AUTONOMOUS ORNITHOPTER

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Abstract - *Now a days automotive have taken remarkable place in growth. The study of autonomous ornithopter is to tame natural flight through automatic means. Many devices are developing using this objective to achieve natural flight capacity since the concept of micro aerial vehicle (MAV) or ornithopters thrive. This project concentrated on the Kline-fogleman aerofoil arrangement and the substance used for the wings that can accomplish efficient performance. Various wing kinds in birds and insects are investigated for understanding the drag and lift forces created by flyers by flapping their wings. The comparative investigation is done on the fields of designing techniques, power source used, mechanism employed, materials, actuators, type of tails, transmission mechanism, controllers and the mainframe. Relative research is made on drawbacks and limitations of previous used flapping aerial vehicles (FAV's) or spy bird are included in this paper. Numerous developed micro aerial vehicles were investigated to further advance.*

***Key Words*: Autonomous ornithopter, Micro Aerial Vehicle, Flapping aerial Vehicle, Spy bird**

1. INTRODUCTION

We notice there is growth in the need of unmanned flight vehicles with improvised capacities like the flapping aerial vehicles for civilian and military observation. The flutter wing concept of birds gives an instance of employ unmannered aerodynamics to industrialize the unmanned flight structures at low Reynolds number. This study attempts to imitate the flutter wing concept of natural insects and birds and investigate how lift force is produced through this concept of mechanism. The conclusion achieved will be used to analyse the flow attributes to improve the blue prints of micro aerial vehicle. The flutter concept is the mobile type which is having the vertical movement of the wings.

In this forecast, a plangency type flutter wing model is improvised. This kind of flapping wing uses the plangency phenomenon of 2 degree of freedom elastic system i.e. spars are used to hold up the wings for fluttering and feathering movements, oscillating, at a plangency frequency of the structure. The proportions of flapping, fluttering and feathering motions and the facet angles between them are controlled by differing the quantity of damping. Understanding the operation of a flapping wing UAV. Calculations are required to be done in order to find the lift that will be produced by the wings and to see if the lift will be enough to overcome the drag that will be experienced by the UAV. Designing the body, tail and the gear mechanism of the UAV with the help of software's like AutoCAD. Constructing the frame, the wing and the gear mechanism of the UAV. To design and manufacture the gear mechanism for the flapping of the wings. To calculate the distribution of the weight of the mechanism of the model, the lift produced and the drag experienced. Utilizing fewer funds on constructing the UAV to make it easily available and cost efficient.

2. LITERATURE REVIEW

Peter Nordin and Krister Wolff of Chalmers University of Tech. in Sweden, in 2002 built an ornithopter that studied flying techniques using flapping(flutter) wing theory. They constructed using balsa wood driven by machine learning technique known as steady state linear algorithm. Inspired from the natural evolution i.e., from the bird and insects, it gives the feedback on how well it performs a given work. From the laboratory apparatus, their spy eagle sustained maximum lift force and horizontal movement.

3. FLAPPING WING THEORY

For years and years now, the natural creature's flight has been fascinating to man. It is like an unresolved mystery of nature. Many attempts have been done to imitate the natural bird's flight by scientists and engineers. For example, an aircraft should always maintain a velocity which is higher than the stall velocity to attempt a successful landing. But, where birds are concerned, birds can stall, and by the use of their tail and body, can attempt a soft and precise landing. In order to understand the complexity of natural flight, it is important to understand the biomechanics of such creatures. It is necessary to analyze the wing configuration, and understand how a certain part of the wing contributes in producing lift. Simultaneously, the motive is to design and construct an air vehicle that can hover, and thereby, important information can be gained by studies of natural hoverers like the humming birds and insects.

Since the start, pioneers of aeronautics, researchers and experimenters like Casey, Lilienthal, and the Wright brothers were obliged by nature. The process or method where natural principles are applied to engineering and mechanical systems is known as bio mimicry. This ideology needs the biological and engineering research to be integrated.

3.1 Morphology of birds

A bird's body, wing dimensions and their correlation acts as an important factor for the flight performance of a bird. Since this is limited by the MAV constraints, this research is limited to small birds only. Even though the studies of humming birds are popular, the information obtained for this research are limited and it suggests a more general overview of birds. Studies conducted on birds should be able to cover the knowledge gap in the study of humming birds.

Wing's Shape

The shape of a bird's wings varies according to their way of adapting to nature. The figure below shows the various types of wings and wing tips.

