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A Review on Design and Analysis of Switch UAV based on Slam Network

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Abstract: The project aims at designing, modelling and analysis of a fixed wing vertical take of landing (VTOL) UAV (Transitional aircraft), (Hybrid drone) and evaluate its performance of airfoil at different angle of attacks. The aircraft possess the merits of fixed wing aircraft which includes high speed, endurance and range and (VTOL) which includes hovering capability and precise low speed flight response which is extremely helpful in remote areas. The CAD modelling of the UAV is done with help of CATIA software The mathematical modelling is done using MATLAB & SIMULINK analysis of the airfoil using ANSYS (CFD simulation). Ultimately the project aims to develop a high-performance UAV that can take off and land vertically while providing efficient forward flight capabilities where the UAV is required to operate in harsh and extreme environmental conditions.

Keywords: Fixed wing, performance, low speed flight, endurance & range.

I. INTRODUCTION

A vertical take-off and landing (VTOL) aircraft is one that can take off and land vertically without relying on a runway. This classification can include a variety of types of aircraft including helicopters as well as thrust-vectoring fixed-wing aircraft and other hybrid aircraft with powered rotors such as Cyclogyro/cyclocopters and gyrodynes. Some VTOL aircraft can operate in other modes as well, such as CTOL (conventional take-off & landing), STOL (short take-off & landing), or STOVL (short take-off & vertical landing). Others, such as some helicopters, can only operate as VTOL, due to the aircraft lacking landing gear that can handle taxiing. VTOL is a subset of V/STOL (vertical or short take-off & landing). Some lighter-than-air aircraft also qualify as VTOL aircraft, as they can hover, takeoff and land with vertical approach/departure profiles.

- **SLAM NETWORK:** SLAM refers to a class of algorithms and techniques that enable a device, typically a robot or a computer system, to create a map of its surroundings while simultaneously locating itself within that map in real-time. The goal of SLAM is to allow an autonomous system to navigate an unknown environment by building a map of it and determining its own position within that map.

Key components of SLAM include:
Localization: Determining the robot's position within its environment.
Mapping: Creating a representation of the environment.

- SLAM is used in various applications, such as autonomous vehicles, drones, and augmented reality systems. The algorithms involved in SLAM leverage sensor data, such as information from cameras, lidar, radar, or other sensors, to make real-time decisions about the system's location and the surrounding environment. If "Slam network" refers to something specific, such as a blockchain network, social network, or another type of network, I recommend checking the latest sources or the official documentation for accurate and up-to-date information.

- **VTOL UAV:** The evolution in the machine complexity of both military aircraft & UAV's and the increase in civil Air traffic with limited runways has led to development of new category of aircraft called Transitional aircraft. Transitional aircraft systems capable of flying as fixed wing aircraft and rotorcraft as well as transition between these modes when desired. Operations in rotorcraft mode makes the aircraft possible to vertical takeoff and landing (VTOL), fly at a low-speed hover and perform some difficult maneuvers. The fixed wing mode offers increasing range, endurance, attitude, payload carrying capacity and maximum forward speed. Therefore, transitional aircraft extend the aircraft flight envelope, machine and performance of its typical aircraft by incorporating the characteristics of both rotorcraft & fixed wing airplanes. Unmanned Aerial Vehicles (UAVs), also known as drones, come in various forms and configurations to serve different purposes. One specific type of UAV is the Vertical Takeoff and Landing (VTOL) UAV. VTOL UAVs

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have the capability to take off, hover, and land vertically, eliminating the need for a runway. This flexibility allows them to operate in confined spaces and areas with limited infrastructure.

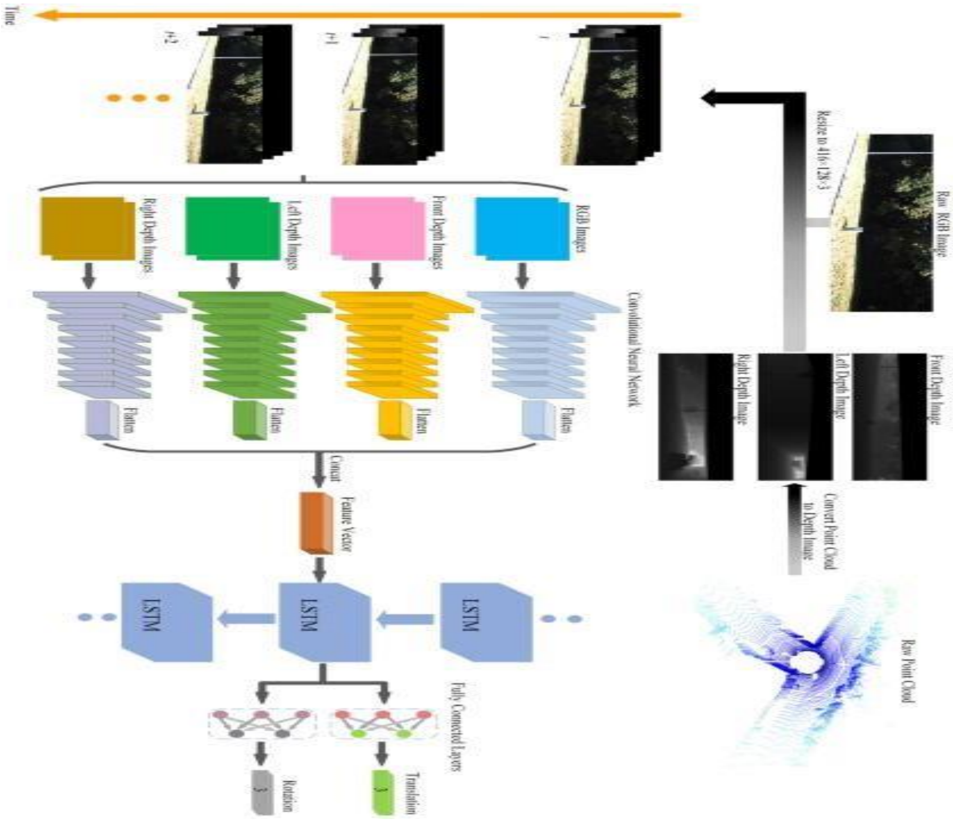

Fig 1 Basic Structure for SLAM Network

- **Vertical Take-off and Landing:** VTOL UAVs have the ability to ascend and descend vertically, much like a helicopter. This is in contrast to fixed-wing UAVs, which require a runway for takeoff and landing.

- **Hybrid Design:** VTOL UAVs often feature a hybrid design that combines the vertical flight capability of helicopters with the efficiency and speed of fixed-wing aircraft. This design allows them to transition between vertical and horizontal flight as needed.

- **Versatility:** VTOL UAVs are highly versatile and can be deployed in various applications, including surveillance, reconnaissance, mapping, agriculture, and even package delivery. Their ability to operate in tight spaces makes them suitable for urban environments.

- **Advantages:**

- **Flexibility:** VTOL UAVs can operate in areas where traditional fixed-wing aircraft might face limitations, such as confined spaces, urban environments, or regions with limited infrastructure.

- **Ease of Deployment:** Since they don’t require a runway, VTOL UAVs can be deployed quickly and from a variety of locations, making them suitable for rapid response situations.

- **Hovering Capability:** The ability to hover provides VTOL UAVs with the advantage of stable aerial observations. This is particularly useful for tasks like surveillance, monitoring, or data collection.

- **Transition Capability:** Some VTOL UAVs can transition between vertical and horizontal flight, combining the benefits of both modes. This is especially valuable for covering larger distances efficiently.

- **Applications:**

- **Surveillance and Reconnaissance:** VTOL UAVs are often used for surveillance and reconnaissance missions due to their ability to hover and cover specific areas with high precision.

- **Mapping and Surveying:** The stable hovering capability makes VTOL UAVs well-suited for mapping and surveying applications, allowing them to capture detailed and accurate data.

- **Agriculture:** VTOL UAVs can be employed in agriculture for tasks such as crop monitoring, pest control, and precision agriculture.

- **Search and Rescue:** The agility and vertical takeoff/landing capability make VTOL UAVs valuable in search and rescue operations, especially in challenging or remote terrain.

- **Military and Defense:** VTOL UAVs are widely used in military applications for reconnaissance, surveillance, and intelligence gathering.

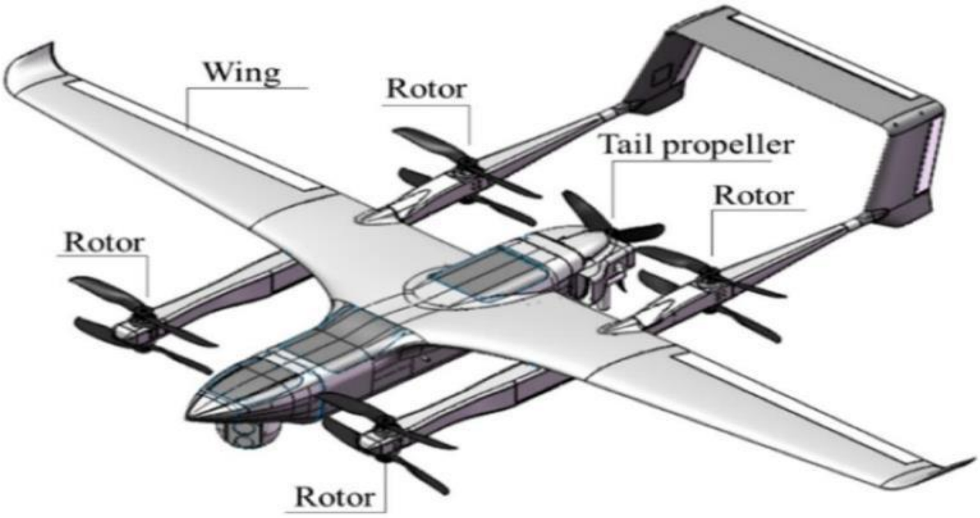

Fig 2 Hybrid Wing VTOL UAV

- **Types of UAV Rotor :**Unmanned Aerial Vehicles (UAVs) use different types of rotor engines or propulsion systems, depending on their design, intended purpose, and size. Here are some common types of rotor engines used in UAVs:

- **Quadcopters:** These UAVs have four rotors arranged in a square configuration. They are popular for their stability and agility.

Fig 3 Multirotor System

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- **Single Main Rotor:** Traditional helicopters with a single large rotor on the top provide lift, and a smaller tail rotor is used for stability and control.

Fig 4. Single Rotor system

- **Quad Tiltrotor:** Combining the features of both fixed-wing and rotary-wing aircraft, quad tiltrotors have four rotors that can tilt to transition between vertical and horizontal flight.

Fig 5 Tiltrotor System

- **Variable-Pitch Quadcopters:** These UAVs have rotors with blades that can change their pitch during flight, providing more control and versatility.

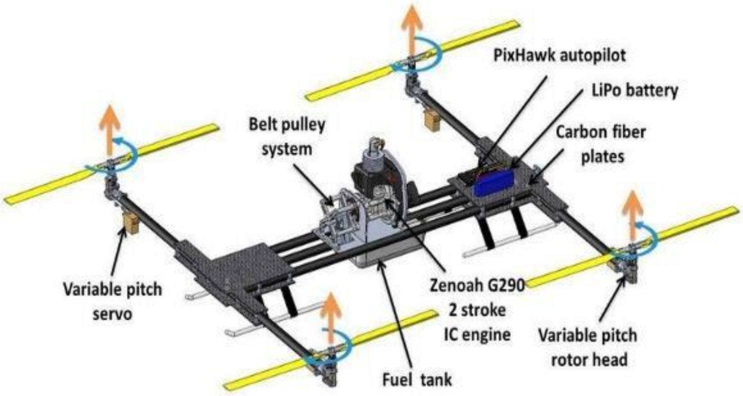

Fig 6 Variable Pitch Rotor

- **Ducted Fan UAVs:** Some UAVs use ducted fans instead of open rotors. Ducted fans can provide additional safety and efficiency, especially in close-quarters operations

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Fig 7 Ducted Fan UAV

- **Hybrid VTOL UAVs:** Combining vertical take-off and landing capability with fixed-wing flight, these UAVs may use a combination of rotors and wings.

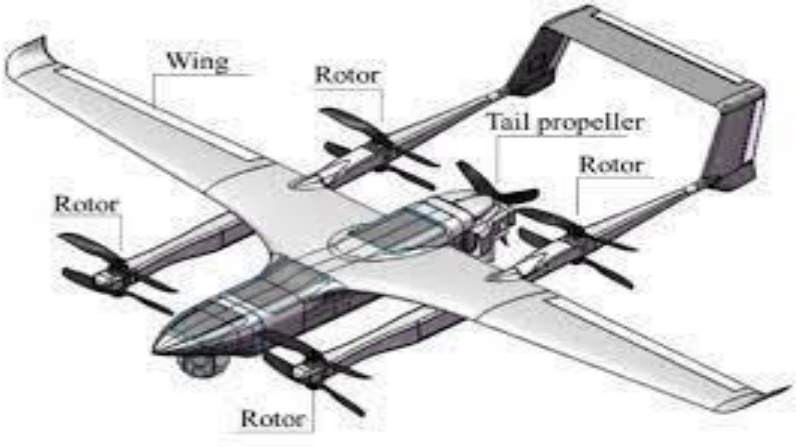

Fig 8 Hybrid System

Each type of rotor engine has its advantages and disadvantages, and the choice depends on the specific requirements of the UAV's mission. Multirotor systems are popular for their simplicity and hovering capabilities, while tiltrotor and coaxial rotor systems offer a balance between vertical and horizontal flight. The selection of a rotor engine is influenced by factors such as payload capacity, range, endurance, and the operational environment of the UAV.

