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Application of Drone Technology in Agriculture

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ABSTRACT: An agricultural drone is an unmanned aerial vehicle used in agriculture operations, mostly in yield optimization and in monitoring crop growth and crop production. Agricultural drones provide information on crop growth stages, crop health, and soil variations. Multispectral sensors are used on agricultural drones to image electromagnetic radiation beyond the visible spectrum, including near-infrared and short-wave infrared.

KEYWORDS: agriculture, drone, vehicle, monitoring growth, crop health, near infrared, short-wave infrared, sensors

I.INTRODUCTION

As drones entered use in agriculture, the Federal Aviation Administration (FAA) encouraged farmers to use this new technology to monitor their fields. However, with the unexpected boom of agricultural drones, the FAA quickly retracted such encouragement, pending new rules and regulations. With incidents such as drones crashing into crop dusters, the FAA and the AFBF (American Farm Bureau Federation) began discussions to agree on regulations that would allow the beneficial use of such drones in a safe and efficient manner.[In 2016, the FAA published rules for commercial drone operations.[1] These rules require that commercial drone operators pass a knowledge exam, register their aircraft, and fly in accordance with published restrictions.[2] While satisfied overall with the rules, the American Farm Bureau Federation would like small adjustments to some of the restrictions that have been implemented.[3]

Many countries, such as Malaysia, Singapore and Australia, have implemented laws regarding the use of drones. Such laws are still nonexistent in many countries around the world, and 15 countries have outlawed all drone operations.[3] The EU plans to implement a common set of drone regulations for all of its members.[4]

The use of agricultural drones has ethical and social implications. One benefit is that they are able to monitor and control the use of pesticides properly. This allows minimizing the environmental impact of pesticides. However, drones do not require permission to fly over another person's property at altitudes of under 400 feet (120 m). They may have microphones and cameras attached, and the resulting concern for potential privacy violation has caused some opposition towards drones.[One other improvement with using drones is the precision that they operate with.[5]

Other companies might start flying their drones in unregulated areas to survey their competition and the condition of their crops and agricultural yield[5].[There is a large capacity for growth in the area of agricultural drones. With technology

constantly improving, imaging of the crops will need to improve as well. With the data that drones record from the crops the farmers are able to analyze their crops and make educated decisions on how to proceed given the accurate crop information. Software programs for analyzing and correcting crop production have the potential to grow in this market. Farmers will fly a drone over their crops, accurately identify an issue in a specific area, and take the necessary actions to correct the problem.[6] This gives the farmer time to focus on the overall task of production instead of spending time surveying their crops. Additional uses include keeping track of livestock, surveying fences, and monitoring for plant pathogens.[7]

Both the purchase and maintenance costs of modern drones make them too expensive for small farms in developing nations. Pilot programs in Tanzania are focusing on minimizing those costs, producing agricultural drones simple and rugged enough to be repaired locally.[8] Apart from african countries, Asian countries like India is also promoting Dones in agriculture sector by use of Kisan van , which means farmer's vehicle, DGCA i.e Director general of Civil Aviation is taking care of it and has launhed safety guidelines for use of Drones in Agriculture[9]

A research team from Washington State University has developed an automated drone system that deters pests like crows or European starlings from feeding on grapes and other crops. The birds could be scared off by the drone's noise, but researchers also could include distress calls and predatory bird noises.[10]

II.DISCUSSION

Aerial seeding is a technique of sowing seeds by spraying them through aerial mechanical means such as a drone, plane or helicopter. When the purpose is reforestation, it is known as aerial reforestation.[11]

Aerial seeding is considered a broadcast method of seeding.[1] It is often used to spread different grasses and legumes to large areas of land that are in need of vegetative cover after fires.[2] Large wildfires can destroy large areas of plant life resulting in erosion hazards.[2] Aerial seeding may quickly and effectively reduce erosion hazards and suppress growth of invasive plant species. Aerial seeding is an alternative to other seeding methods where terrain is extremely rocky or at high elevations or otherwise inaccessible.[3] Problems with direct broadcast include germination, pests and seed predation by rodents or other wild animals. Transplanting seedlings from a plant nursery to the field is a more effective sowing technique. Aerial seeding has a low yield and require 25% to 50% more seeds than drilled seeding to achieve the same results.[4]

