A Comparative study on Rotor wing simulation performance in Martian Atmosphere

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ABSTRACT

The future rotor wing technology will lay the foundation of capable rotor wing copters developed for more ambitious project missions to habitable planets and moons with an atmosphere. The weight of the aircraft will be in the range of 6 to 12 kg, the future rotor craft must have the capability to have successful communication with the landed asset. Future rotor crafts could explore the space region. This paper is a review of helicopter rotor blade tip designs technology to evaluate the performance of new tip designs. The rotor blades tip shapes that have been used in past and present rotorcraft, have been examined with its underlying fluid mechanics to obtain better understanding of tip design problems. It also gives a clear differential classification between the classical aerodynamic knowledge supported by Wind tunnel and model rotor testing and low aerodynamic calculations with the new rotor designs which are subjected to intensive flight test verifications.

key words: Aerodynamics , rotor craft , wind tunnel , airfoil

INTRODUCTION

Aerofoil consideration performs really hard while we're making new wing and aiming for better outcomes. The consideration is also dependent on the requirement that shows the wing's performance on the platter. The entire performance is dependent on the styles of the airfoil. According to the NASA report, NACA 0012 is considered the best4-digit airfoil and NACA 23012 is the best Performing 5-digit airfoil while the 6-digit airfoil operates at a higher level because it shows higher performance so but we use 4 and 5 digits instead of 6-digit airfoil. While considering the airfoil, we should be aware of the uses and some resulting issue of the series that is being consulted under the NACA performance and we also take X foil's help to create a new airfoil as required.

Planet Mars /The Red Planet

Mars is far away from sun as compared to the Earth so it indicating that due to the large distance it seems like as cold planet then the Earth.

The distance between the Earth and the Mars is nearly about 54.6 million kilometer it's the minimum distance and the revolution period of Mars is twice then the Earth whereas the size in order to diameter Mars is having small diameter as compared to the Earth. Its known as red planet due to the present of the rusty dust on the surface.

Martian Atmosphere

On the Mars there is drastically changes in the climate due to the present of very thin atmosphere. Whereas the due to the climate changes quickly that effecting the atmospheric temperature, pressure and requirement of higher velocity.

As per the NASA's documentation report on Martian atmosphere is indicating that in day time on Mars the temperature is reach almost 20°C whereas in night it goes to -153°C at poles. Mars is consisting of carbon dioxide as 95.32%, nitrogen as 2.7%, argon as 1.6%, oxygen as 0.13%, carbon monoxide as 0.08% gases and some minor amount of water.

Mars is having thin atmosphere so that there are plenty of changes in temperature, pressure and density at different— different places on the surface.

The northern pole and the southern pole are considered to be the coldest part then the other place. And there is a possibility of storming dust on the surface anytime and anywhere.

According to the NASA documentation, they agree that water was there on the surface of the Mars, but because of the hematite, clay sand and rock present on the surface. We can find the river flow and the minute quantity of water.

The Earth/ Blue planet

Knowing as blue planet because of the presence of water. Its considering half of the rotation period around the Sun as compared to the Mars. The Sun is far away from the Earth which is nearly about 149.6 million kilometer.

Earth is having thick atmosphere which is considering into different-different parts and they are having their own properties and different values of temperature, pressure and the presenting of gases.

Earth Atmosphere

As comparing to the Mars atmosphere the earth is having different atmosphere which is thicker and containing different-different gases like as Oxygen, Nitrogen,carbondioxide and some others gases. Considering the atmosphere into different—different level like as—

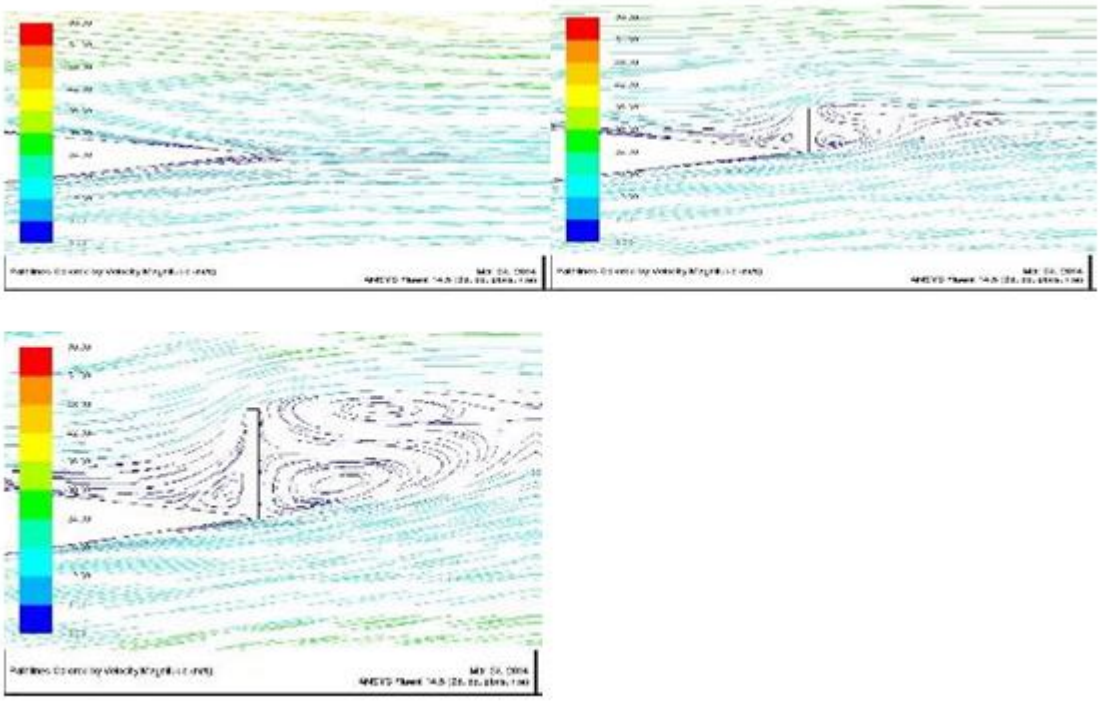
Troposphere,Stratosphere,Mesosphere,Thermosphere,and Exosphere

