV's (Unmanned aerial vehicles) which are equipped with various sensors and cameras for the purpose of gathering data from the fields like soil health, overall performance of the field, crop condition etc. The UAV's can capture high resolution images with the help of hyperspectral, multispectral imaging. These images can give a quick idea about how crop field is working. These images can show the details like soil moisture levels, pest infections, nutrient content, growth patterns. This information is necessary for filed analysis, because it can make the field to lose the crop if not taken care of. This collected information is processed with modern software to produce or generate maps for crop. Then these maps are used for how do planting and other processes.

Sensors used for soil and field analysis

1. Multispectral Sensors

2. Hyperspectral Sensors

3. Thermal Imaging Cameras etc.

Multispectral Sensors

These sensors capture data across multiple bands of electromagnetic spectrum which a human can't see with naked eye. They can detect the different variations in plant health by measuring the reflections at different wavelengths this sensor can identify stresses in the crops, they can also detect the nutrient deficiencies in the crop. These sensors are affordable are really necessary for a drone to imaging a crop field.

Hyperspectral Sensors

These sensors are more advanced and versatile than the multispectral sensors. The hyperspectral cameras are designed to capture images in a much broader range of wavelengths with much higher resolution. These sensors enable us to analyze the crops health with much more precision, also allowing us clearly visualize the crop health and enables us to sense any discomforts in the crop health. These sensors are a bit costlier then the multispectral but more efficient than them.

Thermal Imaging Cameras

These are also used for observing and capturing the crop health and inspecting any discomforts but these cameras measure the heat that id emitted by the plants and soil. These sensors are designed for detecting variations in temperature and comparing those temperature to the ideal readings and will give the reading if there is any issue with plant health, these help for identifying the irrigation issues.

Soil health assessment

Drones or UAV's which are equipped with sensors can be able to analyze soil properties such as moisture content, nutrients composition, PH levels etc. these helps the farmers to make precise decisions about irrigation process, and the fertilization process. It involves evaluating various aspects of soil to support the plant growth.

The assessment methods for soil health

1. Field Observations

2. Laboratory Analysis

3. Soil Sampling

These assessments help for assessing the soil health and allows the farmers to make decision accordingly about the soil management. This assessment helps manage fertilization, crop rotation, irrigation.

Mapping and Surveying

It is the process of the collection and analysis of spatial data across fields to create detailed maps for taking better decision in the agriculture aspect. This mapping helps us how to plan the crops planting in the field and this process also helps to take a better view of the crops. The surveying involves two types of surveying one is aerial surveying and other is ground-based surveying, the surveying is the process of using GPS devices or traditional land surveying methods to gather specific on-site data about field characteristics.

The technologies used in mapping and surveying

1. Global Navigation Satellite Systems

2. Remote Sensing

3. Geographic Information Systems

Mapping and surveying are the internal components of precision agriculture which enables the farmers to make data-driven decisions and these will help to enhance the overall agriculture productivity while minimizing environmental problems.

Weed control

Control of weed by the help of drones involves using UAV's which are equipped with modern technologies like sensors and cameras and sprayers to identify the weeds in agriculture fields. Drones can precisely navigate the fields and identify the different weed species. Weeds are not plants they are like invaders which invade into a life zone and suck up the life source. The weeds grow in the agriculture farms and causes several problems. There compete for available resources like water and space which causes loses for the crops and their growth. The percentage of yield losses in India for rice (10-100%) and for wheat (10-60%) for sugarcane crops (20-50%) for vegetables (25-40%) and for jute (30-75%) for potato (20-30%). The use of the herbicides is the best choice for weed control. In the old agriculture practice the only way reduce the weed control is to use large quantities of pesticides and herbicides even in the weed free areas. The over use of these herbicides makes the weeds get resistant to it and it will affect the crop growth. Usings the hyperspectral images to determine between the spectral signatures of some weeds with different resistances to glyphosate. By using the RGB sensors we can classify various weed species. Researchers have used drones with hyperspectral sensors for monitoring weeds as a function of the plant canopy chlorophyll content and the leaf density.

And the use of heavy chemicals leads to heavy pollution to the environment. To overcome these problems the researchers have started to use specific weed management control. It is to generate an accurate weed cover map for spraying of herbicides precisely. The drones can gather images and can derive data from the whole field which can be used to generate a weed cover map removing the spots where the chemicals are not needed. Agro-drone application for weed spray useful for pre-emergence and post emergence weed control. The drones offer more quicker and targeted weed management which can potentially saves time and resources for the farmers.

Advantages of using drones for weed control

1. Precision Agriculture

2. Efficiency and speed

3. Reduced Herbicide usage

4. Flexibility and Accessibility

5. Data-Driven Insights

There are also challenges for use of drones for weed control such as cost considerations and the need for continuous advancement of technology for accuracy and efficiency.

