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Evaluation of Drone Systems in Precision Agriculture

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ABSTRACT: There are far too many advances in precision agriculture for improving crop production in today's world. Over 70% of rural populations in developing nations such as India rely on agricultural areas. Diseases have caused significant losses in agricultural areas. These diseases are caused by pests and insets, and they decrease crop yield. In order to improve crop quality, pesticides and fertilizers are used to kill insects and pests. WHO (World Health Organization) when spraying pesticides in the crop field manually, the organization projected that one million instances of illness occurred. The Vacant Position Aerial vehicle (UAV) - planes are used to spray insecticides to prevent human health concerns while spraying by hand. Where equipment and manpower are difficult to operate, UAVs may be utilized effortlessly. This article provides a short overview of the program's implementation. Crop monitoring and pesticide application using unmanned aerial vehicles (UAVs).

KEYWORDS: Crop Monitoring, Quad Copter, Spraying System, Unmanned Aerial Vehicle (UAV).

INTRODUCTION

Even though India is heavily reliant on agriculture, it is still lagging behind in terms of adopting cutting-edge technology to produce high-quality crops. UAVs are already being used in precision agriculture, photogrammetry, and remote sensing in developed nations. It is very quick, and it has the potential to decrease a farmer's workload [1]. UAVs are often outfitted with cameras and sensors for crop monitoring and sprayers for pesticide application. Previously, a wide range of UAV types were used for military and civilian purposes. Yamaha develops the first UAV model for agriculture. Yamaha RMAX, an unmanned helicopter, was developed for pest control and crop monitoring applications in agriculture. Yamaha, on the other hand, ceased manufacturing in 2007. A technical study of UAVs in precision agriculture examines their suitability for tasks such as crop monitoring, crop height estimation, pesticide spraying, and soil and field analysis [2].

Their hardware implementations, on the other hand, are solely dependent on key factors such as weight, range of flight, payload, configuration, and prices. UAV technologies, techniques, systems, and constraints are investigated in this study. More than 250 models are evaluated and summarized in order to choose the best UAV for agriculture. Construction of hardware components, integration with the software system, autonomous flight control, aerodynamic modeling, design, and implementations are among the techniques and critical components involved in building a small autonomous mini unmanned rotorcraft vehicle [3].

A heavyweight NASA solar powered pathfinder plus was utilized as a picture collecting platform to show the 3500ha coffee plantation in Hawaii over the last several decades. After that, a low-cost and light-weight UAV, the Viper, was used for site-specific vineyard management by collecting 63 multispectral images in 10 minutes of flight, and the MK-Okto was used for multispectral and thermal imaging collection. Using laser power beaming technology to extend the flying duration of a UAV. The proportional integral derivative (PID) controlling algorithm is used to manage the aerodynamic domain, tuning, and trimming phases of the UAV. The images were then processed and analyzed using the NDVI method [4]. The results accurately reflect the crop's state. Sensors and vision systems can also help UAVs reach their full potential. Fig. 1, Illustrates the different components of a drone used in agriculture domain.

