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SMART AGRICOPTER

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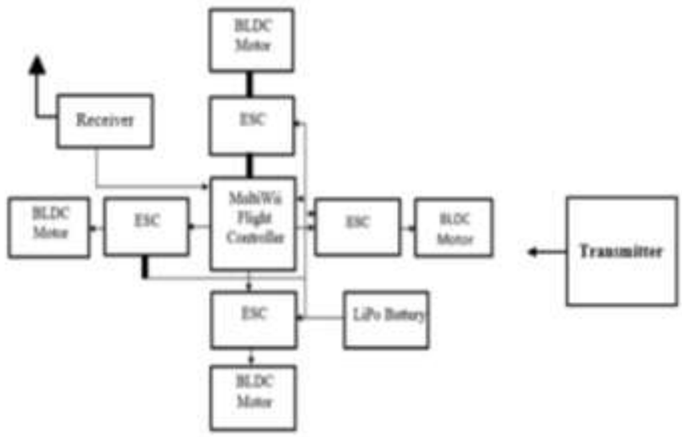
Abstract - *Agriculture in India constitutes more than 60% of occupation. It serves to be the backbone of Indian economy. It is very essential to improve the productivity and efficiency of agriculture by providing safe cultivation methods. The various operations like spraying of pesticides and sprinkling fertilizers are very important. Though spraying of pesticides has become mandatory it also proves to be a harmful procedure for the farmers. UAV (Un-maned Aerial Vehicle) proves to be an alternative method which in turn overcomes the ill-effect of the pesticides on human beings and also is used to spray the pesticides over larger areas in short interval of time as compared to conventional spraying methodology. In this project, a quadcopter which is designed in a X configuration is used to spray the harmful pesticides over the crops. The X configuration is used to provide better stability to the entire body of the quadcopter. The design of the quadcopter is basically a combination of spraying mechanism on a quadcopter frame. The main aim is to develop a strong and highly reliable drone which having capabilities of lifting weight. The drone should also able to transmit live data steaming to ground station over some kilometers distance. The alternate motive of this project is to use this drone in agricultural use such as pesticides spraying/mapping, farm surveillance*

***Key Words:* Quadcopter, pesticide spraying, Drone, agriculture, UAV.**

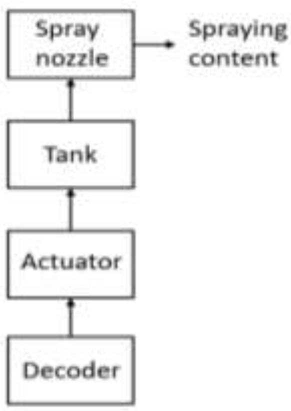
1. INTRODUCTION

Over the last few years, massive growth is seen in the production and sales of Unmanned Aerial Vehicles (UAV). These Unmanned Aerial Vehicles have four arms and fixed pitch propellers which are set in an X or + configuration with X being the preferred configuration because the weight gets equally distributed resulting in increased efficiency and stability. In the standard format two propellers will spin in a clockwise direction with the other two spinning in an anticlockwise direction allowing the craft to vertically ascend, hover in the air and fly in a designated direction. UAVs are made by adding four motors and four propellers to a lightweight frame constructed of light wood, carbon fiber or fiberglass, then connecting it to a remote-control transmitter via a small control board fitted with a gyroscopic stabilization system and connected to a Lithium polymer (Lithium) battery. Quadcopters differ from conventional helicopters which use rotors which are able to vary the pitch of their blades dynamically.

1.1 System Block Diagram:



1.2 Spraying unit Block Diagram:



2. WORKING

There are 4 motions in quad copter viz. Throttle, Pitch, Roll, Yaw. These motions are controlled by the help of a radio control transmitter. The transmitter transmits the data to the receiver which is placed over the quad copter. The receiver then sends the data to the flight control board which is Naze32 flight controller. The flight controller has an inbuilt microprocessor that manipulates the signals received and give suitable commands to the BLDC motors through the Electronic speed controller (ESCs).

After the command is received, the motors act according to the signal transmitted by the remote and continuously checks the orientation and motion of quad copter by using gyroscope and accelerometer sensor which are inbuilt in the flight controller. Data given by the sensors are compared with the previous data which is stored in the flight controller and finds the error. Accordingly, the signal is generated and throttle is created by rotating all 4 rotors at the same speed. An + pitch (forward motion) is created by rotating the 2 rear rotors at greater speed compared to the front rotors whereas for negative -pitch (backward motion) the front rotors have higher speed than rear rotors. +Roll is created by rotating the left 2 rotors to rotate at a higher speed than the right rotors for the right turn and vice versa for the left turn. Yaw action is created by rotating the diagonally situated rotors moving with the same spin to rotate at a greater speed than the other two.

3. CALCULATIONS

Thrust to weight ratio: 2:1
Total weight = 1.6 Kg, therefore total thrust should be 3.2 Kg i.e. 800 g per motor
Spraying unit:
Tare weight: 60 grams.
Liquid Capacity: 540 grams (540 ml)
Total spraying unit: 600 grams

3.1 Thrust Calculations of Drone:

General required thrust is given by,

Thrust required = (total weight of setup) × 2

Therefore, according to the frame, ESC, battery and other setup we are getting a weight of 1.6 Kg.

Required Thrust = 1600×2 = 3200

therefore for 1 motor thrust = 3200/4=800 grams

Here required thrust for each motor is 800 grams.