Consideration of gases by the earth atmosphere is showing that present of Oxygen as 21%, Nitrogen as 78%, Carbon dioxide as 0.04%, Argon as 0.93%, and some amount of helium,methane,krypton and hydrogen and also water vapor is there.

REVIEW OF LITERATURE

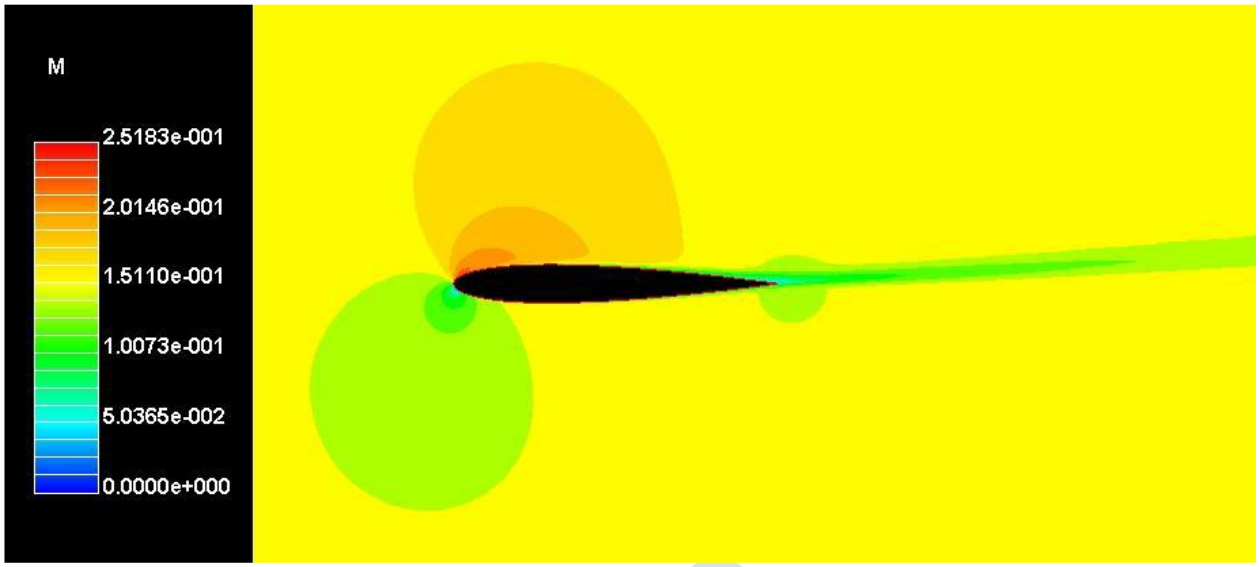
1.Vibration analysis of dragon fly wing in gliding mode at different Reynolds number

This paper describes about the vibration analysis of folded wing (dragon) section at low Reynolds number The primary focus of the paper is to calculate and analyze the natural frequency of a Dragonfly Wing Section. The motive of choosing the Dragonfly insect is that as MAVs and Dragonflies almost work at the same Reynolds numbers (Re 10^2 to 10^4). Moreover the glide up path of a dragonfly without any loss of its altitude is 30 seconds, having a glide speed of 2.3m/sec. This paper focuses on the Numerical study of model Analysis for insects in 2D airfoils at very low Reynolds number in glide modes. This paper further throws some light on the different aerodynamic loading for different Reynolds numbers (100-1000) at different angles of attacks (0° to 15°) using ANSYS-14 Multi Physics Solver. These results displayed by the CFD Solver in forms of lift and drag forces are inputted in the ANSYS and thus model is analyzed.



