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Drones and Agriculture: Farming Smart by Flying High

Anurag Kapoor[1] and Debjeet Sharma[2]
[1]B.Sc. (Hons) Ag, Department of Agriculture, Doon (PG), College of Agriculture Science and Technology, Dehradun, Uttarakhand
[2]Ph.D. Scholar, Department of Plant Pathology, Dr. Y S Parmar University of Horticulture & Forestry, Nauni, Solan, Himachal Pradesh

SUMMARY

The agriculture industry is most promising to cater the human needs but also the most difficult to work with. The Food and Agricultural Organization (FAO) predicts that by 2050, we would need to produce 60% more food to feed a global population of 9.3 billion people (FAO, 2012). Jose Graziano Da Silva is Director-General of FAO in his article "Feeding the world sustainably" said "even if we increase agricultural output up to60 per cent by 2050, we will still have 300 million people going hungry due to lack of proper access to food". Since the world is being defined and prepared according to the modern era, access to advanced technologies is also a must required entity. With the help of modern technology, such as UAVs (Unmanned Aerial Vehicles), also known as drones, agriculture will undoubtedly be benefited greatly.

INTRODUCTION

John Chaytor's employment of a hot air balloon guided by ropes from the ground to scatter grass seed in 1906 was a ground-breaking development in the usage of unmanned airborne vehicles. Unmanned aerial vehicles, or UAVs, are much of the talked topic in agriculture currently because of how quickly and efficiently these are coming into help to farmers. In order to dust crops, the first UAS (Unmanned Aircraft System) in the agricultural industry were created in the 1980s. Later, as technology advanced, it became known as UAV (Unmanned Aerial Vehicle).The world's first agricultural drone, the R-50, which was created for crop mapping and field analysis, was released by the Japanese manufacturer Yamaha in 2000 (Giles, D. K et al, 2015). Drone use in agriculture is already pervasive in regions like Asia and on numerous other continents.By 2030, the market for agricultural drones is anticipated to be worth $5.98 billion. (AVIANA Bioscience, 2022).

Fig : 1.1 Drone in air

Fig : 1.2 Drones in ornamental field

Drones for agriculture can be used to monitor crop development and production, optimise yields, and collect data on soil differences, crop health, and various stages of growth. Insurance claims-friendly Drone data is used by farmers to file crop insurance claims in the event of damage. In the event of a malfunction or other emergency, it can be done manually. The combination of a UAV and a sprayer system creates the possibility of creating a platform for vector and pest management. This site-specific treatment is appropriate for vast crop fields. For large-area spraying, heavy lift UAVs are needed for this purpose (Sarghini F. et al., 2017). Through the use of the PWM controller in the pesticide applications, the spraying system mounted to the UAV operates more effectively as reported by Huang, Y. et al. (2009).

Basic components of drones

1. Chassis: It isthe drone's skeleton, to whom all of its parts are forwarded: The chassis is built to be both sturdy (particularly when additional weights like cameras are connected) and light enough to be lifted by bigger motors and longer propellers.

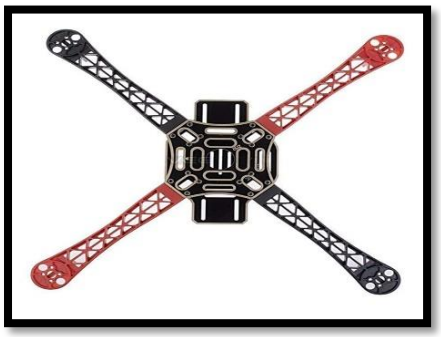

Fig : 1.3 Chassis

2. Propellers: The longer propellers can provide more lift at a lower rpm but take longer, thus speed up the process. Shorter propellers can change speeds more quickly and are therefore more manoeuvrable, but they need to rotate at a faster rate to provide the sameamount of power as longer ones. Larger number of propellors improve the stability of drones and load-carrying capacity but such drones need more battery power to drive more motors to get high power. A quadcopter is a more popular drone. Types of propellers: Bicopter (2 propellers), Triplecopter (3 propellers), Quadcopter (4 propellers), Hexacopter (6 propellers), Ocptacopter (8 propellers).