II. OBJECTIVES

1. To attain good flight performance & Aerodynamic efficiencies Such as high altitude and long range, high endurance, high altitude and long duration operation.

2. Design and modelling of fixed wing VTOL UAV its Structural design, Payload Capacity and Stability.

3. Simulation analysis of airfoil at different angle of attack.
4. Aims to reliable operations of the UAV at harsh environments.
5. Operations of UAV applications such as in Military, Disaster response, Cargo transport,
6. Border Security awareness, Aerial photogrammetry

III. INTRODUCTION TO SOFTWARE

- **CATIA:** CATIA (Computer-Aided Three-Dimensional Interactive Application) is a powerful and versatile computer-aided design (CAD) software suite developed by Dassault Systems. Originally released in 1977, CATIA has evolved into a comprehensive solution for product design, engineering, and manufacturing in various industries, including aerospace, automotive, and industrial design. Key features of CATIA include its ability to create 3D models,

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simulate product behavior, and generate detailed engineering drawings. It supports parametric modeling, allowing users to easily modify designs by changing parameters. CATIA also offers advanced capabilities for surface modeling, rendering, and virtual prototyping, facilitating the entire product development process. CATIA is known for its collaborative design environment, enabling multiple users to work on a project simultaneously.

- **ANSYS:** ANSYS is a widely-used simulation software developed by ANSYS Inc. It plays a crucial role in engineering and product development by providing advanced tools for finite element analysis (FEA), computational fluid dynamics (CFD), and other simulation tasks. Engineers and designers use ANSYS to simulate and analyze the behavior of products and systems under various conditions, helping optimize designs, ensure structural integrity, and improve overall performance. With a comprehensive suite of capabilities, ANSYS is instrumental in industries such as aerospace, automotive, electronics, and more, contributing to the efficient and cost-effective development of innovative and reliable products.

- **XFLR 5:** XFLR5 is an open-source software tool designed for the analysis and design of airfoil profiles and wings in aerodynamics. It is particularly popular among students, researchers, and engineers working in the field of aeronautics and aerodynamics. *XFLR5 is* a free, open-source software package for analysis of airfoils, finite wings, and aircraft operating at low Reynolds numbers. It includes: Xfoil’s Direct and Inverse analysis capabilities. Wing design and analysis capabilities based on the Lifting Line Theory, on the Vortex Lattice Method, and on a 3D Panel Method. Many reconfigured airfoils have been designed and analyzed using a parametric study in XFLR5.

IV. DESIGN PARAMETERS

Parameter	Symbol	Values
Length of fixed-wing UAV (m)	L_o	1.78m
Length of the cockpit (m)	Lcockpit	1.0m
Max width of the cockpit (m)	Wcockpit	0.15m
Max width of the tail boom (m)	Wboom	0.025m
Fuselage depth	d	0.17m
Fuselage side area (m^2)	Sfu	0.1438sq.m
Fuselage pitching moment Coeff, at $\alpha = 0$	(Cmo)f	-0.0178

Table1 Parameters of the Fixed-wing VTOL UAV

Parameter	Value
Mass	12 Kg
MAC	0.34 m
Wingspan	2.6 m
Area	0.87 m^2
Ixx	3.551 kgm^2
Iyy	1.4221 kgm^2
Izz	7.4841 kgm^2
Ixy	0.1274 kgm^2

Table 2 Fuselage Specification

- **DESIGN OF AIRFOIL**

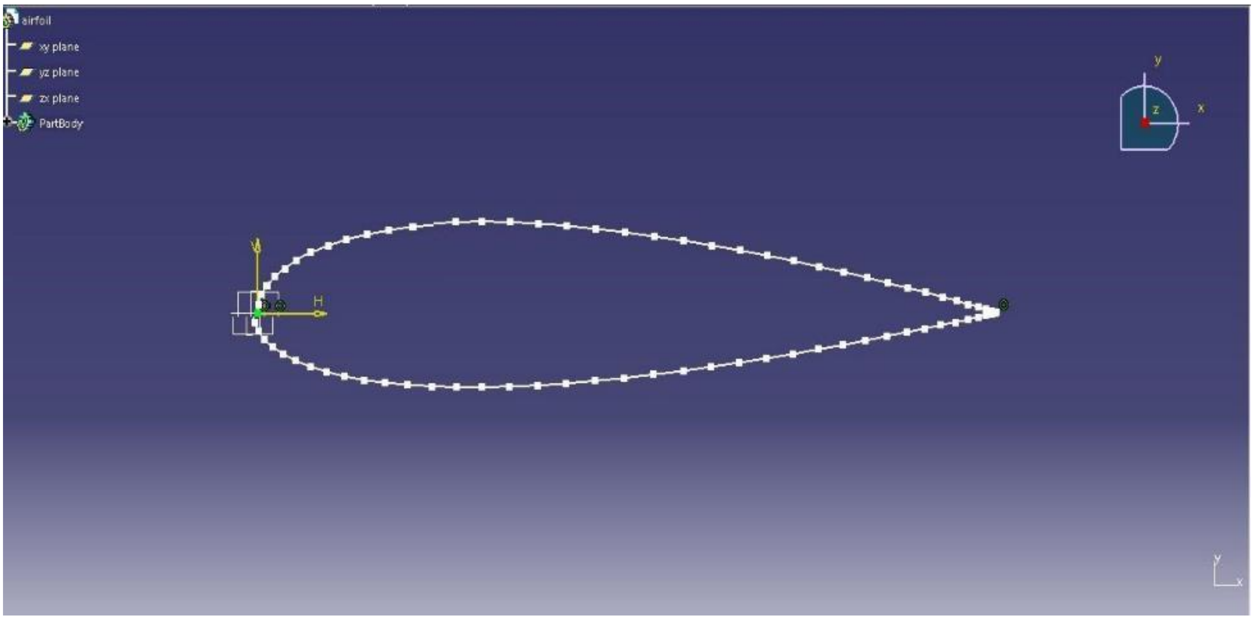

Fig 9 Airfoil Number 1320

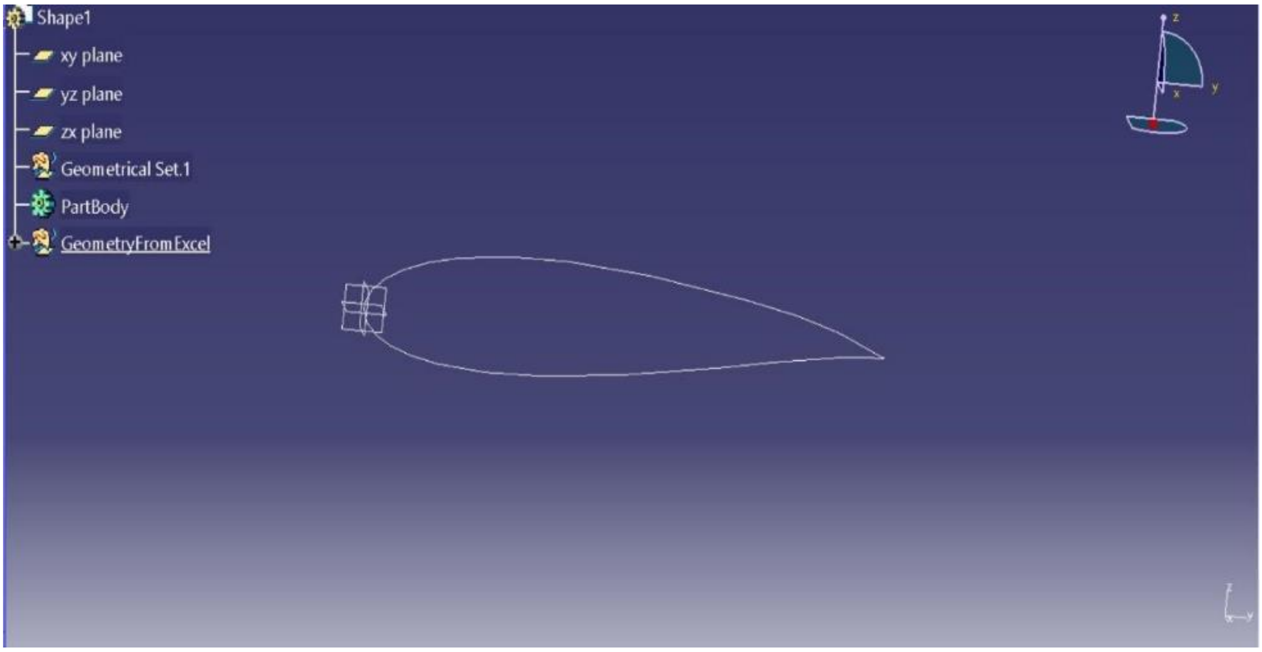

Fig 10 Airfoil Number 2820

- **CO-ORDINATES OF AIRFOIL**

	Airfoil 1320 M=1.0% P=30.0% T=20.0%						
		Airfoil surface		**Camber line**		**Chord line**	
Chord(mm)	100	**X(mm)**	**Y(mm)**	**X(mm)**	**Y(mm)**	**X(mm)**	**Y(mm)**
Radius(mm)	0	100	0	0	0	0	0

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Thickness(%)	100	99.8469	0.0417	0.0783	0.57695	100	0
Origin(%)	0	99.3886	0.166	0.4689	0.335939		
Pitch(deg)	0	98.6278	0.3706	1.1715	0.345024		
		97.5689	0.652	2.1834	0.377674		
		96.2183	1.0053	3.5002	0.426611		
		94.5839	1.4243	5.115	0.488034		
		92.6755	1.9024	7.0188	0.558478		
		90.5046	2.4321	9.2007	0.634442		
		88.0841	3.0052	11.6472	0.71239		
		85.4285	3.6136	14.3429	0.788544		
		82.554	4.2487	17.2704	0.858915		
		79.478	4.9021	20.4101	0.919327		
		76.219	5.565	23.741	0.965653		
		72.7971	6.2288	27.2406	0.993556		
		69.2332	6.8847	30.8694	0.999916		
		65.549	7.5238	34.5676	0.996548		
		61.7672	8.1371	38.3609	0.987837		
		57.9111	8.7152	42.2256	0.973382		
		54.0046	9.2488	46.1374	0.952827		
		50.0719	9.7283	50.0719	0.925869		
		46.1374	10.1444	54.0046	0.892668		

Table 3 Airfoil 1320 Coordinates

		Airfoil 2820 M=2.0% P=80.0% T=20.0%					
		Airfoil surface		**Camber line**		**Chord line**	
Chord(mm)	100	**X(mm)**	**Y(mm)**	**X(mm)**	**Y(mm)**	**X(mm)**	**Y(mm)**
Radius(mm)	0	100.0412	0.2059	0	0	0	0
Thickness(%)	100	99.8938	0.272	0.097	0.5762	100	0
Origin(%)	0	99.4517	0.4682	0.5041	0.264184		
Pitch(deg)	0	98.7156	0.7881	1.2191	0.271182		
		97.6866	1.2216	2.2382	0.299635		
		96.3666	1.7545	3.5557	0.343365		
		94.7581	2.3694	5.1637	0.399958		
		92.8649	3.0457	7.0528	0.467609		

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		90.6919	3.7604	9.2115	0.544935		
		88.2457	4.4884	11.6268	0.630464		
		85.5346	5.203	14.2836	0.722915		
		82.569	5.8769	17.1653	0.820949		
		79.3876	6.4841	20.2539	0.922981		
		76.1126	7.0659	23.5298	1.02753		
		72.6737	7.6437	26.9721	1.133083		
		69.0918	8.209	30.5589	1.237972		
		65.3888	8.7531	34.2672	1.340654		
		61.5878	9.2674	38.0734	1.43946		
		57.7123	9.7427	41.9532	1.53301		
		53.7863	10.1701	45.8819	1.619981		
		49.8346	10.5406	49.8346	1.699156		
		45.8819	10.8451	53.7863	1.769674		

