AERO DESIGN CHALLENGE 2021

VEGETATION MAPPING BY SEMI-AUTONOMOUS UAV

DESIGN REPORT

ADC20210114 – YODDHA

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DATE: 30 May 2021

2021 SAE AERO DESIGN CHALLENGE

STATEMENT OF COMPILANCE

CERTIFICATE OF QUALIFICATION

TEAM NAME	YODDHA
TEAM ID	20210114
COLLEGE	Shri G.S. Institute Of Technology And Science, Indore
FACULTY ADVISOR	Dr. Girish Thakar
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As Faculty Advisor, I certify that the registered team members are enrolled in collegiate courses. This team has designed, constructed and modified the radio controlled airplane they use for the SAE Aero Design Challenge 2020 competition, without direct assistance from professional engineers, R/C model experts or pilots, or related professionals.

(Dr G. Thakar)

Signature of Faculty Advisor

TEAM CAPTAIN INFORMATION	
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1. INTRODUCTION

The motive of Team **YODDHA** was to enter the Micro class UAV competition into the Society of Automotive Engineers (SAE) Aero Design Challenge (ADC) Southern Section. The SAEISS Aero Design Challenge aims to develop and promote Indian expertise and experience in unmanned systems technologies at the college and university levels. The students were tasked to employ various knowledge about the designing methodologies, applied practical knowledge skills, industrial standard skills and management.

1.1. PROBLEM STATEMENT

"The teams are required to make trades between two potentially conflicting requirements, carrying the highest payload fraction possible, while simultaneously pursuing the lowest empty weight possible."

In the present era, improper utilization of soil cover, dried-out flora in urban and non-urban areas remains a constant problem, posing a hindrance to the proper development of the localised regions. Thus, the application-specific field that needed to be focused upon at the primary level to ensure accurate localized mapping, extraction and management of resources, also concerning vegetation and land-use pattern, was chosen to be Urban and Rural Vegetation Mapping using Semi-autonomous UAV.

1.2. LITERATURE REVIEW

The SAEISS Aero Design Challenge 2021 Rulebook was the most essential literature document that laid down basic rules and provided a set of parameters, descriptions, limitations, and restrictions that we would not be allowed to violate. Participating in the Micro-class event required proper research on the appropriate functioning of an application-specific RC Aircraft, followed by its manufacturing and designing to be taken care of, respecting the deadlines for submissions. The Online mode of competition with application-specific designing, being held for the first time, adding onto the small size of the team, equipped with fewer resources, a significant consideration for this design will be the feasibility of manufacturing (if required), in accordance with the constraints of design and application, ensuring sustainable usage. Considering all possibilities of innovations in different design alternatives, design research is done. An example of this research is from the book- Fundamentals of Aerodynamics by John D. Anderson and The Aircraft Design: A conceptual Approach by Daniel P. Raymer. This proved to be an extremely useful book, considering the design specifications and understanding the basics of designing an aircraft.

1.3. DESIGN GOAL AND OBJECTIVE

Before starting to develop the initial design, we considered the primary objectives and established initial assumptions and constraints for the fixed-wing UAV regarding the estimated shape, weight, and size. Next, the team considered the weight and size of the aircraft. To ensure that the final aircraft would be able to accommodate the largest payload possible.

1.3.1. DESIGN APPROACH

- A design approach is a way by which we take small steps towards a common objective by a Mission of achieving it.
- A design approach is carried out by taking care of some parameters and prioritising those of utmost importance.
- The flight should also be stable.

