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Octocopter Drone: Design for Transporting Pesticides and Agricultural Applications

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Abstract

Unmanned aerial vehicles (UAVs), sometimes known as drones, are used in current agricultural practices that involve the application of pesticides and other chemicals for the healthy operation and growth of farm produce. Digital farming is the practice of using digital technologies to move agricultural products from pastoral farmers to the ultimate customers. The system can be manually operated by using a transmitter or autonomously by utilizing flight control software. The technology drastically cuts the amount of time needed while maintaining safety measures. This made it possible to design a drone equipped with a spraying mechanism that includes a 12V pump, a 5liter storage tank, 4 spray nozzles, an octocopter configuration frame, a suitable landing frame, 8 Brushless Direct Current (BLDC) motors with appropriate propellers to produce the required thrust, which is about 38.2 kg (100% RPM), a battery with a current capacity of 5200mAH, and a 22.2V motor. The drone underwent flight tests to determine its calibration, the longevity of the battery, and the ability of the motors to generate the required uplift thrust. For the purpose of watching the spraying operation, a first-person view (FPV) transmitter was attached to the drone. It has been proven that the methods utilized to transport pesticides and other agro-allied chemicals allow for high levels of farm produce sustainability.

Keywords: octocopter drones, agricultural applications, transport technology

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Introduction

Digital farming is the practice of using digital technologies to move agricultural products from pasture farms to customers. In order to enabling farmers and other agricultural value chain partners to increase production and its movement from one location to another, digital farming also integrates the most cutting-edge and potent technologies into a single system. The drone can be managed manually or automatically using the transmitter and flight control software (Kurtuke, 2018). Advanced agricultural drones can be used by farmers and the people who fly the drones they launch to enhance and increase efficiency in certain agricultural transportation activities. These features include things like livestock management, irrigation mapping, plant cultivation, monitoring, and plant spraying. Digital technologies can be used by the agricultural sector to obtain all the data and tools required to make better decisions (Yallappa *et al*., 2017).

Figure 1: High tech agricultural UAV flying to transport pesticides

The agricultural sector in Nigeria is by far the most important, contributing 18% of the nation's GDP and employing 50% of the workforce (Adam,2011). Our nation is primarily dependent on agriculture and has not yet reached its full agricultural potential due to inadequate crop protection systems, irrigation practices, and pesticide use. In Nigeria, more than 35 UAV Startups are competing to cut the cost of agricultural products and raise the bar for technological advancement in UAVs (Mallick et.al., 2016).

Using aerial spraying tools like the M-18B and Thrush 510G, Mone et al. (2017) investigated effective swath width and droplet distribution uniformity. Researchers discovered that the difference in breadth between the Thrush 510G and M-18B aircraft, which flew at heights of 5 meters and 4 meters, respectively, is a result of altitude.

The ability to compress a tiny volume aerosol inside of an autonomous octocopter was demonstrated by Huang et al., (2015). The octocopter's 3 meter-diameter main rotor can carry 22.7kg of payload weight. Every 45 minutes, at least one gallon of gasoline was consumed. The development of drone aeronautical application systems and the manufacture of products with higher target speeds and larger Volume Median Diameter (VMD) droplets were both made possible by the findings of this study.

According to Yallapa et al., an octocopter consists of two 6 cell, 8000mAh LiPo batteries and six BLDC motors (2017). As part of their investigation, they also measure the spray rate, fluid pressure, droplet size, and density. They eventually succeeded in using this effort to produce a drone that can move 5.5 liters of liquid with a 16-minute resistance. The octocopter drone is a current technology used for the spraying of pesticide and other chemicals for the appropriate functioning and growth of farm produce. It is meant to assist in the transportation of pesticides and agricultural application. The technology significantly cuts down on time while maintaining agricultural application safety requirements. The methods utilized to transport pesticides and other agro-allied chemicals allow for high levels of produce sustainability.