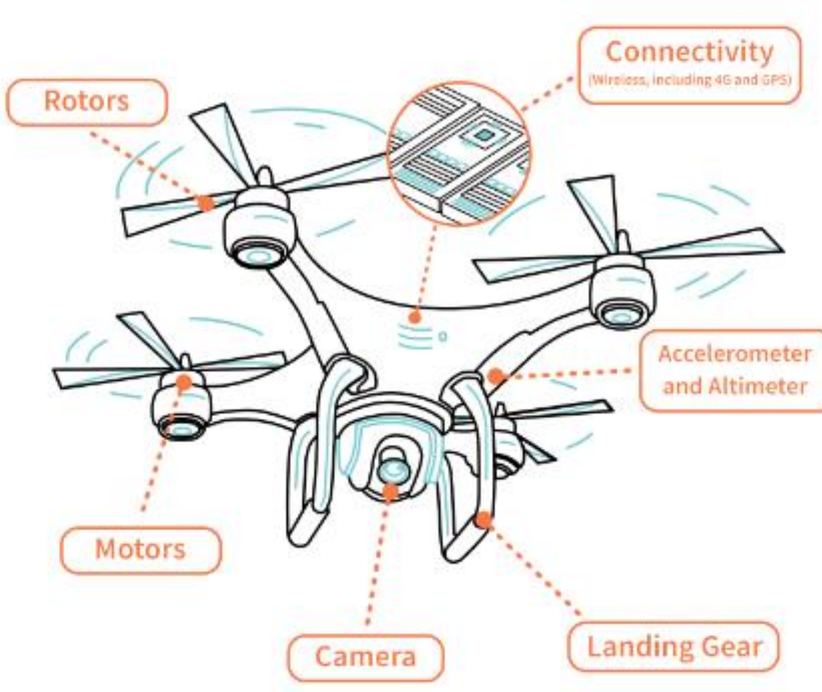

Fig. 1: Illustrates the different components of a drone used in agriculture domain [5]**.**

Another approach was used on the ground, in which a sprayer system was placed to a UAV to spray pesticides. The combination of an unmanned aerial vehicle (UAV) with a sprayer system has the potential to offer a platform for pest management and vector control. For vast agricultural fields, this is a precise site-specific application. Heavy lift UAVs are needed for large-area spraying in this case. The PWM controller in the pesticide applications improves the effectiveness of the spraying equipment installed on the UAV.

Yamaha RMAX is a petrol-powered unmanned aerial vehicle designed for pesticide spraying in Asian rice fields. Pesticide deposition from the developed UAV is nearly identical to that of ground-based sprayers. The RMAX is a crop sprayer designed for high-value crops. A prototype that can be developed into a UAV with a volume mean diameter droplet size of up to 300mm. Because of its speed and precision, UAVs are increasingly being used in spraying operations. However, certain variables decrease crop quality, such as some parts in the crop field not being adequately covered when spraying, crop areas overlapping, and the spraying process extending beyond the crop field's outer borders.

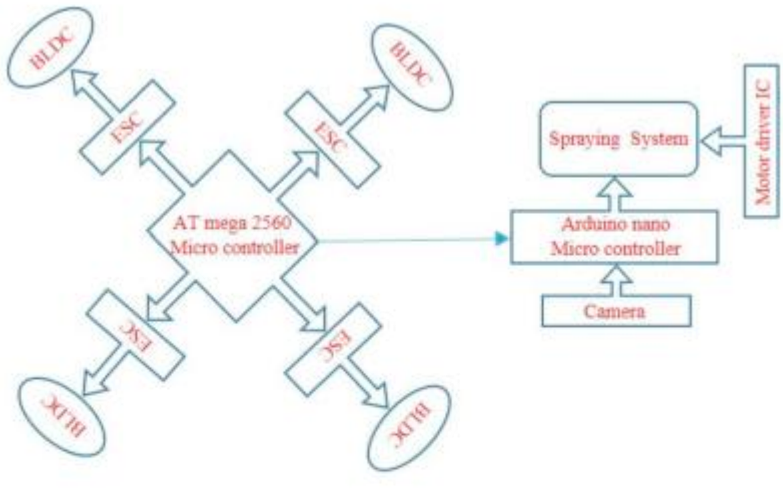

Fig. 2: Illustrates the block diagram of an unmanned aerial vehicle [6]

To overcome these obstacles, a swarm of unmanned aerial vehicles (UAVs) were employed in a control loop of an algorithm for agricultural operations, were unmanned aerial aircraft spray pesticides. The input from the WSNs placed in the field organizes the process of spraying herbicides on the crop [7]. Fig. 2, Illustrates the block diagram of an unmanned aerial vehicle A control loop is used to modify the path of the unmanned aerial vehicle in response to variations in wind speed and the number of messages sent between them. A brief pause in the control loop allows the unmanned aerial vehicle to evaluate data from the WSN and plan a new path. It may also help to reduce pesticide waste. MSP430 is an automated navigation UAV spraying system that directs the UAV to the appropriate spray area. In a lower altitude setting, a blimp integrated quad copter aerial automated pesticide sprayer (AAPS) was designed for pesticide spraying based on GPS coordinates.

