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Design and Experimental Analysis of Unmanned Aerial Vehicle

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ABSTRACT

In the past decade Unmanned Aerial Vehicle (UAV) has become a topic of interest in many research organizations. The project focuses on the design of Quad copter with ducted propellers after study and analysis of the present trend. The main idea of this work is to experiment a new design and construction of a quad copter that can eliminate instability faced by usual quad copter structures. It uses KK2.1.5 flight control board and FS-CT6A transmitter and receiver. Usual quad copters struggle with instability and significant loss of thrust. These problems are aimed to overcome in this design. A new frame has been designed and used, that is lighter in weight than the actual frame provided, which has lateral holes provided in the body, rather than vertically oriented holes. The new frame is made of plywood (body) and plastic, which is usually used to make light weight doors. A duct is made of plastic material and placed around the propellers mechanically, that helps in improving the thrust produced during the throttle increase of the quad copter. Thus the work was experimented using a quad copter set up. The actual objective of the project is to improve the stability and thrust of an unmanned aerial vehicle using the ducted profile design on a light weight frame. Thus, the project can be upgraded to increase the performance of a twin copter also.

Keywords: *quad copter, thrust, frame, ducted propellers, design*

I. INTRODUCTION

A quad copter, also called a quad rotor helicopter or quad rotor is a multi rotor helicopter that is lifted and propelled by four rotors. Quad copters are classified as rotorcraft, as opposed to fixed-wing aircraft, because their lift is generated by a set of rotors (vertically oriented propellers). Quad copters 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.

Ducted fan UAVs with vertical takeoff and landing provide many advantages to their equivalent fixed- and open-wing counterparts. When it comes to safety, payload, and scalability, the ducted fan UAV is incomparable.

- The vehicle's propeller is shrouded, allowing closer access to specific targets or areas of interest and preventing the user from risk or injury so it is much safer than an open blade or propeller.
- Ducted fan UAVs maintain a higher payload to vehicle ratio. The vehicle can carry 4x the payload of an open-wing UAV.

II. MAIN COMPONENTS

A. KK 2.1.5 Flight Control Board

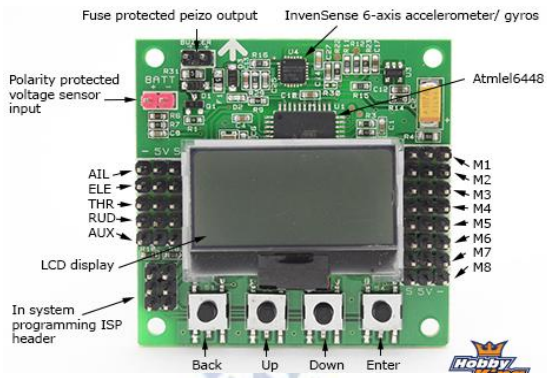

Fig. 1. KK 2.1.5 Flight Control Board parts

Fig. 1. Gives the various parts in the FCB. Some of the specifications of the FCB used are:

Size : 50.5 mmX50.5mmX12 mm
Weight : 21gram (inc piezo buzzer)
IC : ATMEGA 324PA

It controls the signal transmission from the transmitter to the receiver and also electronic speed control unit. Thus it behaves as the CPU of a quad copter.

B. Transmitter and Receiver

Fig. 2. Receiver

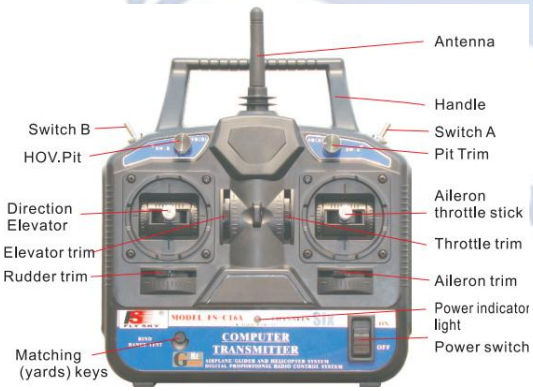

Fig. 3. Transmitter

They are the components used for transmission. Fig. 3. shows the transmitter which consists of elements like power supply, oscillator, modulator, amplifier, antenna etc. A receiver is the opposite of a transmitter. It uses an antenna to capture the signal waves and processes it to extract only the waves of desired frequency from the transmitter. Some specifications of the Tranciever are:

Channel : 6
Frequency Band : 2.4 GHz
Power Resource : 1.5V*4"AA Battery
Program Type : Gaussian Frequency Shift Keying
Modulation Type : FM (Frequency Modulation)
RF Receiver Sensitivity :-76 db

C. Brushless Motors and ESCs

The ESCs receive the signal from the FCB and power from the battery to send electric signal that could run the motors at desired rpm. The motors are used to feed desired rpm to the propellers based on the current received from the ESC (Electronic Speed Controllers). In brushless motors precise motion is based upon a closed loop control system that provides tightly controlled and stable operation.

Fig. 4. Brushless motors

Fig. 5. Electronic Speed Controllers

D. Propellers

The propellers are the most important components of a quad copter as its profile determines the actual flight behavior and efficiency of the vehicle. It is coupled with the motor using adapter set. Two propellers run in CW and the other two runs in CCW directions (alternatively).

Fig. 6. Propellers

III. ASSEMBLY

The typical assembly used in a quad copter set up is given above. The ESCs are connected to PCB (Printed Circuit Board) by soldering. The other connections like ESCs to receiver, battery to FCB, FCB to receiver etc., are connected using wires. Here we have used X Configuration for the quad copter.

