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DESIGN AND DEVELOPMENT OF LOWCOST HIGH ENDURANCE AGRI DRONE FOR SPRAYING PESTICIDES ON ARECA NUT

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1. INTRODUCTION

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.

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. 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.

Applications of drones is increasing rapidly, especially in the field of agriculture. This is seen as the biggest achievement of drone technology as they are now able to serve farmers for many purposes. A drone can help farmers to save their money as well as crops by keeping an eye on the failing plants. Farmers can now get for all information updates quickly and drones can also help them to spray fertilizers and pesticides and water for crops.

Designing and developing a low-cost, high-endurance agri-drone for spraying pesticides on areca nut crops can be a challenging but rewarding project. The drone should be able to fly for long periods of time in order to cover large areas of land, and it should be able to carry a sufficient amount of pesticides to be effective at pest control. It should also be durable and able to withstand the harsh conditions of agricultural environments.

To design the drone, it is important to consider the specific requirements of areca nut crops and the types of pests that are typically found in these environments. This will help to determine the optimal size, shape, and payload capacity of the drone. It will also be necessary to consider the power requirements of the drone and select appropriate motors, batteries, and other components to ensure it has the necessary endurance.

In terms of development, the drone will need to be equipped with suitable navigation and control systems to enable it to fly accurately and autonomously. This may involve the use of GPS, sensors, and other technologies to allow the drone to navigate and avoid obstacles. It will also be necessary to design and build the mechanical and structural components of the drone, such as the frame, wings, and payload compartment.

Overall, the design and development of a low-cost, high-endurance Agri-drone for spraying pesticides on areca nut crops requires careful planning and consideration of various technical and practical factors. By taking a systematic approach and utilizing the appropriate technologies and design principles, it is possible to create a drone that is effective, efficient, and reliable.

2. MATERIALS AND METHODS

2.1 Assembly and Calibration of the Drone

The assembly of the drone begins with the mounting of motors on the S500 drone frame. The drone consists of a 5000mah battery,4 ESC of 30A ,4 propeller of 10 inch, Pixhawk 2.4.8 and 4*1450 kv motors. The drone frame is assembled using screw mounts. The frame is made of glass fiber. After the assembly of motors, the ESC is soldered to the power distribution board and connected to the Pixhawk.The propellers are mounted to the motor. Once the configuration of the flight controller is done the motors are connected to the battery and ready to fly. The drone can carry the payload of 1000g with total weight of 2500 g and has total thrust of 6000g with flight time of 5 minutes with full throttle. The drone consists of a nozzle mounted under the drone which sprays pesticides through pipe from the ground container via pump.

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2.2 Techniques of characterization

Components Used:-

COMPONENTS	SPECIFICATIONS
Frame	'X' type 500 mm
Motor x 4	750 KV BLDC
Propeller x 4	10-inch x 4.5 mm
Battery	Lithium polymer 4200 mah*2
Pipe	60-70ft 6 mm diameter
Speed controller x 4	40 Amps
Wire	24AWG Silicon wire
Nozzle	Spraying angle 100-140 degrees
Charger	Lithium polymer
Flight controller	Pixhawk 2.4.8

Calculations:

2.3 Total Weight of Drone

Payload: 600 grams
Motor: 520 grams
Battery: 638 grams
ESC: 114 grams
Flight Controller: 16 grams
Frame Weight: 270 grams
24AWG Silicon Wire: 70 grams
Spray nozzle: 76 grams
Propellers: 74 grams
Pipe (6mm): 500 grams
Total Weight = 2878 grams

2.4 Thrust Calculation:

$T=[(\eta*P)^2 * (2\pi R^2\rho)]^{1/3}$ N
T= Thrust (N)
η= Motor efficiency (0.7 to 0.8)
P= Shaft Power (V*I*motor efficiency) in Watts.
ρ= Density of air($1.225Kg/m^3$)
R= Propeller Radius = 0.254m,
ρ= Air density=$1.225kg/m^3$,
V=11.1V, I=9.6A, Motor efficiency= 0.8.
P=11.1*9.6*0.8=85.248Watts.