Spraying

We need protection and production materials for achieving high productivity in the agriculture sector. The fertilizers are used for getting rid of pest and insects in the fields and increase the crop productivity. In modern technology drones are being used for spraying fertilizers on the fields based on spectral variability of crops and fields. And amount of spraying can be adjusted based on the crop conditions or the amount pest or insects in the fields. The integration of drones with sprayer systems results a potential to provide a platform to pest management and control. For the spraying purposes we have to use heavy powered UAV's for large area of spraying. Researchers have proposed the Quad copter system which is low cost and light weight. These drones are small in size and these can be used for indoor crops as well as out door crops. The quadcopters are autonomous vehicles that can spray pesticides and fertilizers using any android device.

The communication between the android and drone will be done by the use of Bluetooth device in the real time operation. These can be used to increase the yield of agriculture. The spraying efficiency of a pesticide system mounted on a UAV improves with the use of a PWM (Pulse Width Modulation) controller. An innovative solution called an Aerial Automated Pesticide Sprayer (AAPS) was created by integrating a blimp with a quadcopter. This system operates based on GPS coordinates, particularly in lower-altitude environments. To address cost concerns and enhance user flexibility, a low-cost pesticide spraying drone named "Freyr" was developed. Control of this drone is facilitated through an Android app. Laboratory and field evaluations were conducted to analyse the factors such as liquid discharge and pressure rate, spray uniformity, liquid loss, droplet density, and sizes using a hexacopter-mounted sprayer. Efforts have been made to reduce pesticide wastage by introducing an electrostatic sprayer designed with electrostatic spray technology, which is integrated with a hexarotor UAV. The World Health Organization (WHO) estimates that there are over 1 million pesticide-related cases every year, emphasizing the significance of efficient and controlled pesticide application methods to minimize potential health and environmental risks. Accelerometer and Gyroscope sensors are used for spraying fertilizers and pesticides and they have the ability to reduce time and human efforts.

Advantages of spraying by drones

1. Precision Agriculture

2. Cost efficiency

3. Time Saving

4. Reduced environmental impact

5. Flexibility

Crop Monitoring

Drones play a crucial role in monitoring crop conditions throughout the growing season, allowing for timely and need-based actions. Various sensors on drones, including those sensitive to visible, near-infrared (NIR), and thermal infrared rays, enable the computation of multispectral indices based on the reflection patterns at different wavelengths. These indices help assess crop conditions such as water stress, nutrient stress, insect-pest attacks, and diseases. The sensors on drones can detect the incidence of diseases or nutrient deficiencies even before visible symptoms appear. This early detection capability serves as an effective tool for identifying potential issues early on. Drones, therefore, function as an early warning system, enabling farmers to take timely actions and apply remedial measures based on the severity of the stress. Unmanned Aerial Vehicles (UAVs), commonly known as drones, have the capability to observe large hectares of fields in a single flight. Thermal and multispectral cameras, mounted on the underside of the quadcopter, are used to record the reflectance of the vegetation canopy. These cameras capture images at a rate of one per second, storing the data in memory and transmitting it to the ground station through telemetry. This technology provides farmers with valuable insights into crop health, allowing them to make informed

decisions and take proactive measures to optimize yields. The data that comes from the multispectral camera through telemetry is analysed by the Geographic indicator Difference Vegetation Index (NDVI).

The Normalized Difference Vegetation Index (NDVI) is a straightforward measure that assesses the health of green vegetation. This metric is based on the principle that chlorophyll strongly reflects near-infrared light (NIR, around 750nm), while red and blue light are absorbed. Although chlorophyll reflects strongly in the green spectrum, the reflection in NIR is even greater, providing precise data for analysis. The calculations yield values ranging from -1 to +1, where values close to zero indicate little to no vegetation on the crop, while values near +1 (0.8 to 0.9) suggest the highest density of green leaves on the crop. Farmers can use these results to easily identify the health condition of their crops and make informed decisions, such as determining where to spray pesticides. Drones play a crucial role in monitoring crop conditions throughout the growing season, allowing for timely and need-based actions. This quick and appropriate action can prevent yield loss. The technology eliminates the need for farmers to visually inspect crops manually. Drones enable the monitoring of horticultural crops and other crops in remote areas, such as mountainous regions. They are also efficient in monitoring tall crops and trees, which would otherwise be challenging for farmers to inspect physically. Overall, the use of NDVI and drones enhances farmers' ability to make data-driven decisions and efficiently manage crop health.

Advantages of crop monitoring by drones

1. Efficiency

2. Precision

3. Cost Effectiveness

4. Data Accuracy

5. Timely action

6. Environmental Benefits

Conclusion

We conclude that using drones in farming is a big deal. These flying machines help farmers a lot by giving them useful information about their crops. With drones, farmers can see how their plants are doing and use resources like water and fertilizer more wisely. This means they can grow more crops without harming the environment too much. Drones are like high-tech cameras in the sky that take pictures of the fields. Farmers can look at these pictures to figure out if there are any problems with the plants. If there are bugs or diseases, they can catch it early and fix it before it gets worse. This is good for the crops and helps farmers save money. But, using drones in farming is still a bit tricky because there are rules and it can cost a lot to get started. As time goes on, it will probably get easier and more people will be able to use drones on their farms. In short, using drones in farming is a cool and helpful idea. It makes farming smarter and better for everyone, and even though there are some challenges, things will likely get better in the future.

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