Table 4 Airfoil 2820 Co-ordinate

V. AIRFOIL ANALYSIS

- **Airfoil 1320**

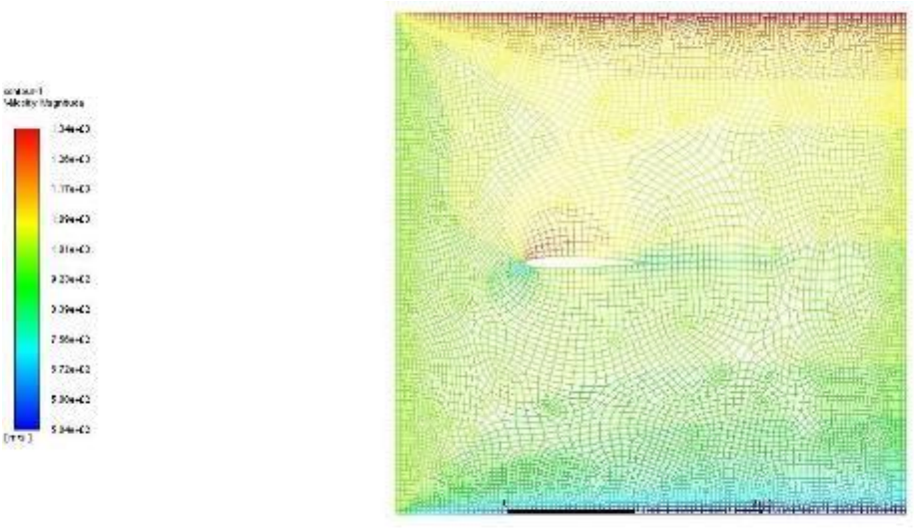

Fig 11 Velocity Magnitude Curve

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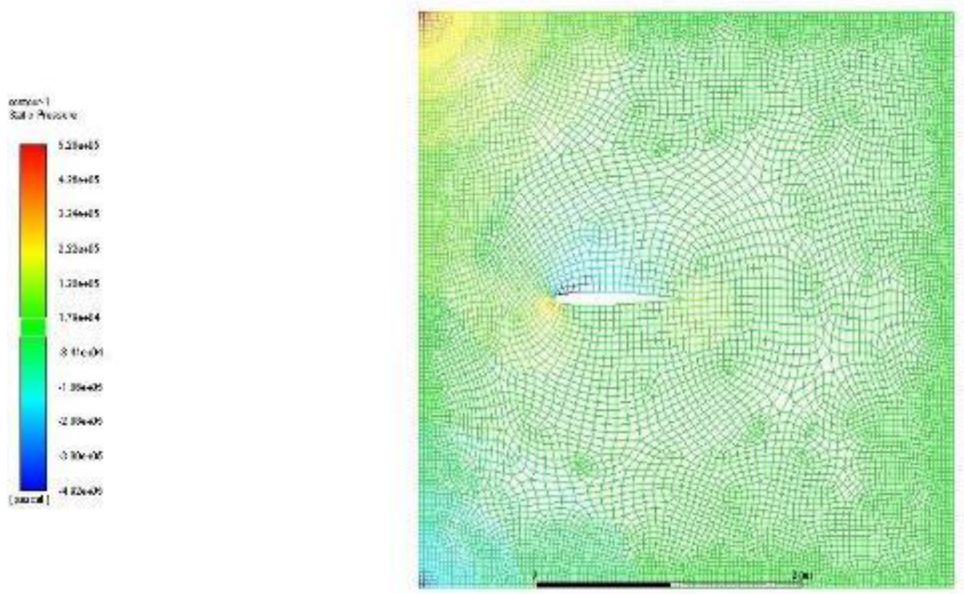

Fig 12 Static Pressure Curve

- **Airfoil 2820**

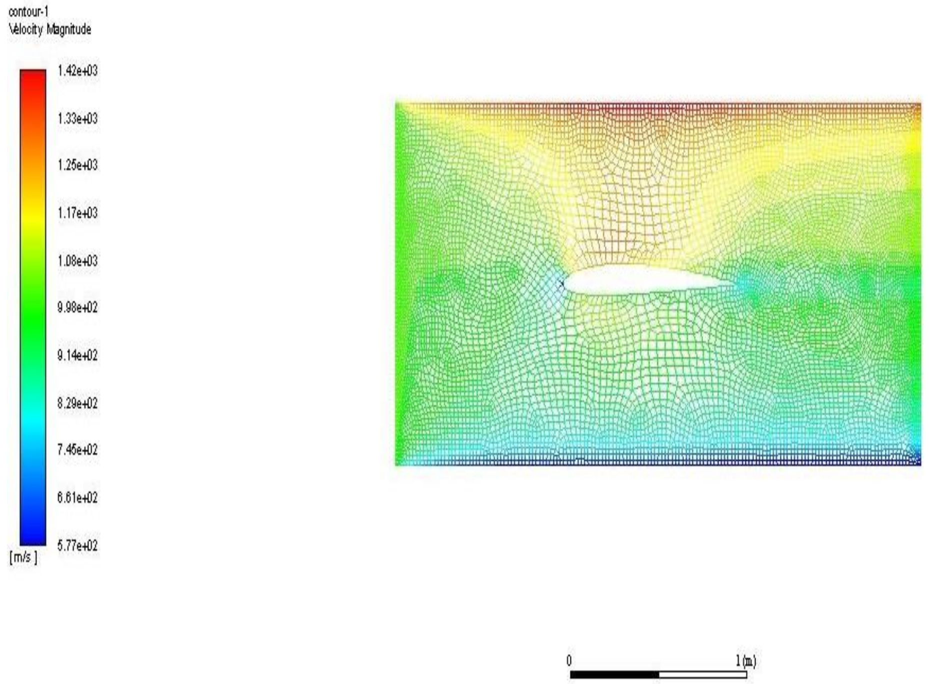

Fig 13 Velocity Magnitude Curve

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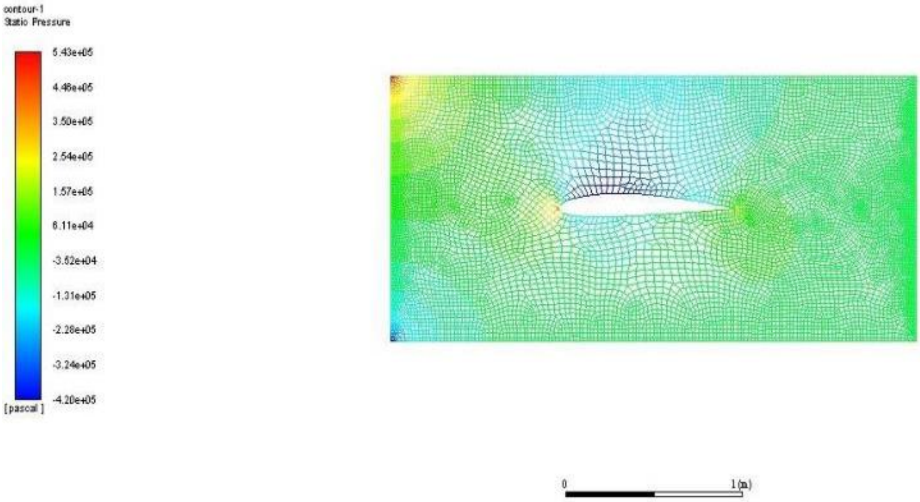
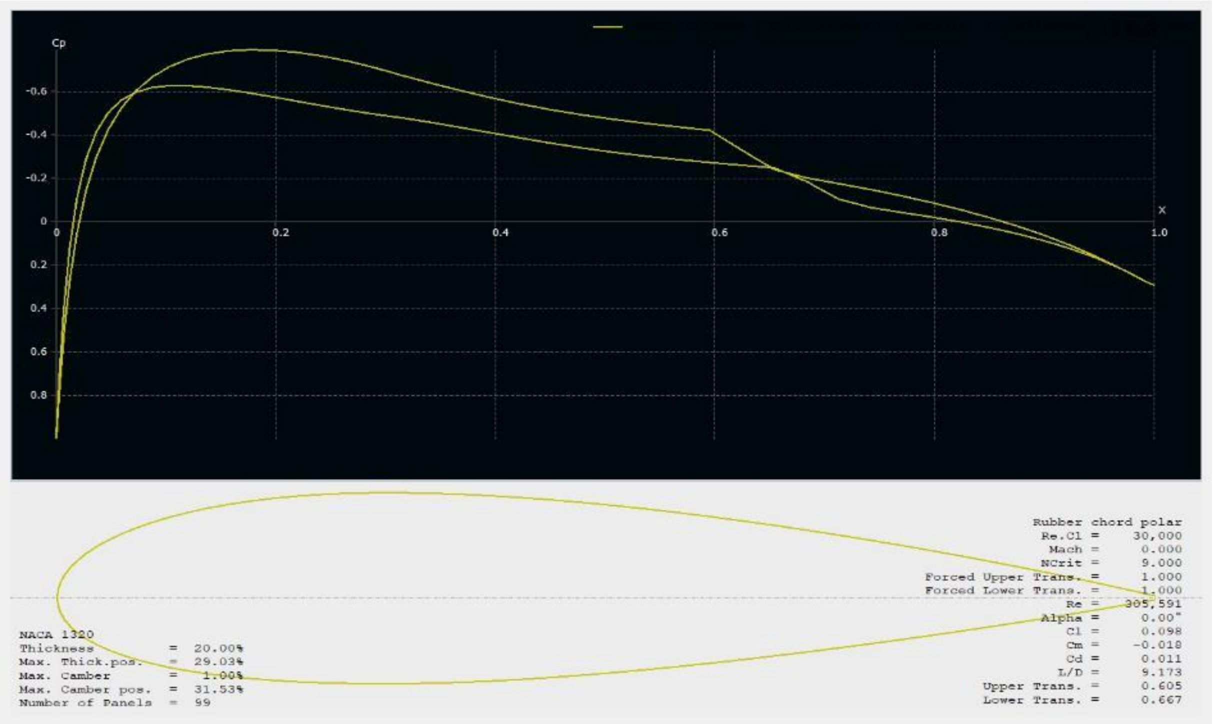


Fig 14 Static Pressure Curve

- **XFLR 5**



```
NACA 1320
Thickness            =  20.00%
Max. Thick.pos.      =  29.03%
Max. Camber          =   1.00%
Max. Camber pos.     =  31.53%
Number of Panels     =  99
```

```
         Rubber chord polar
         Re.Cl =     30,000
          Mach =      0.000
         NCrit =      9.000
Forced Upper Trans. = 1.000
Forced Lower Trans. = 1.000
            Re =    305,591
         Alpha =      0.00°
            Cl =      0.098
            Cm =     -0.018
            Cd =      0.011
           L/D =      9.173
   Upper Trans. =     0.605
   Lower Trans. =     0.667
```

Fig 15 Co-efficient of Pressure for Airfoil 1320

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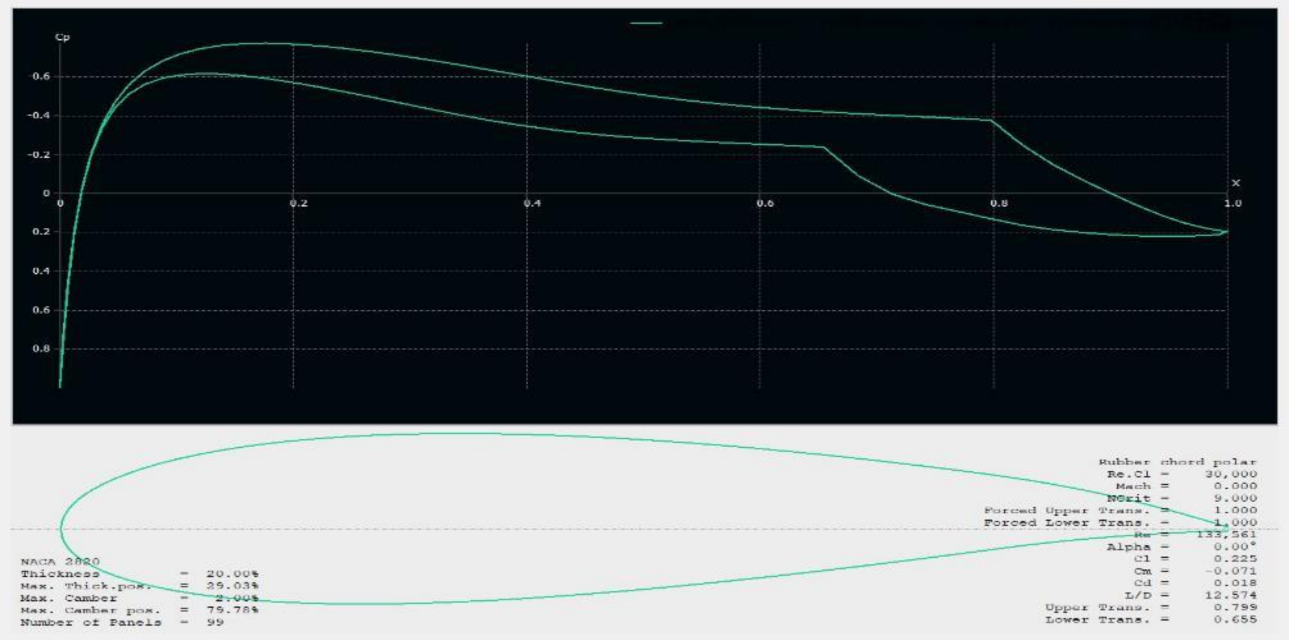
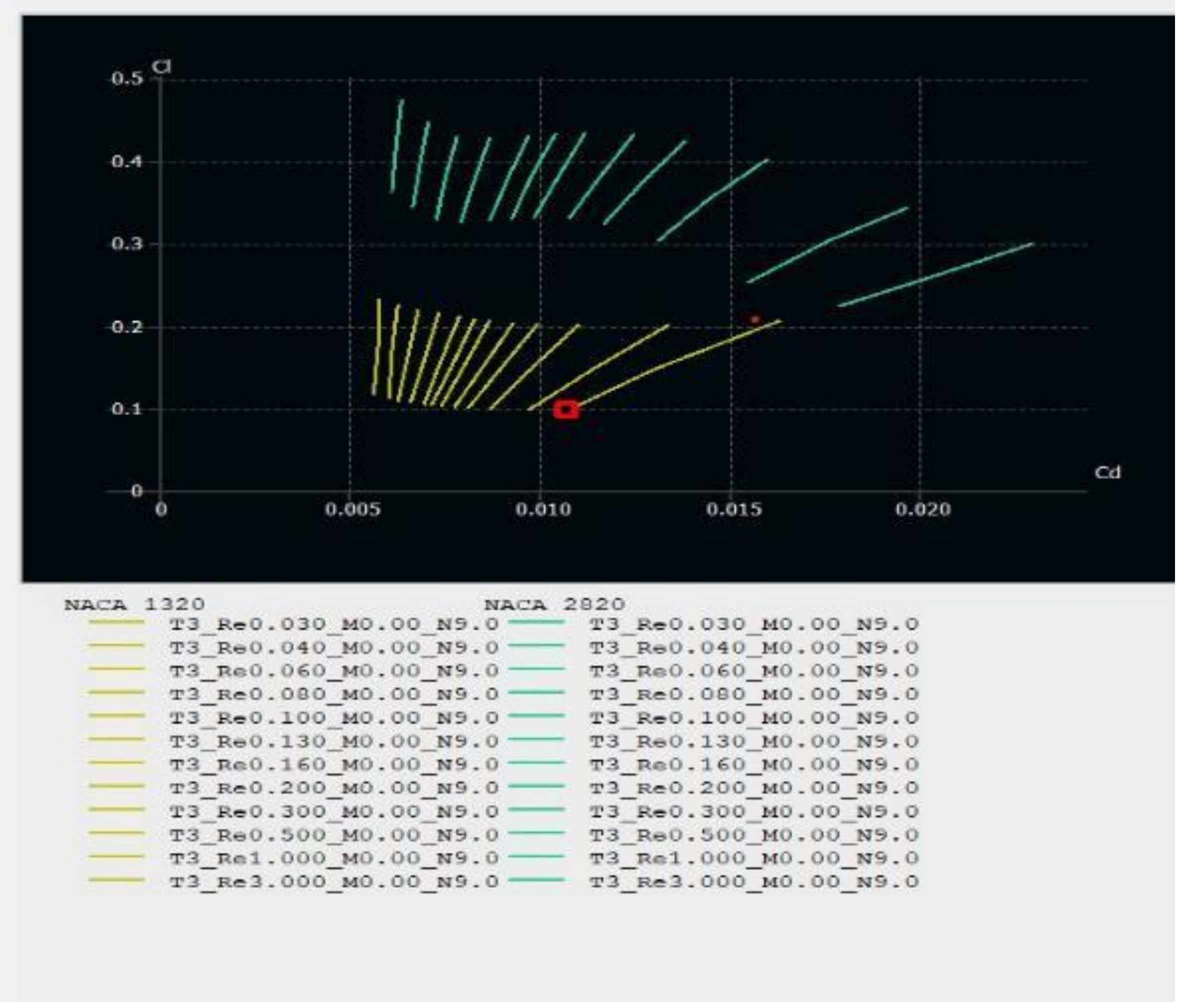


```
                     Rubber chord polar
                    Re.Cl =       30,000
                     Mach =        0.000
                    NCrit =        9.000
      Forced Upper Trans. =        1.000
      Forced Lower Trans. =        1.000
                       Re =      133,561
                    Alpha =        0.00°
                       Cl =        0.225
                       Cm =       -0.071
                       Cd =        0.018
                      L/D =       12.574
             Upper Trans. =        0.799
             Lower Trans. =        0.655
```

```
NACA 2820
Thickness           =  20.00%
Max. Thick.pos.     =  29.03%
Max. Camber         =   2.00%
Max. Camber pos.    =  79.78%
Number of Panels    =  99
```

