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Designing and Modelling of Spy Micro-UAV Ornithopter for Reconnaissance and Intelligence

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ABSTRACT: In the era of technologies, the subject of micro aerial vehicle, better known as ornithopter, has attracted the attention of a lot of researcher fellows and scientiest. These micro size vehicles are designed so as to closely impersonate the flight and wing motion of an actual bird. this makes it nearly impossible to identify them apart from the live bird in the air. Their potential applicatiions, like search annd rescueas well as survillence and reconnaissance, make them attractive with rrespect to traditional fixed or rotatory aerial vehicles. This paper presents the matheatical modeling of an ornithopter, it is propped by a pair of flapping wings. In perticular, we describe the design and modeling of an ornithopter.

KEYWORDS: Micro aerial vehicle, surveillance, reconnaissance, Flapping wings, etc.

I. INTRODUCTION

The bird is a superior and by far one of the most efficient flying objects which can glide as well hover. In 1924 the mechanism of flapping wings was studied. Onne of the maajor problem with the existting drones is their weight lifting caacity and the problem with the remotely controlled aerial planes is they cannot hover t one place. So by using the concept of flying birds the ornithopters can be made which provides the hovering capacity as that of drones also it offers greater thrust nd weight liting capacity. In short ornithopters combie the features of drones and remote-controlled plane with greater thrust and hoveing pcceity.

Ornithoter is one type of flapping wing robot or an Unmanned air vehicle which uses its tail to give direction and stabilize itself during fight. the oscillatory flapping of wings helps the UAV to generate the high pressure region below its body and gain lift; the wings control the altitude and propulsion of the Ornithopter where as tail acts as a steering of the Ornithopter. Bird's wing doesn't only serve the purpose of going up or down but also control the movement in forward and backward direction and allows hovering at one place too.

II. LITERATURE REVIEW

Yanghai Nan, Bei Peng, Yi Chen, Zhenyu Feng and Don Mcglinchey introduced dimensional analysis is an effective valuable tool in studying the biomechanics flyers. In their paper geometry similarity study is presented and used this geometry in wing performance estimation.

MohdFirdos bin Abas, AzminShakrine bin Mohdrafi, reviews kinematics of flapping wings for both, ornithopter and insects also the contributions of flapping wing kinematics toward lift, thrust and drag, force generation are also reviewed membrane wing structure are also explained for both ornithopter and insects separately. Referring different materials verifying the thickness.

Karishma S. Iyer, NikhileshLoknath, Abhilash K. Shtriya, deals with the membrane of the wing. Considering Graphine to be used as membrane it's mechanical strength, thermal properties and used as composite material have been listed.

VenkatasubramanianKalapathyVenkiteshwaran, Hai-Jun su, carried out numerical analysis including aerodynamic forces and dynamic model of flapping mechanism. Also sensitivity analysis are carried.



Sanjay D. Sane and Michel H. Dickinson used a dynamically scaled mechanical model of the *Drosophila melanogaster* to study how changes in wing kinematics influence the production of unsteady aerodynamic forces in insect flight.

Z. Jane Wang studied insects flight. have focus on aerodynamic lift both in quasi steady and unsteady regimes. Investigate force generation and energy cost of hovering flight used different combination of lift and drag, wing motion parameterized by inclined angle of stroke plane.

Mwonngera V. M. did work on the study of flapping wing flight in the field of entomology. Examines hover capable flapping wing flight. The kinematics and aerodynamics seen in nature and resulting control methods are explored and determines stability behaviour of flapping wing flight dynamics model.

III. METHODOLOGY

The purpose of this project is to design and modeling of a flappingwing micro air vehicle. The drivemechanism will be gear mechanism to drive the flapping wing MAV. A preliminary design of flapping wing MAV drawn and necessary calculation for the design will be done. A CAD model is drawn in CREO PARAMETRIC software, structural analysis done in the ANSYS 19R3.

IV. DESIGN AND CONFIGURATION

Model design

The 3D modeling of the MAV is done by CREO PARAMETRIC.

