for an Agricultural Application

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Abstract__ *In this paper a technique is presented for design and fabrication of quadcopter for an agricultural application .Pesticide spraying tank has been attached with this quadcopter. As pesticides are not only harmful to the insects but also to the human beings. The pesticides affect the nervous system and lead to disorder in human beings. An Unmanned Aerial Vehicle (UAV) can be used to spray the pesticides and fertilizers which will reduce risk to human involved. Therefore this project is about design and fabrication of quadcopter with spraying unit used for agricultural purpose. This will give an upper hand of faster land coverage due to the speed of the UAV and also reduce the wastage of pesticides. This method is relatively reduces the effort of humans involved and cost effectiveness. However, some factors may reduce the yield, or even cause damage such as crop area not covered in spraying process, over lapping spraying etc. which is also common in manual spraying. The design methodology will be based in the load carrying capacity of the UAV and spraying unit. Fabrication and testing of a Radio Controlled (RC) Quadcopter will be carried out.*

Keywords: **Pesticides, Quadcopter, spraying unit, unmanned aerial vehicle (UAV) etc..**

I. INTRODUCTION

Quadcopter, also known as quadrotor, is a helicopter with four rotors. The rotors are directed upwards and they are placed in a square formation with equal distance from the centre of mass of the quadcopter. The quadcopter is controlled by adjusting the angular velocities of the rotors which are spun by electric motors. Quadcopter is a typical design for small unmanned aerial vehicles (UAV) because of the simple structure. Quadcopter are used in surveillance, search and rescue, construction inspections and several other applications. The basic dynamical model of the quadcopter is the starting point for all of the studies but more complex aerodynamic properties has been introduced as well. Different control methods has been researched, including PID controllers, back stepping control, nonlinear H1 control, LQR controllers, and nonlinear controllers with nested saturations. Quadcopter generally use two pairs of identical fixed pitched propellers; two clockwise (CW) and two counter clockwise (CCW). These use independent variation of the speed of each rotor to achieve control. By changing the speed of each rotor it is possible to specifically generate a desired total thrust; to locate for the centre of thrust both laterally and longitudinally; and to create a desired total torque, or turning force. Quadcopter were seen as possible solutions to some of the persistent problems in vertical flight. Torque-induced control issues can be eliminated by counter-rotation, and the relatively short blades are much easier to construct.

For an agricultural purpose, a small tank is being attached to the quadcopter for carrying the pesticides. The tank is incorporated with the spraying unit for spraying the pesticides. The spraying unit works with the help of the motor and pumps. Pump is used to generate a pressure to suck the fluid which is in the tank and nozzle is used to spray the on to the field.

II. LITERATURE REIVEW

Teresa Donateoa et al…[1] in this survey paper conveyed that; Design and performance evaluation of a hybrid electric power system for multicopters we to investigate addresses the problem of designing a hybrid electric multicopter and comparing its endurance in electric and thermal power systems. The design and the comparison were performed by assuming a target mass for two different multicopters: a quadcopter (11.2 kg) and a hexacopter (16.8 kg). For the smaller multicopter, the best endurance was obtained with the thermal power system whereas the series hybrid electric appeared to be more advantageous for the hexacopter. The hybrid power system improved the endurance with respect to the electric power system for both the quadcopter and the hexacopter. However, it performed worse for the quadcopter where the highest endurance was obtained with a thermal power system. However, the results strongly depend on the size of the chosen components, on the threshold for the SOC and on the battery charging power.

Manuel Ramsaier et al..[2] in his paper explains a novel approach towards a digital design life-cycle. This approach features the application of graph-based design languages on the basis of the unified modeling language UML. The key advantages of this methodology are fewer interfaces between modelling and simulation tools and a standardized, consistent language which avoids discrepancies in form and content throughout the models in engineering processes. The feasibility of this approach was demonstrated on the example of a quadrocopter. Obviously, further research is necessary and planned in order to underline the feasibility of the approach and to detail and further improve this approach.

James T. Luxhøj et al..[3] in his survey he explains Precision Agriculture (PA) is an innovative trend in farm management. The integration of UAS for precision agriculture applications offers significant benefits; however, the safety risk needs to be understood and managed. The ASRM PA notional scenario provides a systems-level framework for the integration of socio-technical hazards related to the UAS, the crop duster, operations and the environment. Geo fencing or establishing a “virtual barrier” in the sky, offers one mitigation strategy in the avoidance of mid-air collisions. Preliminary ASRM results suggest that the geo fencing mitigation is effective in this notional scenario.

E.G. Hernandez-Martinez et al..[4] Conveyed I his paper presents a hierarchical two-level control scheme for the trajectory tracking of the quadcopter UAV. In the posture control, a change of variables is designed to generate the desired values of the angles and the main thrust force for the orientation control. The control laws do not use some approximation of the original nonlinear dynamics of the vehicle. The parameter gains are selected according to the LQR method in order to increase the settling time and reduce the magnitude of inputs in order to save energy.

