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Design and Development of UAV Based Pesticide Sprayer in Agriculture Application

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Abstract: *Agriculture is vital to the Indian economy. Agriculture is a major source of revenue in India. Crop production rates in agriculture are determined by a variety of factors such as temperature, humidity, rain, and so on. Which are natural causes beyond the control of farmers. Agriculture is also affected by elements such as pests, disease, fertilizers, and so on, which may be controlled by properly treating crops. Pesticides could improve crop output, but they also have an impact on human health. Crop production is determined by the pesticides and fertilizers used in the fields. However, manual handling of these items poses health risks. The World Health Organization projected that over 2.5 million pesticide poisoning incidents occur each year, with the bulk occurring in nations like India. The goal of this study is to solve the problem by automating the spraying of pesticides and fertilizers in the fields. The system is made up of an aerial sprayer, which is made up of a quadcopter and a spraying mechanism. The quadcopter is controlled by radio frequency signals, and pesticide spraying is accomplished with minimal physical work and no health risks. The goal of this project is to primarily counteract the negative effects of pesticides on humans while also covering more acres of land in a short period of time.*

Keywords: Fertilizers, Drone, Radio Frequency

I. INTRODUCTION

There has been a significant decrease in the amount of agricultural land as a result of rapid population growth and industrialization. According to the World Bank, in order to meet demand, they will need to produce 50% more food by 2050. Methods for regular forming must be altered to meet this challenge. Therefore, the agricultural sector must adopt and implement new technological innovations. Thanks to agricultural breakthroughs, we will be able to estimate farm information such as soil pH, water saturation, weeds, disease, crop health, and yield. We can determine where to irrigate and apply pesticides based on this information. Plant diseases frequently result in losses for the agricultural sector. Pesticides and fertilizers play a significant role in plant growth. Using hand pesticides to spray pesticides and fertilizers and controlling fertilizer spray and crop monitoring can cause cancer, asthma, allergies, and other diseases.An inexpensive UAV that is used to spray pesticides on agricultural areas is introduced in this study. The agricultural drone sprayer makes a promise to decrease the harmful effects of pesticides on humans while swiftly spraying alarge area. Due of its speed and accuracy, it helps farmers save time and physical labour. In essence, this device performs the roles of a quadcopter and a spraying device.

II. LITERATURE REVIEW

R. Gorantla et al [1] presented the design and modelling of a low-cost UAV-based pesticide sprayer for agricultural applications. They create a UAV with a lift capability of 4.8kg and a payload capacity of 1.8kg. UAVs are operated manually or semi-autonomously using Mission Planner software, which is an open source programme for controlling planes, helicopters, and rovers. Mission Planner can be used to configure an autonomous vehicle or as a dynamic control augmentation.

ShilpaKedari et al [2] presented a more affordable Quadcopter (QC) system. Unmanned Aerial Vehicle (UAV) is another name for a quadcopter. These quadcopters are compact, and the system is suitable for both indoor and outdoor plants. A quadcopter is a self-contained aircraft that sprays spray and fertiliser using an Android cellphone. A Bluetooth

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gadget in real-time operation connects the quadcopter and the Android mobile. This programme is used to decrease agriculture sector difficulties while increasing agricultural productivity.

Sadhana B et al [3] conceived and constructed a quadcopter unmanned aerial vehicle (UAV) with a basic shower module for pesticide spraying in the agriculture sector in order to boost productivity and protection equipment. The drone lift for this project weighs 1000 g and is utilised for land-based pesticide application.. This quadcopter is piloted with an Arduino UNO AT mega328 and a Brushless Direct Current (BLDC) Electronic Speed Control (ESC). MPU-6050, which combines a MEMS accelerometer and a MEMS gyro on a single chip, as well as a radio receiver, a LIPO battery, and a pesticide spray module.