Drone Technologies in Transporting and Implementing Agricultural Applications

• **Planting**: Start-ups have developed UAV planting systems, according to Balaji et al. (2018), that achieve a 75 percent absorption rate and cut agricultural expenditures by much to 85 percent. These systems release plant nutrients and seed pods into the soil, giving the plant everything, it needs to survive.

• **Crop Spraying**: According to Kurkute et al., UAVs can scan the ground and spray the right amount of liquid while adjusting their distance from the ground to ensure even coverage (2018). As a result, productivity will increase while less chemical waste will enter the groundwater. Experts claim that employing drones to spray is five times quicker than using convectional gear.

Crop Monitoring: The biggest obstacle to farming is the result of vast farms and inadequate crop monitoring. The monitoring problems get worse with more unpredictable weather, which raises the risks and maintenance costs.

Irrigation: UAVs equipped with thermal, multispectral, or hyperspectral sensors can identify dry areas and areas that require improvement. The plant index, which determines the energy or heat output and the heat signature released by the plant and describes its relative density and health, may also be calculated by the drones while the plant is growing.

Methodology

This essay outlines the planning and research methods used to create the overall system for the octocopter agricultural drone. An efficient research technique on UAV intended for agricultural crop spraying was intended. The hardware component, including the payload estimation, must be taken into account when building the octocopter drone. The drone's frame must be developed by figuring out the required arm number, arm length, and payload application; the drone battery must then be selected by knowing the current and voltage needs of the components; the thrust requirement must then be computed. the radio transmitter, receiver, pump, electronic speed controller, and payload motor weights must also be calculated.

This study focuses on agricultural practices that employ contemporary technology, including the use of unmanned aerial vehicles (UAVs), also known as drones, to spray pesticides and other chemicals for the healthy operation and growth of farm produce. Digital farming is the practice of using digital technologies to move agricultural products from pastoral farmers to the ultimate customers. The system can be manually operated by using a transmitter or autonomously by utilizing flight control software. The system drastically cuts the amount of time needed to apply pesticides and other agricultural applications while maintaining safety precautions in the agricultural environment. This made it possible to design a drone equipped with a spraying mechanism that includes a 12V pump, a 5liter storage tank, 4 spray nozzles, an octocopter configuration frame, a suitable landing frame, 8 Brushless Direct Current (BLDC) motors with appropriate propellers to produce the required thrust, which is about 38.2kg (100% RPM), a battery with a current capacity of 5200mAH, and a 22.2V motor.

Design Analysis

Design conceptualization, the procedure of formulating concepts for the ideal remedy to the design challenge in light of the anticipated functioning of the product, is the first step in a normal design analysis. Two crucial components that make up the unmanned aerial vehicle must be taken into account in order to build the drone (UAV).

Hardware Analysis

The drone's structural design is part of the hardware module of the design. To control how quickly the motor spins the propeller, a signal is sent from the transmitter, information is received from the flight controller, and it operates on an electronic speed control. Among the components used in the design are the LIPO battery, flight controller, frames, propellers, brushless motors, electronic speed control, landing gears, RC transmitter, and receiver. The payload consists of the spraying system, which consists of the spraying tank, pump, nozzles, and water pump. The frame design, drone load (estimated payload, drone component weight, and total weight), flying time, RC

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transmitter, and spraying system are all included in the representation of hardware design analysis in figure 2.

