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Research Paper

AUTONOMOUS ARGO-FERTILIZER DISPENSING DRONE WITH LIGHT WEIGHT FRAME

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Abstract

An agricultural drone is a specialized type of Unmanned Aerial Vehicle (UAV) equipped with Vertical Take-Off and Landing (VTOL) capability, making it highly suitable for precision farming applications. According to global health reports, millions of pesticide poisoning cases occur every year, with a significant number of fatalities recorded, especially in developing countries where manual spraying is widely practiced. Farmers are frequently exposed to hazardous chemicals during pesticide handling and spraying, leading to serious health problems such as respiratory illnesses, skin and eye irritation, allergic reactions, hormonal imbalance, reproductive disorders, neurological complications, and an increased risk of certain cancers. Even prolonged exposure to small quantities of agricultural chemicals can negatively affect the nervous system, resulting in reduced coordination, slower reflexes, impaired vision, mood disturbances, and behavioral changes. To overcome these challenges, agricultural spraying drones provide a safer, faster, and more efficient alternative by minimizing direct human contact with harmful chemicals while improving spraying accuracy and reducing labor requirements. This project focuses on the design and development of a lightweight aluminum-frame quadcopter capable of carrying and spraying liquid fertilizers or pesticides over agricultural fields. It also presents the structural design considerations, payload distribution, and the development of an efficient spraying mechanism integrated with the quadcopter platform. The proposed system aims to enhance agricultural productivity, reduce operational costs, improve farmer safety, and promote sustainable farming practices through the adoption of modern drone technology.

Keywords: Quad copter, UAV, Fertilizer, pesticides, spraying

INTRODUCTION

The main source of Indian economy is agriculture. The agriculture production depends on various Environmental parameters like temperature, rain, etc. It is also affected by other major biological factors such as pests, diseases, etc. These biological factors can be controlled by human beings with the help of pesticides, ultimately increasing the productivity. Pesticide exposure affects the human health in various ways and causes neurological and skin diseases. According to survey conducted by World Health Organization was analyzed that each year three million employees area unit plagued by poisoning from pesticides from that 18000 die. This comes aims to beat the unwell Effects of the chemicals on citizenry people in general persons groups of people individuals personalities and conjointly wont to spray chemical over large areas briefly interval of your time compared to traditional spraying by an automatic aerial pesticide sprayer. This product is basically a design and development of quadcoper frame structure and spraying mechanism to reduce time an human efforts.

NECESSITY

The agricultural fertilizer spray drone is used to carry pesticides to spray all over the farm which reduces the work of farmer as well finish his work soon. The agricultural fertilizer spray drone is user friendly interface for the farmers. The Drone is a pesticide spraying Quad copter

for agricultural purpose which helps the farmer to spray the pesticides all over his land so that it reduces his work which can evenly spray all over his farm from safe and secure location.

OBJECTIVES

The Main objectives include:

1. To get an efficient solution for payload carrying capacity using UAV (up to the weight of 3kg including vehicle).
2. To Design light weight frame and chassis.
3. Assemble the UAV using necessary components.
4. To build a suitable quad copter with stable flight control.
5. To design a mechanism for spraying and controlling various parameters like drone speed, spraying speed control etc.
6. To spray Fertilizer's or pesticides aerially on Crops.



Figure1: *Digram ofAgricultural Fertilizer Spraying Drone.*

MOTIVATION

Different climate and temperature variations on land scape the wind speed varies. So the drones are not able to spray the required amount of fertilizer to particular Area. Our aim is to provide a controlled automotive spraying mechanism with atmospheric conditions. So our aim is to provide a controlled automotive spraying mechanism with atmospheric Conditions.

LITERATURE SURVEY

In 2012, Aditya S. Natu., Kulkarni, Zhang, C., and Kovacs, J. M says that, As much as India depends upon the agriculture, still it is far short from adapting latest technologies in it to get good farm. Developed countries have already started use of UAV's in their precision agriculture photogrammetry and remote sensing. [1] After this invention in 1999 Van Blyenburgh P. worked on the crops of agriculture He says, it is very fast and it could reduce the workload of a farmer. In general, UAV's are equipped with the cameras and sensors for crop monitoring and sprayers for pesticides praying [2]. In 2012 A Costa, F., Ueyama, J., Braun T, Pessin G, Osorio F, Vargas P. was found factors reduce the crop quality like some area in the cropfield is not covered properly while spraying Crop areas overlapping and outer edges of the crop field in the spraying process [3].
In the past, Variety of UAV models running on military and civilian applications. In 2015 The Yamaha developed first UAV model for Agriculture purpose [4].