Fig 16 Co-efficient of Pressure for Airfoil 2820



```
NACA 1320                            NACA 2820
    T3_Re0.030_M0.00_N9.0               T3_Re0.030_M0.00_N9.0
    T3_Re0.040_M0.00_N9.0               T3_Re0.040_M0.00_N9.0
    T3_Re0.060_M0.00_N9.0               T3_Re0.060_M0.00_N9.0
    T3_Re0.080_M0.00_N9.0               T3_Re0.080_M0.00_N9.0
    T3_Re0.100_M0.00_N9.0               T3_Re0.100_M0.00_N9.0
    T3_Re0.130_M0.00_N9.0               T3_Re0.130_M0.00_N9.0
    T3_Re0.160_M0.00_N9.0               T3_Re0.160_M0.00_N9.0
    T3_Re0.200_M0.00_N9.0               T3_Re0.200_M0.00_N9.0
    T3_Re0.300_M0.00_N9.0               T3_Re0.300_M0.00_N9.0
    T3_Re0.500_M0.00_N9.0               T3_Re0.500_M0.00_N9.0
    T3_Re1.000_M0.00_N9.0               T3_Re1.000_M0.00_N9.0
    T3_Re3.000_M0.00_N9.0               T3_Re3.000_M0.00_N9.0
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Fig 17 Comparison of Airfoil

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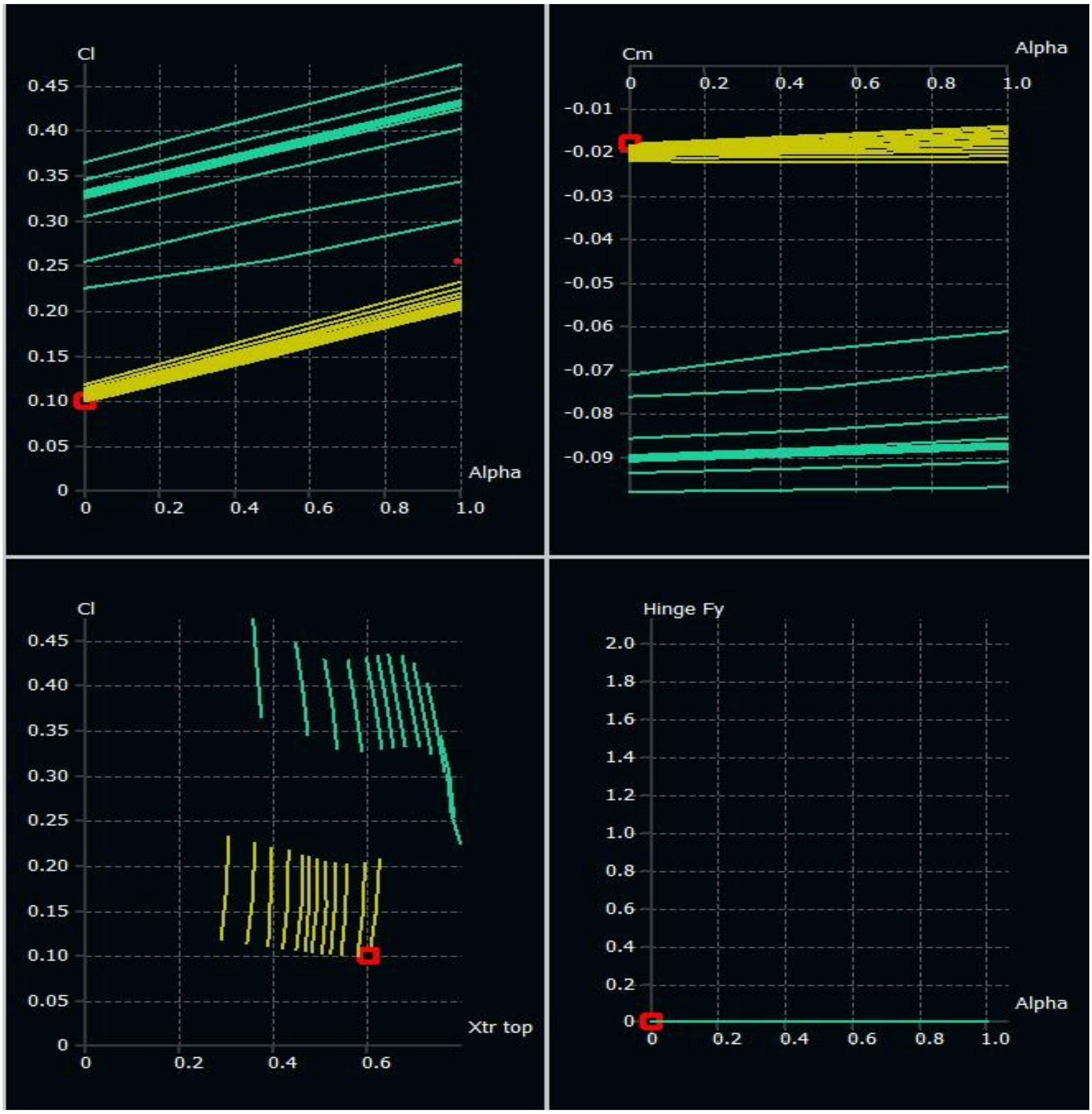

Fig 18 Comparison of Airfoil

Angle of Attack (degrees)	Cp at 25% Chord	Cp at 50% Chord	Cp at 75% Chord	Coefficient of Lift (Cl)
0	-0.1	-0.2	-0.1	0
2	-0.05	-0.15	-0.05	0.2
4	0	-0.1	0	0.5
6	0.1	0.05	0.1	0.8
8	0.2	0.15	0.2	1.2
10	0.3	0.25	0.3	1.5

Table 5 C_p and C_l

Based upon the above results of comparison between the two airfoils 1320 and 2820 we can conclude by saying airfoil 1320 is selected for this project due to its high **C_p/C_l** ratio which increases the range, endurance and efficiency of flight.

VI. DESIGN

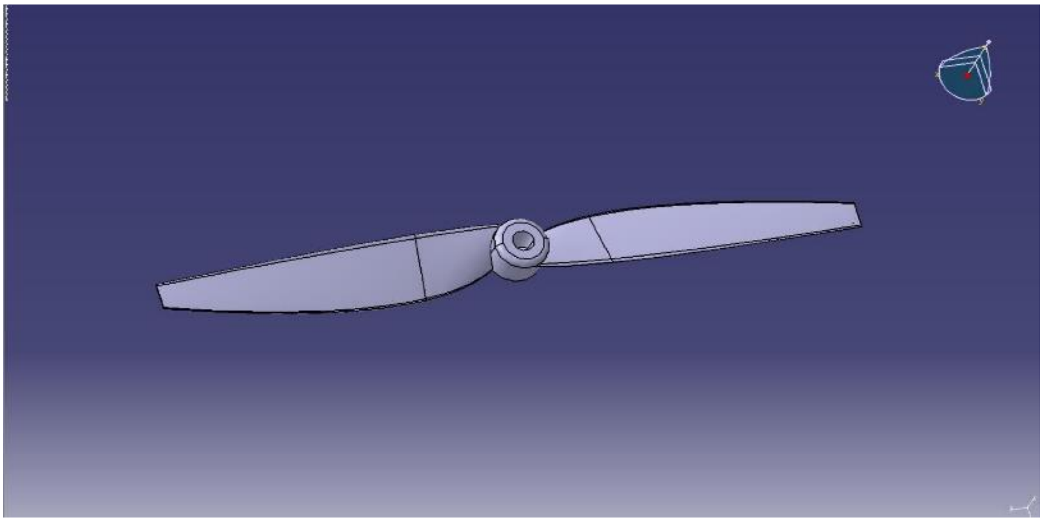

Fig 19.: Small Propellers

Propeller	APC 9045
Quantity	4
Diameter	9.0 inches
Pitch	4.5 inches
Made up of	Carbon fiber
Rotational Speed	Less than 4000 r/min
Thrust	7N

Table 6: Small Propellers Properties

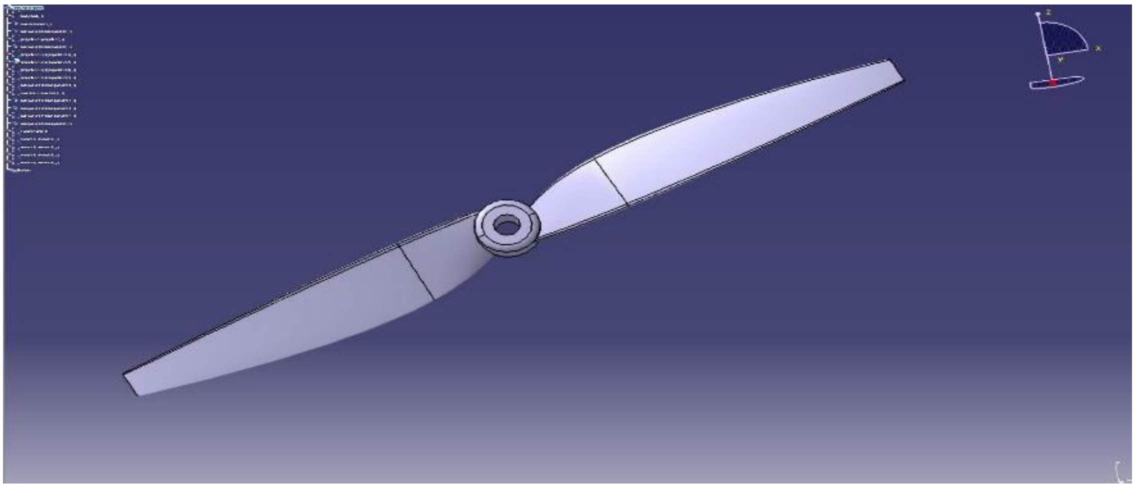

Fig 20: Big Propeller

Propeller	T4013
Quantity	1
Propeller Type	Straight Propeller
Pitch	13 inches
Material	Carbon fiber
Single weight(g)	257
Thrust	13kw
Length(mm)	1016(40 inches)
Optimum RPM	2200-2800RMP/min

Table 7: Big Propeller Properties

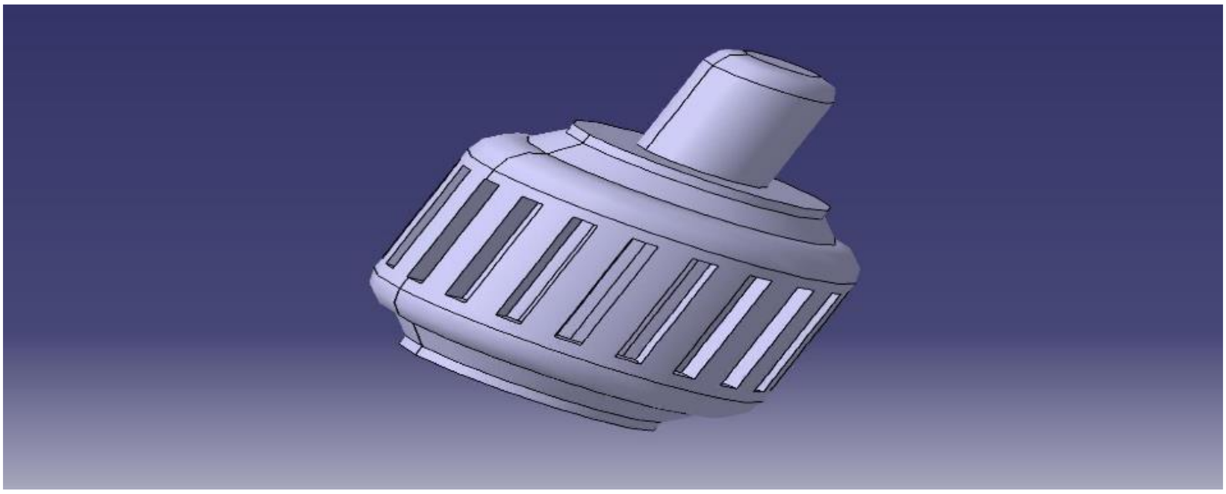

Fig 21: Small Propellers Motors

Model	2212
Quantity	4
Motor KV (RPM/V)	920
Maximum Thrust (gm)	500
Compatible LiPO Batteries	3S – 4S
Rated Voltage(V)	7 – 12
Required ESC (A)	30
Shaft Diameter (mm)	6
Length (mm)	28