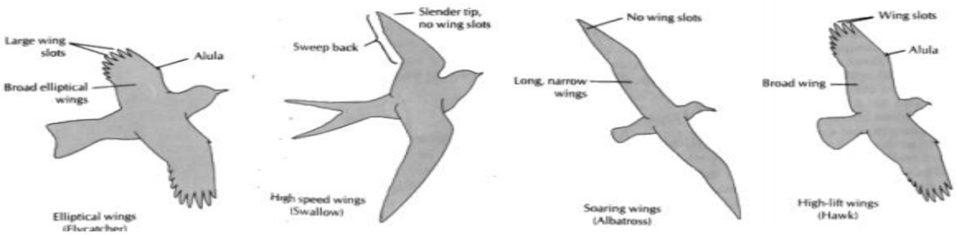

Figure 1: Various types of wings

The analysis of a wing geometry shows that a bird's flight varies in adaptation to its surroundings. Broad wings enable efficient power use for soaring. Long wings enable efficient lift required for gliding. Pointed wings decrease the drag induced and speedy flight. Round or elliptical wings give better maneuverability. Tapered wings favour very high velocities and maneuverability.

3.2 OPERATING PRINCIPLE OF A FLAPPING WING

The lift which is generated on a flapping wing is much similar to an inflexible airfoil which is flown from the front. But, at the wing upstroke, the wing is hit by the airflow from the above and at the bottom during the down stroke. These changes are small in the wing root area and increases towards the wing tip.

With permanent changing twisting the flapping wing must adapt to such alternate flow direction. The distribution of lift along the wingspan shouldn't be kept constant in order to generate thrust.

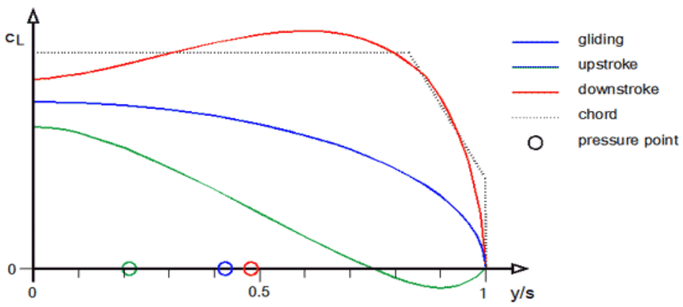

Chart 1: Lift distribution for inclined climb with limited wingspan

When the wing down stroke takes place, the distribution of lift increases compared to the lift distribution when gliding and more displaced towards the wing tip. We can say that thrust is generated throughout the wingspan while stroke motion. This function similarly to a propeller blade with a very large pitch only that the propeller torque force has to be overcome is here called lift and is also used like that.

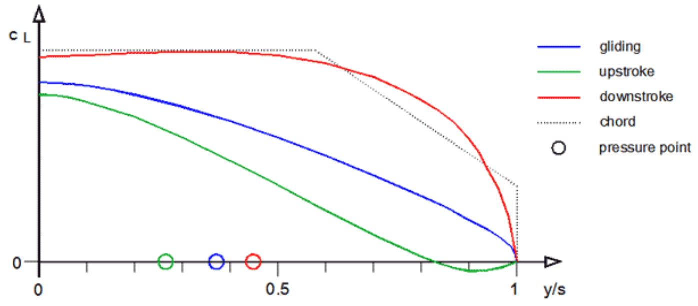

Chart 2: Lift distribution for inclined climb with unlimited wingspan

During the upstroke of the wing, the situation is the opposite. The distribution of lift is less and is focused more towards the wing root. The flapping wing acts like a wind turbine blade with the stroke motion in the direction of the lift force. If the lift force is huge enough it pushes the wing upwards even in the absence of a mechanical drive. Therefore, the wing functions with the working drag of a wind turbine against the flight direction. Simultaneously, the outboard wing areas are flown against rather from above. A negative lift is generated but there is thrust generated as well just like a propeller.

Whether in the upstroke the wind turbine or the propeller functions dominates depends on the twisting of the wing and the shape of the lift being distributed.

4. FABRICATION OF AUTONOMOUS ORNITHOPTER

4.1 DESIGN FOR SPY EAGLE

In order to select the design for the Spy Eagle, I carried out a parametric study where I compared a Cybird Ornithopter and I-fly Vamp Ornithopter with the design and features of the Spy Eagle. I then finalized with the design of the Spy Eagle where the length of the model will be about 100 cm and it will have a wingspan of 104 cm.