K. Anand and Goutam. R. [5] address two significant issues of UAV in agriculture: 1) most present UAV systems' operating systems are still extremely restricted. Actually, the most of them are still controlled via remote. 2) Because of the low accuracy of the flight control near the plants, the UAV's operational precision is insufficient. This study article provides a mix of new techniques and technology in contemporary agriculture, as well as an ideal mission assignment system that assures the benefits of using Unmanned Aerial Vehicles in many areas of agriculture based on the spraying drone.

Huang Xin et al [6] studied and solved the problem of liquid sloshing while spraying with an unmanned aerial vehicle (UAV). A significant volume of liquid payload may cause sloshing inside the liquid tank, resulting in hazardous phenomena such as wind gusts and obstacle avoidance. This all-around sloshing force inside the tank may interfere with the UAV's trajectory. This article presents a simple baffle solution for all types of pesticide tanks and examines the effects of baffle systems on main shaped tanks.

III. MOTIVATION

The use of chemicals in pesticides affects farmers and workers, thus in order to decrease this, we want to create a prototype model that will be put into practise physically utilising a drone.

Because sprinkling the entire field takes a lot of time.

As labour costs rise daily and farmers cannot pay them all the time, drone spraying is the ideal solution to effectively save money and time.

IV. OBJECTIVE

The objective of our project is to create, test, and use a steady waving agricultural vehicle for spraying pesticides, which will enable us to produce an affordable tool that can be used in agriculture to reduce the amount of time that the field is in use and to address the health issue of the farmer.

V. METHODOLOGY OF PROPOSED SYSTEM

5.1) Existing Method - Pesticides are often sprayed using a conventional power sprayer, which comes in three main varieties. Sprayers that are operated by hand, electricity, or gasoline. Additionally, tractors with GPS systems and large sprayers may spray pesticides autonomously from the ground.

5.1.a) Disadvantage of Existing Method –

By Employing an ordinary power sprayer to saturate partially aquatic regions is laborious and causes excessive weight burden..

Tractors take up a lot of space in the areas, consuming land that may be utilised for cultivation, and sprinkling can't be performed accurately..

5.2) Proposed Method - Quadcopters are employed as sprayers in the proposed system. This aids in lowering health risks related to pesticides by avoiding most physical labour. Radio frequency is used to construct quadcopter flight control, and the transmitter and receiver software on the quadcopter may be used to automate spraying. The technique is intended to benefit farmers by allowing them to spray pesticides and fertilisers using quadcopters rather than traditional hand sprayers.

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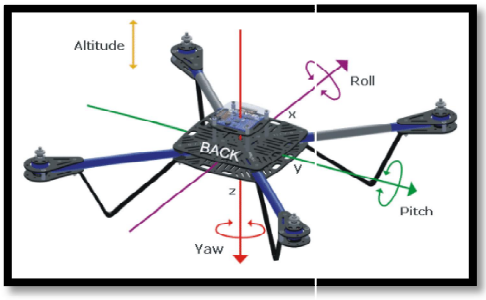
5.2.a)Advantage of Proposed Method –
It may be used to spray over high landscape, such as on the cultivation of tea,
It could be used to sprinkle on partially aquatic fields like sorghum fields because it is aerially applied and has no influence on aquatic fields.
Improves spraying efficiency and can replace 50 people, protecting 50 workers from adverse effects.
Lessens the amount of time needed to aerosols in contrast to hand spraying.

VI. HARDWARE INFORMATION OF PROPOSED METHOD

The suggested approach is divided into two parts: the chasing section and the liquid storage and spraying section.

6.1) Chase section -A quadcopter uses four propellers, each of which is propelled by a separate motor and electronic speed controller. This is described in section 6.1, "Chase." The accelerometers may be used to measure the quadcopter's angle in terms of X, Y, and Z, and the rpm of each engine can be changed in response. This allows the quadcopter to self-stabilize. The platform is stable because to the quadcopter's counter-rotating engines, which provide a net moment of zero at the core of the craft. By changing the velocity of every single motor, this approach enables accurate control of a quadcopter's yaw, pitch, and roll motions.



