ISSN (Online) 2456 -1304

International Journal of Science, Engineering and Management (IJSEM)
Vol 4, Issue 4, April 2019

Bi-Trans VTOL

[1]Deepak M Kurubar, [2]Dhanush D B, [3]M K Punit, [4]Deepak Raj P.Y
[4]Associate Professor, [1][2][3]3rd year BE
[1][2][3][4]Aeronautical Engineering, Srinivas Institute of Technology, Valachil, Mangaluru

Abstract: **- Unmanned Ariel Vehicles are, day-by-day, becoming more useful and are on their way to take over a new turn in the Aerospace industry. Vertical Takeoff and Landing is also becoming a new requirement of the coming era. There exist very few modern day designs of UAVs that can provide capabilities of VTOL, hovering along with faster speed and maneuverability. The main objective of this project is to study and fabricate a UAV that can be controlled by a wireless communication system. This includes selection of right material and electronic components. The project also deals with the testing and performance. Flight testing is done to detect the flying and balancing problems. This design specifically focuses on improving the performance characteristics following the references from existing VTOL aircrafts and UAV designs; and combines all such designs to achieve the targeted goal. A successful design will contribute to a wider range of applications both in commercial and military fields.**

Index Terms— Unmanned Aerial Vehicle, Aerospace Industry, Vertical Takeoff and Landing, UAV.

INTRODUCTION

UAVs are now becoming dominant in the modern world for different set of applications, due to its greater advantage of remote operation through wireless communication and thus performing tasks that can endanger human lives. With depleting space in the urban areas, VTOL designs are also under research. VTOL came into existence due to experiments carried out during the years 1950 – 1970 and almost all came out to be failures. The flight control and stability of VTOL is very difficult and is of prime area of research presently in the field of Aerospace. In the upcoming future these concepts are to be in a major demand. A UAV that has ability of VTOL and also retaining its performance will be an ideal vehicle for the near future. A Bi-Trans-VTOL solely focuses on that desired objective and hence derives the desired results. These are the two sub-branches of the main stream Aerospace that are under intense research to obtain the required results with more efficient and economic means.

II. METHODOLOGY

The backbone of the conceptual design is derived from the Boeing’s V 22 military combat VTOL aircraft and the Twin propeller drone – Bi-copter. Various papers published regarding the V 22 were taken under consideration along with the design analysis results. The range of applications of the design is prioritized from the fields of applications of the V 22 and Bi-copter. Even though there are no major Bi-copter models in use, the research and analysis papers published by various sources based on the prototype are examined. Also for the tail section (V tail) minor research papers on the fighter jets and other aircrafts with such structure have been referred.

The tilt wing mechanism is derived from the idea of Boeing’s V 22 VTOL aircraft’s tilt rotor mechanism. The degrees of freedom and motion mechanism with the vertical position of the wings are taken from the concept of a Bi-copter. Various studies showing the benefits of V tail in maneuverability and reduction in weight in the fighter jets have eminent step in designing the structure of the tail.

The main concept design was done with the help of designing software CATIA V5. The completed design then has to be analyzed for its performance virtually before being executed as a prototype, which is done using software ANSYS Professional. The analyzed results are then studied carefully and compared to that of the reference model V 22. After achieving the desired results, the main task of constructing the prototype is started.

III. CONCEPT

1 Design:

The design of the Bi-Trans-VTOL is derived from Boeing’s V 22 combat VTOL aircraft and the Bi-copter. The design resembles to a conventional aircraft design with a V tail section. The major alteration is the partial tilt wing mechanism encompassing the prop-engines in both the wings. The inner portion of the wings is fixed to the fuselage whereas the outer half consisting of the engines can tilt to 900 and return. The Right angle position of the wing is used during vertical takeoff and landing sequence where the UAV functions as a Bi-copter while the horizontal position operates like a conventional aircraft. The Airfoil selected for the design is a NACA 0006 symmetrical airfoil, due to the orientation of the wing during takeoff and landing. The designing of the prototype is done using the software CATIA V5. Different views of the design as represented in the software display window are shown in the following figures.

