Design and Manufacturing of Multipurpose Agri-copter

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Abstract-*The core intention of this project is to design and manufacture a Quadcopter which can be used for various purposes in the agricultural sector. At this particular point the main aim of the project is to reduce human efforts in agricultural surveillance and pesticides spraying.*

The purpose can be easily achieved by equipping an UAV with a wireless mesh node. In this scenario, the UAV or Quadcopter swarm can be considered to be a highly mobile wireless mesh network. We propose an architecture based on Quadcopter that can be employed to implement a control loop for agricultural applications where Quadcopters are responsible for spraying chemicals on crops. The process of applying the chemicals is controlled by means of the feedback from the wireless sensors network deployed at ground level on the crop field. An algorithm will be evaluated to adjust the Quadcopter route under changing conditions of wind (intensity and direction) and the impact related to the number of messages exchanged between the Quadcopter and the wireless sensor network (WSN). The information retrieved by the WSN allows the Quadcopter to spray the chemicals strictly on the designated areas. Since there are sudden and frequent changes in environmental conditions the control loop must be able to react as quickly as possible.

Keywords-Quad-copter, NAZA MV-2,UAV

I. INTRODUCTION

In India about 73% of population directly or indirectly depends upon farming. Hence it is said that India is an agriculture based country. But till now our farmers are doing farming in traditional ways. They sow seeds, spray fertilizers and pesticides, and cultivate by conventional methods. There is need of development in this sector and most commonly in fertilizers and pesticides spraying technique, because it requires more efforts and time to spray by the traditional way.

In order to meet the requirement of food for the growing population and rapid industrialization, there is a need of the modernization of agriculture sector. On many farms, production suffers because of delay in sowing, improper distribution of pesticides and fertilizers, and harvesting. Automation of all these tasks solves all the problems which are responsible for low production. It conserves the input, such as the efforts required and improves the precision in work. It reduces quantity needed for better response, prevent the losses and wastage of input applied. It gets high productivity so that cost of production will reduced.

Nowadays, most precision agriculture (PA) research is oriented towards the implementation of new sensors and instruments, able to remotely detect crop and soil properties in quasi-real time. Unmanned Aerial Systems (UAS) are aerial vehicles, which come in wide varieties, shapes and sizes and can be remotely controlled or can fly autonomously through software-controlled flight plans in their embedded systems working on the basis of GPS. Some of the advances of the use of UAS are that they are lightweight and easy to transport, they capture high resolution and low cost images, they can fly at variety of altitudes depending on data collection needs, they can travel areas which are not accessible via car, boat, etc. They are used to spray pesticides and fertilizers, sowing seeding, crop monitoring etc. In the last decade, the development of unmanned aerial vehicles (UAV) platforms, characterized by small size has offered a new solution for crop management and monitoring.

Proposed System Work

One of the most challenged task for farmers is to spray pesticides on pre or post emergent crops. This process includes selection of water to pesticide ratio, which brings complexity to operation. There are various conventional methods used to spray pesticides or fertilizers on crops are hand pump (manual), tractors with pump mechanism, Aerialspraying, Ultra-low volume spray application, crop dusting. Among all these methods aerial spraying is more effective than any others. This methods provides advantages like health issues, reduction in time period, covers larger area. This is done with radio frequency transmitter, so we can spray pesticide without entering in a field. Aerial spraying of pesticides can done with helicopters, small aircrafts and drones. Drones are less energy consuming, operate without an ease. For making of drones various flight controllers are used

like NAZA M-lite, NAZA MV-2, KK2, CC3D, NAZE32 etc. Though there are various flight controllers in market, but NAZA MV-2 provides better stability and GPS module. So we can control our drone with flight controller through wireless communication. Also we can adjust actuator of nozzles used for spraying purpose by radio frequency.

Working Principal:

The quadcopter is simple design with four rotor propellers with controller. The flight controller is the main part of this vehicle. NAZA MV2 controller controls all the operation commanded by operator. The four rotors to create differential thrust and the quadcopter hover and move accordance with the speed of those rotors. There are two types of configuration in quadcopter construction. First one is Plus (+) configuration and another one is Cross (X) configuration. Both the models are same, but the control of these models slightly different. The cross configuration is easier than plus configuration model, but according to the project application X- Configuration is most suitable. Total mass to lift is 1.5kg means, the total thrust produced by rotors should be 3 kg. GPS guidance system is used to navigate the UAV. Pre-loaded trajectory gives the real time coordinates to NAZA MV2 controller. Based on this GPS coordinates, the microcontroller navigates the UAV.

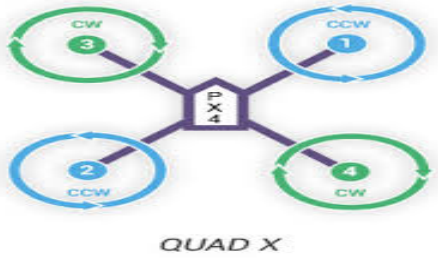

Fig 4.3.1(b). X-configuration for quadcopter

II. HARDWARE IMPLEMENTION

Flight controller(NAZA MV2)-

Naza is a light weight flight controller providing multi-axis control platform. They are specially designed for multi-rotor model. This type of controller is used for carrying heavy payloads and aero photography. Naza not only inherits the outstanding flight stability of DJI products, but also provides excellent maneuverability and reliability, which gives user a wonderful flight experience.