ADEQUATE STABILITY: TO DAMPEN THE EFFECT OF CROSSWINDS AND GUSTS ENCOUNTER DURING FLIGHT

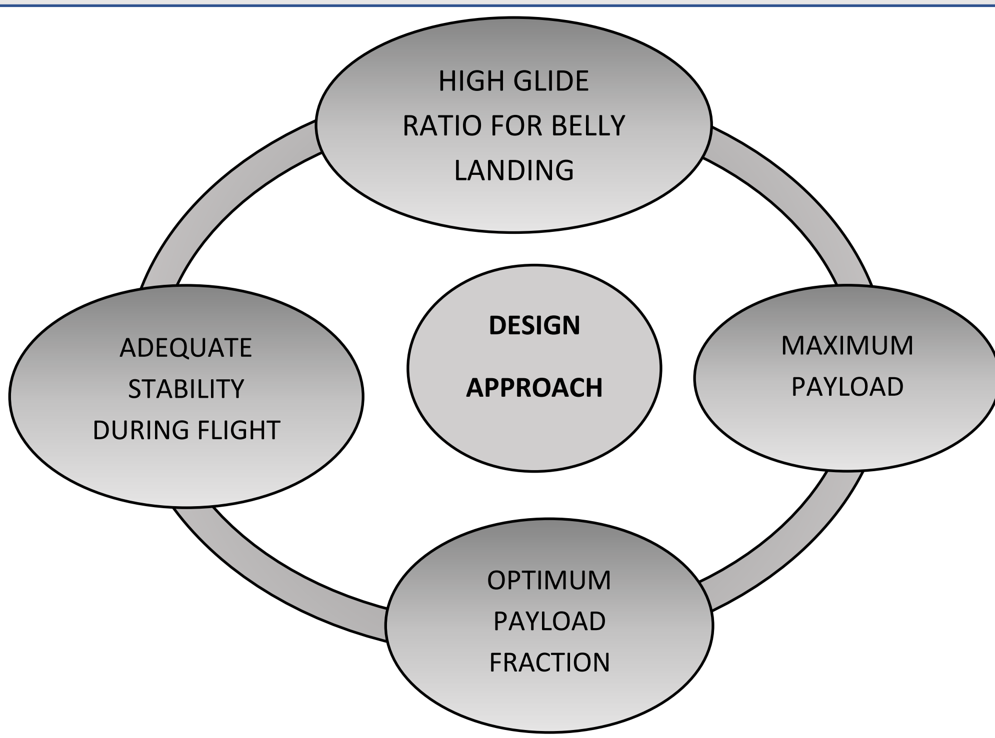


Fig1. Design Approach

1.3.2. CONSTRAINT AND OTHER CONSIDERATION

- Constraints are basically the restrictions; A team has to follow before starting with the design process.
- Constraints are necessary elements of any competition. It is the set of limitations; we followed in the fabrication of our aircraft.
- Aircraft constraints, Environmental considerations, Payload bay, are constraints here.
- During fabrication, we have to consider constraint and other consideration.