Width (mm)	28
Height (mm)	46
Weight (gm)	56
Shipment Weight	0.059 kg
Shipment Dimensions	8 × 6 × 5 cm

Table 8: Small Propellers Motors Properties

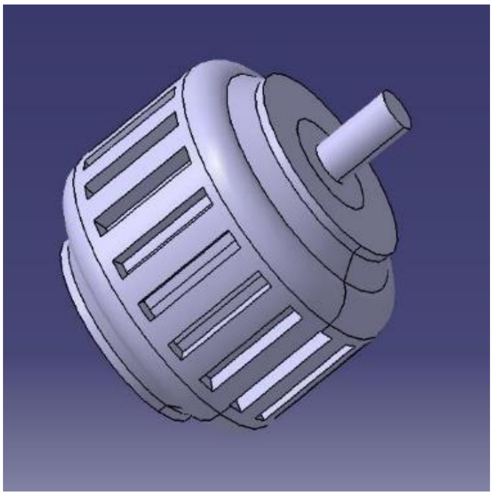

Fig 22: Big Propeller Motor

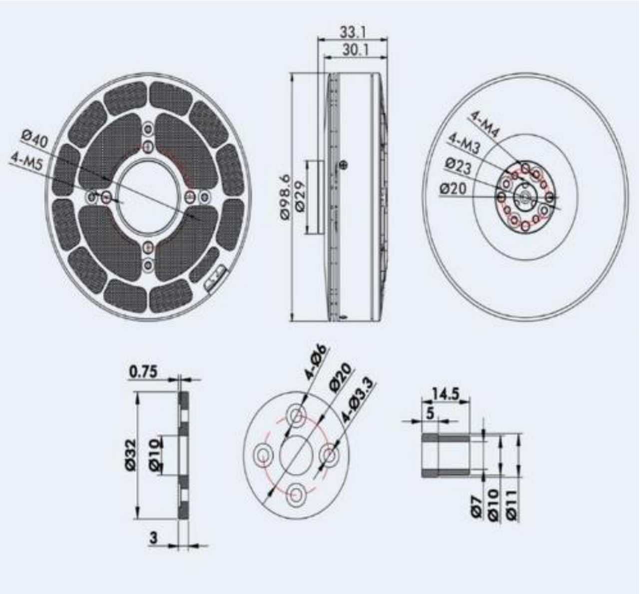

Fig 23: Big Propeller Drawing

Model	Brushless DC Motor
Quantity	1
Motor KV (RPM/V)	1571W
Maximum Thrust (gm)	10060
Compatible LiPO Batteries	3S – 4S
Rated Voltage(V)	125
Maximum Power	1600W
Shaft Diameter (mm)	15
Internal Resistance	101+_5
Propeller Recommendation	28-30
Height (mm)	33.1
Weight (gm)	56
Shipment Weight	0.059 kg

Table 9: Big Propeller Motor Properties

- **Preliminary Design:**

The second stage of the design process is the preliminary design. This design process involves the calculation parts. The calculations are performed on weight estimation, range and endurance, cl and cd, aerodynamics, flight mechanics, flight dynamics, structural analysis.

- **Sizing and Layout:**

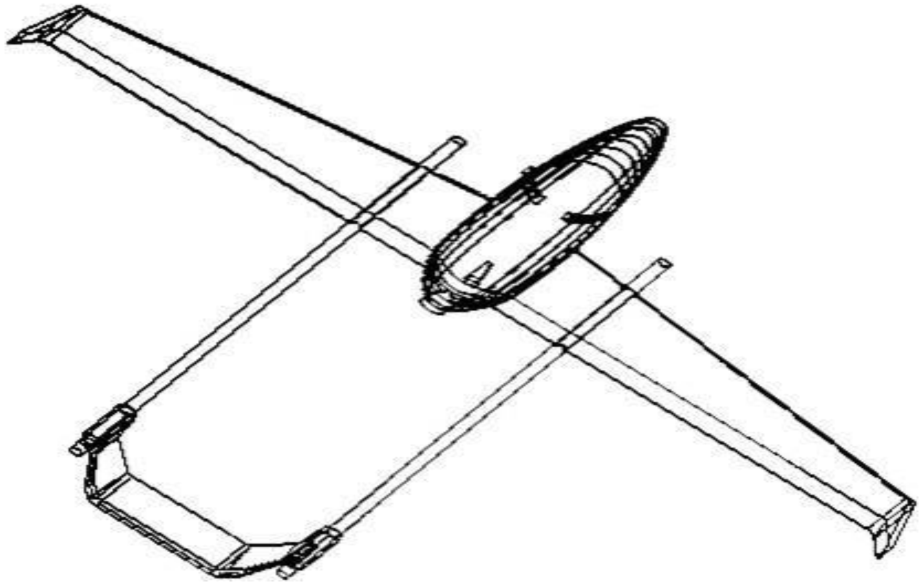

Fig 24: Sizing of the UAV

To design a small-scale VTOL UAV, it is important to limit certain parameters of sizes to a practically reasonable figure so that other parameters concerning dimensions would be feasible for fabrication. The design parameters chosen should also obey known theoretical concepts and equations to confirm that the VTOL UAV will be able to accomplish stable and safety flights across all its flight modes. The general procedures to determine basic structural design parameters are:

1. Estimate the All-Up-Weight of the aircraft
2. Wing Design: Determine the size of the wing loading, wingspan, aspect ratio and chord
3. Fuselage Design: Determine the size of the fuselage
4. Tail Design: Determine the size of the tail wing and its distance from the main wing These general procedures will be used to estimate the size of the prototype.

Parameters	Value
Airfoil	Airfoil 1320
Wing Span [b]	8m
Width Of Wing [w]	3.61m
Root Chord	13.3m
Tip Chord	2.67m
Area Of Tapered Wing [s]	Span * Width = 8 * 3.61 $= 28.88m^2$
Aspect Ratio [A.R]	$A.R = b^2/s$ 64/28.88 A.R = 2.21
Taper Ratio [λ]	λ = Ct / Cr 0.2
Mean Aerodynamic Chord [M.A.C]	M.A.C = 2/5 0∫b/2 C2 dy = 2/3 Cr [1+λ+λ2 / 1+λ2]

	= 2/3 *0.18827 [1+0.194+(0.194)2 / 1+(0.194)2]
	M.A.C = 7.70m
Reynolds Number [Re]	Re = ƒVl / u
	1.225 * 50 * 7.7 / 1.818 * 10 $^{-5}$