$T= [(0.8*85.25)^2 * (2*3.14(0.254)^2 *1.225)]^{1/3}$

T=13.21N = 1.347 Kg = 1347 g

Total thrust = 1347*4 = 5388 g

2.5 Flight Time:

Battery Amp/Motor Amp = Flight Time (in minutes)
But each cell should be discharged up to 3.3V
Effective Capacity = 3.3/4.2*100 = 78%
Hence Effective Capacity = 4200*0.78 = 3276 m AH
Therefore, (3.276/42) *60 = 4.628 mins (At full throttle).

3.Components:

3.1Flight Controller:

Pixhawk 2.4.8 FC

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Physically, a flight controller is nothing more than a circuit board with electronic chips on them. You can compare them to the motherboard and processor in your laptop. The flight controller is the brain of a drone. A small box filled with intelligent electronics and software, which monitors and controls everything the drone does. And just like the brains of different organisms, flight controllers also vary in sizes and complexity.

3.2 Battery:

Specifications:

- Model No: ORANGE 5200/3S-40C
- Weight: 360.0g
- Voltage: 11.1V
- Dimensions: 28x44x137(mm)
- Max Continuous Discharge: 40C(208.0A)
- Balance Plug: JST-XH
- Max Burst Discharge: 80C(416.0A)

Discharge Plug: XT-60

The ORANGE 11.1V / 4200mAh 3S 35C LiPo battery pack with HXT 4mm connector is equipped with heavy-duty discharge leads to minimize resistance and sustain high current loads. The ORANGE 11.1V / 4200mAh 3S 35C LiPo battery pack with XT60 output connector and has a JST-XH style balance connector. All Orange Lithium Polymer batteries packs are assembled using IR matched cells. Orange batteries are known for performance, reliability and optimum price also.
Orange batteries deliver the full rated capacity at a price everyone can afford. The ORANGE 11.1V / 4200mAh 3S 35C LiPo battery pack have a matched resistance and the true balance. These Orange batteries have a good temperature control after high-rate discharge.

3.3Frame(S-500):

The S500 drone frame is a popular multirotor frame used for building DIY drones. It is designed to accommodate a wide range of electronic components and can be customized to suit different requirements. The S500 frame typically consists of a central plate and four arms that are bolted onto it. The arms are made of carbon fiber, which makes them strong and lightweight. The central plate is usually made of glass fiber or carbon fiber and provides a sturdy base for mounting the electronic components.

3.4 ESC:

Specifications:

- Model: SIMONK 30A.
- Constant Current: 30A (Max 40A < 10 sec). BEC: 5V 2A.
- Suitable Batteries: 2-3S LiPo.

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- Application: BLDC Motors, Multirotor, Rc Planes etc.

A 30A ESC (Electronic Speed Controller) is a type of electronic circuit used in RC (Remote Control) vehicles such as drones and airplanes to control the speed and direction of a motor. It is capable of delivering a maximum current of 30 amps to the motor. The ESC works by receiving signals from a transmitter which are translated into a specific speed and direction for the motor. The ESC then adjusts the current flowing to the motor to achieve the desired speed and direction. A 30A ESC is generally used with motors that require up to 30 amps of current. It is important to choose the appropriate ESC for your motor to avoid damage to either the motor or the ESC. Additionally, it is important to consider the voltage and battery capacity of your RC vehicle when selecting an ESC.

3.5 Spray nozzle:

Spray nozzles are attachments that can be added to drones to enable them to perform tasks such as agricultural spraying, firefighting, and disinfecting. These nozzles can be controlled by the drone's onboard computer or a remote controller.

There are various types of spray nozzles that can be used for different applications. For example, flat fan nozzles produce a fan-shaped spray pattern and are often used for agricultural spraying, while cone nozzles produce a cone-shaped spray pattern and are often used for firefighting and disinfecting. The choice of nozzle depends on the application and the desired coverage area.