Aerial seeding is also often used to plant cover crops. Some plants often seeded by this method are perennial rye (Timothy, Red Fescue, Red Top, Bluegrass), Sudan grass, soy beans, [12] buckwheat, hairy vetch, corn, cereal rye, winter wheat, oats, mammoth or medium red clover, sweet clover, berseem clover and crimson clover (Timothy).[4]

There are several advantages of aerial seeding:[17]

- It achieves the most efficient coverage of a large area in the least amount of time.
- It facilitates seeding in areas that otherwise would be impossible to seed with traditional methods, such as land that is too hard to reach by non-aircraft or ground conditions being too wet.[13]
- It may be used when existing crops are already planted. This is important when living in an area where there is a small window between harvesting the crop and the end of the growing season, because seeding cover crops after harvest can cause poor stand establishment due to cold temperatures or moisture.[14]

Soil moisture plays a large role in the success of aerial seeding. Adequate soil moisture for germination and establishment of seed requires that the top 0.5 -1 inch be moist. These conditions should be at the time of the seeding or within 10 days of the seeding. If the required soil moisture is not present at these times, the seeds may become the target of predation by insects and other animals. Along with soil moisture, surface conditions also play a key role in the success of aerial seeding and establishment of seed.[15]

The best soil surface conditions are those that are moist and friable. A loose and rough soil surface with cracks or residue cover is also very conducive to seed germination. These conditions allow for the seed to make the best contact with moist

soil while adequately allowing the seed to settle into the ground. Another important factor besides soil surface conditions are that of timing of aerial seeding and seeding rates.[16]

III.RESULTS

An agricultural robot is a robot deployed for agricultural purposes. The main area of application of robots in agriculture today is at the harvesting stage. Emerging applications of robots or drones in agriculture include weed control,[1][2][3] cloud seeding,[4] planting seeds, harvesting, environmental monitoring and soil analysis.[5][6] According to Verified Market Research, the agricultural robots market is expected . In recent years, autonomous drones have begun to transform various application areas as they can fly beyond visual line of sight (BVLOS)[while maximizing production, reducing costs and risks, ensuring site safety, security and regulatory compliance, and protecting the human workforce in times of a pandemic. They can also be used for consumer-related missions like package delivery, as demonstrated by Amazon Prime Air, and critical deliveries of health supplies.[17]

There are numerous civilian, commercial, military, and aerospace applications for UAVs.[2] These include:

General

Recreation, Disaster relief, archeology, conservation of biodiversity and habitat, law enforcement, crime, and terrorism.

Commercial

Aerial surveillance, filmmaking,[12] journalism, scientific research, surveying, cargo transport, mining, manufacturing, Forestry, solar farming, thermal energy, ports and agriculture.

India is primarily an agrarian economy. Agriculture remains the chief source of income for the majority of the rural households. India's economy is also heavily dependent on the agricultural produce that constitutes a major portion of its exports as well. However, despite mounting importance of agriculture, the sector is still far behind in technological advancements. Crop failure due to adverse weather conditions and uncontrolled pests issues have been the key contributors to this scenario. Moreover, Indian farmers are even now dependent on monsoon rains for irrigation and use age-old methods for other farming practices. Hence, the quality and quantity of agricultural produce is sometimes compromised in spite of the relentless efforts of farmers.[2]