Diego Domingos et al..[5] in his paper explains the use of an advanced adaptive fuzzy control approach and compared its performance against Mamdani like fuzzy controllers. More precisely, the paper has investigated the performance of a self evolving parameter free rule based controller to control a quadcopter during a complex mission. Simulation results show that the autonomous evolving approach achieves superior performance, especially in stabilization and navigation under unpredictable environment disturbances simultaneously with parameter variations

III. DESIGN

A. *Frame selection*:

The aluminium material is used for this X-configuration quadcopter. It is strong, light ad easiest to repair of all the frames. Because the pieces are made of flat aluminium, even if crash it really hard, it just gets bent, you can flatten it back out with hammer.

The opted Multicopter configuration is a Quadcopter, due to its simplicity and high maneuverability. In Quadcopter the opted configuration is X, due to its orientation simplicity and cost effectiveness. Intuitively, in the 'X' configuration, the pitch and roll axes both have two counter-rotating propellers each, on each side. It justifies "X" configuration has a greater manoeuvrability and simplicity compared to "+" configuration. In case if heavy lifting is required then Octocopter may be opted. Configuration of the quad copter is shown in fig: 1.

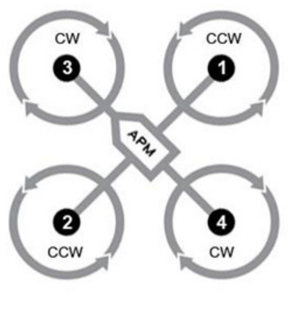

Fig1. Configuration of quadcopter

B. *Components*

1. Aluminium frame
2. Brushless DC motor(A2212)-1000kv
3. Electronic Speed Controller(ESC)-30A
4. Propeller-10"x4.5
5. LipoBattery-3000mah
6. Flight controller
7. Transmitter & Receiver
8. Pump 12V DC
9. Pesticide tank
10. Arduino board

C. Spray tank design

The sprayer unit consists of a 12V DC Pump, Pesticide/Fertilizer Tank and Nozzle. The 12V DC Pump is used to generate a pressure to suck the fluid which is in the tank and nozzle is used to spray the on to the field. The specification of the sprayer unit is as follows:

1.Specifications

- Rated voltage: DC 9V
- Size- 14*6cm
- Noise:<60db
- Rated Current:<150mA
- Water Flow: 0.4-0.7L/ min
- Operation Temperature Range: 5-45℃
- 350ml tank
- 0.4mm Nozzle

IV. FABRICATION

A.Frame

Aluminium frames of equal size has been attached to the centre plate. Quadcopter frames come in a variety of sizes and weight ratings. Most have the same basic appearance – a vague X shape. The centre plate doubles as a power distribution board which tidies things up quite a bit and allowed me to get rid of my ugly DIY wiring harness.

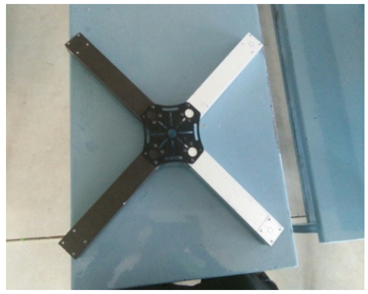

Fig2. Frame setup of quadcopter

B. Brushless DC motor

Brushless DC electric motor (BLDC motors, BL motors) also known as electronically commutated motors (ECMs, EC motors) are synchronous motors that are powered by a DC electric source via an integrated inverter/switching power supply, which produces an AC electric signal to drive the motor.

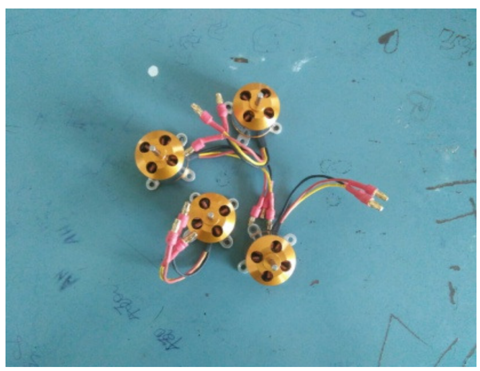

Fig3.Brushless motor

C. Propeller

Quadcopter there arises the need of two types of propellers to need the purpose of flight. A pair of clockwise (CW) and anticlockwise (ACW) propellers is needed. The care should be taken in finalizing the dimensions of the propellers. A propeller is a type of fan that transmits power by converting rotational motion into thrust. A pressure difference is produced between the forward and rear surfaces of the air foil-shaped blade, and a fluid (such as air or water) is accelerated behind the blade. Propeller dynamics can be modelled by both Bernoulli's principle and Newton's third law. Also the pitch can be defined as the travel distance of one single prop rotation.