Fig : 1.4 Propellers

3. Motors: There is one motor per propeller drone motors are rated in 'KV' units which equates to the number of revolutions per minute it can achieve when a voltage of 1 volt is supplied to the motor with no load.

Fig : 1.5 Image of motors

4. ESC (Electronic Speed Controller): This provides each motor a control document so it can create the proper spin speed and direction.

Fig : 1.6 Image of an ESC

5. Flight controller: The onboard computer that interprets signals received from the plot and instructs the ESC to operate the quadcopter using the appropriate inputs.

Fig : 1.7 Image of a flight controller

6. Battery: Due of their great power density and rechargeability, lithium polymer batteries are typically utilised.

Fig : 1.8 The battery

Moreover, sensors like accelerometers, gyroscopes, GPS, and barometers can be used to measure position. Furthermore, cameras are commonly attached for aerial photography and navigation.

Working principle of drones

Design and development of aircraft and drones heavily rely on the field of fluid dynamics. Lift is the term for the process of lifting a vehicle against gravity with a significant amount of upward power. Thrust is a force produced to move a body or a moving object. The kinematic rules of fluid flows can be used to investigate these forces. Pressure, viscous drag, and air flow over an aerofoil affect the profiles.The air velocity at the inlet is directly proportional to force. (CFD Flow Engineering, 2023)

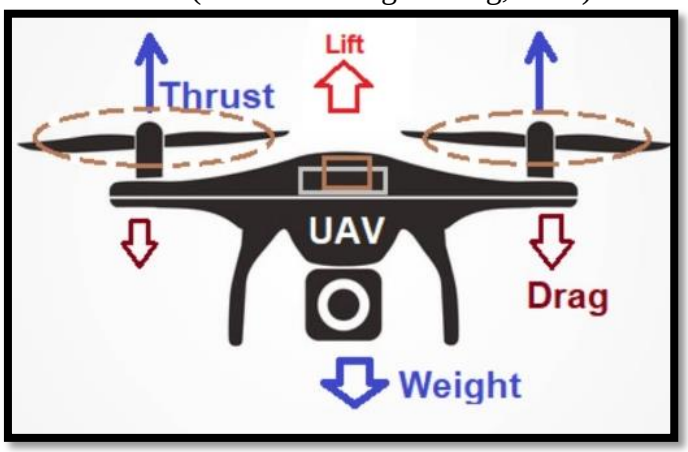

Fig : 1.9 Working principle of thr drone

The illustration above depicts the flow pattern around the cross-section of the aerofoil or propeller.The upward force, known as a lift, is caused by high fluid pressure at the bottom and low pressure at the top of the propeller. Lifting an aeroplane or drone's weight is accomplished by this force.The tilt of the aerofoil or propeller affects the amount of lift force.Based on the principle of conservation of energy in fluid flow (Bernoulli’s principle, the sum of all forms of energy in a fluid is constant along the streamline. As the air flows over an aerofoil or wing, its velocity increases at the top portion. But the pressure of air decreases.In contrast, the air velocity decreases, and pressure increase at the bottom side of the blade. The next pressure difference across the aerofoil results in an upward force which is called a lift. CFD modeling of flow over an aerofoil has been important in many vehicular and aerospace industries.

