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Agro-based Pesticide Spraying Quad Copter using Flight Controller

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***Abstract*— One of the prime sources of income in India is Agriculture., The field of agriculture is depending upon some of factors like pesticides, fertilizers, etc. which can be control by providing proper treatment to crops. Pesticides bot only increase the productivity of crops but also effects on human health. So, the main aim is to use drone for agricultural purpose like spraying pesticides. In this paper, we will discuss different architecture based on drone or UAV technology. The use of pesticides in agriculture is essential to agriculture and it would be easy if intelligent machines such as robots used. This paper gives an idea about technologies used to reduce human efforts in various farm works like spraying of UREA, spraying of fertilizers and pesticides etc. This paper describes design and development of quad copter and the spraying unit mechanism. The discussed system involves designing a prototype which uses simple and cost-effective equipment including BLDC motor, Flight controller ESC units, Battery, Pump etc.**

Keywords*— Unmanned Arial vehicles, Brushless motors, remote sensing, ESC wires, Li-Po Battery.

I. INTRODUCTION

Agriculture in India constitutes more than 65% of occupation. It proves to be crucial part of Indian economy. It is very important to improve the productivity and efficiency of agriculture by using recent technologies. Operations like spraying of pesticides and fertilizer play important role in productivity. Though spraying of pesticides has become compulsory it also proves to be a harmful for the farmers. Farmers specially when they spray urea, have to take to many precautions like wearing appropriate outfit masks and hand gloves. Avoiding pesticides is also not possible as it affects quality of crops. So, use of automation for this problem gives the best of the solution, along with the required productivity and quality of the crops. According to survey conducted by ICMR (Indian council of medical research) it is estimated that every year about 3.5 lakh workers are affected by pesticides from which approximately 18000 died. This project aims to reduce the ill-effect of the pesticides on farmers and also use to spray pesticides over large farm area in short time compare to conventional sprayer. This project is combination of spraying mechanism mounted on quadcopter. This is used to spray the liquid pesticides over the areas that cannot easily accessible by humans.

II. LITERATURE SURVEY

Prof. P. P. Mone and Chavhan Priyanka Shivaji [1] stated application of Agriculture drone for automatic spraying mechanism. In this paper, they gave problem statement of Indian council of medical research where it estimates that there are 3.5 lakh cases of pesticide poisons in each year and up to 18000 deaths, primarily in developing countries. In this paper they also explain what precautions the farmer should have to use to avoid bad effects of pesticides and fertilizing effects as well as cost effective technology using components like microcontroller to control the agriculture robots.

Prof. S. Meivel and Dr. R. Maguteeswaran [2] has implemented of Agriculture wonder drone. They gave details about Quadcopter and sprayer module and also discuss pesticide liquid to the areas that can't easily approach by human beings. They discussed use of cameras which are used to capture images to identify the green field as well as the edges of crop area. Total pay load lift of their quad copter is 8.3 kg. They used QGIS software for the purposed of analyzing the remote sensing images.

Prof. K. B. Korlahalli and Mr. Mazhar Ahmed Hangal [3] stated about implementation of Agro-Drone System. In this paper, the wireless system based on flight-controlled board (FCB), GPS, Brushless DC motor, electronic speed control (ESC), wireless transceiver, frame, propellers and battery. They used flight controller board for controlling the function of drone such as movement, lifting, positioning, etc.

III. FLIGHT CONTROLLER

1. Agro Drone using NAZA flight controller:

The Agro Drone system is designed by using NAZA-M lite flight controller. In given diagram of Agro Drone accelerometer and gyro meter sensors are used to measure accelerations and forces. A gyro meter is used to measure angular velocity, in other words the rotational speed around the tri-axes. There are different parts of transmitter and receiver. In this block diagram the transmitter section consists of signal sampling block which is used for quantization and sampling of signal. Frequency modulator is used for modulation making and filtering which is done by band pass filter. The receiver part consists of battery, ESC controller, motors and nozzle. nozzles have two sections simultaneously remote controller and sprayer controller. The remote controller section is used to control the actuator of sprinkler. The nozzle of sprayer module was get activated by remote controller. Wherever there was a need to activate a pump by RF transmitter remote. Sprayer model contains two modules nozzle and controller module.