2. CFD Analysis of NACA 0012 Airfoil validation

This paper is a validated study or comparison of experimental data of NACA 0012 airfoil at various Angle of attacks. Three types of grid topologies are used for the study firstly Structured O-grid, secondly Structured C-H grid, and thirdly Unstructured T- Rex grid.A grid generation software named Point wise is used to create Grids. The provided NACA0012 airfoil geometry was used, keeping the chord length as 1 meter. Field Boundary is set at approximately 50 chord lengths away from the airfoil. The differences to be minimized between each grid topology; wall spacing is kept at Δ s =1.0e-4; whereas grid point distribution kept at Δ d=0.01 at both its trailing and leading edges. After completion of the grid generations CFD++ Solver generated solutions at different angles of attacks are used. These generated Data and simulations were analyzed on Microsoft Excel. Coefficient of lift versus AoA is plotted in comparison with experimental data. Theoretical Co-efficient of lift was calculated using the thin airfoil theory within the same graph to set a comparison which is plotted against Co-efficient of drag.Conclusions were provided as that the structural grids give better results than the unstructured grids if the grid resolutions are good.



3. A Review on Aerodynamics of Flapping Wings

This paper is a validation study of the flapping wing concept which shows the advance technology under the category of wing section where as the, it can be use in airplane. According to the paper which consider the flying theory of bird and the main advantage of taking this type of wing is indicating that it can be able to produce the lift as well as thrust at same interval of time. By using this technology we are assure it's the more reliable, fuel efficient and simple & quieter. there is a concept of aerodynamic characteristics which indicate that the design which make the sustainable flight condition. The flapping replica is sustaining equal time interval of up and down stroke. Also the consideration of Navier Strokes equation in that the flapping angle denoted by ψ which can varies with different interval of time. Conclusion is showing that we can able to increase the aerodynamic stability of the unsteady force and also improve the better performance. It containing light in weight, the thrust performance increase more compared to lift. A best performance is obtained by setting the down-stroke angle greater than the upstroke angle. We can use this concept in the future for better stability, better performance and the lighter weight with producing higher amount of thrust and consuming less fuel so it's the best things we can consider under the wing design.

4. Influence of Camber Variation on the Performance on Symmetric NACA airfoil

Since the airfoil design and selection of it makes a huge difference in required parameters. The parameters are plunging motion, reduction of drag, high propulsive efficiency, increased lift coefficient .thus the knowledge of aerodynamic study, experimental and numerical methods are performed. A new concept is framed which is flapping wing to be analyzed on the NACA 0002 series to NACA 0020 series. Computing the unsteady flow dynamic characteristics was found by Knoller and Betz.The altered NACA 0012 series simulation variation are preferred by locating the position where the thickness could be increased with respect to leading edge .The position where it reduces the drag coefficient or the leading edge vortex shedding. The backward flapping wing is 25cm span wise which has trivial pitching but the pitch values are ignored .After the changes in the thickness analysis performed in CFD fluent. The grid meshing is performed for further results as the meshing signifies the variations occurred on each nodes when the boundary conditions and the flow happens

Conclusions: The NACA 0012 was simulated by changing the thickness with the given conditions K=2.0, h=0.4,u=10.0 m/s, c=0.1 m, and Re=1.0x10^4, St=0.2546. It results in the LEV strength and delay in leading

edge vortex shedding.Also it increases the propulsive efficiency. NACA 0012 with LOC=50% decreased by 17.8% time averaged thrust coefficient and 11.9% propulsive efficiency comparing the results with the original ones at LOC=30% of NACA 0012

5. Mars Helicopter Rotor Model for Comparative Analysis

This research is done to provide the performing model for Mars Helicopter (MH) to understand and identify the complexity of flow for future regions of flow simulations, and can be improved though. The Martian atmosphere has very low density so the aircraft (Mars Helicopter rotor) will be small, at Martian atmosphere Reynolds number is very low which results in low chord based Reynolds number flows(10^3 to 10^4).The lifting force and lifting efficiency is reduced due to less atmospheric density and Reynolds number. During analyses the range of the rotor chord based Reynolds number is found to be subcritical which results in making boundary layer unlikely transitional. Calculations for two dimensional rotor boundary layer is approximated by calculating instability point, laminar separation point and transitional location to understand flow rate at high Mach and low Reynolds number regime . Then the result is put into Computational Fluid Dynamics (CFD) for turbulence modeling.

In this study the air foil deck is generated by using Reynolds-Averaged-Navier-Stokes (RANS) approach using C81 Gen. The objective of this research work is to create aerodynamic rotor blade helicopter for Martian atmosphere, and it is concluded that transition model is not necessary as Reynolds number is subcritical for hovering with flow remaining of the airfoil.

Conclusion

This paper includes the detailed study conducted on the existing proposed mechanisms and different geometries of airfoils to find the research gap, after which new ideas can be implemented accordingly. This project basically deals with the designing constraint, structural and compactness for construction of rotor blades capable for generating lift in Martian conditions with the help of software simulations in order to achieve lift in thin atmosphere of Mars.

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