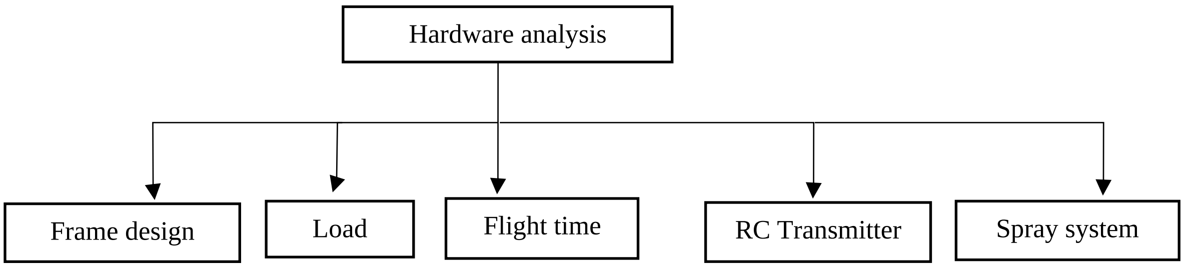

Figure 2: Block Diagram of Hardware Design Analysis

The operational theory of the octocopter drone is based on aerodynamic concepts. Aerodynamics The aerodynamic interactions between the rotors of unmanned aerial vehicles (UAVs) or drones affect their performance. As illustrated in the block diagram below, the signal will be sent from the transmitter to the receiver in the drone. The flight controller receives the signal from the receiver and processes it using accelerometer and gyroscope sensors. As soon as the signal reaches the ESC, it is processed and delivered, allowing a precise quantity of current to be delivered to the motor based on the signal it receives. The motors and propellers are mechanically linked and revolve to produce thrust. The pressurized liquid in the storage tank flows along the pipeline and is sprayed at the nozzle thanks to the pump's utilization of the Li-Po battery's electricity. The transmitter controls the input current, which can be altered to modify the pump's flow rate.

Software Analysis

The drone's software serves as its brain. The drone software was created to gather and connect all of the relevant data coming from the drone as it flew from point A to point B. The mission planner simulation application was used to calibrate the drone's motion and operation. The software was set up and is currently running on the Windows 7 operating system. It utilizes a layer-based architecture. This layer combination, often referred to as a flight stack or an autopilot, was properly coupled to regulate flight simulations, altitude, and other essential data for the drone to run and function correctly. A rovers, helicopters, and aircraft ground control station is the mission planner. Only Windows is capable of using it. Michael Oborne created the open-source, community-supported tool known as Mission Planner for the open-source APM autopilot project. It can be used to configure the autonomous vehicle or as an addition to its dynamic control system.

Assembling of Drone Frame

Due of its less weight, strength, and longevity, aluminum was chosen or used to manufacture the drone frame. The drone's frame was built using the OCTO H configuration type, which was used to reduce friction between the components mounted on the frame. The H configuration is made up of a quadcopter in the middle, two propellers up front, and two propellers down rear. It has eight arms, just as the term octo-copter ("octo" = eight) suggests. The aluminum material was measured and cut to the desired size. A hole was then created in the material using a drilling machine so that air could pass through it while the drone was in flight, making the weight that is linked to it lighter and easier to lift. Each arm has a length of 492 mm, a motor at each free end, and a mechanical connection between the motor and propeller. The illustration for this explanation is shown in figure 3.

Figure 3: Drone Frame Construction

Assembling of the Spraying System

The storage tank will have a sloped bottom that will allow it to be entirely drained, and it will be mechanically linked to the frame. A 1.3-meter-long plastic tube with four nozzles is positioned at 45mm intervals. The pump is powered by a power distribution board that was anchored to the ground. The pump has an input connected to a storage tank and an outlet connected to a plastic tube with attached nozzles. The landing frame is joined to the main frame at a height of 300mm so that the storage tank stays off the ground and the drone can land safely. Before connecting the 12v DC water pump to the 5-litre spraying tank, it was tested with water. after verifying the process was successful.

