THE ROLE OF DRONES IN MODERN AGRICULTURE

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Abstract

The use of drones in agriculture has gained attention in recent years due to its potential to improve traditional farming practices significantly. Drones, also known as Unmanned Aerial Vehicles (UAVs), offer several advantages that can enhance crop productivity and quality while also reducing labour costs and environmental impact. In this article, we review the current state of research on using drones in agriculture and highlight some of the benefits they offer. We also discuss some of the challenges associated with integrating drone technology into agricultural operations, such as regulatory issues and technical limitations. Finally, we provide some insights into future research directions and potential applications of drone technology in agriculture, such as crop monitoring, yield forecasting, plant health assessment and pesticide management. Overall, this article aims to demonstrate the potential of drones in precision farming and sustainable agriculture and to highlight the opportunities that lie ahead, as their adoption is prone to increase highly in the near future.

Key words: drones, agriculture, farming, environmental impact

In recent years, the use of drones in agriculture has been gaining increasing attention as a promising approach for improving traditional farming practices. Drones, also known as Unmanned Aerial Vehicles (UAVs), offer several advantages over the traditional methods of crop monitoring, yield forecasting and so on. The use of drones in agriculture has the potential to enhance crop productivity and efficiency while reducing labour costs and environmental impact. With the increasing availability of drone technology and advancements in remote sensing and data analysis, the adoption of drones in agriculture is likely to skyrocket within the next few years.

One of the main advantages of using drones in agriculture is their ability to provide real-time and high-resolution data on crop conditions. With the help of sensors and cameras mounted on drones, farmers can monitor their crops more efficiently and with ease. This data can be used for various purposes, such as identifying areas of crop stress, predicting yields, and detecting the presence of pests or diseases in specific areas. Additionally, drones can be used to precisely apply pesticides and fertilisers to crops, reducing the amount of chemicals used and minimising both environmental damage and impact on the health of the consumers. The use of drones in agriculture can also reduce labour costs and increase efficiency by automating tasks that would otherwise require significant manual labour, for example, crop mapping, monitoring, spraying and even irrigation management. These advantages are numerous and impactful, and they have the potential to improve crop production and sustainability significantly.

MATERIAL AND METHOD

In the past, small planes were often used for agricultural purposes, but this method of farming was not without its drawbacks. Piloted planes can pose a significant safety risk to both the pilot and those on the ground, and the high cost of fuel and maintenance makes this method of farming very expensive. Additionally, the environmental impact of planes in agriculture can be considerable, as the noise pollution and emissions produced are harmful to both the environment and wildlife. As a result, the use of drones in agriculture has become an increasingly attractive alternative, offering numerous benefits over traditional methods of farming.

One of the most significant advantages of using drones in agriculture is their ability to provide real-time data on crop conditions. With the help of sensors and cameras mounted on drones, farmers can monitor their crops more efficiently and accurately. This data can be used for various purposes, such as identifying areas of crop stress, predicting yields, and detecting the presence of

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pests or diseases. Drones can also collect data on factors such as soil moisture, nutrient levels, and temperature, which can help farmers make more informed decisions about irrigation and fertilisation. By collecting this data in real time, farmers can quickly respond to changes in their crops and make the necessary adjustments to their practices.

In addition to providing real-time data, drones can also offer high-resolution imagery of crops. This, in turn, can provide a more detailed and accurate picture of crop conditions, enabling farmers to detect problems that might not be visible to the naked eye. This can be particularly important for detecting early signs of diseases or pests, which can be difficult to spot without a close inspection of individual plants. Drones can capture detailed images of crops from various angles and distances, allowing farmers to create accurate maps of their fields and identify the areas that require special attention. High-resolution imagery can also be used to analyse crop growth patterns and identify areas of the field with lower yields, enabling farmers to adjust their practices and improve overall crop productivity.

Another advantage of using drones in agriculture is the potential to reduce labour costs and increase efficiency significantly. Drones can be used to automate tasks that would otherwise require significant manual labour, such as crop scouting, seed planting, and crop spraying. With the help of drones, farmers can cover larger areas of land in less time, thus reducing the need for manual labour and increasing productivity. Additionally, by automating these tasks, farmers can reduce the risk of human error and improve the accuracy and precision of their operations. This can lead to more efficient use of resources, such as water and fertiliser, and, ultimately, higher yields. Overall, the use of drones in agriculture can help farmers save time and money while improving the quality and quantity of their crops.

While the use of drones in agriculture holds great potential, there are also some challenges and limitations that should be considered. One of the most significant challenges is technical limitations. Although drones have advanced significantly in recent years, they still have some limitations that can affect their performance in agricultural settings. For example, drones may not be able to fly in adverse weather conditions, such as high winds or heavy rain. They may also have limited battery life, which can restrict their flight time and range, but this is a problem that should falter over time, as battery technology is improving pretty fast at the time of writing this article. Additionally, drones may not be able to capture data on certain crops or terrains, which can limit their usefulness for some types of agriculture. To address these technical limitations, further research and development are needed to improve drone capabilities and create specialised drones for agricultural use.

Another challenge associated with the use of drones in agriculture is regulatory issues. Depending on the country and region, there may be restrictions on the use of drones in agriculture, such as requirements for licensing, training, or certification. Additionally, there may be limitations on the types of operations that can be performed with drones, such as restrictions on flying over certain areas or using drones for crop spraying. Compliance with these regulations can be a significant challenge for farmers, especially in areas where regulations are complex or unclear. Furthermore, as the use of drones becomes more widespread, there may be potential privacy concerns related to the collection and use of data, intrusion, hacking and cyber threats. These concerns must be addressed through clear guidelines and regulations to ensure that drones are used ethically and responsibly in agricultural settings.