Application of drones

- Landscape mapping: Drones are the ideal equipment for performing terrain mapping because of their natural capacity to survey large areas of land. Farmers employ contemporary drones fitted with LiDAR and other sensors to map the landscape across large areas of land as a scouting tool for land preparations. Drones with advanced computer vision skills can map the terrain precisely and provide farmers with real-time input for effective field management.
- Livestock Monitoring: Farmers frequently employ drones in the agricultural sector to efficiently manage their cattle. Programmable drones with AI capabilities are the ideal tools for automating livestock monitoring at a fraction of the cost.These drones can be used to locate any wounded or missing animals as well as to track down the rest of the herd. It can be pre-programmed to continue tracking the livestock through the pasture and is especially useful for locating pastures spread across large areas of land.
- Monitoring the Irrigation: Irrigation management and monitoring have been another issue for farmers since a long time. Drones with thermal imaging systems are now widely utilised to efficiently monitor the entire irrigation network and identify any problems in real time. Farmers are better able to maximise drainage and create backup plans for problems when they have access to real-time information via drones. Drones are highly efficient for irrigation scheduling purposes also.
- Crop spraying: Farmers traditionally had to physically spray their entire field using, hand operated sprayers however some have occasionally employed aeroplanes. Modern smart drones that have received FAA approval can carry substantial reservoirs of fertilisers or insecticides as payload for effective field spraying. In fact, farmers can manage agricultural yields and prevent pest infestation in crops much more safely and affordably by programming AI drones to perform spot spraying. Scientific UAVs with specific camera sensors, including optical and thermal cameras, as well as specialist optical filters, such Red Edge or hyper spectral cameras (Torres-Rua A et al, 2015), appear to be a viable option for carrying out the monitoring, according to research studies.
- Mapping and Surveying of Crops: Monitoring crops across large swathes of land using drone technology is another crucial application in the agriculture sector. Recently, IT companies have surveyed and mapped crop fields using satellite or airborne photography, but this comes at a significant expense. Drones with AI capabilities have recently taken over farming's surveying. UAVs (drones) can monitor the crop using a variety of indices and can cover up to hectares of land in a single flight (Simelli et al., 2015). For this observation, the reflectance of the vegetative canopy is acquired using thermal and multispectral cameras (Colomina I et al., 2014).
- Seed Planting: Startup businesses, though, have begun exploring the technique for quicker and more efficient seed planting.In order to determine the technology's cost-effectiveness, some farming drone manufacturing companies are also testing the payload effectiveness of drones using tree seeds, fertiliser, water, and pesticide.
- Soil and field analysis: Drones are excellent tools for gathering meaningful information about the soil's quality at the start or end of a crop cycle. In order to understand any concerns with the soil's quality, including the nutrients or any dead zones, 3D maps of the soil can be created using AI drones fitted with LiDAR.The best planting strategies and enhanced crop management can both be made with the help of all this information. Drones can also be used to identify and monitor water resources across areas more accurately.
- Health evaluation: Finally, crop health monitoring with drones is successful. Drones with thermal and infrared sensors are frequently utilised to collect real-time imagery for crop health analysis. UAVs (Drone) are capable of observing the crop with different indices (Simelli et al., 2015)

General drone legislation in India (UAV coach, 2018)

India allows the usage of drones, however there are several drone regulations that must be followed when flying it when operating a drone in India that weighs more than 250 grams.

Operators must make sure they abide by the following drone laws:

- Flying of drones should be avoided at crowded places.
- Privacy of others should be respected while using drones.
- Drones should not be flown within 5 kms of airports or in regions where aeroplanes are in operation.
- Drones should be used only in good weather and during daylight hours.

- Flying a drone in sensitive regions, such as inside of military or government buildings, should be prohibited.
- Before using a drone there should be proper training and age must be more than 18 years.
- Every drone must have a licence plate that identifies the operator and provides contact information.
- Flying a drone within 50 kilometres of a border is prohibited.
- When flying a drone it should not cross more than 500m towards the sea from the shore.
- National parks and wildlife sanctuaries should not be flown over.
- There must be liability insurance on every drone.

CONCLUSION

Drones prove to be an amazing solution for agriculture as with passing day and increasing population, food security has become a topic of utmost importance. Drones are a solution to the tedious work in agriculture and provide precise and accurate results. It is reliable and simple to operate. It has high quality sensors for good imaging. Drone technology has a great potential in agriculture and allied sectors.

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