International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 05 Issue: 07 | July - 2021 ISSN: 2582-3930

Unmanned Aerial Vehicle (Ornithopter Drone)

Vaibhav Nehe[1], Vishwajit Kadlag[2], Pratik Bhalare[3], Aashish Kale[4], A.D.Dighe[5]

[1234]*Student, Department Of Mechanical Engineering*
[5]*Professor, Department Of Mechanical Engineering*
[12345]*Pravara Rural Engineering , Loni, Maharashtra*

Abstract - The purpose of this paper is to identify a longitudinal linear model of an ornithopter by automated flight tests. Flight tests were conducted outdoors, and an avionic board with sensors was installed on-board for measuring angular rates, Euler angles, and a total velocity. For accurate flight test, automated signal input is designed for elevator deflection: doublet and multi-step 3211 maneuver. During a cruise flight, the ornithopter normally had oscillation which is generated by flapping motion of the main wings. Fast Fourier transform (FFT) is used for analyzing flight data in a frequency domain, and a Butterworth filter is designed to filter the corrupted data by the flapping motion. The structure of the ornithopter linear model is assumed to be similar to a fixed-wing aircraft which has a periodic oscillation because it has similar control surfaces except the flapping motions. For system identification, unknown parameters are estimated by unconstrained nonlinear optimization.

***Key Words*:** longitudinal , Euler angles , Fourier transform , Butterworth filter, ornithopter , flapping motions

1. INTRODUCTION :

An ornithopter (from Greek ornithos "bird" and pteron "wing") is an aircraft that flies by flapping its wings. Designers seek to imitate the flapping-wing flight of birds, bats, and insects. Though machines may differ in form, they are usually built on the same scale as these flying creatures. Manned ornithopters have also been built, and some have been successful. The machines are of two general types: those with engines and those powered by the muscles of the pilot.

2. What is Ornithopter ?

An ornithopter (from Greek ornithos "bird" and pteron "wing") is an aircraft that flies by flapping its wings. Designers seek to imitate the flapping-wing flight of birds, bats, and insects. Though machines may differ in form, they are usually built on the same scale as these flying creatures. Manned ornithopters have also been built, and some have been successful. The machines are of two general types: those with engines and those powered by the muscles of the pilot. The research on Micro Aerial Vehicles (MAV) is comparably young, which has emerged over the past few years. The ongoing miniaturization of electric components such as electric motors and the improvements in microelectronics made it possible to build miniature planes and helicopters at relatively low costs. This development also made it possible to start imitating insect and bird flight, which needs a sophisticated miniaturized actuation chain for their flapping wing motion.

Fig -1: Ornithopter

3. OBJECTIVES:

i. To design and build a Unmanned Aerial Vehicle (Ornithopter Drone) at a lower cost.
ii. To improve repair times / eliminate the need of helicopter survey.
iii. Improve power outage restoration times and find broken components quickly with better success.

4. DESIGN

4.1 MOTOR (Brushless) KV Rating = 2300KV**.** Operating voltage = 11.1V

4.1 Material selection of shaft Material = Alloy steel

i. Tensile Strength (Sut) = 655N/mm2 ii. Yield Strength (Syt) = 415N/mm2 iii. Assume length of shaft = 160mm iv. Bulk Modulus = 140Gpa v. Shear Modulus = 80Gpa

4.2 Gear Ratio

Gear Ratio= 1.48

Electric Motor operating Voltage = 11.1V

2300KV X 11.1V = 25530RPM

25530 / 60 = 425 Revolution per second

Flapping per Stroke = 425 / 48 = 8.8 (In no load condition).

4.3 Bearing Selected For shaft "6844zz"

Material = Chromium steel

d = 4 mm

D = 9 mm

Width = 4mm

Weight = 1 g

Weight Capacity = 250kg.

5. CONSTRUCTION

5.1 DC Motor

A DC motor is any of a class of rotary electrical motors that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current in part of the motor.

Fig no 5.1.1: DC Motor

5.2 Lithium Polymer Battery:

A lithium polymer battery, or more correctly lithium-ion polymer battery (abbreviated as LiPo, LIP, Li-poly, lithium-poly and others), is a rechargeable battery of lithium-ion technology using a polymer electrolyte instead of a liquid electrolyte. High conductivity semisolid (gel) polymers form this electrolyte. These batteries provide higher specific energy than other lithium battery types and are used in applications where weight is a critical feature, such as mobile devices, radio-controlled aircraft and some electric vehicles

Fig no 5.2.1: Lithium Polymer Battery

5.3 Carbon Fiber Sheet:

Carbon fibers or carbon fibers (alternatively CF, graphite fiber or graphite fiber) are fibers about 5 to 10 micrometers (0.00020–0.00039 in) in diameter and composed mostly of carbon atoms. Carbon fibers have several advantages including high stiffness, high tensile strength, low weight to strength ratio, high chemical resistance, high temperature tolerance and low thermal expansion.[These properties have made carbon fiber very popular in aerospace, civil engineering, military, and motorsports, along with other competition sports. However, they are relatively expensive when compared with similar fibers, such as glass fiber, basalt fibers, or plastic fibers.

Fig no 5.3.1: Carbon Fiber Sheet

5.4 Radial Ball Bearings

A ball bearing is a type of rolling-element bearing that uses balls to maintain the separation between the bearing races. The purpose of a ball bearing is to reduce rotational friction and support radial and axial loads. It achieves this by using at least two races to contain the balls and transmit the loads through the balls. In most applications, one race is stationary and the other is attached to the rotating assembly (e.g., a hub or shaft). As one of the bearing races rotates it causes the balls to rotate as well. Because the balls are rolling they have a much lower coefficient of friction than if two flat surfaces were sliding against each other.

Fig no 5.4.1: Radial Ball Bearings

5.5 Main Shaft:

A shaft is a rotating machine element, usually circular in cross section, which is used to transmit power from one part to another, or from a machine which produces power to a machine which absorbs power. The material used for ordinary shafts is mild steel. When high strength is required, an alloy steel such as nickel, nickel-chromium or chromium-vanadium steel is used..

Fig no 5.5.1: Main Shaft

6. ADVANTAGES:

i. They are more forgiving in the air than other models.

ii. The average flight time is a couple hours and can go up to an impressive 16 hours or more if the drone is gas engine powered

iii. And have the ability to carry more weight.

iv. It improve repair times.

v. Improve power outage restoration times and find broken components quickly with better success.

7. CONCLUSION:

The ornithopter can be designed from grouped up with the needs of research in minds. All components can be designed to be as lightweight and high performance as possible to maximize payload capacity and are intended to fail in predictable and field repairable ways. In addition to this all, all parts of ornithopter are simple and inexpensive to fabricate and assemble. With the newer innovations and researches in technology, we can make them as per requirements.

8. FUTURE SCOPE:

Through the comparative study of various ornithopters, Increased research, development and interest in this field. Hereby are the areas that can be focused upon fixed amplitude and variable frequency flapping motion of wings. Development of wing-twisting mechanism, progression in the technique to reduce negative lift generated during the upstroke of wing, provision of increased versatile maneuvering capabilities.

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