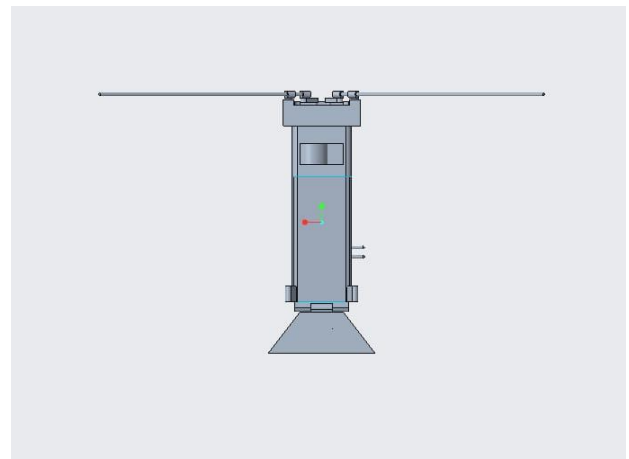
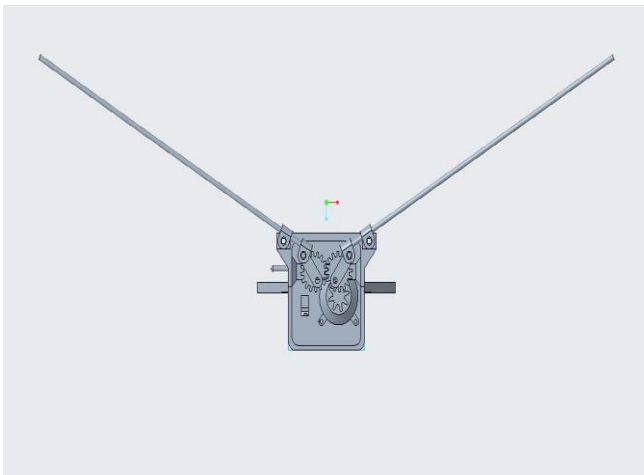


Fig1: Front view of ornithopter Fig2: Top view of ornithopter

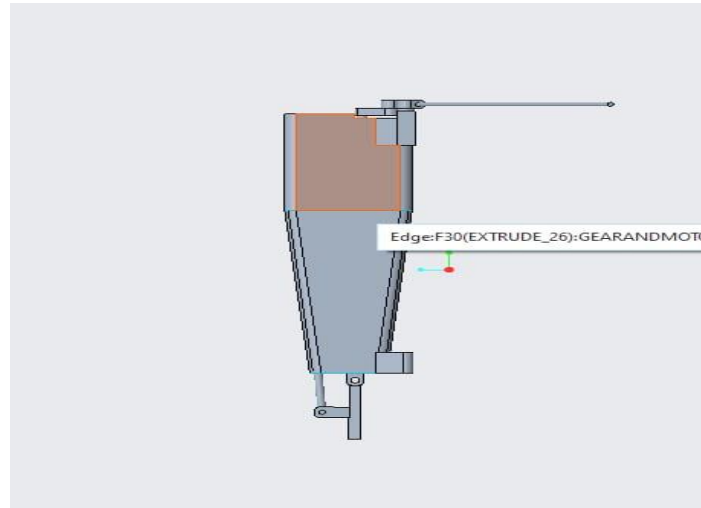


Fig3: side view of ornithopter

V. MATERIAL DATA

MATERIAL	MYLAR	DIGITAL ABS PLUS	CFRP
DENSITY	1390	1180	14475
POISSON'S RATIO	0.38	0.33	0.3
BULK MODULUS	7.2778e + 09	1.1278e + 09	4.9077e + 10
SHEAR MODULUS	1.8986e + 09	1.1278e + 09	4.9077e + 10
TENSILE STRENGTH	2.3536e + 08	6e + 08	1.6e + 09

VI. ANALYSIS

Structural analysis of flapping wing and casing. Considering the density at sea level and meshing is tetrahedron (it has 6 edges, 4 vortices and is bounded by 4 triangular faces).