Fig 4.Propellrs

D. Electronic speed controller

As shown in fig: 5; The electronic speed control, or ESC, is what tells the motors how fast to spin at any given time. You need four ESCs for a quadcopter, one connected to each motor. The ESCs are then connected directly to the battery through either a wiring harness or power distribution board.

The ESC controls the speed of an AC motor with frequency, not voltage. If 11.1 volt battery plug into your power system, 11.1 volts going to the motor with the full amperage potential of the battery backing that voltage. The AC brushless motors we use are true 3-phase AC motors. The motors DC run on AC current. The speed of the motor has nothing to do with voltage or amps. By increasing and decreasing the wave length (frequency) of the trapezoidal wave on the 3 phases, the ESC causes the motor to spin faster and slower. The ESC switches the polarity of the phases to create the waves. This means that the voltage through any given winding flows 'Alternately' one direction then the other. This creates a push-pull effect in magnetic field of each winding, making the motor more powerful for its size and weight. The motor and the load that is placed on it, is what determines the amp draw from the ESC and the battery.

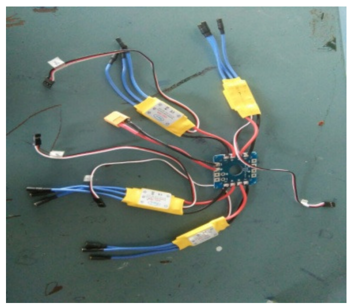

Fig 5.Electronic speed controller

E.Flight controller

The brains of the quadcopter is the flight controller. The flight controller is basically the little computer which controls the craft, and interprets the signals the transceiver sends to guide the quadcopter. For builders of quadcopter, choosing a flight controller is more of a personal choice in many ways, not unlike choosing from various PC processors in the same power range. Each have various options that each manufacturer wants and may or may not be customizable. If this is something that needs to be fixed, start reading the forums and listen to hobbyists who recommend affordable, reliable controllers which work with most components easily Flight controller is shown in fig: 6.

Fig 6.Flight controller

F.Transmitter & Receiver

As shown in fig: 7 Fly sky Transmitter and Receiver which we are using is CT6B which has 6 channels. It Requires a PC to change the channel variables, mixing and servo reversing. The radio transmitter and receiver allow you to control the quadcopter. There are many suitable models available, but you will need at least four channels for a basic quadcopter with the CC3D control board. In electronics and telecommunications a radio transmitter is an electronic device which, with the aid of an antenna, produces radio waves.

Fig 7.Transmitter&Receiver

G.Sprayer unit

The sprayer unit consists of a 12V DC Pump, Pesticide/Fertilizer Tank and Nozzle. The 12V DC Pump is used to generate a pressure to suck the fluid which is in the tank and nozzle is used to spray the on to the field. The pump is run with the 9V battery.

V. RESULT

The components like motor, electronic speed controller, flight controller, battery and the receiver are attached to the aluminium frame which is fitted with the Arduino plates. The basic setup as shown in fig.8.

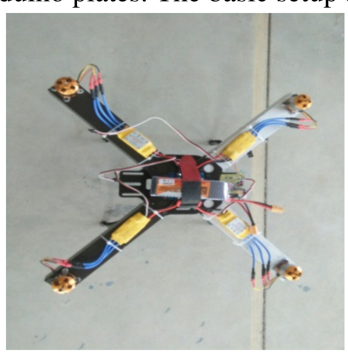

Fig 8.Basic setup

The landing gear is also attached to the quadcopter for the safety and proper landing purpose. The complete setup off the quadcopter without the spraying unit is shown in fig.9.

Fig 9.Complete setup

Right after building the quadcopter the ESC calibration is to be done and whenever we suspect that the speed of the motors are not correctly balanced. It aims to make the speed controllers react in the same fashion to the APM and to the RC commands. Automatic calibration is the easiest way to perform it, since it is just necessary to hear the tones emitted by the APM and move the remote sticks1 as a consequence.

The sprayer unit as shown in fig: 10 and fig:11 is fixed to the quadcopter , as the capacity of the pesticide tank is about 350ml and the battery which is in the quadcopter will function up to 10-15mins. This model will help in spraying the required region.


Fig 10.pesticide Tank **Fig 11.Pump**

VI. CONCLUSION

This paper was about design and fabrication of multicopter with spraying unit used for agricultural purpose. This gave an upper hand of faster land coverage due to the speed of the UAV and also reduced the wastage of pesticides. This method relatively reduced the effort of humans involved and cost effectiveness. However, some factors may reduce the yield, or even cause damage such as crop area not covered in spraying process, over lapping spraying etc. which is also common in manual spraying. The design methodology was focused on the load carrying capacity of the UAV and spraying unit. Fabrication and testing of a Radio Controlled (RC) Quadcopter was carried out.

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