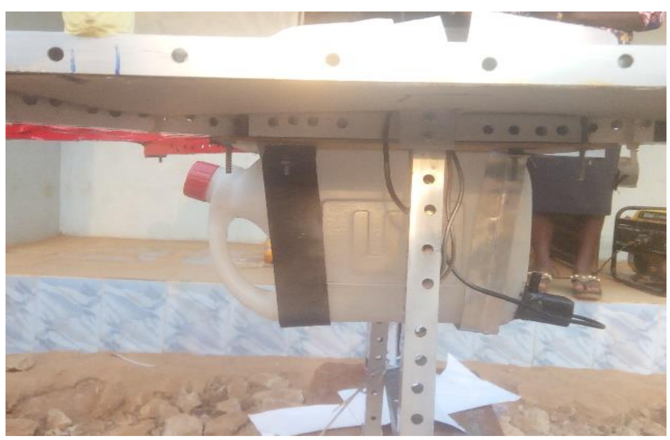

Figure 4: Spraying System

Working Operation of the Drone

Using the RC transmitter, the drone will take off, and it is guided to the intended spraying spot by flying there. This is how the suggested system operates. The servo motor turns on the pesticide sprayer at the intended spraying location, and the pesticide is then dispersed across the designated area before being turned off by the drone pilot via the RC transmitter. The drone will be flown back to its original place once the spraying process is finished. The location of where to spray the insecticides is determined by GPS coordinates in the suggested method.

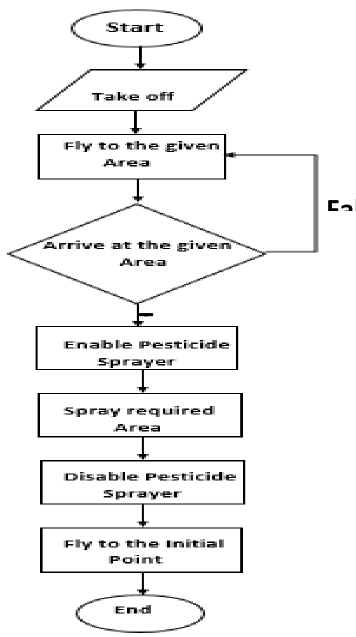

Figure 5: Flow Chart of the Working Operation

Results and Discussion

The spraying system aboard the drone, which was made specifically for agricultural use, consists of a 5-liter spraying tank, a 12-volt DC water pump, a nozzle, and a servo motor for turning the pump ON or OFF. Tests were carried out to ascertain the building work's functioning, check for flaws, and apply corrective steps to fix the issue and guarantee the efficient operation of all system components.

Performance Test

Before the entire system was put together, the operation was monitored and the construction was tested; if there was a problem that needed to be fixed, it was fixed. The drone's payload was significant, which reduced its overall weight. Because a bigger payload reduces flight time and a lower payload increases flight time, the drone operation is successful as a result. Using personal computer-based mission planner calibration software, the flight controller was successfully calibrated. To ensure that each component performed as expected, tests were conducted on each one. After ensuring the landing gear was securely attached to the drone and was ultimately prepped for its initial flight, which provides further support. During this operation, it was determined that the drone's construction had been successful because it maintains stability while flying and is not affected by wind or other environmental factors.

Discussion of Result

A handheld radio remote control is used to control the drone's propellers manually. You can go in different directions with the controller's sticks, and you can adjust the drone's trim by pressing the trim buttons. The transmitter transmits the signals, which the drone's receiver then receives. The Flight Controller processes the signal after it is sent from the receiver. The signal is evaluated and provided as soon as it reaches the ESC, allowing the motor to get a precise amount of current dependent on the signal it receives. The propellers and motors are mechanically connected and turn to create propulsion. The pump pressurizes the liquid in the storage tank before it passes through the pipeline and is sprayed at the nozzle using the electricity from the Li-Po battery. The transmitter controls the input current, which is changed to alter the pump's flow rate.

Conclusion and Recommendation

This study created and put into use a drone system to spray fertilizer and pesticides on farms, thereby lowering health concerns for the farming community. The more reliable and economical method is the octocopter technology. A specified piece of land can be plotted with the help of this module so that the drone can automatically spray fertilizer along the mapped path. To maintain a steady height and prevent collisions, Pixhawk can be interfaced with an ultrasonic sensor. The drone uses GPS to find its starting position in low power and limited signal range situations.

The study suggests increasing the flight controller's capabilities to make it more stable. With GPS technology and the option to automatically return home, manual control can also be converted to autonomous control. The drone can be utilized for surveillance to find evidence of plant pest assaults and the state of ripening fruit using image processing techniques. Additionally, if equipped with expensive equipment, it can undertake scanning of plants, security checks, and inspections of the specific seeds, fertilizers, and pesticides used on crops according to the soil conditions recommended by agricultural specialists.

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