To address this low-cost, user-friendly pesticide spraying drone controlled by an Android app, was created. The discharge and pressure rate of the liquid, spray uniformity and liquid loss, droplet density and sizes of a designed copter mounted sprayer are all investigated in the lab and in the field. An electrostatic sprayer was developed and designed on electrostatic spray technology with a hexa rotor UAV to minimize pesticide waste. Using a double pulsed laser, a particle image velocimetry technique was utilized to quantify the downwash flow field droplet mobility and deposition over the crop at various rotational speeds of the rotors of an octocopter. When compared to the upper levels of rice and wheat fields, the Drift of ultralow altitude UAVs downdraft generated by the rotors penetrated the deposition of the droplets in the lower layers nearly all equal [8]. Furthermore, filter papers and water sensitive papers are utilized to investigate spraying deposition and droplet coverage across several spraying swaths. In light of these facts, a crop monitoring and pesticide spraying UAV comprised of an automated drone system and a sprinkling system with multi spectrum camera has been created. The sprinkling system is connected to the UAV's bottom section, with a nozzle underneath the pesticide tank that sprays the pesticide downstream.

The multi spectral camera scans the whole crop field and produces a spatial map as the first method of monitoring. This map shows the crop's status using NDVI, and the farmer then decides which herbicides and fertilizers to use on the crop. A UAV is an unmanned aerial vehicle (UAV) that can fly without a human pilot and is controlled through radio. Multi rotors are a kind of UAV that may be further categorized by the number of rotors in its platform. A quad copter is a kind of unmanned aerial vehicle (UAV) with four rotors. These rotors are responsible for the quad copter's lift. The two opposing rotors rotate in a clockwise (CW) direction, while the other two rotate in a counterclockwise (CCW) direction (CCW). Pitch (backward and forward), roll (left and right), and yaw are the three modes of quad copter movement around the axis (clockwise and counter clockwise).

UAVs have the ability to observe the crop using several indexes. In a single trip, the UAVs may cover hundreds of hectares of land. Thermal and multi-spectral cameras placed on the quad copter's backside were used to capture the reflectance of the plant canopy for this observation. The camera captures one image per second, saves it in memory, and transmits it to the ground station through telemetry. The MAVLINK protocol is used for this wireless connection [8]. The images were captured in five distinct wave lengths: I blue wavelength 440-510nm, (ii) green wavelength 520-590nm, (iii) red wavelength 630-685nm, (iv) red edge wavelength 690-730nm, and (v) near infrared wavelength 760-850nm. The sprinkling system is usually connected to the bottom portion of the UAV, with a nozzle underneath the pesticide tank to spray the pesticide downstream. The sprinkler system is made up of two modules: one is the sprinkler system itself, and the other is the controller. Spraying material (pesticides or fertilizers) and a spraying nozzle are included in the sprinkling system. The second is a controller that is used to turn on the sprayer's nozzle [9].

A pressure pump is a sprinkler system component that pressurizes the insecticide so it can flow through the nozzle. To pressure the pump as needed, a motor driver integrated circuit is utilized. Different spraying rates and nozzles utilized in UAVs for spraying were investigated. Because the world's population is growing by the day and is expected to reach 9 billion people by 2050, experts predict that agriculture consumption will rise at the same time. Food production (net of food used for biofuels) must rise by 70% to feed this bigger, more urban, and wealthier population. From 2.1 billion tones now, yearly grain output would need to increase to about 3 billion tones, and annual meat production will need to increase by more than 200 million tones to reach 470 million tones. Agriculture is the most promising and difficult industry due to its reliance on climate or weather, soil condition, irrigation water quality and quantity, and application rate [10].