	Re = 2594674
Max (Cl / Cd) max	(Cl / Cd) max = 100
Critical Reynolds Number [Ncrit]	Ncrit = 9
	α = 88.7
Cruise [Aircraft Flight Condition]	S = b/2 * CR * (1+λ)
	28.88 * 2 = 8 * CR *(1+ 0.2) CR = 28.88 *2 / 8 *(1 + 0.2) CR = 6.01m
Thrust Coefficient [CT]	CT = λ * CR
	0.2 * 6.01
	CT = 1.202

Table 10: Parameters of Airfoil 1320

Parameters	**Value**
Airfoil	Airfoil 2820
Wing Span [b]	8m
Width Of Wing [w]	4.225m
Root Chord	6.67m
Tip Chord	1.6m
Area Of Tapered Wing [s]	Span * Width = 8 * 4.225 33.8m^2
Aspect Ratio [A.R]	A.R = b^2/s 1.89
Taper Ratio [λ]	λ = Ct / Cr 0.2
Mean Aerodynamic Chord [M.A.C]	M.A.C = 2/5 0∫b/2 C2 dy
	= 2/3 Cr [1+λ+λ2 / 1+λ2]
	3.78m
Reynolds Number [Re]	Re = ƒVl / u
	1.225 * 50 * 3.78 /1.81 * 10 $^{-5}$
	Re = 12730941
Max (Cl / Cd) max	(Cl / Cd) max = 90

Critical Reynolds Number [Ncrit]	Ncrit = 9
	α = 5.5
Cruise [Aircraft Flight Condition]	S = b/2 * CR * (1+ג)
	7.041
Thrust Coefficient [CT]	CT = ג * CR
	CT = 1.4083

Table 11: Parameters of Airfoil 2820

- **3D Modelling:**

In the final design stage, the concept is designed using the software's like CATIA for CAD design, based on the sizing and layout of the design parameters, the 3D model is been developed. Other parts such as the carbon fiber and aluminum frames are less important to model because these parts are known for their reliability and strength during actual flight test and would not be easily be damaged by light crashes. The steps for the 3D modelling are:

1. Determine the airfoil shape of the wing.

2. Project the airfoil cross-section into 3D model

The cross-section (airfoil shape) of the wing is modelled using standard NACA coordinates which are available online. For the proposed prototype, the suitable airfoil would be the NACA 4415 airfoil and the propeller has embedded with airfoil NACA 0012. It has low camber and the lower surface is quite flat and therefore would produce good Lift-Drag ratio for the estimated airspeeds. For the horizontal tail cross-section, NACA 4415 airfoil family is used which is thinner and result in lower drag. As calculated before, the area of the horizontal tail is quite small and therefore the tail is expected to be able to withstand pressure during flight. In addition, both the main and tail wing would be reinforced with aluminum angled beam if the actual flight tests fail to sustain it from crashes.