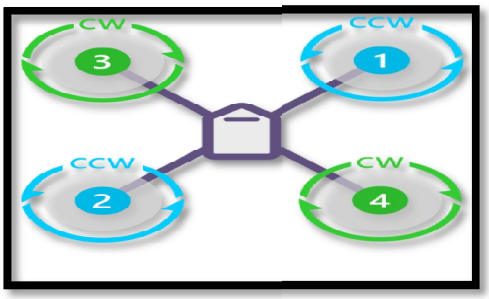


Fig. 1.The Pitch, Roll and Yaw for Quadcopter.Fig.2 Direction of motion of motor

Yaw Angle- The angle that a plane's longitudinal orientation makes with its path of flight.
Pitch Angle - The angle created by a spinning object's axis and a line that is perpendicular to its orbiting path.
Roll Angle- The angle formed by the rotation of an automobile with regard to its longitudinal plane.
Pitch, Roll, and Yaw for a quadcopter are shown in Figure 1. In order to maintain the ideal balance in the quadcopter's core, two of the motors—motors 4 and 3—rotate in a clockwise manner, while the other two—motors 1 and 2—rotate anticlockwise. The quadcopter's yaw angle may be adjusted to regulate movements to the left and right. The speed of the rear rotor is increased to regulate forward motion. By slowing down the front rotor, backward velocity may be controlled.

Airfoil: An airfoil is a rotor blade that generates lift as it flies throughout the air around it. Aerodynamic forces must be produced in order to keep the air moving around the rotor blades moving higher. Non-symmetrical airfoils come in a variety of higher and bottom surface configurations. Applications for symmetrical airfoils, which have basically no centre of pressure, are ideal for rotarywings. Under various conditions, a balanced blade spreads efficiency as needed while providing the benefits of cheap price and simplicity of construction. Because the blade may be built with a twist, an airfoil region may have a larger angle of pitch than a piece near its tip. An airfoil's top surface moves through the air more swiftly than its bottom because of its forms.As a result, there is more tension below the aerofoil than above it. The upward motion is caused by the pressure differential.

6.2) Liquid storage and spraying section

The fertilisers are kept within the tank in this portion for storage purposes. Chemicals are moved from a tank to the fields using a submersible water type pump. With appropriate pressure, it displaces the chemicals.The chemical substances are finally applied to the agricultural land as small droplets using a device called a sprayer.

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VII. COMPONENTS DETAILS

1) Frame - This is a very basic glass fibrequadcopter frame that is simple to assemble (as shown in Fig. 4). There are several reasons why this frame is one of the most well-known exterior frames: a) It is less costly. c) It is strong.

Fig. 4. Frame

2) BLDC Motor - Brushless DC motors (BLDC), which are seen in Fig. 5, are also known as synchronous electric motors powered commutation systems. These motors are deficient in the brush on the shaft that controls the direction of the coil's power. The frequency-to-speed and current-to-torque characteristics of the BLDC motor are linear. Since BLDC motors contain fixed permanent magnets and probably fewer poles on the stator than the rotor, they can be likened to stepper motors or reluctance motors. It is a three-phase electric rotating machine with an induction motor-like stator. The interplay of the flux from the rotor and the flux in the stator determines the motor's torque and speed. Brushless dc motors are known for their stability, high efficiency, and lack of brush wear.

Fig. 5.BLDC Motor

3) Propeller - The quadcopter is lifted significantly by the propeller (as seen in Fig. 6) by creating the thrust at a high rate of speed. Depending on the propeller's diameter, thrust can be produced, and more speed is needed to make the propeller spin. The quadcopter's speed, stability, and effectiveness are all impacted by the propeller. Lower pitch propellers produce greater torque while also enhancing stability.