2. NAZA flight Controller

It takes the signal from 6050 MPU Acc/gyro (roll pitch/yaw) then passes the signal to NAZA flight controller IC. The NAZA flight controller IC unit processes this signal

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according to user selected firmware and passes control signal to ESC. This signal instructs to make fine adjustment to rotor rotational speed which in turn stabilizes multi rotor craft. Hobby king 2.1.5 multi rotor control board which uses the signal from radio system (RX) and passes the signal to the NAZA flight controller/IC via aileron, elevator, throttle and radar input. Once the information has been proceeded, The IC will send varying signal to ESC in which in turns adjust the rotational speed of each rotor to induce controlled flight (up, down, forward, reverse, left, right and yaw).

IV. OTHER COMPONENTS

Table 1 shows all components used to make drone.

TABLE 1. COMPONENT SHEET

Sr. No.	Component	Specification
1	Motor	BLDC motor, kv (rpm/v) - 1000,power 920w, weight-160gram
2	Propeller (1045)	Material-plastic such as nylon, Hub thickness-0.41 inch, Hub dia-0.8 inch, Shaft dia-0.25-, weight-21 g
3	Battery	Orange li-po battery, capacity-2200mAh, weight-175 gm, output voltage-11.1v
4	Nozzle	Material-PVC, spray area-706m^2
5	Spray unit	Length-30mm, diameter-2mm, voltage-2.5-6 v, power-0.4-105w, weight-28 gm
6	Tank	Material-PVC, Capacity-500ml
7	ESC (Electronic Speed Controller)	Racestar RS 30A lite, input voltage-2.45, weight-8.5 gm, cons. current-20A
8	Power distribution board	Lite Bee, input range (35-45lipo operation):9.18v pc, regulated 5v and 12v output, weight7.5 gm
9	Control receiver	FS-iA6B, range-2.4055-2.475 GHZ, transmitting power-4.0-6.5 vpc, dimension-47X26.2X15 mm

V. DESIGN CALCULATIONS

Two key components to consider:

A. The total weight of quad copter

B. Size of structure of quad copter

At initials stages as we have not finalized weight of quadcopter, we have to assume weight of quadcopter. The total weight generally includes the frame, Flight controller, BLDC motors, ESCs, battery, payload (Sprayer & other). Considering this approximation, the finalization of weight will be only after the selection of all components. To find the optimal propeller size we need to decide maximum frame.

By restricting the size of propeller, we decide to thrust required to lift quadcopter in the air. With respect to this raw data we could select frame with motor – motor distance equal to 450 mm which is sufficient to test all feature required in our project.

1. Total Weight: 1220.9 g = 1.2209 kg

(But for a quad copter to take fight the required thrust is twice the total flying weight). Total weight of all components as listed in table 2.

TABLE 2. WEIGHT CALCULATION

Weight of frame 450 (i.e.)	147 g
(assume as per car model wooden density,650 kg/m^3)	
Weight of one Esc	28g
Weight of battery 2200mah	173g
Weight of one motor 1000kv	57.6g
Weight of flight control board	50g
Other	8.5g
500 ml water	500g

A. Thrust power required

= (1220.9*2) = 2441.8g

Total Thrust :2.4 kg

B. Power of the motor is indicated in the motor itself,

P =37 W

2. Current:

By Ohm's Law,

I =P/V= 37/11.1 = 3.3Amp.

There are 4 propellers used so (4*3.3) =13.2 Amp.

3. Battery Runtime:

The duration for which we can extract current from battery (with respect to battery capacity and current consumption).

T = (C/I) *60

T = (4/13.2) *60

T =18.18 Min. (Variable as per current requirement)

4. Propellers:

Motor thrust calculation with 1045 propeller.

Here,

1 motor gives thrust = 800 grams

= 4 motor * 800 g

= 3200 g

Thrust for 4 motors = 3.2kg

5. Dimension Quad-wooden frame:

For smaller frame size i.e. smaller propeller size, smaller motors and lower weight. Vice versa, to carry higher weight of nearby 2 kg, we referred the motor thrust data to ensure that the current drawn does not exceed the safety rating of the motor when attaching the propellers that you we want for our quadcopter.

We referred the tabulated data that has been compiled based on the assumption that we are using 3S LiPo batteries. According to our cad model & quad DMU that we have designed as per the assumptions, frame dimension we have used as 450, considering flight controller size and other stuff like water container on the top of drone.

