Aerial Agricultural Quadcopter

The Change to Master Pesticide Dispersion

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***Abstract*—Quad copter are the unmanned air vehicles and these are playing a predominant role in different areas like surveillance, military operations, fire sensing and some important areas having many complexities. Drone technology could help farmers around the world fend off pests, improve land tenure and more. Since this Quad copter is amphibious we specially designed an unconventional frame for pesticides dispersal. Quad copter frame will sustain the strength of whole body and carry the load.**

I. INTRODUCTION

A Quad copter is a rotorcraft with more than two rotors. Multi rotors often use fixed-pitch blades, whose rotor pitch does not vary as the blades rotate; control of vehicle motion is achieved by varying the relative speed of each rotor to change the thrust Here we used 'X' configuration rotors. These vehicles use an electronic control system and electronic sensors to stabilize the aircraft. Using receiver and transmitter system (2.4GHz) the drone is controlled. Drones in agriculture can be used for a variety of task, aimed to increase farm crop yields and accurately monitor fields, simultaneously decreasing time, labour and resources. In terms of growth, the residential sector for civil applications
This presents annual growth forecasts of 19%, compared with the modest 5% of the civilian/defence sector. Within the civil aviation cluster, the technological applications in agriculture consist of:

• Environmental monitoring (detection of fires, presence of weeds);
• Development of chemical and biological treatment applications.

A. Abbreviations and Acronyms:

DRONE-Dynamic Remotely Operated Navigation Equipment
ESC-Electronic Speed Controller
UAV-Unmanned Aerial Vehicle
BLDC-Brushless Direct Current Motor
FAA-Federal Aviation Administration
RFRT- Radio Frequency Receiver & Transmitter.

These Quad copter are classified into two types micro air vehicle and mini air vehicles this classification mainly depending on the size and weight of the Quad copter. Each rotor has its own significance in creating thrust, torque and direction.

II. PROJECT OVERVIEW

• To devise Quad copter for application in agriculture, extent.
• To design and fabricate a concerned base tank for fluid dispersal.

III. DESIGN GOALS

1. Optimized Quad copter for efficient purposes.
2. Tank setup assigned with Quad copter
3. Conceptually simple and minimalistic in design.
4. Safe in operation.
5. Adequate balancing in direction and orientations.
6. Organized sprayer module for pesticide exposure.

1) *Color/Grayscale figures:*

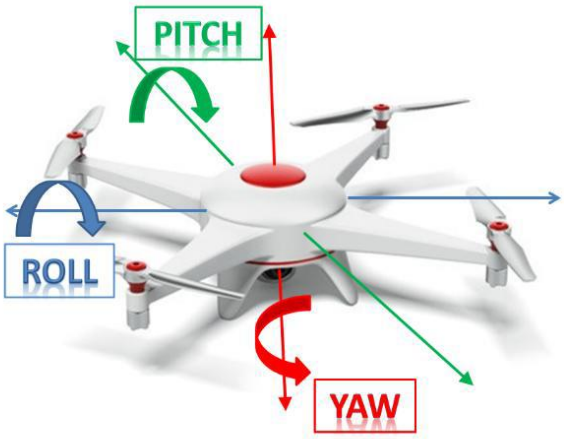

Fig 1-Direction of Pitch, Roll and Yaw moment

2) *Performance Graph*
The graph shows us the Performance of an Quad copter about Thrust Vs Angular velocity(rpm)

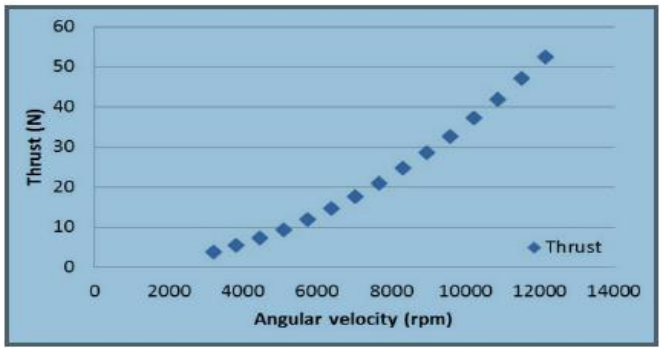

Fig 2-Thrust Vs Angular velocity

This graph depicts the relationship between the Angular Velocity of the D.C.Brushless Motor and Thrust developed by the Motor. Increase in the amount of Angular Velocity increases the thrust developed by the Quad copter.