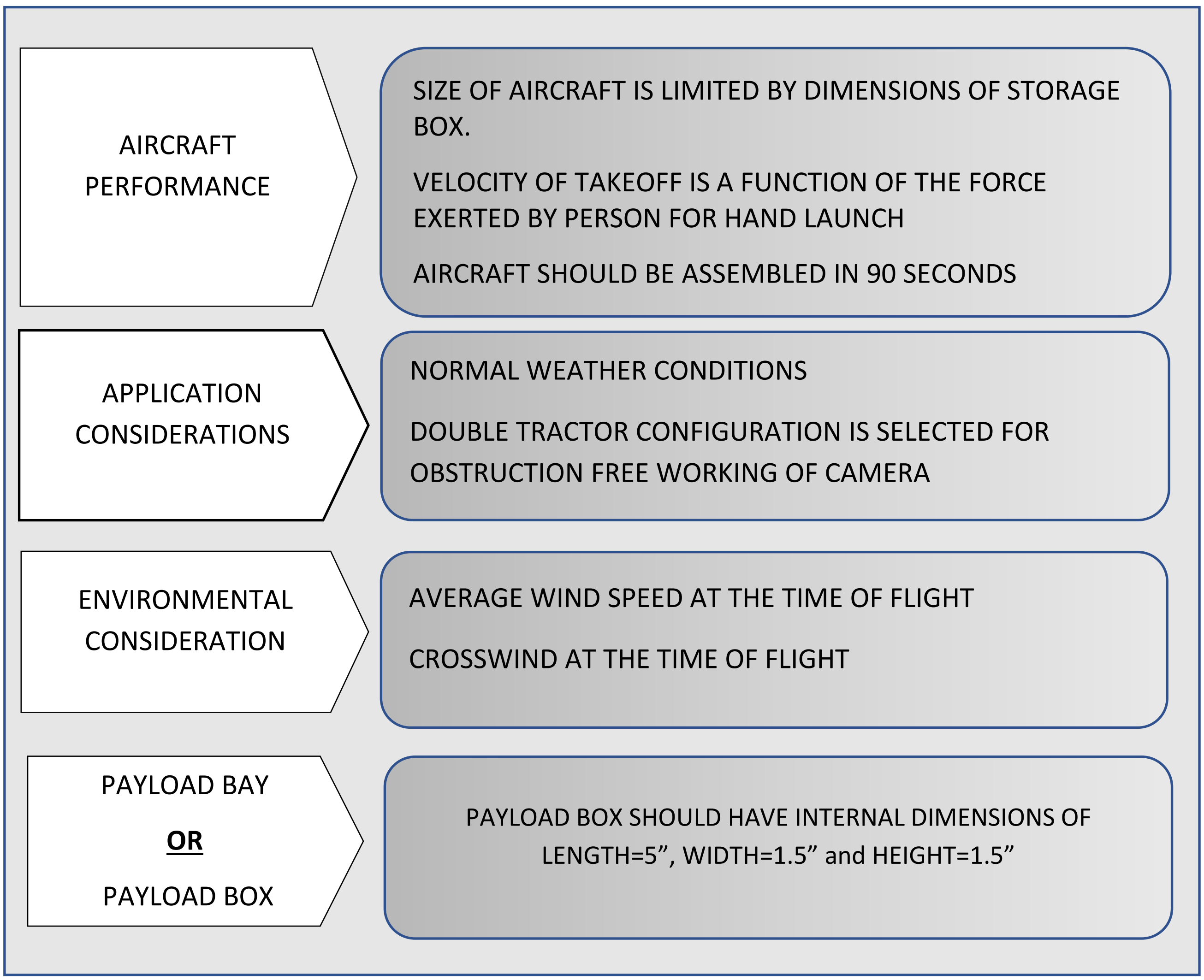


Fig 2. Constraint and other Consideration

2. DESIGN PROCESS

2.1. RESEARCH

Aircraft design is an iterative process. The design depends on many factors such as Application and Manufacturer demand, safety protocols, physical and economic constraints etc. It compromises many competing factors and constraints and accounts for existing designs and market requirements to produce the best aircraft.

The team's primary plan is to design a flying model of a micro class aircraft mainly intended to undertake missions. The overall objective of the study is to develop an accurate classification method for urban vegetation mapping using UAV. By using vegetation maps, created by analysing aerial photographs taken by a UAV.

S No.	PARAMETERS	PRELIMINARY STAGE
1.	Flying Weight	1.5 Kg
2.	Aircraft Assembly	90 sec
3.	Aerodynamic Control Surfaces	Ailerons, Elevators and Rudders
4.	Aircraft Container	3 feet cubic/cuboidal box