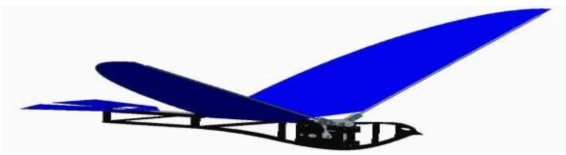

Figure 2: Design for Spy Eagle

Then I finalized the gear mechanism for the wings of the model where the mechanism will comprise of 4 gears i.e. 2 spur gears, 1 pinion wire and 1 pinion gear.

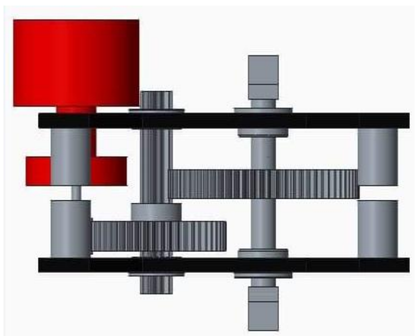

Figure 3: Gear mechanism (Top View)

The figure above shows the top view of the gear mechanism clearly showing how the motor is connected to the wings with the use of four gears through distribution of motion.

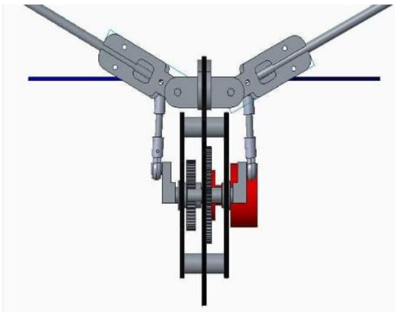

Figure 4: Gear mechanism (Front View)

The figure above shows the front view of the gear mechanism which clearly shows how the wings are connected to the gears and how the flapping motion of the wings is achieved.

4.2 CIRCUIT DIAGRAM

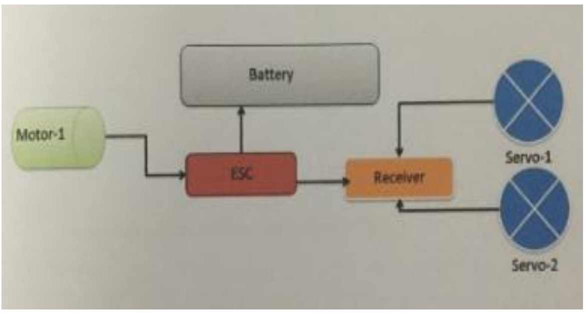

Figure 5: Circuit Diagram for Spy Eagle

The diagram above shows the circuit diagram for the Spy Eagle. The brushless motor which controls the wings is connected to the electronic speed control (ESC) which is used to control the speed of the motor and the ESC is then connected to the receiver and the battery. The two servo motors used to control the tail of the ornithopter are connected to the receiver directly.

5. RESULT

5.1 ENDURANCE

Endurance of a prototype is the maximum time the prototype can function at once. The battery used for the spy eagle is a Li-Po 500 mAh battery which runs a motor drawing a current of 3 A. Therefore, the endurance of the spy eagle can be calculated by.

$(500 \times 10^{-3}) / 3$

Endurance = 0.167 hours

$= 0.167 \times 60$

Endurance = 10.02 minutes

5.2 CHARGING TIME

The battery used is a Li-Po 500 mAh battery as mentioned above and the current supply to charge is battery is about 10 A. Therefore, the time required for the battery to get 100% charged can be calculated by.

$(500 \times 10^{-3}) / 10$

Charging time = 0.05 hours

= 0.05 x 60

Charging time = 3 minutes

6. CONCLUSION

This report carries out a research and development on the Spy Eagle which is a flapping wing UAV. The UAV mimics other flying birds. Results suggest that the Spy Eagle creates lift by the vortex lift mechanism. They maneuver by the flapping motion of their wings at varied amplitudes rather than using the wingtip only. In a forward motion, the wings generate a vortex ring at the leading edge. It was noticed that there was lift generated mostly during the down stroke with negative lift being created during the upstroke. Flexible wings tend to produce high velocity, higher frequency, lift and thrust. While analysing the wing angle motion, it was noticed that there was positive lift produced when the wing was at an angle of 0^{o} and -10^{o} and there was negative lift produced when the wing was at an angle of 30^{o} and 45^{o}.

7. REFERENCES

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