2.1) Structural Analysis:

S.NO	MATERIALS	CONSTRAINTS	QUANTITY
1.	Brushless D.C. Motor	2200kv	4
2.	Electronic Speed Controllers(ESC)	30A	4
3.	Propellers	10*4.5	4
4.	Battery(Li-Po)	2000mAh	1
5.	R.C.Receiver & Transmitter	2.4GHz	1
6.	Flight Controller	Kk 2.1.5	1
7.	Frame(calculated Dimensions)	15cm(each arm)	4
8.	Base Setup for Dispersals	2litre capacity	1

Table 1: Material and its constraints

Based on the approximate weight of the Quad copter, the appropriate motors and corresponding electronic components were selected.

3) COMPONENTS USED:

3.1) Brushless Motor: Brushless motors give the 1:1 speed ratio. In quad copter four rotors with brushless motors are used to get high efficiency for less power and low weight.2200kv brushless motor used for this product.

3.2) Propeller: Propellers are used to generate the thrust for the quad copter hover or lift. These are in different variants which are classified based on their diameter and pitch by which they travel. To create maximum thrust we use to have two "standard rotation" and two "right hand rotation" propellers.

- **Pushers:** Pushers give thrust when they are rotated in clockwise direction
- **Pullers:** Pullers give thrust when they are rotated in anti-clockwise direction.

When using low RPM motors the larger propellers can be used as there could be trouble with the small ones not being able to lift the Quad copter at low speed. The size of propellers is given as 10*4.5.

3.3) Electronic Speed Controllers: Electronic speed control converts the available 2 phase battery current to the 3-phase power and also regulates the speed of brushless motor by taking the signal from the control board. Electronic Speed Controller (ESC) is an electronic circuit to vary the speed, direction and possible to act as a dynamic brake, of a brushless Motor. The maximum current flowing in the ESC is in between the range 30-40 ampere.

3.4) Lithium Polymer Battery: It is a constraint of weight so we use a lithium polymer battery in which hi power due to that reason we use these batteries for these micro air vehicles. These are available in different variants from 1000mAh to 10000mAh.

3.5) Receiver and Remote Control: These Quad rotors are controlled by using a 2.4 GHz transmitter and the receiver has been connected to control board. Some of the unique features of this radio are ● Interchangeable from mode 1 to mode 2 with the use of a Slider at the back of the radio
● Remote range test
● Variable transmission power

3.6) Flight Controller: The flight control board is the "Brain" of the Quad copter. It houses the sensors such as gyroscopes and accelerometers that determine how fast each of the Quad copter's motors spin. Flight control boards range from simple to highly complex. This Flight controller KK 2.1.5 is the latest one and program is pre-installed in it. The flight control board is regarded as the "Brain" of the Quad copter. Flight control boards range from simple to highly complex.

B. DIRECTION ORIENTATION

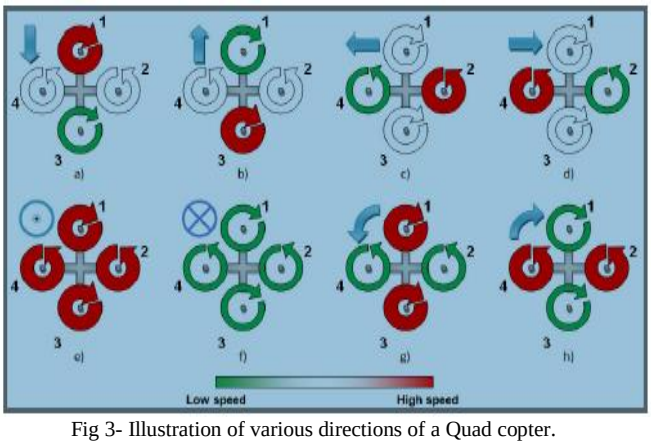

Fig 3- Illustration of various directions of a Quad copter.