The new automatic navigation UAV spraying system MSP430 technology developed to direct the UAV in desired spray area in2016 by Xue, X., Lan, Y., Sun, Z., Chang, C., & Hoffmann, W. C. [5].

In 2017 ,To overcome a low cost user flexible pesticide spraying drone was developed by Spoorthi, S., Shadaksharappa, B., Suraj, S., Manasa, V.K. which is controlled by an android app [6].

After this invention, a laboratory and field evolutions are analyzed for discharge and pressure rate of the liquid, spray uniformity and liquid loss, droplet density and sizes of a developed quad copter mounted sprayer in 2017 [7].

The extra added features in UAV was developed in 2017 by Sohail, S., Nasim, S., & Khan, N. H. In this innovation such as An aerodynamic domain, tuning and

trimming phases of UAV is done by using proportional integral derivative (PID) controlling algorithm [8].

SYSTEM DEVELOPMENT

Power Supply

Li-Polly batteries are fully charged when they reach 4.7v/cell, and their minimum safe charge, is3.0v/cell. 3.7v is pretty much in the middle, and that is the nominal charge of the cell. Capacity of battery is 5500 mAh this is 3 cell high power battery having high discharge rate. Voltage of the battery is11.1v and current of battery is 5.5 Amp.



Figure 2: *Diagram showing Li-Polly battery*

Block Diagram

Following figure shows the block Diagram of quad copter

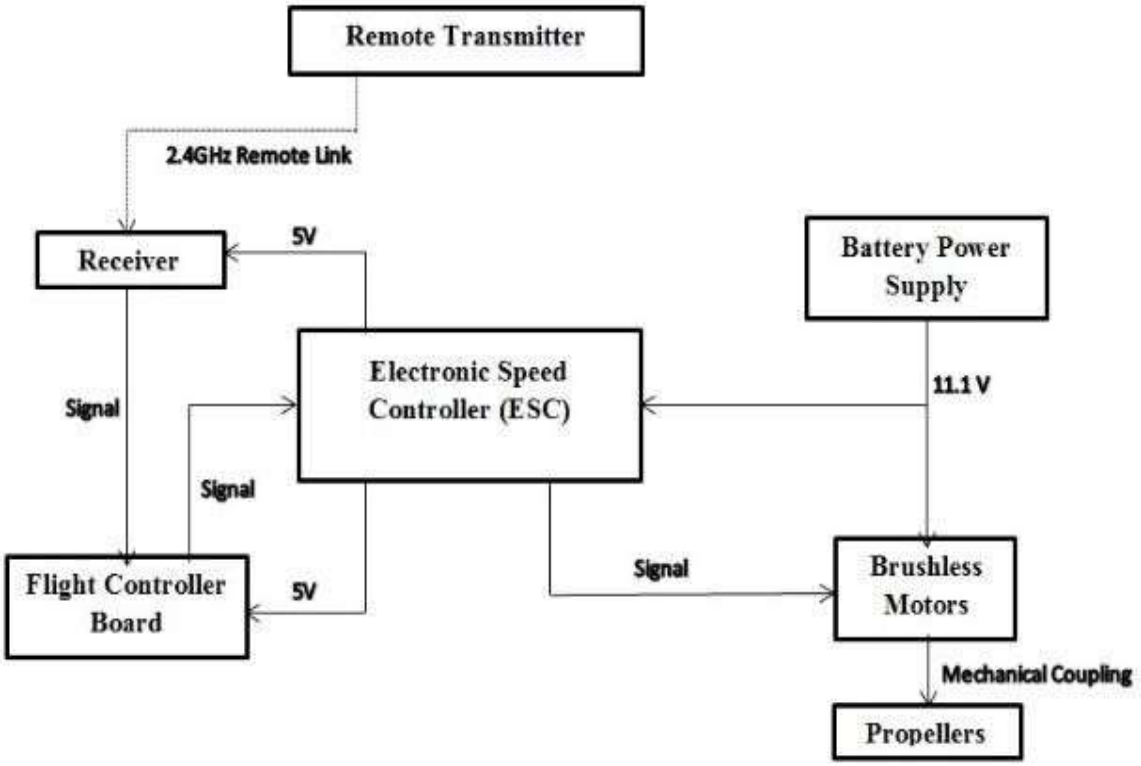


Figure 3: *Block Diagram of Quad copter*

Balance Charger

The IMAX B6 is an advanced multi-function charger, able to charge, balance and discharge Lion, LiPo, LiFe (A123), NiCd and NiMH batteries. It also can be accustomed charge Lead Acid (Pb) batteries. It's a good style of voltage settings for charging varied cell count batteries, further as a zero.1 amp adjustable charge rate of up to five amps. To use this charger.



Figure 4: *Diagram of LiPro Balance Charger*

Flight_Controller
pixhawk 2.4.8
This controller can control fixed-wing aircraft, multi-rotor helicopters, as well as traditional helicopters. It is a full autopilot capable for autonomous stabilization, way-point based navigation and two way telemetry with Xbee wireless modules. Supporting 8 RC channels with 4 serial ports.

It features the latest advanced processor technology from STMicroelectronics®, sensor technology from Bosch® and InvenSense®, and a NuttX real-time operating system, delivering incredible performance, flexibility, and reliability for controlling any autonomous vehicle. Pixhawk 4's microcontroller now has 2 MB of Flash memory and 512 KB of RAM Data-ready signals from all sensors are routed to separate interrupt and timer capture pins on the autopilot, permitting precise time-stamping of sensor data. Newly designed vibration isolation enables more accurate readings, allowing vehicles to achieve better overall flight performance.