3.2 Vertical climb and Horizontal speed:

Area of Drone (A) = $\frac{1}{2} * (MTM)^2 + 3 \prod (Rprop)^2$

Where,

MTM = Motor to Motor distance (450 mm = 0.45 m)

R prop = radius of propeller (0.114 m)

$$A = \frac{1}{2} * (0.45)^2 + 3 \prod (0.114)^2$$

$$A = 0.225934 \text{ m}^2$$

Vertical climb rate= $\sqrt{((2 m*g0)/(Cd*A*\acute{\rho}))} * \sqrt{(Tr-1)}$ m/s

Where,

m = mass (weight of drone i.e. 1.6 Kg)

g0 = gravity of earth (9.81 N)

Cd = drag coefficient (1.3)

A = top area of quadcopter (m^2)

$\acute{\rho}$ = density of air (Kg/m^3)

Thrust = 800 g per motor

Tr = Thrust ratio (800*4/1600 =2) for calculation 90% of peak thrust is considered i.e. 1.8

$$V = \sqrt{((2*1.6*9.81)/ (1.3*0.225934*1.2))} * \sqrt{(1.8-1)}$$

$$V = 8.44 \text{ m/s}$$

Horizontal speed = $\sqrt[4]{1-1/Tr^2} * \sqrt{(2*m*g0)/(Cd*A*\acute{\rho})} * Tr$

$= \sqrt[4]{1-1/1.8^2} * \sqrt{(2*1.6*9.81)/ (1.3*0.225934*1.2)} * 1.8$

Speed (hor) = 15.49 m/s

3.3 Flight time:

Average ampere drawn (AAD) = AUW * P/V

Where,

AUW = all up weight

P = power to carry 1 Kg weight

V = voltage

AAD = 1.6 * 170/11.1

AAD = 24.50 A

Flight time = Battery capacity * battery discharge / AAD

Flight time = 3.3 * 0.8 / 24.50

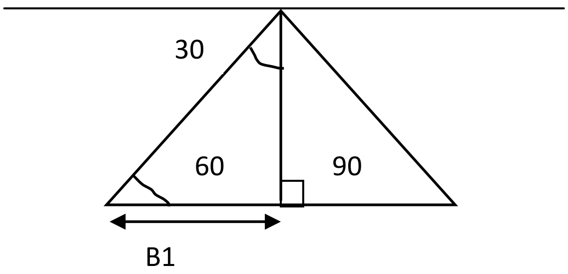
Flight time = 0.1077 hour * 60

Flight time = 6.46 min

3.4 Spraying unit calculation:

Diameter of nozzle = 1 mm

Angle of spraying = 60 degree



B1 = 1.5 m / tan 60° = 0.86 m ≈ 1 m

Nozzle covers 1 m at a time, therefore for whole flight time it can cover area of

= 6.46 min * 1 m * 60

Area covered by Quadcopter = 387.6 m

Pesticide Flow rate:

$$\text{Flow rate} = d^2 * 0.00111 * \sqrt{P}$$

Where,

d = diameter of nozzle (1 mm)

P = pressure in KPa (kilo pascals)

$$\text{Flow rate} = (1)^2 * 0.00111 * \sqrt{200}$$

$$\text{Flow rate} = 15.31 \text{ ml/s}$$

4. FUTURE SCOPE

1) Estimating Soil Condition:
Smart farming is data-driven, enabling farmers to take action based on accurate information on soil conditions. Extracting this data had previously involved physical visits to the field and gathering metrics manually. Equipped with agriculture smart sensors, drones can collect and deliver this data - needless to say, they can also do it in a faster and more precise manner.

2) Planting Future Crops:
The soil gets prepared for planting and a drone shoots seeds in it, rather than using outdated planting techniques. Using drones for seed planting is relatively new; yet, some companies are experimenting with this approach.
For example, Drone seed is a startup that uses drone technology for crop planting and more. Unmanned aircrafts can also spray fields with water, fertilizers or herbicides, reducing costs, manual labor, and time spent on these processes.

3) Fighting Infections and Pests:
Not only can agriculture drones inform farmers on soil conditions using thermal, multispectral, and hyperspectral technology, they can also detect field areas inflicted by weeds, infections, and pests. Based on this data, farmers can decide on the exact amounts of chemicals needed to fight infestations, and not only help reduce expenses, but also contribute to better field health.

4) Crop Surveillance:
Agricultural fields occupy large areas, and it's often nearly impossible to estimate the overall state of crops. By using drones for agriculture mapping, farmers can stay updated on the health of plants in a particular area and indicate which field areas require attention.
To estimate the state of crops, drones inspect the field with infrared cameras and determine light absorption rates. Based on accurate real-time info, farmers can take measures to improve the state of plants in any location.

5) Livestock monitoring:
In livestock farming, drones can keep an eye on the cattle as it grazes on pastures, reducing the need for human workforce on horseback and trucks. Using thermal sensor technology, drones can find lost cattle, detect injured or sick animals, and calculate their exact numbers. Admittedly, drones are capable of doing a better cattle surveillance job than herding dogs.

5. CONCLUSION

The modern farming industry is at a turning point. With the development of more advanced farm management techniques, such as precision agriculture, industry professionals now have more tools than ever to improve the accuracy and efficiency of processes. Creation of electronic maps of fields, operational monitoring of crop conditions, evaluation of germination and predicting crop yields, checking the quality of ploughing, maintaining environmental monitoring of agricultural land, etc can be done. Consequently, drones are very important tools in the modern agriculture and farming systems.

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