DISCUSSION

According to this study, the necessary increase in food production may be accomplished by using advanced agricultural production methods. The use of modern technology in agriculture, such as drones, has the potential to address a number of big and small problems. Irrigation, crop monitoring, soil and field studies, and bird control are some of the most common uses of drones in agriculture. A UAV (Unmanned Aerial Vehicle) is a flying device that uses an autopilot and GPS coordinates to fly a pre-determined route. In the event of a malfunction or a hazardous circumstance, the gadget may also be flown manually. The word UAV is sometimes used to refer to the whole system, including ground stations and video systems, although it is most frequently used to refer to model aircraft and helicopters with both fixed and rotary wings. Unmanned Aerial Vehicles provide a less stressful atmosphere, allow for better decision-making, and enable them to fly for longer periods of time as long as the vehicle permits (no human weariness in the aircraft).

It does not require a qualified pilot to fly it; in the long run, an Unmanned Air Vehicle can stay in the air for up to 30 hours, performing repetitive tasks such as performing a precise, repetitive raster scan of the region, day after day, night after night, in complete darkness or fog, and under computer control. Unmanned Air Vehicles may do geological surveys, visual or thermal imaging of the area, and measure cell phone, radio, or television coverage across any terrain. Drone pilots or operators can simply pass over control of the drone without any downtime. Drones can achieve better precise precision across longer distances. A drone's or quadcopter's four propellers are fixed and oriented vertically. Each propeller has its own changeable and independent speed, allowing for a wide range of motion. The following are the main components of a drone: the drone's skeleton, to which all componentry is attached. The chassis design is a compromise between strength (particularly when extra weights like cameras are added) and weight, which will need longer propellers and stronger engines to lift. The weight the drone can carry, the speed it can fly, and the speed it can man oeuvre are the most important factors. The length of the propeller may be changed; longer propellers can provide more lift at lower rpms, but they take longer to accelerate up and slow down. Shorter propellers are more maneuverable because they can change speeds faster; nevertheless, they need a greater rotational speed to generate the same power as longer blades. This puts too much pressure on the motors, shortening their lifespan.

A faster movement is possible with a more forceful pitch, but hovering efficiency is decreased. Drone motors are rated in “kV” units, which equals the number of revolutions per minute the motor can accomplish when supplied with a voltage of 1 volt and no load. A quicker motor spin provides greater flying power, but it also consumes more battery power, resulting in a shorter flight duration. A drone is piloted using a portable radio control transmitter that controls the propellers manually. The controller's sticks enable you to travel in various directions, while the trim buttons let you to change the trim to balance the drone. Screens may also be utilized to show sensor data and receive live video feed from the on-board camera. In today's world, military use of drones or RPAS (Remotely Piloted Aerial Systems) has become the norm. Drones have long been a component of military forces throughout the globe, serving as target decoys, combat operations, research and development, and monitoring. In today's world, military use of drones or RPAS (Remotely Piloted Aerial Systems) has become the norm. Drones have long been a component of military forces throughout the globe, serving as target decoys, combat operations, research and development, and monitoring. Drones may save a lot of time and money by transferring traffic from the ground to the air. They may also be used to transport small parcels, food, mail, medications, drinks, and other items across shorter distances. Drones are also utilized in law enforcement. They assist in the monitoring of big gatherings and the protection of the public. They aid in the surveillance of criminal and unlawful operations.