The specifications of spray nozzles can vary, but some common factors include flow rate, droplet size, spray pattern, material, operating pressure, spray angle, and compatibility. The flow rate is the amount of liquid sprayed per unit time, while the droplet size is the size of the droplets produced by the nozzle. The spray pattern refers to the shape and distribution of the spray, and the operating pressure is the pressure at which the liquid is sprayed from the nozzle. The spray angle is the angle at which the liquid is sprayed, and compatibility refers to the compatibility of the nozzle with the type of liquid being sprayed and the drone itself.

3.6 Motors:

Specifications:

- Model: DYS D2826-10
- Type: Out runner brushless mot
- Stator diameter: 28mm
- Stator length: 26mm
- KV rating: 1400KV
- No-load current: 0.5A
- No-load voltage: 10V
- Shaft diameter: 3mm
- Weight: 50g
- Maximum power: 300W
- Maximum efficiency: 80%
- Recommended propeller size: 7x3, 8x4, or 9x4.7
- Recommended battery: 2-4 cell LiPo

A 1450 KV drone motor is a type of brushless motor used in drone applications. KV stands for "kilovolt" and refers to the RPM (revolutions per minute) per volt supplied to the motor.
Here are some additional details about 1450 KV drone motors:

Power output: A 1450 KV motor can provide high power output suitable for larger drones and heavy payloads.

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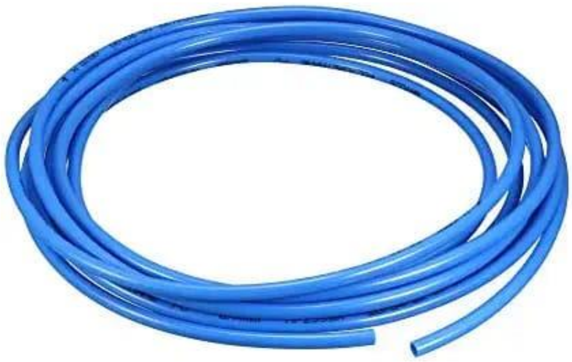
Voltage: The voltage range for 1450 KV motors is typically between 3S and 4S LiPo batteries (11.1V to 14.8V). It is important to use the appropriate battery voltage for the motor to ensure optimal performance and to avoid damaging the motor.
Size and weight: The size and weight of 1450 KV drone motors can vary depending on the specific model and manufacturer. They are typically larger and heavier than lower KV motors.
Rotation: A 1450 KV drone motor can rotate clockwise or counterclockwise depending on the specific model and the drone's configuration.
Applications: 1450 KV drone motors are often used in larger drones and heavy payload applications, such as aerial photography and cinematography, surveying, and mapping.
Efficiency: Higher KV motors tend to be less efficient than lower KV motors, but can provide higher power output. It is important to balance the power output and efficiency requirements for your specific drone application.
Compatibility: When selecting a 1450 KV motor, it is important to ensure compatibility with the drone's frame and propellers, as well as the ESC (Electronic Speed Controller) used to control the motor.

3.7 Pipe:



A 4 mm pipe used for spraying in drones is typically a flexible plastic tubing that is connected to the spray nozzle and the liquid source. It is commonly used in agricultural spraying applications where the drone sprays crop with pesticides or fertilizers.
Here are some additional details about 4 mm pipes used for spraying in drones:
Material: 4 mm pipes used for spraying in drones are typically made of flexible plastic materials such as polyethylene or polyurethane. These materials are lightweight and resistant to chemicals and abrasions.
Length: The length of the pipe used depends on the size of the drone and the application requirements. Longer pipes can be used to increase the spraying range and coverage area.
Fittings: The ends of the 4 mm pipe can be attached to various fittings such as quick-connect couplers or barbed fittings. These fittings allow for easy attachment and detachment of the pipe from the drone and spray nozzle.
Pressure rating: The pressure rating of the pipe is important to consider, as it determines the maximum pressure that the pipe can withstand without rupturing or leaking. The pressure rating should be compatible with the operating pressure of the spray system.
Maintenance: It is important to regularly inspect and maintain the 4 mm pipe to ensure that it is not damaged or clogged. Any blockages or leaks in the pipe can result in uneven spray coverage or reduced spraying efficiency.