This aim for fixed pitch rotors are used to control the vehicle motion. The speeds of these four rotors are independent. By independent, pitch, roll and yaw attitude of the vehicle can be control easily. Pitch, roll and yaw attitude off Quad copter are shown

- **Yaw Motion (ψ):** Rotation around the vertical axis is called Yaw. The Rudder controls Yaw (Left and Right).
- **Pitch Motion (ɵ):** Rotation around the side-to-side axis is called Pitch i.e. Moving Upside and Downside about horizontal axis. The Elevator controls the Pitch.
- **Roll Motion (Φ):** Rotation around the front-to-back axis is called Roll i.e. tilting about the axis. The Ailerons controls Roll axis (Left and Right).

C. *GRAPHICAL VIEW*

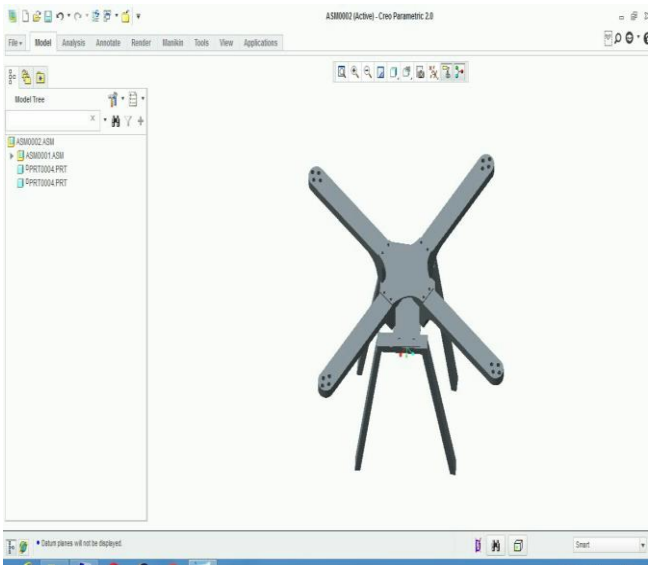

Fig 4 Orthographic view of Aerial Agricultural Quad copter

D. *CONSTRUCTION:*

Quad rotor consisting of a main body having four arms centrally connected to each other and four DC brushless motor attached to each free end of arm. Quad rotor consists of four rotor/propeller attached to each motor shaft. Four rotors with fixed angles represent fixed pitch to generate equivalent force at each end to lift the body and payload. All DC brushless motors are attached to electronic speed controller to control speed of each individual motor. Four electronic speed controllers connected with each other by parallel connection in to power distribution board. A battery is used as power source. The rotation of propeller is controlled by remote controller (RC).Power distributed to power distribution board from battery. Accelerometers will measure the angle of Quad rotor in terms of X, Y and Z axis and accordingly adjust the RPM of each motor in order to self-stabilize by it. The stability is provided by setting the direction of rotation clockwise of one set of opposite motors and counter-clockwise of other set of motors which nullifies the net moment and gyroscopic effects.

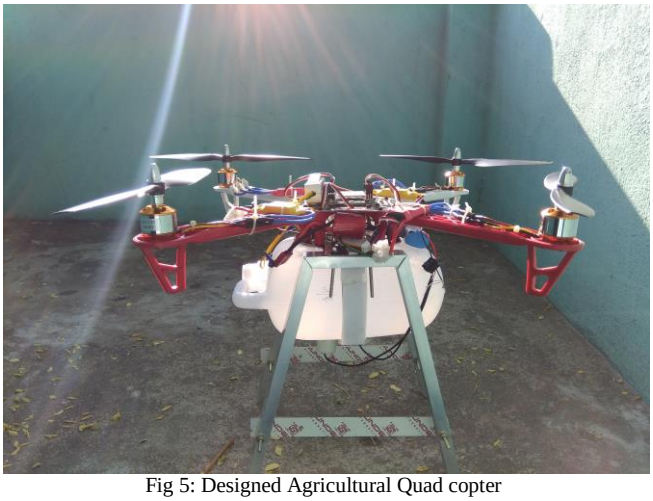

Fig 5: Designed Agricultural Quad copter

E. *WORKING*

Quad copter is a device with an intense mixture of Electronics, Mechanical and mainly works on the principle of Aviation.