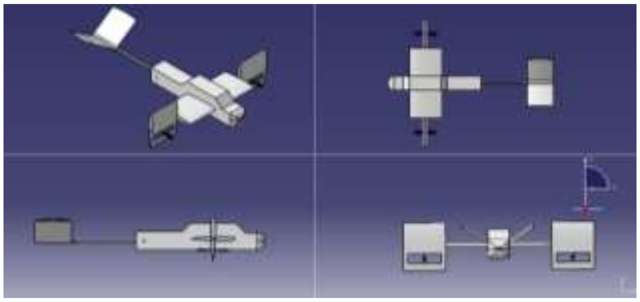

Figure. 1.1 Views in different planes with wings at 900 position.

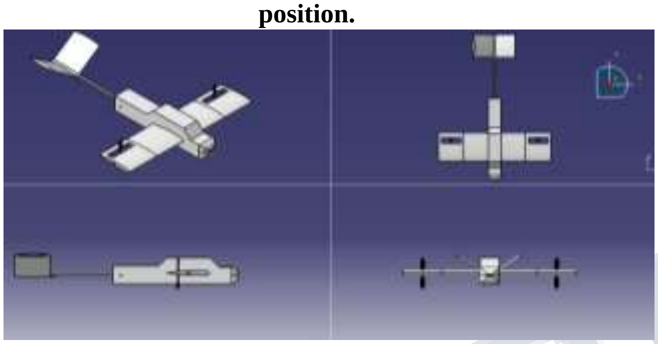

Figure.1.2 Views in different planes with wings at 00 position.

These views in different planes depict the actual design of the Bi-Trans-VTOL UAV that has to be constructed as per the stated concept.

2. Analysis:

The virtual 3D model designed using CATIA V5 is analyzed for different parameters like pressure distribution, flow velocity, behavior of the flow over the body, lift and drag measurements, etc. is obtained using ANSYS Professional software. The results observed are depicted in the following figures in the format displayed by the software window tabs.

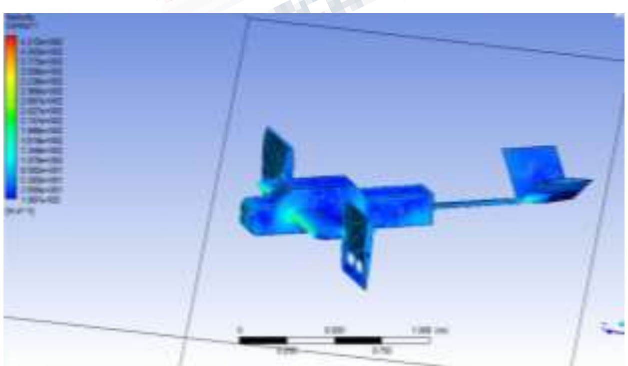

Figure. 2.1 Velocity contour

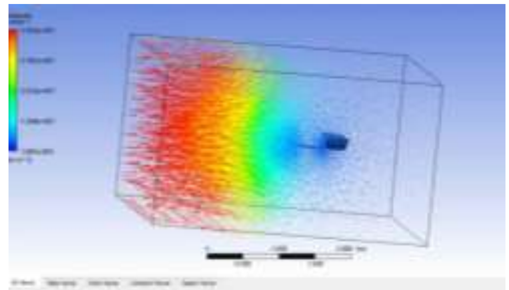

Figure. 2.2 Velocity Vector

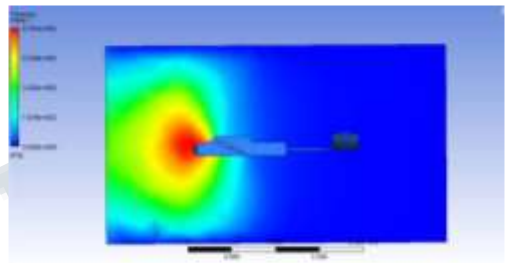

Figure. 2.3 Pressure distribution (Plane 1)

Figure. 2.4 CL Iterations graph

Analyzed results of different parameters for the NACA 0006 symmetrical airfoil are obtained using virtual wind tunnel and flow simulations as indicated in the following graphs.