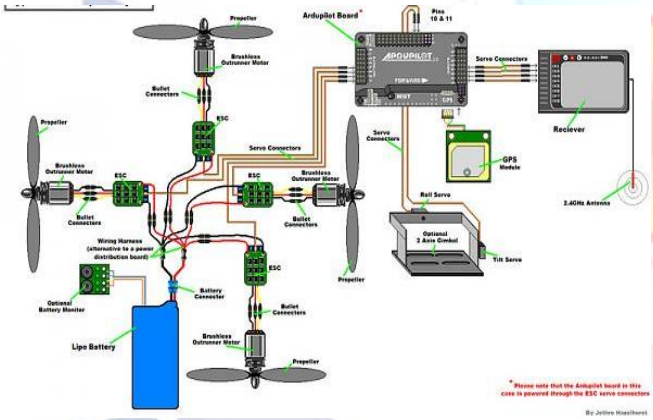

Fig. 7. Typical Quad copter layout

IV. OLD FRAME

Frame of the quad copter plays a major role in flight as it holds the FCB, battery and ESCs in place and contributes to the total weight of the vehicle. The old frame consists of four arms and a PCB (anyway that does not contribute to the circuit used).

The following are the disadvantages of the old frame:

- Using PCB as a mere supportive component.
- The vertical holes provided in the frame reduce thrust.
- Costlier manufacturing
- Less availability

V. NEW DESIGN

Fig. 8. Quad copter with new frame

Fig. 8. shows the prototype of quad copter setup with new frame. The new frame has various advantages as follows:

- Simple design and manufacturing
- Lateral holes provided in the frame improves thrust.
- Reduced weight
- Increased availability
- Cheaper

The new design was first simulated and compared with the old design using CFD analysis. Then its prototype was made and experimented. According to the analysis, we can conclude that the new frame provides better thrust for a given rpm of the propeller compared to the old design. Fig. 9. Shows the CAD modeling of the new frame used for analysis.

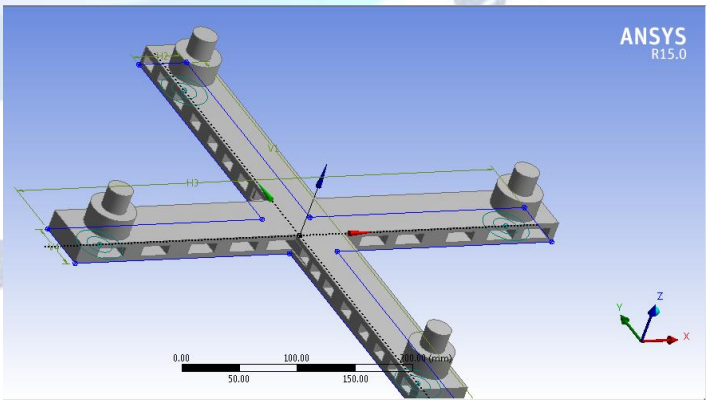

Fig. 9. CAD Modeling of the new frame

VI. DUCTED PROPELLERS

The duct is cylindrical structure with large diameter to height ratio and very small thickness to

diameter ratio. It helps in avoiding the formation of vortex around the propeller during flight that affects the thrust produced. The CAD modeling of the ducted propeller was simulated and analyzed in CFD. From the analysis, it is inferred that the ducts eliminate the formation of vortex around the propeller.

Based on the modeling and analysis made, we have developed a prototype of the ducted propeller in quad copter, shown in Fig. 10.

Fig. 10. Quad copter with ducted propellers.

VII. Conclusion

Thus we have analyzed the flight behavior and performance of a quad copter using CFD Analysis with a new frame consisting of lateral holes and with straight profiled ducted propellers. Based on the analysis and model, the prototype was created and experimented.

Therefore we infer that the disadvantages such as instability and loss of thrust faced by normal quad copters can eliminated or reduced using the new frame and straight ducted propellers.

REFERENCES

[1] Ashfaq Ahmad Mian and Wang Daobo (2007) , “Nonlinear Flight Control Strategy For An Under actuated Quad rotor Aerial Robot Networking, Sensing And Control”, IEEE International Conference, Sanya, China

[2] Aditya Intwala and Yash Parikh (assistant professor), “A Review on Vertical Take Off and Landing (VTOL) Vehicles”, Symbiosis Institute of Technology, Pune.

[3] Faiyaz Ahmed and Y. Shivraj Narayan, “Design and Development of Quad copter for Surveillance” , Dept. of Mechanical Engineering, VNR Vignana Jyothi Inst. of Engineering and Technology, Hyderabad, India

[4] Hoffman, G. Huang, H., Waslander and S.L., Tomlin C.J.,"Quadrotor Helicopter Flight Dynamics And Control: Theory And Experiment", The American Institute Of Aeronautics And Astronautics, Hilton Head, South Carolina.

[5] John K. Sanders, Jr,J. Kenneth Sanders, Arturo Aviles, Jr. and Arturo F. Aviles(2006), "Quiet vertical takeoff and landing aircraft using ducted, magnetic induction air-impeller rotors" ,US 7,032,861 B2

[6] Mariusz RUTKOWSKI and Witold KRUSZ , “Design and analysis of ducted fan for multi-rotor VTOL UAV”

[7] Robert Thomas Sheber (December 2014), “Ducted Unmanned Ariel Vehicle” ,University of Arizona

[8] Steveis , “KK2.1.X V1.18S1Pro (Flight control board guide and manual)” firmware.