It is a small module which supports firmware upgrades with extendible data ports. With the new firmware, new attitude stabilization algorithm and optimized control is been provided. The Naza-MV2 provides better flight performance, even without the GPS module. It has smoother take-off algorithm. When the throttle stick is let go the quadcopter will hover. Support is also included for optional Bluetooth LED module to allow parameter adjustment via a mobile application.

Features

- NAZA simplifies installation and saves space and weight.
- Independent PMU with function extension.
- Independent LED Module.
- Advanced attitude stabilize.
- Multiple flight control mode/intelligent switching.
- Accurate Position hold.

B. Brushless DC Motor(BLDC):

Brushless DC electric motor (BLDC motors, BL motors) also known as electronically commutated motors (ECMs). ECM's 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. AC (alternating current) does not imply a sinusoidal waveform, but rather a bi-directional current with no restriction on waveform. Additional sensors and electronics control the inverter output amplitude, waveform (and therefore percent of DC bus usage/efficiency) and frequency (i.e. rotor speed).

The rotor part of a brushless motor is often a perma nent magnet synchronous motor, but can also be a switched reluctance motor, or induction motor.

Brushless motors may be described as stepper motors; however, the term "stepper motor" tends to be used for motors that are designed specifically to be operated in a mode where they are frequently stopped with the rotor in a defined angular position.

Calculation

1) We know that,

$$F = m*a$$

Total mass(m) of the system(Quadcopter+Pump)= 1.5Kg

Here,

Gravitational force(g) = 9.81 m/s

$$F = 1.5x9.8$$

$$F = 14.715 \text{ Nm}$$

For moving in forward and backward direction there will be air force which will affect on the moor.

Assume,

Air force =2N

Total force=14.715+2

=16.715N

For safety of motor we have to take factor of safety(F.O.S).

F.O.S=2

Total force= 16.715x2

=33.43N

This is total force carried by the four motor.

Now we have to calculate force/motor

=33.43/4

=8.358 Nm

Therefore, 8.358Nm force is been carried by each motor.

2) As we know the force we have to calculate torque,

T = F x perpendicular distance

Perpendicular distance is the distance between tip of propeller to center of propeller.

Total Propeller distance = 12'' (30.48cm)

R=D/2

R=30.48/2

R= 15.24cm

Therefore, Perpendicular distance = 15.24cm

T =F x perpendicular distance

T = 8.358x15.24

T =127.37

T =1.2737Nm2

This is the torque produced by the single motor.

Total torque produced by Four motor = 1.2737x4

T =5.09Nm2

Therefore, 5.09 is total torque produced by the motor

3) P= (2x3.14xNxT)/60

= (2x3.14x900x1.2737)/60

=7198.95/60

=119.98watt

Electronic Speed Controller (ESC)::

ESC is used to control BLDC motor. It takes signal from microcontroller and breaks into 3 parts and sends it to the BLDC motor. We would require 4 ESCs as we are using 4 BLDC motor. The ESC is an inexpensive motor controller board that has a battery input and a three phase output for the motor. Each ESC is controlled independently by a PPM signal (similar to PWM). The frequency of the signals vary, but for a Quadcopter it is recommended the controller should support high enough frequency signal, so the motor speeds can be adjusted quick enough for optimal stability.

Lithium Polymer Battery (LIPO):

Lithium batteries are the preferred power sources for most electric modelers today. They offer high discharge rates and a high energy storage/weight ratio. However, using them properly and charging them correctly is no trivial task. LIPO Battery provide small size with high current storing capacity.

Propeller:

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 airfoil-shaped blade, and a fluid (such as air or water) is accelerated behind the blade. Propeller dynamics, like those of aircraft wings, can be modelled by either or both Bernoulli's principle and Newton's third law. A marine propeller of this type is sometimes colloquially known as a screw propeller or screw, however there is a different class of propellers known as cycloidal propellers. They are characterized by the higher propulsive efficiency averaging 0.72 compared to the screw propellers average of 0.6 and the ability to throw thrust in any direction at any time. Their disadvantages are higher mechanical complexity and higher cost.

ADVANTAGES

1) Less complex system;
2) More reliable;
3) Used for multipurpose in agricultural sector;
4) Security: protect farmers away from pesticide harm, to prevent poisoning and heatstroke incidents;
5) High efficiency;
6) Environment protection: can spray pesticides with fixed position and fixed orientation, reducing the pollution to water and soil;

III. FUTURE SCOPE

- This system can rapidly realize the automatic networking irrigation system, transmission and exhibit.
- Through the Web technology, we can realize the function of remote monitoring of the agricultural field.
- It shows that the system can meet the requisites of the moisture level of the soil, according to that motor can be controlled.
- Thus, the utilizer can anytime view their sensor data details and the motor functionality status. The utilizer can access the sensor details and motor functionality status from the PC via LAN connection.

IV. CONCLUSION

This Report gives the solution to all problems like shortage of labour, health issues which are faced by farmers during pesticide spraying. In future, battery power will be replaced by solar system as a power source. We can implement this on large scale using multi-copter with increase tank capacity. The QC is unable to perform at long distance range due to limited amount of power supply from Lithium polymer battery. Increment of power source will increase the range.

ACKNOWLEDGMENT

Our sincere thanks and deep gratitude to head of Dept. Prof.V.S Deshpande our internal guide Prof.P.P .Kulkarni and other faculty member, but also to all those individuals involved both directly and indirectly for their help in all aspect of the project .At last but not the least we express our sincere thanks to our institute's principal Dr.R.S.Prasad, for providing us the infrastructure and technical environment

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