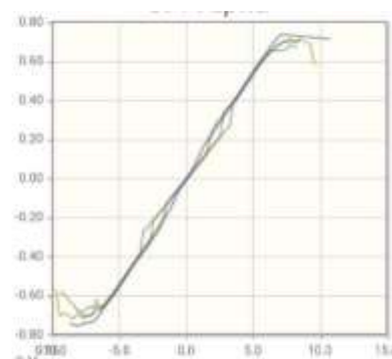

Figure. 2.5 C_L v/s Angle of attack

ISSN (Online) 2456 -1304

International Journal of Science, Engineering and Management (IJSEM)
Vol 3, Issue 4, April 2019

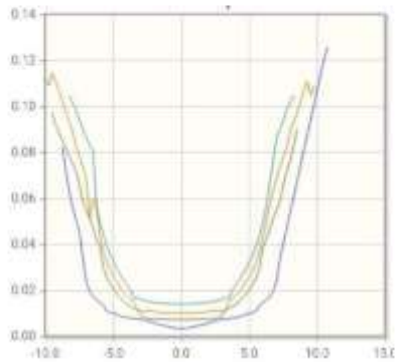

Figure. 2.6 C_D v/s Angle of attack

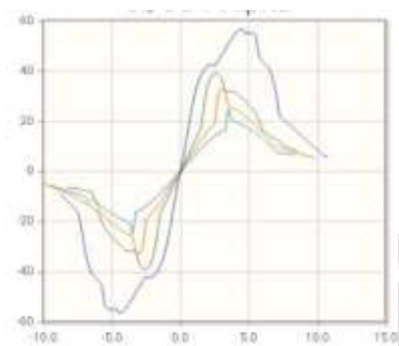

Figure. 2.7 C_L/C_D v/s Angle of attack

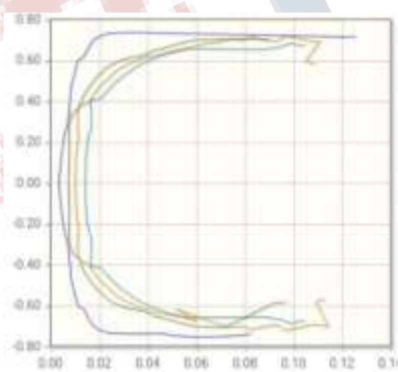

Figure. 2.8 C_L v/s C_D

From figure 2.1 to figure 2.8 shows the results obtained from the simulated control parameters variations and the actual results may differ due to different errors and other uncontrollable factors introduced while testing.

3 Structure and Material:

The structure of the fuselage is analogous to any other aircraft fuselage with its truss and other internal structural parts made from Titanium. The skin of the fuselage and wing uses Aluminum alloy 2024. Wing ribs are more preferably manufactured using composite materials due to the loads and stresses they are exposed to due to the tilt mechanism, engine weight and other fatigue stresses. Spars, in many modern aircrafts use composites like Carbon Fiber or Kevlar. The tail section is attached to the fuselage through a beam like structure. The V configuration reduces weight significantly as it requires only two airfoil structures instead of three as in classical design thus decreasing the load by approximately 1/3rd for the tail section. Material for tail in modern day aircraft is usually fiber polymer composite.

Whereas for the prototype, the tilt wings are made using the High density foam, supported by rib-like structures at the ends and junctions using Balsa wood. The same technique is followed by fuselage and the tail section. Adhesive materials used for joining purpose are Epoxy, Hot Glue and normal glue.

4 Basic specifications for prototype:

Material	High density foam, Balsa Wood, Depron
Adhesives	Hot glue, Epoxy, Normal glue
Motors	Brushless 1200KV
Battery	LiPo 3000mAh 3 cell
Servo	2 HITEC HS 5085MG
Airfoil	NACA 0006
Weight	2 to 2.5 kg
Empennage	V tail

5 Flight Execution:

As discussed above, the design is derived from Boeing's V 22 and a typical Bi-copter, hence the working procedure is also similar. Initially for Vertical takeoff, both the wings will be in 900 position, thus vectoring the thrust vertically downwards and lifting the aircraft as in V 22. The usual maneuver during this phase will be like a Bi-copter.