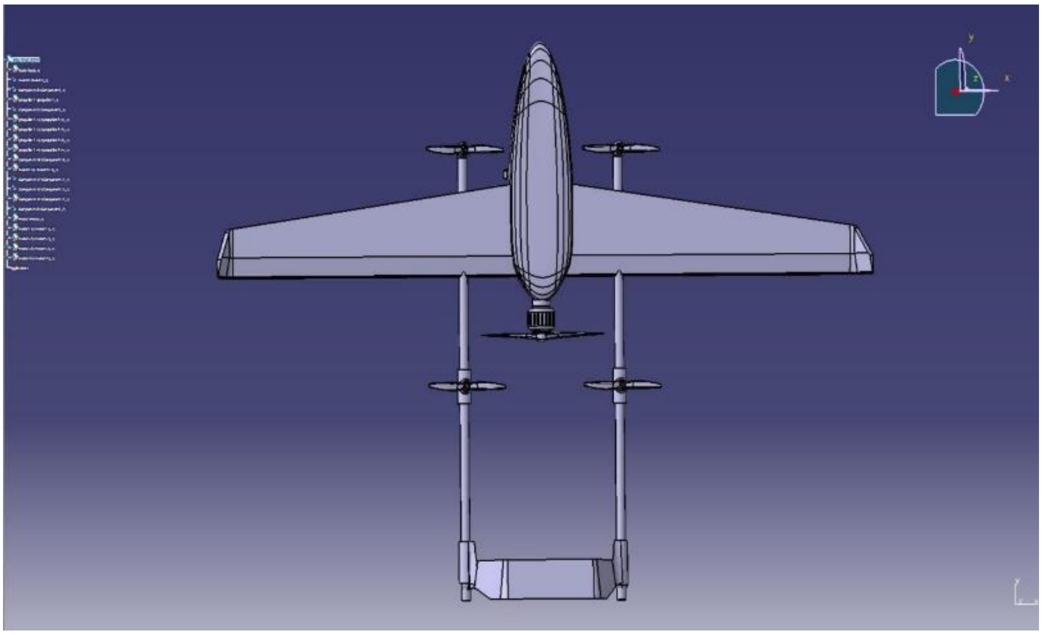

Fig 25: Top View

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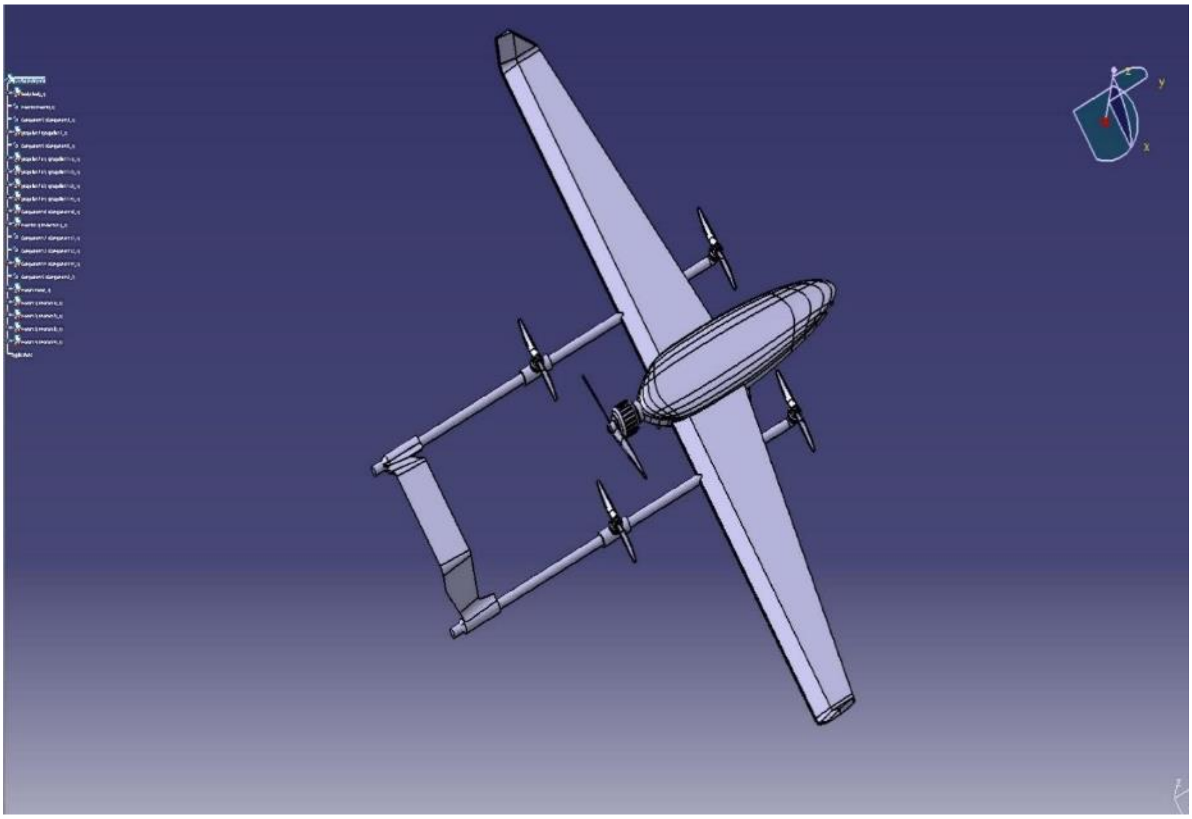

Fig 26: CATIA 3D Model

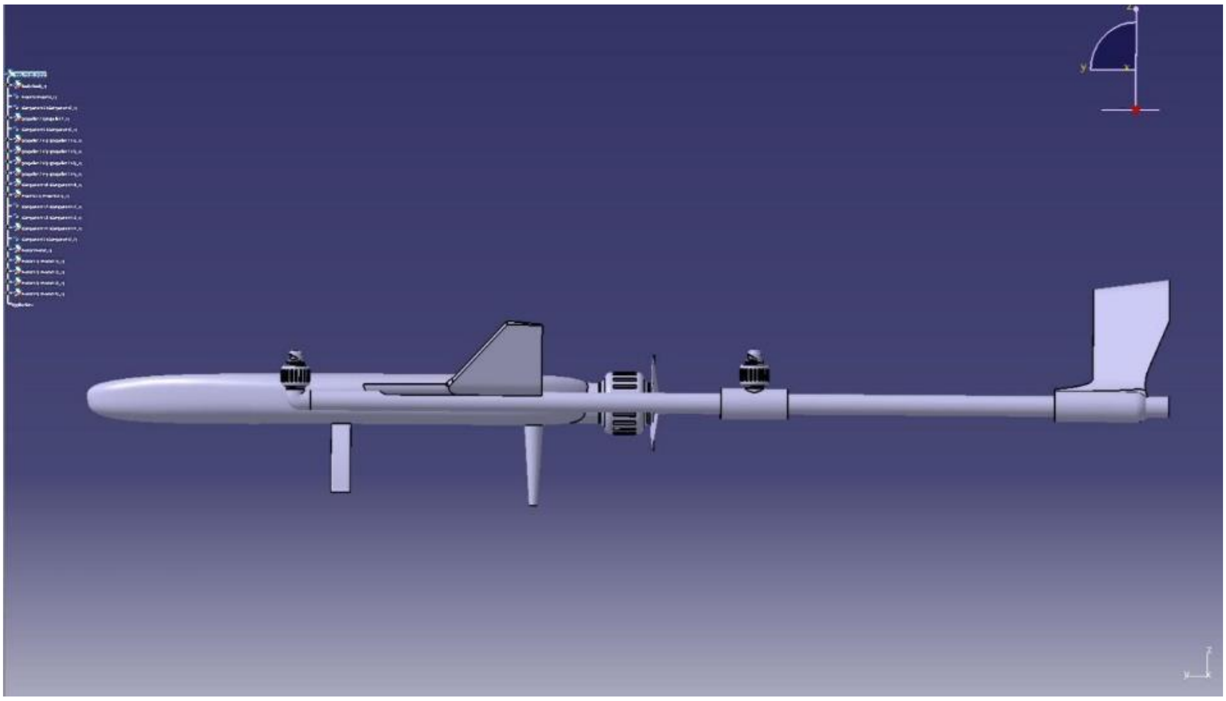

Fig 27: Side View

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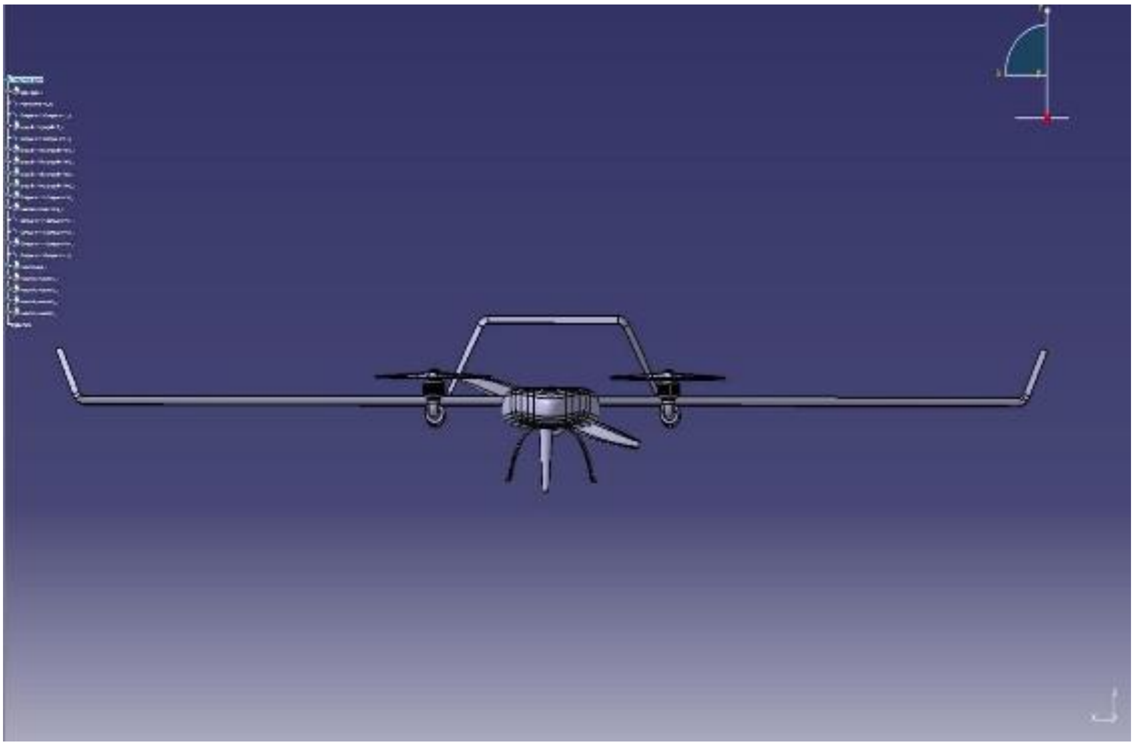

Fig 28: Front View

VII. RESULT AND ANALYSIS

- **CFD ANALYSIS:** The imported CATIA model is subjected to mesh in the ANSYS (ICEM) software and analysis in the ANSYS (fluent) software. This analysis is carried out for different angles of attack and corresponding pressure distributions are taken out. The CATIA model is imported into the ANSYS (ICEM 16.0). After importing, the UAV is sectioned and given named selections and root to obtain fine meshing. A hemispherical control volume is created and the symmetry is created in the geometry. The medium inside the far field is considered as air. Once the geometry is created, the model is now subjected to meshing.

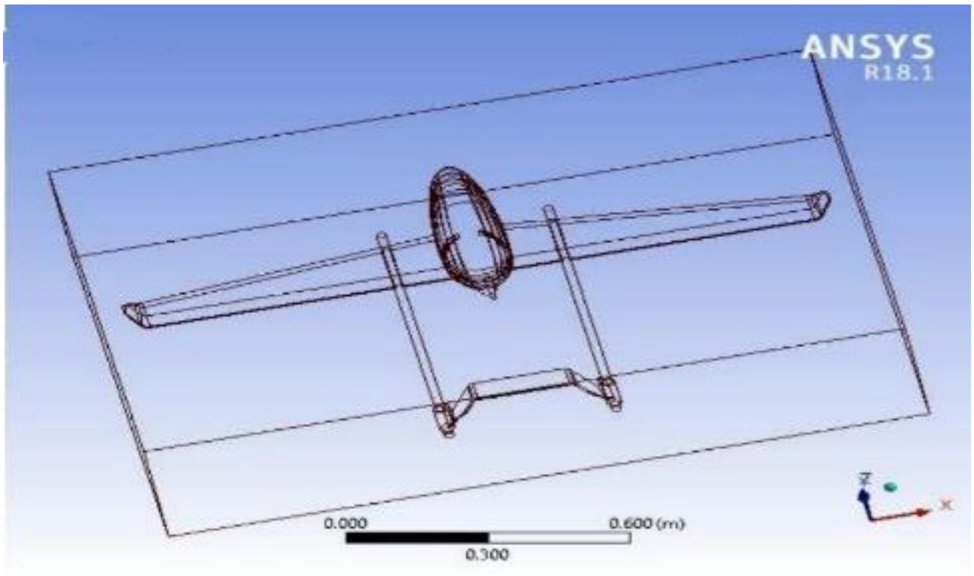

Fig 29: UAV Geometry in Design Modeler

- **Meshing:**

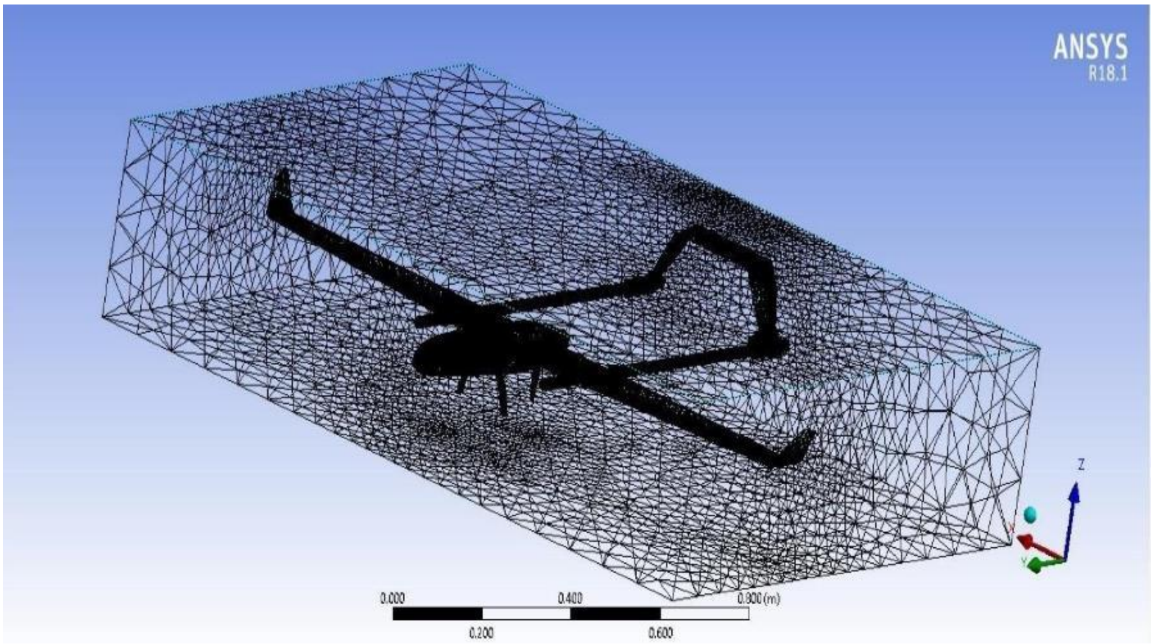

Fig 30: Meshing of the UAV

Tetrahedral meshing is done on the wing along with its control volume and symmetry. The obtained Mesh is now checked for its quality, Skewness and orthogonality. Total number of elements after meshing is 1536272 and the total number of nodes is 278337. Prism layers are now created on the mesh to capture boundary layer with less numerical diffusion. The model is again checked for its quality, Skewness and orthogonality.

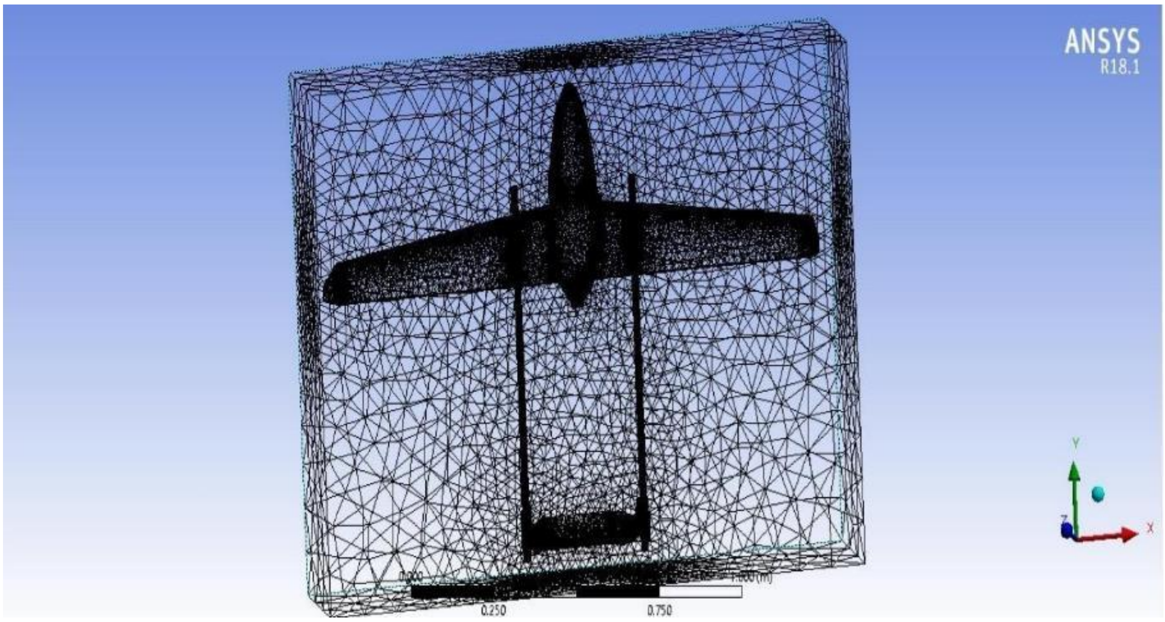

Fig 31: Top view of the Meshing of UAV

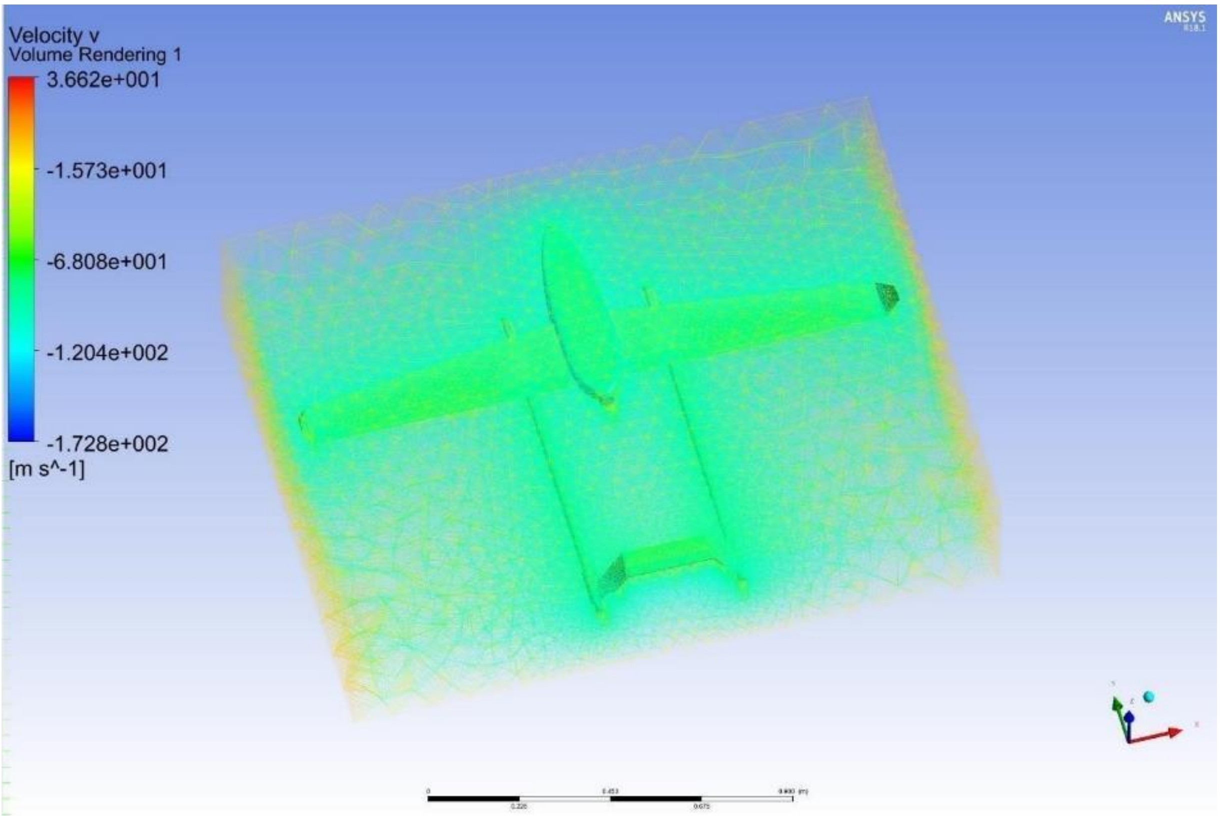

Fig 32: Volume Rendering

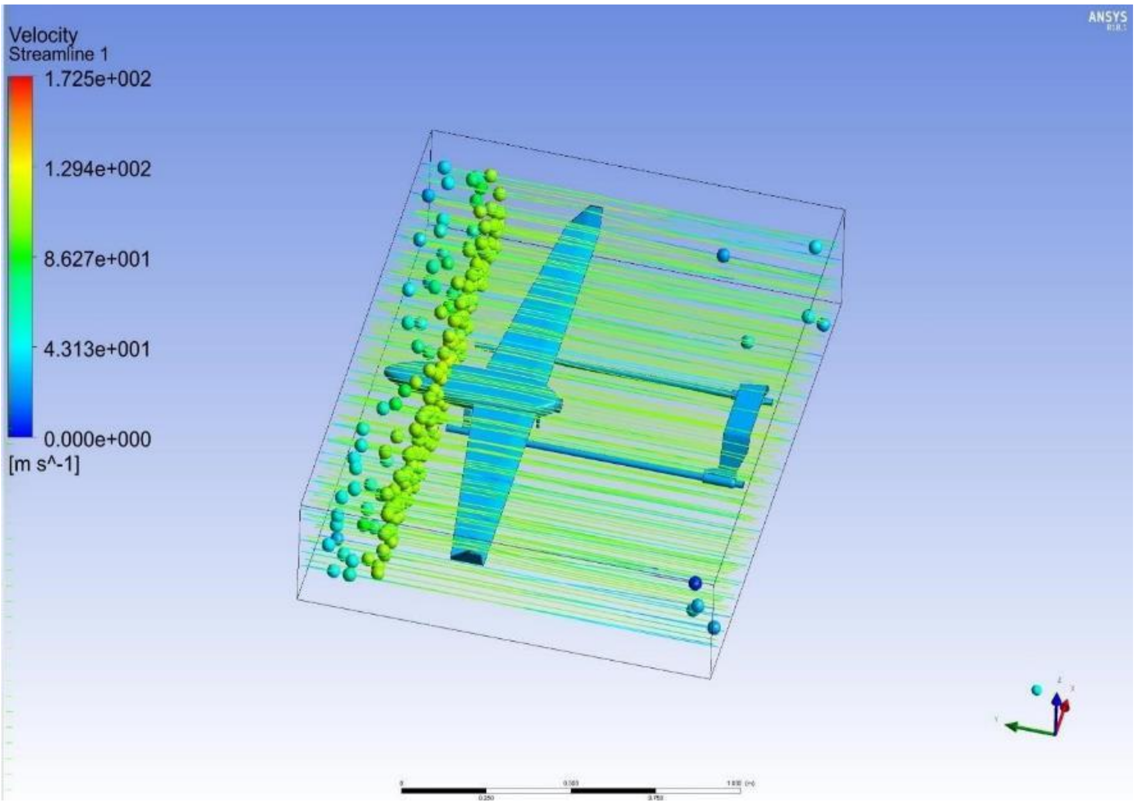

Fig 33: Velocity flow over the streamlines

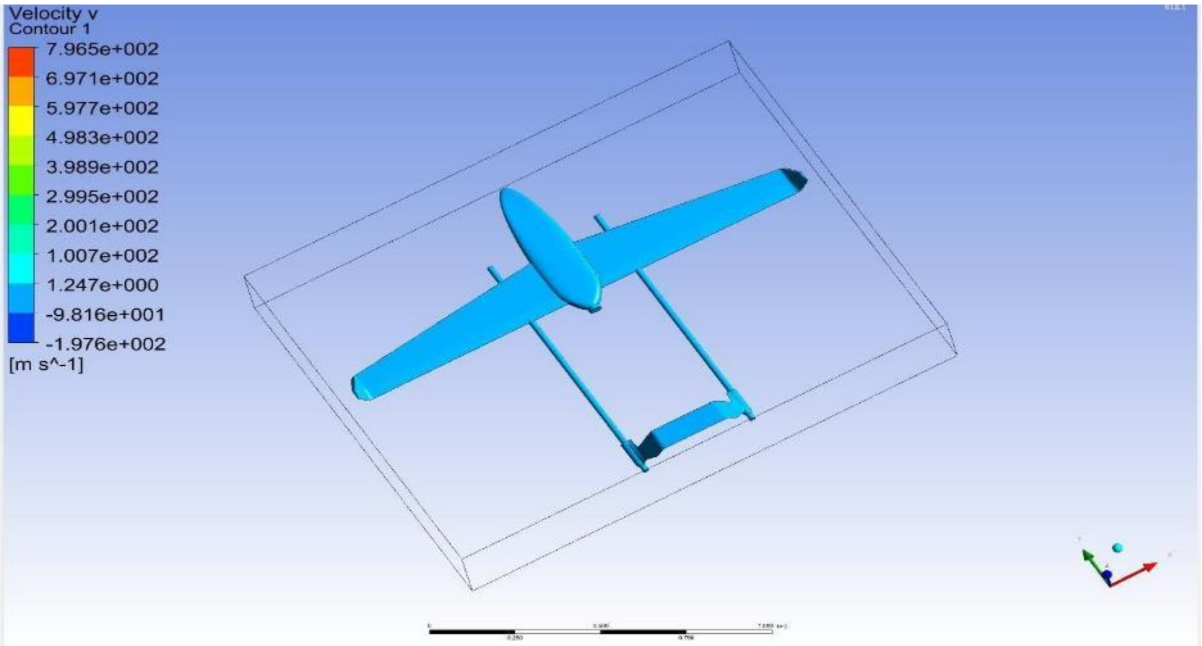

Fig 34: Velocity Counters-I

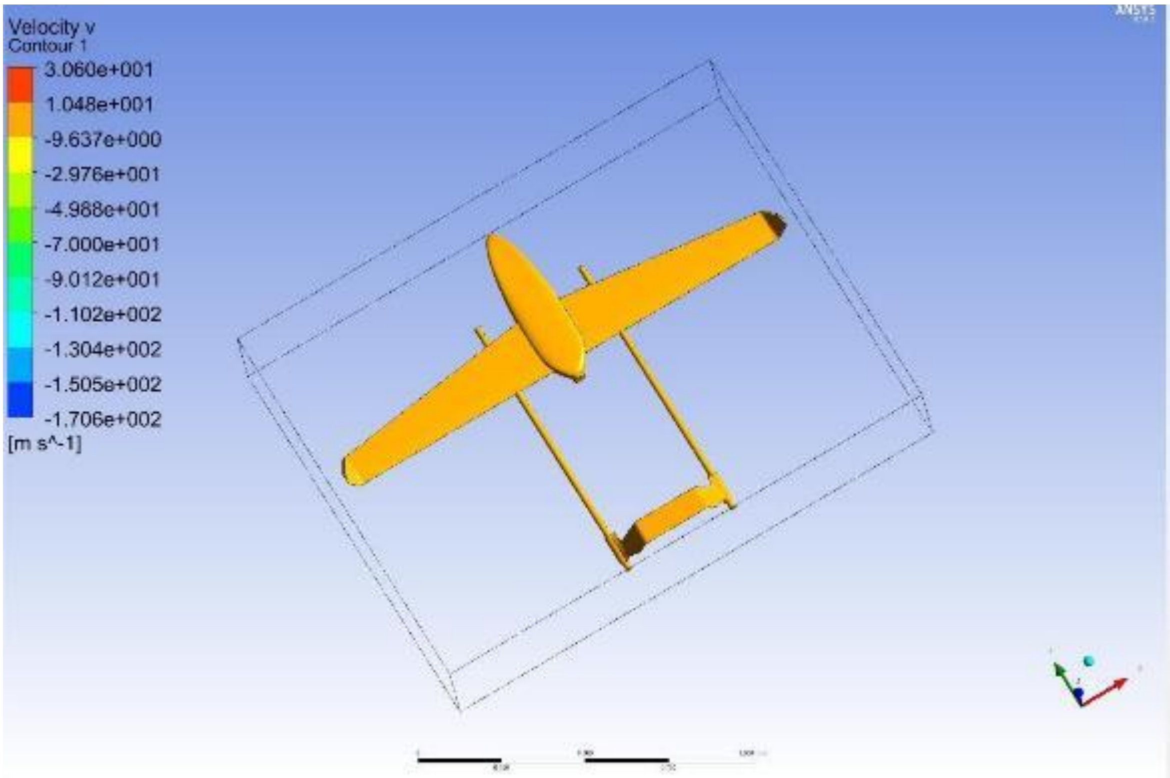

Fig 35: Velocity Counters-II

- **STRUCTURAL ANALYSIS:**

The CADD model from CATIA is imported into ANSYS. It is then subjected to meshing and the analysis is done from the results obtained from CFD. The CADD model of the wing along with the ribs and spars, which is saved as a STEP file is imported into a new database in the ANSYS software. Total mass of the model is 2.27kg.