Meshing:

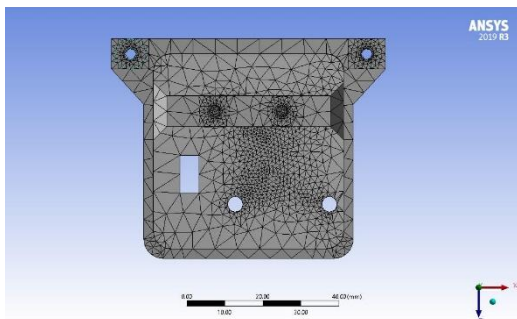


Fig 4: Meshing of casing

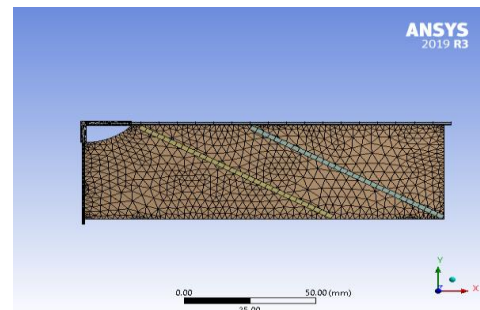


Fig 5: Meshing of wing



Deformation:

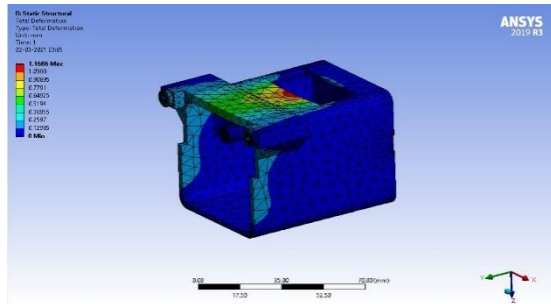


Fig 6: Deformation analysis of casing

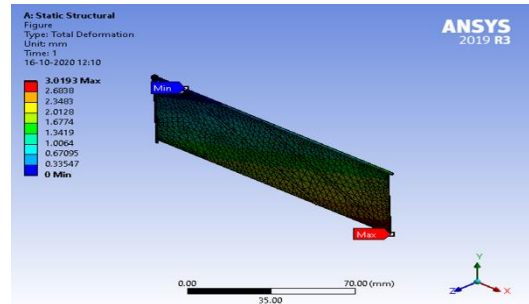


Fig 7: Deformation analysis of wing

Stress analysis:

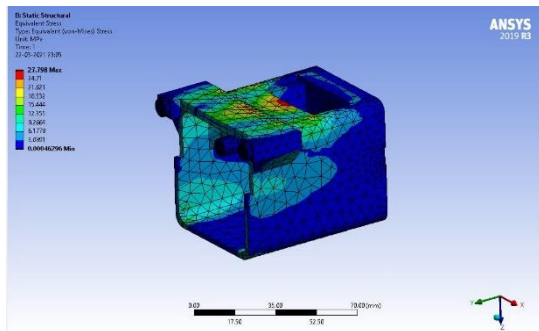


Fig 8: Stress analysis of casing

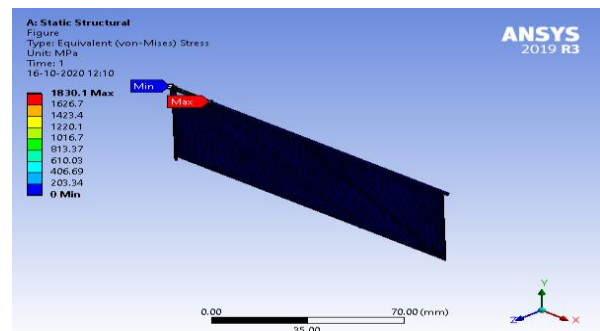


Fig 9: Stress analysis of wing

VII. MODELING OF ORNITHOPTER

This is a small size ornithopter which is having fuselage length of 24 cm and wing span of 43.8 cm tip to tip. The flapping motion is accomplished by gear mechanism. Both the wings flaps symmetrically and are hinged on the different shafts. The fuselage, crankshafts, linkages and casing are made from light weight Digital ABS Plus material. The connecting rods and some linkages are connected by pin joint, Fig1 shows a CAD design of an ornithopter.

VIII. RESULT

Successful flight with proper working of all parts is achieved. Reconnaissance and surveillance is done with the help of footage collected by camera which is installed in the ornithopter.

IX. CONCLUSION

This study constructs mechanical membrane of flapping wings. A gear driven by an electric motor was used as the flapping wing mechanism. The wing surface was formed by covering the structure by thin Mylar sheet. From the research regarding the various designs of flapping wings and articulated wings Ornithopter we can conclude that:

- To ameliorate the performance of ornithopter the important factors which need to be focused are propulsion efficiency and lift.
- The flexibility of outer part of articulated wings renders to better propulsion efficiency and inner part provides the lift.
- The long wingspan mitigates the high flapping frequency requirement.



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