In addition to the technical and regulatory challenges, the cost of implementing drone technology in agriculture can also be a significant hurdle for farmers. While drones have become more affordable in recent years, there are still considerable expenses associated with purchasing, maintaining, and operating the technology. Additionally, specialised training may be necessary for farmers to effectively use drones, which can further add to the cost. This expense might be a major barrier for small-scale farmers who may struggle to compete with larger operations. However, as technology continues to advance and become more commonplace in agriculture, the cost of implementation will decrease, making it more accessible for farms of all sizes.

RESULTS AND DISCUSSIONS

The use of drones in agriculture has already shown promising results in various applications, including crop monitoring, yield estimation, and plant health assessment. In a case study conducted by researchers from the University of California, drones equipped with multispectral cameras were used to assess the health of almond orchards. The study found that the drones were able to detect early signs of stress in the trees, which allowed for targeted treatment and ultimately improved crop yield (Hogan S. *et al*, 2017). Similarly, a study published in the Arabian Journal of Geosciences demonstrated the use of drones for crop monitoring in rice paddies. The study found that the drones were able to accurately estimate the rice yield, which helped farmers optimise their harvests (Khose S.B. *et al*, 2022).

Another promising application of drone technology in agriculture is in the area of precision agriculture. By using drones to gather data on crops and soil conditions, farmers can make more

informed decisions about irrigation, fertilisation, and pest control. In a study that took place in Queensland, Australia, drones were used to map crop yields on a sugarcane farm in Australia. The study found that the use of drones allowed for more precise identification of areas with low crop yields, which could help farmers optimise their use of resources and ultimately improve their profits (Akbarian S., *et al,* 2022). Another study conducted by researchers from the University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca used drones to monitor nitrogen levels in barley crops. The study found that the drones were able to accurately measure nitrogen levels. This could help farmers adjust their fertiliser application and reduce waste (Tripon C. *et al,* 2019).

The second advantage of using drones in agriculture is their potential to provide real-time monitoring of crops and other agricultural assets. Drones equipped with cameras, multispectral sensors, and other remote sensing technologies can capture high-resolution imagery of fields, crops, and livestock. This imagery can be used to monitor crop health, detect nutrient deficiencies, identify pests and diseases, and track the growth and development of crops over time. Real-time monitoring can help farmers make more informed decisions about when to irrigate, fertilise, and apply pesticides, reducing waste and increasing efficiency. Moreover, real-time monitoring can enable farmers to detect and respond to potential problems before they become major issues, ultimately increasing yields and reducing losses. Some studies have shown that drone-based monitoring can lead to significant improvements in crop yields and quality, as well as reductions in input costs (i.e., water, fertiliser, pesticides) (Mulla D.J., 2013; Torres-Sánchez J. *et al,* 2015).

Autonomous farming is an emerging application of drone technology in agriculture that holds tremendous promise for increasing efficiency and reducing labour costs. Autonomous drones can be programmed to perform a range of tasks, from planting and harvesting crops to applying pesticides and fertilisers and monitoring crop health. These tasks can be performed with greater precision and accuracy than human labour, and sometimes even faster, leading to higher yields and reduced costs. In addition, autonomous drones can work around the clock, without the need for breaks or rest, providing farmers with real-time data and insights that can help the decision-making process.

Integrating drones with artificial intelligence (AI) can take autonomous farming to the next level, enabling even more advanced and complex tasks to be performed. AI-powered drones can be programmed to learn from data collected over time, improving their decision-making and analytical abilities. For example, by analysing data on weather patterns, soil conditions, and other environmental factors, AI algorithms can provide farmers with more accurate predictions about when to plant and harvest crops, how much water and fertiliser to apply, and other key decisions. Learning over time could also translate into drones being capable to predicting the areas where crops might have trouble with pests or irrigation and checking on those areas more frequently. This can help farmers optimise their yields and reduce waste, ultimately leading to higher profits and greater sustainability. However, integrating drones with AI technologies also presents several challenges, including the need for high-quality data and the potential for biases and errors in algorithmic decision-making.

As the technology for drones in agriculture continues to develop, it is likely that new opportunities, maybe even some that we cannot think about now, will emerge for their use in other areas of farming. For example, there is potential for drones to be used in precision breeding, pest control, and even in the harvesting of crops. Additionally, as drones become more integrated with other technologies, such as artificial intelligence, the potential for innovation and development in this area will only continue to grow. Ultimately, the continued advancement of drones in agriculture offers exciting possibilities for the future of farming and for the development of more sustainable, efficient, healthy and environmentally friendly agricultural practices.

CONCLUSIONS

In conclusion, the use of drones in agriculture offers significant potential benefits, such as increased efficiency, reduced labour costs, and improved sustainability. While there are challenges and limitations associated with their use, such as technical limitations, regulatory issues, and privacy concerns, the ongoing advances in technology and the integration of artificial intelligence offer even greater potential benefits, such as improved decision-making and increased automation. As a result, the use of drones in agriculture represents a promising opportunity for farmers and agricultural businesses to optimise their operations and contribute to a more sustainable future.

It is important to note that the use of drones in agriculture is still a relatively new and developing field, and there is much that remains to be explored and understood. Continued research and development in this area are essential and necessary for realising the full potential of drones in agriculture and for addressing the challenges and

limitations associated with their use. With ongoing investment in research and development, it is likely that the use of drones in agriculture will continue to evolve and expand, offering even greater benefits to farmers, businesses, and the environment.

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