VI. CAD MODELLING

Figure 1 shows cad model done on Catia V5 R12 software shows assembly of all components with Frame, include BLDC Motor, Propellers, Battery, Fluid tank.

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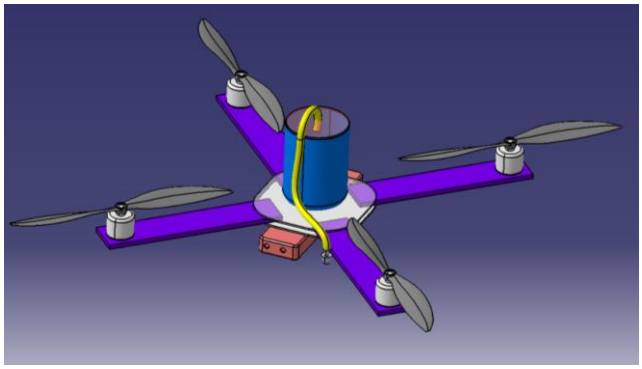

Fig. 1. Assembly of quad copter with spraying mechanism

VII. ANALYSIS

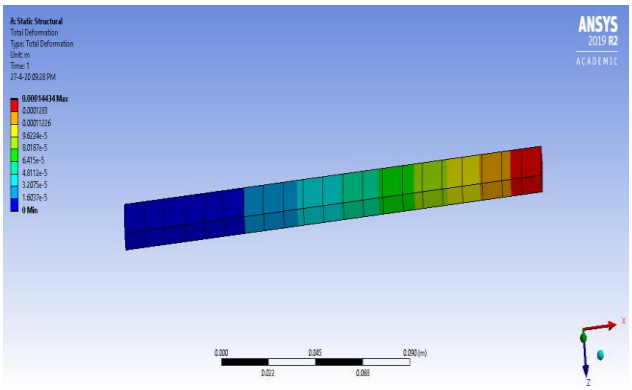

Fig. 2. Deflection analysis of frame member

Figure 2 shows Ansys result of deflection of frame member was done by using Ansys 2019 R2 and got maximum deflection is 0.00014434 m.

VIII. TESTING, EXPERIMENTATION AND RESULTS

Fig. 3. Flying test of drone

Figure 3 shows flying test with actual model of drone, consist of 3 basic tests are as follows.

Test 1- First flight test has been conducted on drone with battery 100% charged. The flight initially wasn't sufficient as thrust provided by propeller equally. With modification of direction in BLDC Motors error was eliminated with proper connection.

Test 2- Drone is well stable and working well. But fluid spraying mechanism not working. By making some circuit connections issue been solved.

Test 3- Test has been successful .max altitude achieved is 13ft, on 100% battery charge drone run for 17 minutes.

- Drone-controller

A. Right Stick

The roll and pitch of the quadcopter is controlled with right stick, that allows it to move right/left as well as forward and backward.

B. Left Stick

The yaw and throttle of the quadcopter is controlled with left stick, that allows it to control the height at which it flies and rotate the drone clockwise or counterclockwise in flight.

C. Trim Buttons

If you notice your drone tilting toward one direction when you first start flying this probably means it needs to be trimmed. You can use the corresponding trim button to correct the balance as needed.

The Agriculture drone has the potential to improve the crops. Agriculture Drone can help the farmers to transform the agriculture industry. With use of mechanical hand pumps for spraying pesticide, labor take large amount of time to spray the crops and they don't uniformly spray the pesticides could not achieve uniform spraying. But by using drone we can achieve uniform spraying work in less amount of time as compare to human. With normal wage around Rs. 200 to 500/- per day for pesticides spraying, the drone takes 3 watts of power then it will charge 20/- rupees of electricity. Drone will uniformly spray the fertilizers, hence there is equal and possible chance for plant growth. This will reduce the time consumption and also it will reduce the diseases caused by chemicals to the human body such as skin diseases as per the research of World Health Organization. Hence, drone will minimize the efforts of farmers for agriculture purpose.

IX. CONCLUSION

Agro-Drone system using flight Controller is best compatible design for Drone system for Agriculture purpose. Some of the advantages and disadvantages along with existing implementation was discussed. This paper, concludes that if the system is designed with the use of NAZA flight controller makes it as more efficient implementation. The experimentation and expected result also discussed for further implementation.

From experimentations it was concluded that, as drone can achieve max 13ft height, and can be run for max 20 min at 100% battery.

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