Table 1. Design Restriction

2.2. DESIGN ANALYSIS AND REVIEW PROCESS

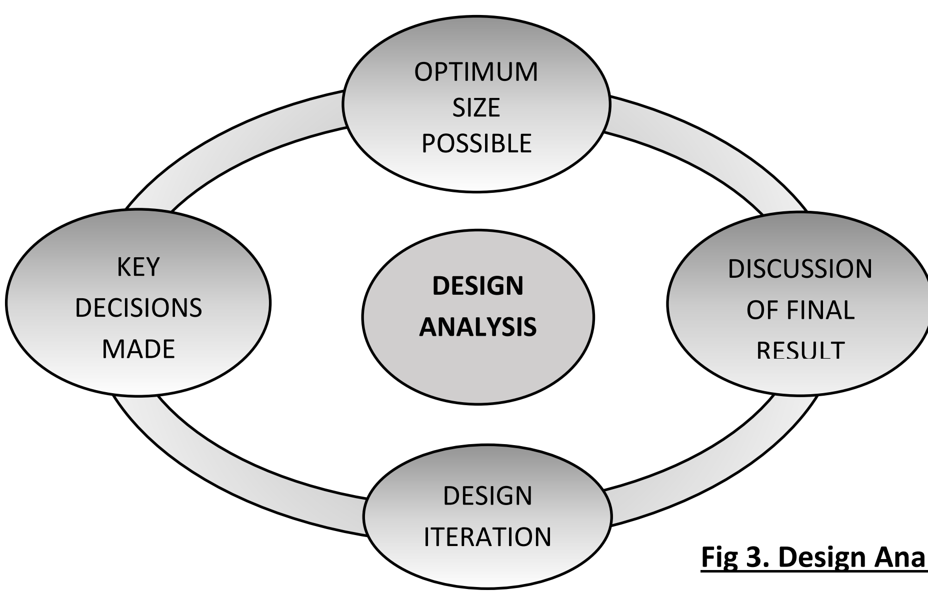


Fig 3. Design Analysis

The design analysis began with many steps depicted in the figure, and the same are discussed below.

- It started by designing various prototypes and testing each one of them.
- The most optimum and efficient amongst all is chosen.
- Key decisions made on the selection of aerofoil and other related parameters helped us to Arrive in a final result.
- The final model was chosen for the consistency in its performance and was finalised