I. CONTROLLING FEATURES:

1. **Take-off and Landing motion mechanism** Take-off is movement of Quad copter that lift up from ground to hover position and landing position is versa of take-off position. Take-off (landing) motion is control by increasing (decreasing) speed of four rotors simultaneously which means changing the vertical motion.
2. **Forward and Backward motion**: Forward (backward) motion is control by increasing (decreasing) speed of rear (front) rotor. Decreasing (increasing) rear (front) rotor speed simultaneously will affect the pitch angle of the Quad copter.
3. **Left and Right motion:** For left and right motion, it can control by changing the yaw angle of Quad copter. Yaw angle can control by increasing (decreasing) counter Clockwise rotors speed while decreasing (increasing) clockwise rotor speed.

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F. *REQUIREMENTS AND REASONS FOR SELECTION OF THIS DESIGN*

There are many requirements that need to be met to produce a product that is both feasible and optimal. There are also some constraints, both geometric and engineering that also need to be satisfied. The following list describes these requirements and constraints. The WHO (World Health Organization) estimates there are more than 1 million pesticide cases in every year. In that more than one lakh deaths in each year, especially in developing countries due to the pesticides sprayed by human being and handling of pesticides. The health effects of pesticides include asthma, allergies and hypersensitivity, and pesticide exposure to cancer, hormone disruption and problems with reproduction and baby development. Other pesticides may be irritated the skin and eyes. More pesticides are very dangerous carcinogens

• Optimization of treatments with fertilizers, with a possible overall reduction of 20-40% in terms of overall distributed products;

• Reduction and prevention of water waste, reducing the use of water resources (water consumption will be reduced in some cases up to almost 90%);
• Reduction of labor and material costs;
• Reduction of pollution in the UAV powered by electric motors;
• Reduction of risks through the automatic analysis of the state of the crop production processes on the field supplemented by prevention activities.

G.FLIGHT TEST

The Quad copter was put to test flight to see its performance on Takeoff, Landing, Pesticide Spray and transmission to ground station, time of flight on fully charged batteries and following results were obtained in the Transmitter for which the Flight Test is conducted. All the Configurations made are through the FLYSKY CT6B Software which should be given manually and it is shown in the below diagram.

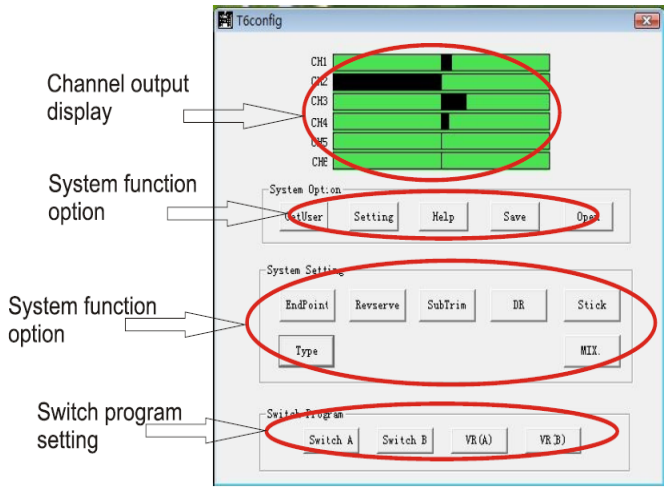

Fig 6: Transmitter Configuration for Flight.

1. A maximum controllable height of approximately
5 meters was achieved
2. Maximum flight time was 15 minutes under normal operating conditions.
3. Six degrees of freedom was achieved. Rolling motion was partially achieved.
4. The vehicle was able to spray pesticides successfully within its range of its controllable height of 2 meters.
5. The Quad copter was able to successfully land and takeoff from water, it's stability on water surface was satisfactory.

IV. CONCLUSION

Integration of components is not a straightforward task due to a lack of an integrated theory, application is challenging since it requires expert knowledge in aerodynamics and control theory, and the commercial development of heavy lift drones it is still today limited to few companies, often with export limitations on aircraft and sensors (i.e. frequency of IR sensors) due to military implications. Nonetheless it is possible, using simplified theories on standard configurations (X or Y design), to develop optimize and the design of heavy lift UAVs for agricultural use with significant performance in terms of payload and flight envelope.

ACKNOWLEDGMENT

FLYSKY FS-CT6B Productions wishes to acknowledge and other contributors for developing, operating and bringing improvements in working of AERIAL AGRICULTURAL QUADCOPTER.

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