Fortunately, there is hope. What if crop failure could be detected in advance, and necessary steps could be taken? Can there be a juxtaposition of traditional farming methods and innovative solutions like agri-drones to tackle the problems ailing the agricultural sector in India? Can drones become major players in the area of crop surveillance, thus leading to better chances of failure mitigation? We will explore all these opportunities in this article and try to see what the future has in store.[4]
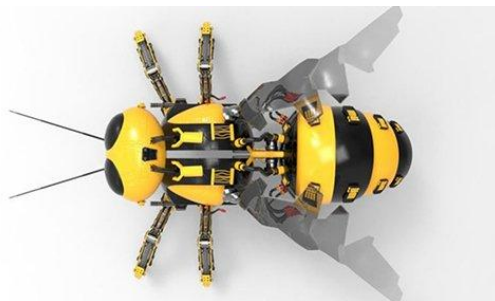
Drone pollination

Drones and the Indian agriculture industry

Drones are uncrewed aerial vehicles (also known as UAVs), which are used for surveillance in various industries. Till now, they were primarily used by companies working in industrial sectors such as mining and construction, army, and hobbyists.[6]

But now, drone technology is increasingly available for use in various sectors of agriculture as well. Though the technology is still nascent in India, many companies are trying so that it is easily available to Indian farmers and ready to be used to increase efficiency in agricultural production.[7]

The Use of Agri-Drones is on the Rise

A lot of drone-based agricultural projects are undergoing in India. Consider the following real-life scenarios:

- On 26th January 2022, the Government of India has also released a certification scheme for agricultural drones, which can now carry a payload that does not include chemicals or other liquids used in spraying drones. Such liquids may be sprayed by following applicable rules and regulations.[9]

- On 23rd January 2022, to promote the use of drones for agricultural purposes and reduce the labour burden on the farmers, the government of India has recently offered, a 100% subsidy or 10 lakhs, whichever is less, up to March 2022 to the Farm Machinery Training and Testing Institutes, ICAR Institutes, Krishi Vigyan Kendras & State Agriculture Universities.

  Additionally, a contingency fund of Rs.6000/hectare will also be set up for hiring Drones from Custom Hiring Centres (CHC). The subsidy and the contingency funds will help the farmers access and adopt this extensive technology at an inexpensive price.[11]

- On 16th November 2020, the Indian government granted the International Crops Research Institute (ICRISAT), to use of drones for agricultural research activities. With this move, the government hopes to encourage budding researchers and entrepreneurs to look at budget-friendly drone solutions for more than 6.6 lakh Indian villages.

  Though the usage will be conditional, yet it is a revolutionary step. Amber Dubey, Joint Secretary, Ministry of Civil Aviation, emphasized that drones are poised to play a big role in agriculture, especially in areas including precision agriculture, improvement in crop yield, and locust control.[13]

Soil and field analysis

For efficient field planning, agricultural drones can be used for soil and field analysis. They can be used to mount sensors to evaluate moisture content in the soil, terrain conditions, soil conditions, soil erosion, nutrients content, and fertility of the soil.

Crop monitoring

Crop surveillance is the supervision of crop progress from the time seeds are sown to the time for harvest. This includes providing fertilizers at the right time, checking for pest attack, and monitoring the effect of weather conditions. Crop surveillance is the only way that a farmer can ensure a timely harvest, especially when dealing with seasonal crops.

Any errors at this stage can result in crop failure. Crop surveillance helps in understanding and planning for the next farming season. Drones can help in effective crop surveillance by inspecting the field with infrared cameras and based on their real-time information, farmers can take active measures to improve the condition of plants in the field.[15]

Plantation

Drones can help in planting trees and crops, which was done by farmers before. This technology will not only save labor but also help in saving fuels. Soon, it is expected that budget-friendly drones will be used instead of huge tractors, as they emit harmful gases and pollute the environment in the process.

Livestock management

Drones can be used to monitor and manage huge livestock as their sensors have high-resolution infrared cameras, which can detect a sick animal and swiftly take actions accordingly. So, the impact of drones on precision dairy farming is soon to become a new normal.