The two external SPI buses and six associated chip select lines allow for additional sensors and an SPI-interfaced payload.



Figure 5: *Diagram of Controller*

TRANSMITTER
Avionic RCB OS-10 Transmitter
Drone sender is associate
degree device that uses radio signals to transmit commands wirelessly via a group frequency over to the tuner that is connected to a quadcopter being remotely controlled. In alternative words, it's the device that interprets pilot's commands into movement of the multirotor. In other words, it's the device that translates pilot's commands into movement of the multirotor.



Figure 6: *Diagram of Transmitter*

RECEIVER
Avionic RCB OS-10 Receiver
RC 2.4 GHz receiver is used for the receiving signal which is transmitted from RC transmitter. The receiver is also connected to the flight controller. It is attached to the vehicle. So that it can be receive signal in a certain rang from ground station.



Figure 7: *RC Receiver*

BLDC Motor:
Brushless
DC motor is called electronically commutated motors or synchronous DC motors, high-powered by DC

electricity that produces Associate AC electrical phenomenon to drive every section of the motor via a closed-loop system controller. The magnet winding provides pulses of current to the motor windings that control the speed and force of the motor.
KV: 910kv motor; Weight: 102gm;
Thrust: 1050gm



Figure 8: *Diagram of BLDC Motor*

Brushless ESC
A brushed ESC is used for controlling 12V DC water pump.At the output of ESC water pump is connected.



Figure 9: *Diagram of Brushless ESC to control water pump*

Brushless ESC:
Bushless ESC is used for controlling BLDC motor. At the output of ESC BLDC motor is connected.



Figure 10: *Diagram of Brushless ESC to control BLDC motor*

Propeller
An aircraft propeller, or airscrew, convert's rotary motion from an engine or other power source, into a swirling slipstream which pushes the propeller forwards or backwards.



Figure 11: *Diagram of Propeller*

12V DC Submersible Water Pump:
A submersible water pump is use for spraying water. It is attached to the fertilizer tank. The connection of water pump and brushed ESC is shown in spraying mechanism. By controlling pot on transmitter the speed of water flow is changed.