In reality, drones are used by the border patrol to monitor fire investigations, migrant smugglers, and illicit drug trafficking along coasts. Drones with thermal sensors have night vision, making them an effective surveillance tool. Drones are capable of locating missing people and unlucky victims, particularly in difficult terrains or severe circumstances. A drone may deliver supplies to hard-to-reach areas in war-torn or disaster-stricken nations, in addition to finding casualties. A drone may, for example, be used to drop a walkie-talkie, GPS locator, medications, food supplies, clothing, and water to trapped victims before rescue personnel can transport them to a safer location. Drones are increasingly being utilized to collect video that would normally need the utilization of costly helicopters and cranes. Aerial drones are used to shoot fast-paced action and sci-fi sequences, making cinematography simpler. These self-piloted aircraft are also utilized in real estate and sports photography. Journalists are also contemplating using drones to gather video and information during live broadcasts. Farmers and agriculturists are constantly searching for low-cost, efficient solutions to check their crops on a regular basis. Drones' infrared sensors may be programmed to monitor crop health, allowing farmers to respond and improve agricultural conditions on the spot with fertilizer or pesticide applications. It also enhances crop management and results in higher yields. Drones will account for almost 80% of the agriculture industry in the next several years. Inspection of power lines and pipelines: Drones can inspect a variety of systems, including power lines, wind turbines, and pipelines. Poachers have been deterred by the use of drones.

They offer unrivaled protection to animals such as elephants, rhinos, and big cats, which are popular targets for poachers. Drones have the ability to operate at night thanks to their thermal cameras and sensors. This allows them to observe and study wildlife without causing any disturbance, and it gives them information about their patterns, behavior, and habitat. After a natural or man-made disaster, drones provide a quick way to gather information and navigate debris and rubble in search of injured victims. Its high-definition cameras, sensors, and radars provide a larger field of view to rescue teams, reducing the need for manned helicopters. Drones, due to their small size, can provide a close-up view of areas where larger aerial vehicles would be dangerous or inefficient. Drones can be extremely useful at the beginning of the crop cycle. They create precise 3-D maps for early soil analysis and seed planting pattern planning. Drone-assisted soil analysis provides data for irrigation and nitrogen management after planting. Drone planting systems developed by startups have a 75 percent uptake rate and 85 percent lower planting costs. These systems fire pods containing seeds and plant nutrients into the soil, providing the plant with all of the nutrients it requires to live. Drones can scan the ground \sand spray the correct amount of liquid, modulating distance from the ground and spraying in real time for even coverage. As a result, efficiency has improved while the amount of chemicals leaking into groundwater has decreased. In fact, experts estimate that drones can complete aerial spraying up to five times faster than traditional machinery.

Drones equipped with hyper-spectral, multispectral, or thermal sensors can detect areas of a field that are dry or in need of improvement. Drones can also calculate the vegetation index, which describes the relative density and health of the crop, and show the heat signature, which is the amount of energy or heat the crop emits, once the crop is growing. People anticipated the new millennium at the turn of the twenty-first century. No one could have predicted the type of new technology that would emerge. In this way, agricultural drones are a fantastic advance technology that is quickly becoming a tool similar to any other agricultural equipment. Various factors have contributed to this, including the availability of a relatively inexpensive agricultural drone with advanced imaging capabilities and sensors that provide specific data to the farmer. Farmers can increase yields and reduce crop damage by using this information. Furthermore, using fewer pesticides has a positive impact on the environment. Farming, on the other hand, is an input-output problem. Farmers can reduce inputs such as water and pesticides while maintaining the same output, thus overcoming the food shortage. Farmers' capacity to monitor and control important aspects of farm operations that are difficult to maintain in distant locations is changing thanks to agricultural drones. To summarize, we may say that Drone, which began as a military technology, may become better recognized as a green-tech device in the future.

CONCLUSION

Precision agriculture has used cutting-edge technology in the last decade to boost crop production. These technologies are helpful in situations when human involvement is not feasible, such as spraying pesticides on crops, or where labor is scarce. It also makes spraying easier and quicker. The suggested method covers crop monitoring using a multispectral camera mounted on an unmanned aerial vehicle (UAV). The camera captures images throughout one flight and analyzes them using the geographic indicator. It may be simple to locate the region where pesticides should be sprayed based on the findings. The UAV sprinkling system used GPS coordinates to automatically spray pesticides on diseased regions where the NDVI showed no vegetation. This may also cut down on water and chemical waste.

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