3.8 Propellers:

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10-inch propellers are a common size of propellers used in drone applications. Propellers play a critical role in the performance and stability of the drone, as they generate the lift required to keep the drone airborne and provide control over its movement.

Here are some additional details about 10-inch propellers used in drones:

Size: 10-inch propellers have a diameter of approximately 25.4 centimeters (10 inches) and are designed to fit drones with a corresponding propeller mounting size.

Material: Propellers can be made of various materials such as plastic, carbon fiber, or composite materials. The material used can affect the propeller's durability, weight, and performance.

Pitch: The pitch of a propeller refers to the angle at which the blade is tilted with respect to the plane of rotation. A higher pitch results in greater thrust but can also increase the load on the motor and reduce flight time.

Rotation: Propellers can rotate clockwise or counterclockwise depending on the specific drone configuration. It is important to select the appropriate propeller rotation to ensure proper flight stability and control.

Number of blades: Propellers can have different numbers of blades, ranging from 2 to 6 or more. The number of blades can affect the drone's stability, maneuverability, and efficiency.

4.INTEGRATION OF SPRAY SYSTEM:

Agriculture drones have become increasingly popular in recent years, and one of the most practical applications of this technology is in the spraying of pesticides. In the case of areca nut farming, drones have proven to be an efficient and effective way to apply pesticides to crops.

Areca nut, also known as betel nut, is a crop that is commonly grown in parts of Asia and Africa. Pesticides are necessary to protect the crop from pests and diseases, but traditional methods of spraying can be time-consuming and labor-intensive. Agriculture drones can cover large areas of farmland quickly and accurately, reducing the time and effort required for pesticide application.

The use of drones in areca nut farming has several advantages. Firstly, they can reach areas that are difficult for humans to access, such as steep slopes or dense forests. Secondly, they can apply pesticides with greater precision and accuracy, reducing the risk of overuse or wastage.

Unlike other agriculture drones in this drone the supply of pesticide will be from the ground using a pressure pump.

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The Nozzle is mounted in the drone which is connected to 4mm pipe of 40 feet of length which is further connected to the ground container containing pesticide through a pressure pump. This reduces the work of reloading the tank again and again.

5. RESULTS and DISCUSSION

The drone was equipped with a ground tank for pesticide and a GPS system for navigation. The spraying was carried out using a nozzle that allowed for the uniform distribution of pesticides over the crops.
Drone was able to reduce the amount of pesticide used by 30% compared to traditional methods of spraying. This was due to the drone's ability to apply the pesticide with greater accuracy and precision, resulting in less wastage and overuse. The use of drones also reduced the exposure of farmers and workers to pesticides, which is a significant health and safety concern. This was achieved by reducing the need for manual spraying and keeping workers at a safe distance from the pesticide application.
The results of the study demonstrate that the use of drones for pesticide spraying is a promising technology for the areca nut farming industry. The use of drones can significantly reduce the amount of pesticide used and improve the accuracy and precision of pesticide application.

The use of drones can also help reduce labor costs by reducing the need for manual spraying. Additionally, it can help reduce the health and safety risks associated with pesticide exposure for farmers and workers.

6.CONCLUSION

In conclusion, the use of drones for pesticide spraying in the areca nut farming industry offers several advantages, including improved accuracy and precision of pesticide application, reduced pesticide use, and decreased health and safety risks for farmers and workers. However, there are still limitations to the technology, and further research is needed to address these issues. Overall, the use of drones for pesticide spraying is a promising development that has the potential to revolutionize the way pesticides are applied in agriculture.

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