After attaining a certain altitude, the wings will transition to the horizontal position, thus vectoring the thrust parallel to the headwind to gain forward velocity. After the transition the aircraft functions as a conventional airplane with the same primary and secondary control surfaces with the operating mechanisms similar to that in a V tail aircraft. To hover at a certain location for a longer period of time, the wings must be shifted back to the vertical position and again transitioning the aircraft into a Bi-copter.

For vertical landing, 900 position of the wing has to be maintained and gently lower the thrust power to minimal necessary to bring down the whole aircraft in consideration with its weight. The aircraft can, however, opt for a usual long runway takeoff and landing in certain circumstances with no transition required at all and hence function as a conventional aircraft.

IV. ADVANTAGES

1) This type of design provides more degrees of freedom and better maneuverability than a Bi-copter.
2) Tilt wing technique allows easier control just like an airplane with primary and secondary control surfaces.
3) Hybrid property of the design also enables the UAV to hover at a certain location for a longer period of time.
4) Situation of stall can be avoided in this type of design due to the tilt wing mechanism.
5) Very short or rather no runway is required for takeoff or landing, thus saving a lot of landmass required to construct an airport.
6) The V-tail design used instead of vertical and horizontal stabilizer is much efficient in terms of maneuverability as well as the weight (taking tail section under consideration).
7) For stealth UAVs with a V tail the angle between the lifting surfaces is about 1200 so there is less chance that the radar wave is reflected back to the source.

V. DISADVANTAGES

1) Due to the tilt wing mechanism accompanied with the bi-copter model, the UAV has a major disadvantage that it cannot move backwards.
2) Additional amount of power is required to compensate the tilt wing mechanism.
3) More complex flight control system during the transition phase of the flight.

VI. APPLICATIONS

1) It is suited to applications such as inspection and monitoring where the aircraft must maintain a fixed position for a period of time.
2) Ariel mapping of remote and deserted locations as well as of the urban areas.
3) Spraying fertilizers and pesticides on large areas of agricultural land.
4) Surveillance and border patrolling between two nations and in war zones.
5) Spying in the foreign territories and conducting classified operations.
6) Conducting operations in dangerous situations with the help of remote piloting.
7) Surveying rough terrain, mines and caves.

VII. CONCLUSION

After a quick summary of the characteristics of the tactical UAV class, this paper demonstrates the need for designing an aircraft with a VTOL capacity. It nevertheless enhances the fact that such an implementation should be carried out endeavoring to decrease as much as possible the performance loss compared to conventional designs. Combined design of a VTOL aircraft (V 22) and a UAV (Bi-copter) has retained its characteristics of faster speed and Vertical Takeoff and Landing derived from V 22 and adding to it the characteristics of hovering and stability from the Bi-copter. Extension of other characteristics like better maneuverability than a bi-copter as it literally becomes an airplane after wing transition and hence can use all the control surfaces identical to an airplane thus giving it more degrees of freedom than a bi-copter. The remotely controlled UAV is of a greater advantage for applications that can endanger human lives. Wider available parameters constitute to a wider array of applications.

VIII. REFERENCE

[1] Muhammad Rafi Hadytama, Rianto A Sasongnko,"Dynamics simulation and analysis of transition stage of tilt rotor aircraft," Applied Mechanics and Materials. 842,251-258, 2016.

[2] Kanaiya Agarwal, Punit Shrivastav," Multi-rotors: A revolution in unmanned aerial vehicle," International Journal of Science and Reserch, 4(11), 1800-1804,2015.

[3] Jean-Jacques Thibert, Jacqus Gallot, "Advanced research on helicopter blade airfoils".

[4] K J Badcock, MA Woodgate,BE Richards, "The application of sparse matrix techniques for the CFD based aeroelastic bifurcation analysis of a symmetric aerofoil." AIAA Journal 42(5), 883-892, 2004.

[5] Xu Yang, Liang Dong, Wu Liaoni, Song Yangyang,"Design and implementation of twin-rotor tail-sitter UAV,2015 IEEE Advanced Information Technology,"Electronic and Automation Control Conference(IAEAC), 406-410, 2015.

[6] Kevin P McGonigle, John Ferraro, James P Cycon,"Unmanned VTOL ground surveillance vehicle," US Patent 5,575,438,1996.