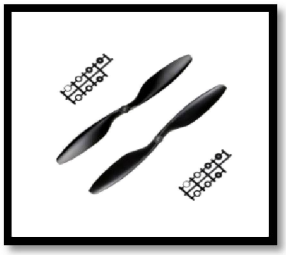

Fig.6. Propeller

4) ESC(Electronic speed controller) - In order to limit the speed of an electric motor and serve as a dynamic brake, radio controlled models that are driven by electricity employ Electronic Speed Controllers (ESCs), as seen in Fig. 7. By directly connecting to an external power source, ESCs require a greater voltage. A radio frequency receiver module powers it. The ESC regulates power pulses to control the speeds at which the motor tries to revolve.

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Fig. 7. Electronic speed controller (30A)

5) Flight controller - The KK2.1.5 is a popular open-source flight controller designed for multi-rotor aircraft. It was developed by Rolf Bakke, and it is an upgraded version of the original KK2.0 flight controller.The KK2.1.5 flight controller features a 6-pin USB port, a micro SD card slot, and a built-in LCD display screen. It also has a 3-axis accelerometer and a 3-axis gyro for flight stabilization. The flight controller supports several flight modes, including acrobatic, stable, and auto-level.It has a simple interface that allows users to easily configure and tune their aircraft. Additionally, it supports a wide range of motor and propeller combinations, making it a versatile option for hobbyists and professionals alike.The KK2.1.5 flight controller can be programmed using a computer with the KKMulticopter Flash Tool or using the LCD interface on the flight controller itself. It also supports firmware updates to keep the controller up-to-date with the latest features and bug fixes.Overall, the KK2.1.5 flight controller is a reliable and popular choice for multi-rotor aircraft enthusiasts, particularly for those who value simplicity and ease of use.

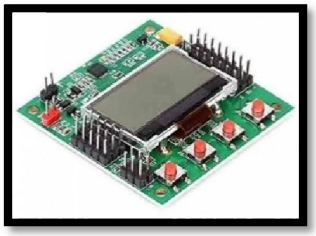

Fig. 8. Flight Controller (KK 2.1.5)

6) Transmitter and receiver - We employ a CT6B with 6 channels FLYSKY transmitter and receiver requires changing the deceleration, servo interaction, and channel kinetics on a computer You may control the quadcopter using the radio receiver and the transmitter (as illustrated in Fig. 9).

Fig. 9.Flysky transmitter and receiver (2.4 GHz with 6 channels)

7) Lithum Polymer battery - Drones commonly use Lithium Polymer batteries, which are available in a range of forms and abilities. Usually, we utilise 3S1P batteries, which comprise three cells. It has a capacity at 11.1 volts since each cell has a voltage of 3.7 volts (as seen in Fig. 8)

Fig.8 LiPo battery (2200 mah)

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VIII. FUTURE SCOPE

- Increasing the number of engines, the size of the propellers, or the engine rpm all improve the quadcopter's weight-lifting capabilities.
- Improving the duration of flight time by boosting the battery's size..
- Increasing the tank's size will improve the pesticide's capacity.
- Spraying angle can be controlled for optimum spraying.

IX. RESULT AND DISCUSSION

- Time required for spraying by using traditional method is more around (1 hr /acre) and time required by using drone is about (15 min/acre).
- It is time effective which saves a lot of time of farmer and also reduces the fatigue load.
- The requirement of money in the traditional method is quite high because of high labour charges.
- And on the other side by using drone based spraying it is quite feasible because it can be easily operate even by farmers also.
- By using the drone based spraying the heath issue of farmers get also reduced as compare to the traditional methods.

X. RESULT AND DISCUSSION

With the help of a UAV (Unmanned Ariel Vehicle) or quadcopter, we have automated the spraying of fertilizers and pesticides in this project, making it more attractive and cost-effective. This technique allows farmers who were manually applying pesticides and fertilizers to big agricultural fields areas in a short amount of time while reducing health risks to them. It was created using innovative technology, which is particularly beneficial to farmers in the agricultural industry. Environmental contamination can also be decreased when these pesticides and fertilizers are sprayed from lower altitudes.

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