Figure 12: *Diagram of Submersible Water Pump*

Frame & Chassis
Material Used
1. For chassis 3mm acrylic sheet.
2. For quad copter legs 1*1.5 inch aluminium.
3. For stand c channel aluminium.

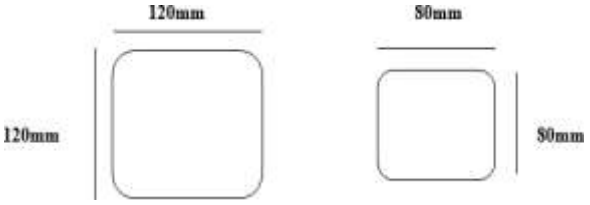
For attaching legs of drone, stand, motor mound 3mm, 4mm & 5mm nut & bolt is used.



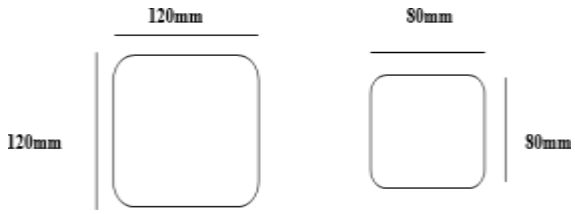
Figure 13: *Diagram of Frame and Chassis*

Dimensions

Base of Chassis-



Drone **sender** is **associate**
degree device that uses radio signals to transmit commands wirelessly via **a group frequency** over to the **radio set**, Legs of quadcopter



SOFTWARE SECTION

Software name- MissionPlanner V1.3.49
Mission Planner is a full-featured ground station application for the ArduPilot open source autopilot project. We use Mission Planner version 1.3.49 .The following window shows Mission Planner Software Flight Data Screen.



Figure 14: *Software name- Mission Planner V1.3.49*

SPRAYING MECHANISM

The spraying mechanism mainly consists of an microcontroller which is programmed to perform various functions. It also contains a tank of 1000ml capacity to which a water pump is connected. To this pump, a splitter is connected that spits the chemical to the 2 nozzles that square measure connected at the 2 opposite ends and spraying is achieved. It additionally contains a motor driver circuit to manage speed of spraying and chemical level indicator circuit with buzzer, for indicating once the chemical is empty.

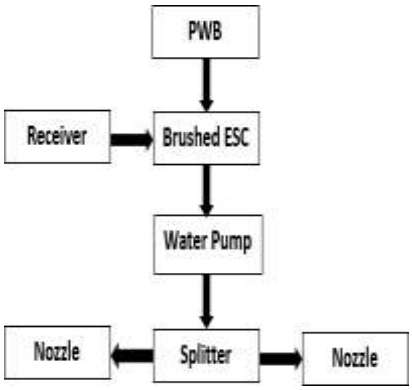


Figure 14: *Flowchart showing spraying Mechanism*

The spraying mechanism performs the following functions.

Pump ON/OFF control: It is used to turn On/Off the water pump which is used to spray. This is done by sending 5V control

signal to the Brushed ESC From transmitter.

Spraying Speed Control: The speed of spraying is achieved by sending a PWM signal to the motor Brushed ESC. Based on the ON time of this signal, speed of spraying can be controlled.

Tank status: The status of the tank will be monitored using water level sensor. If the pesticide level reaches below the threshold, say 25ml in the prototype it can be notified to operator by sending a control signal to the controller which in returnturnson the buzzer. Hence when the buzzer is heard by the operator he can land the quadcopter for refilling.

OVERALL SYSTEM



Figure 15: *Whole system ofAgricultural Fertilizer Spraying Drone with Remote Controller and Autonomous Control with low weight Aluminium Alloy frame Structure*

FUTURE SCOPE

1. weight lifting capacity of the quad copter can be increased by increasing the number of motors or by increasing the propeller size or by increasing the rpm of the motor.
2. Flight time can be increased by increasing the battery capacity.
3. Pesticide carrying capacity can be increased by increasing the size of the tank.
4. Larger area can be covered by using more nozzles which can be arranged in the form of array.
5. Angle of spraying can be controlled for accurate spraying.

CONCLUSION

The main advantage of our drone will be helpful for farmers in spraying fertilizers, pesticides and crop protection products while being controlled by a single person operating from a safe and secure location.

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