Crop spraying

Agri-drones can be used to spray chemicals as they have reservoirs, which can be filled with fertilizers and pesticides for spraying on crops in very little time, as compared to traditional methods. Thus, drone technology can usher in a new era for precision agriculture.[15]

Check crop health

Farming is a large-scale activity that takes place over acres of land. Constant surveys are necessary to monitor the health of the soil and the crop that has been planted. Manually, this may take days, and even then, there is space for human error. Drones can do the same job in a matter of hours. With infrared mapping, drones can gather information about both the health of the soil and the crop.

Avoid overuse of chemicals

Drones can prove to be especially effective in reducing the overuse of pesticides, insecticides, and other chemicals. These chemicals indeed help to protect the crop. But, their overuse can prove to be detrimental. Drones can detect minute signs of pest attacks, and provide accurate data regarding the degree and range of the attack. This can help farmers calculate the required amount of chemicals to be used that would only protect the crops rather than harming them.[17]

Prepare for weather glitches

Weather conditions can prove to be a farmer's best friend and worst enemy. Since these cannot be accurately predicted, it becomes extremely difficult to prepare for any shift in patterns. Drones can be used to detect upcoming weather conditions. Storm drones are already being used to make better predictions. And this information can be used by farmers to be better prepared. Advance notice of storms or lack of rain can be used to plan the crop to be planted that would be best suited to the season, and how to take care of planted crops at a later stage

Benefits of agri-drones

- Security
  The drones are operated by trained drone pilots. So, there are no chances of their misuse.

- High   efficiency
  Drones do not have any operational delays and can work double the speed of human labor.

- Water-saving
  In comparison to traditional spraying methods, agricultural drones use ultra-low volume (ULV) spraying technology, thus saving more water.[11]

- Low   cost   and   easy   to   maintain
  Agri drones are sturdy, low in cost, and require minimum maintenance. Some of the key features include a detachable container, low-cost frame, precise spraying of pesticides.

IV.CONCLUSIONS

The use of drones in almost every sector of the economy is growing fast, but drone usage in the agricultural industry is booming. According to some reports, the agricultural drone market is expected to grow from a $1.2 billion(USD) industry in 2019 to $4.8 billion in 2024. From scouting to security, drone use will become more ubiquitous on large and small scale farms in a few short years. The information gathered by drones on farms is often used to better inform agronomic decisions and is part of a system generally referred to as 'precision agriculture'.[15]

In many areas, drone use has become an essential part of large scale precision farming operations already. The data collected from drones recording fields help farmers plan their planting and treatments to achieve the best possible yields. Some reports indicate that using precision farming systems can increase yields by as much as 5%, which is a sizeable increase in an industry with typically slim profit margins. Drones using 'regular' cameras are also used to monitor crop health. Many farmers already use satellite imagery to monitor crop growth, density, and colouration, but accessing satellite data is costly and not as effective in many cases as closer drone imaging. Because drones fly close to fields, cloud cover and poor light conditions matter less than when using satellite imaging. Satellite imaging may offer to the meter accuracy, but drone imaging is capable of producing accurate image location to the millimetre. This means that after planting, areas with stand gaps can be spotted and replanted as needed, and disease or pest problems can be detected and treated for right away. Some of the newer uses for drone use in agriculture are still in testing and development. One of the most publicized (and often fictionalized) uses is pollinating drone technology. Researchers in the Netherlands and Japan are developing small drones that are capable of pollinating plants without damaging them. The next step is to create autonomous pollinating drones that will work and monitor crop health without constant instruction from operators.[13]

Drones have already vastly altered the agricultural industry and will continue to grow in the coming years. While drone use is becoming more useful to small farmers,there is still a ways to go before they become part of every farmer's equipment roster, particularly in developing nations. Regulations around drone use need to be made and revised in many countries and more research needs to be done on their effectiveness at certain tasks, such as pesticide application and spraying. There are many ways drones can be useful to farmers but it is important to understand their limitations and functions before investing in expensive equipment. [15]

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