- **Structural Meshing**

The type of mesh created on the model is two-dimensional shell mesh. Initially, the ribs are meshed with quad and tri elements. Then, the spars are meshed using quad elements with respect to the mesh of the ribs to maintain the

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connectivity. Eventually, the skin is also meshed with quad elements maintaining the connectivity. Once the mesh is completed, equivalence is done and the FE model is verified.

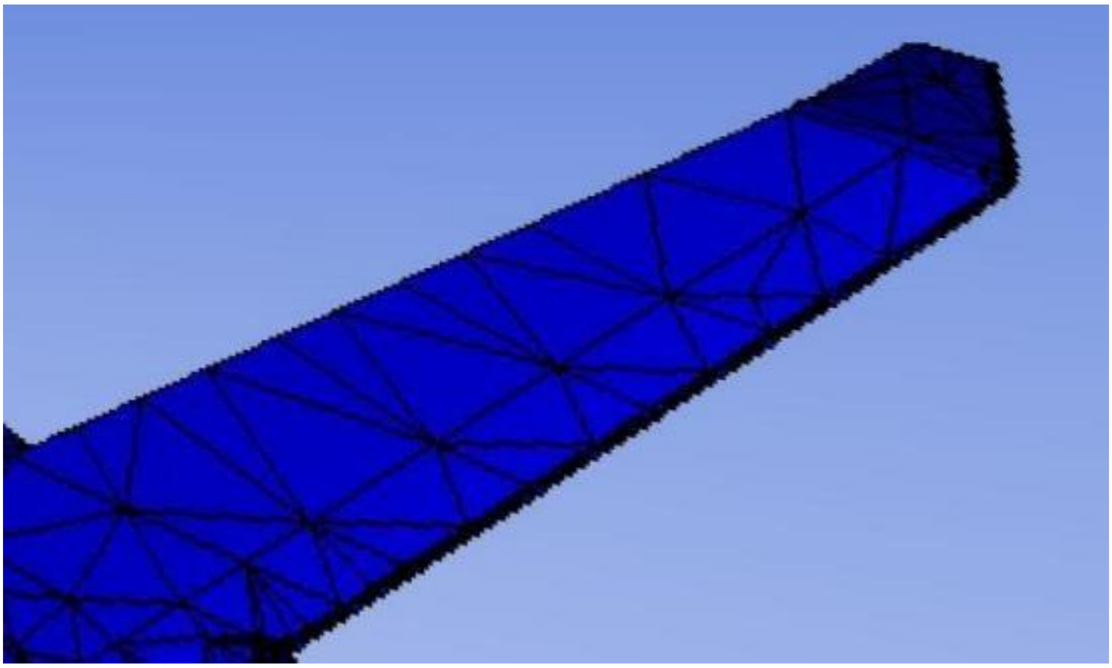

Fig 36: Mesh over the skin

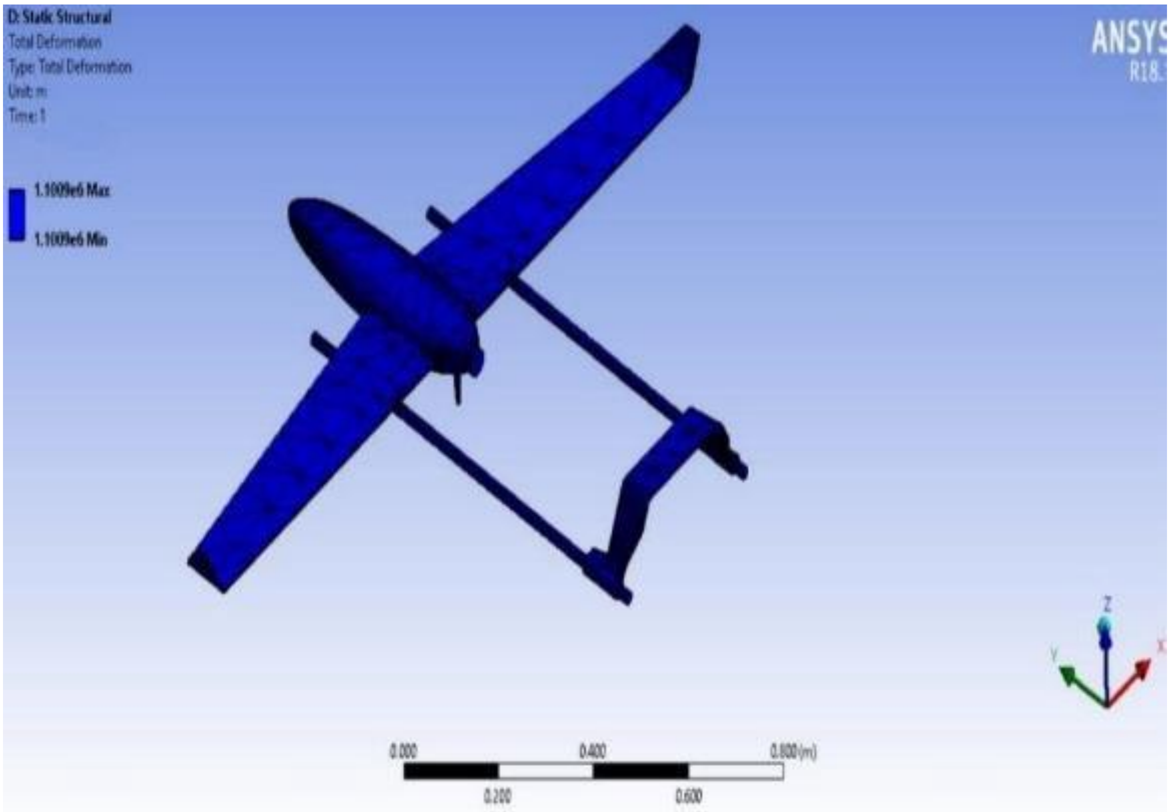

Fig 37: Structural Analysis of Total Deformation

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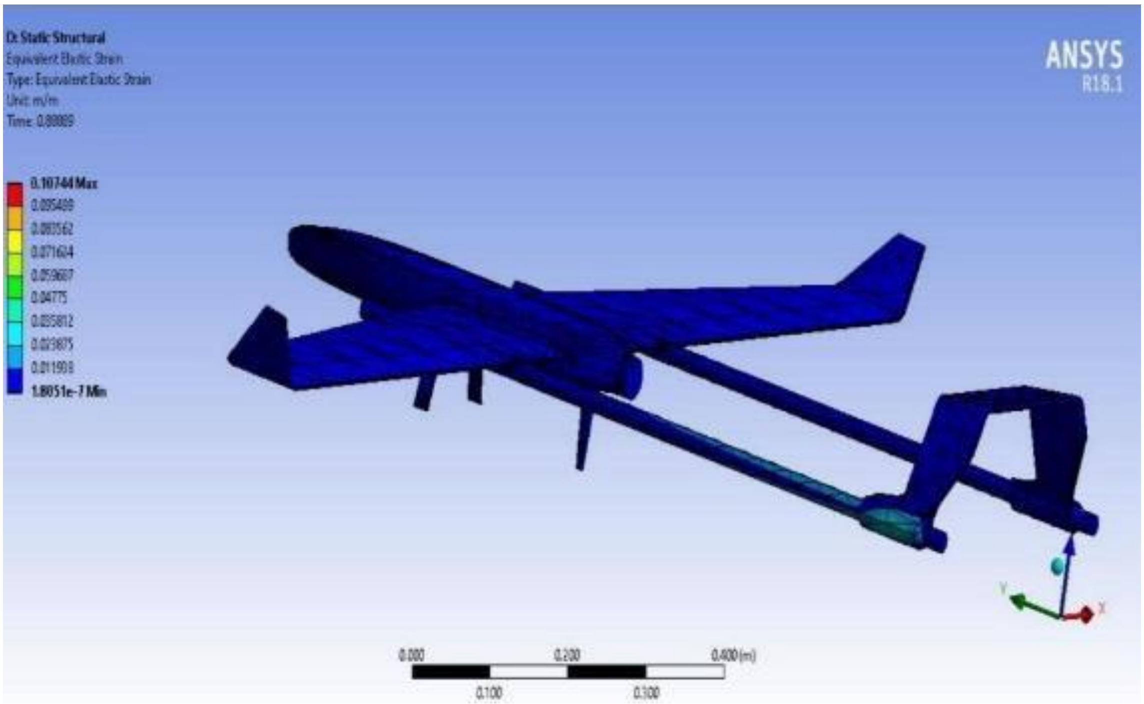

Fig 38: Structural Analysis of Equivalent Elastic Strain

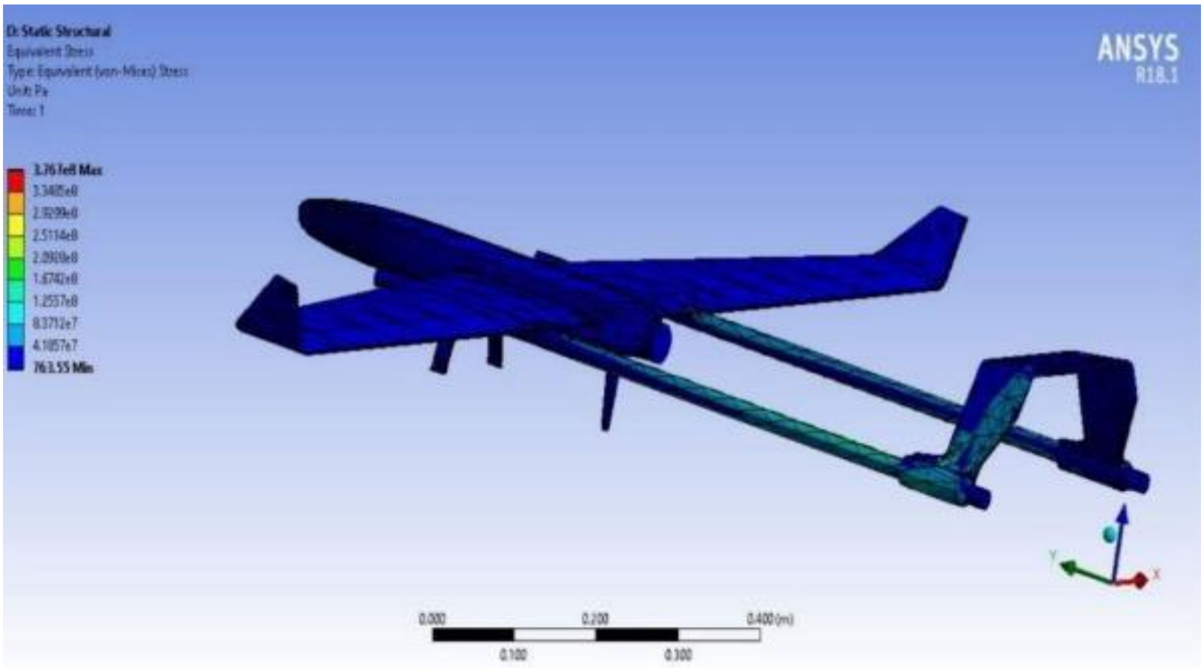

Fig 39: Structural Analysis of Equivalent Stress

VIII. CONCLUSION

The future of SLAM (Simultaneous Localization and Mapping) networks is poised for remarkable advancements across diverse domains. As technology continues to evolve, SLAM is expected to play a pivotal role in shaping the landscape of robotics, autonomous systems, and spatial awareness applications. The ongoing research and development efforts are likely to yield improvements in SLAM algorithms, making them more robust, adaptable, and capable of handling complex real-world scenarios. Collaborative multi-agent systems, enhanced human-robot interactions, and real-time 3D reconstruction are among the exciting prospects that hold promise for the next phase of SLAM network evolution.

Furthermore, the integration of SLAM with emerging technologies like 5G, edge computing, and artificial intelligence is set to enhance the real-time processing capabilities and overall performance of SLAM systems. As these innovations unfold, SLAM networks are expected to become indispensable tools, enabling autonomous vehicles, drones, robots, and other devices to navigate, map, and interact with their environments in increasingly sophisticated ways. The future of SLAM is characterized by a trajectory of continual refinement and expansion, with far-reaching implications for industries ranging from transportation and manufacturing to healthcare and environmental monitoring.

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