2.3. DESIGN SELECTION PROCESS

2.3.1. DESIGN REQUIREMENTS

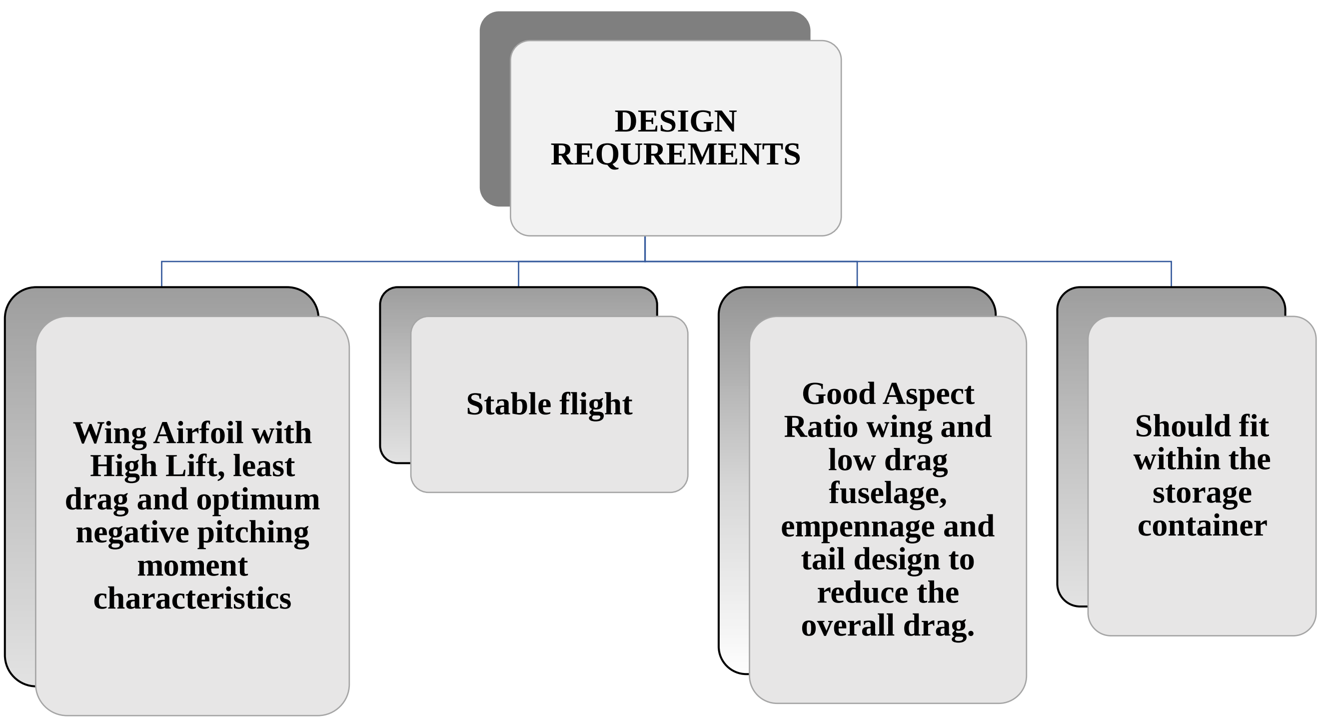


Fig 4. Design Requirements

2.3.2. AIRFOIL COMPARISION

The airfoil cross-section of wings is the most important for the aerodynamic performance of the aircraft. Previous SAE Aero Design report revealed that the Selig S1223 high lift low Reynolds number airfoil, referred to as S1223, is a commonly used standard airfoil shape for heavy lifting model aircraft. For selecting the best airfoil for our design, Our team used airfoiltools.com and UIUC airfoil database to search for standard airfoil shapes with high-lift, low-speed aerodynamic properties similar to those of S1223, using the “similar airfoils” features and also proceeded to filter the airfoil list by using the following search criteria:

- **MAX C_l Of 1-2.5** to remove the low performing airfoils.
- **Max Thickness 10%-14%** to eliminate extremely thin airfoils that would be very hard to manufacture**,** and thick airfoils are generally less efficient.
- **Max Camber 6-10.5** to get airfoils that would produce high lift.

This yielded three airfoils for the team to consider: S1223-RTL, MH114, E423.

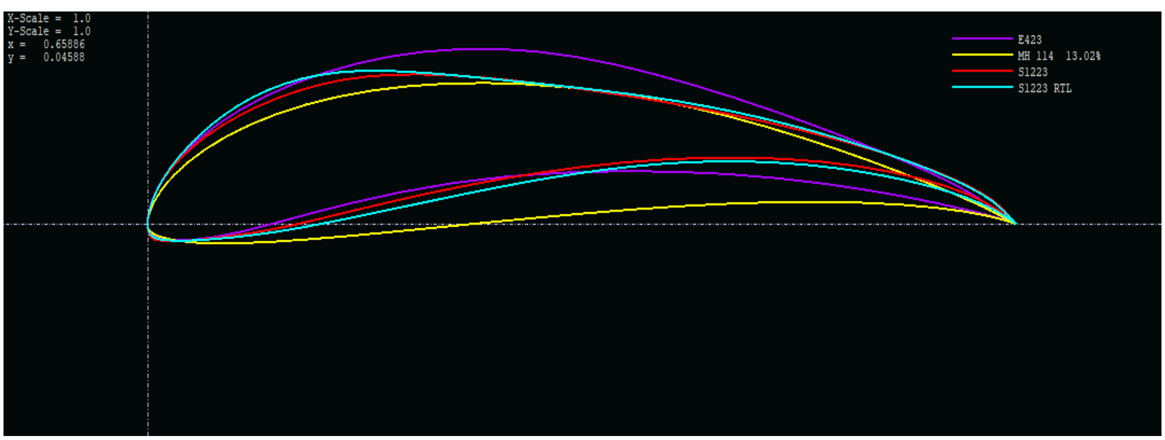


Fig 5. Profile of airfoils. Copyright: UIUC Airfoil coordinate database

NAME	THICKNESS (%)	AT (%)	CAMBER (%)	AT (%)
E423	12.52	24.03	10.03	44.85
MH114	13.06	30.03	6.58	48.15
S1223	12.14	19.82	8.67	49.05
S1223-RTL	13.51	19.82	8.46	52.85

Table 2. List of highly cambered airfoil tested.

For the further airfoil selection process, analysis was done for a range of a Reynold's number, that is between 4 lakh to 10 lakh. Team first estimated velocity as 12 m/s and a mean geometric chord length of 18 cm. For a consistent comparison, our team evaluated all four airfoils at a 142942 Reynolds number (which we calculated using the formulae, $Re = \frac{\rho V L}{\mu}$) using the XFLR5 Xfoil analysis. To narrow down the options from the four initial airfoils, the team first looked at the coefficient of lift results from the XFoil Direct Analysis. This graph generated by XFLR5 purple line shows E423, Yellow line shows MH114, Red colour shows S1223, and blue colour shows S1223. We can clearly see that the most significant amount of lift is created by S1223 airfoil. MH114 and S1223-RTL have slightly less coefficient of lift as compared to S1223. The E423 lift coefficient is significantly lower than all other airfoils. Since a high lift coefficient is required to carry a large payload successfully, the E423 airfoil was eliminated for further process

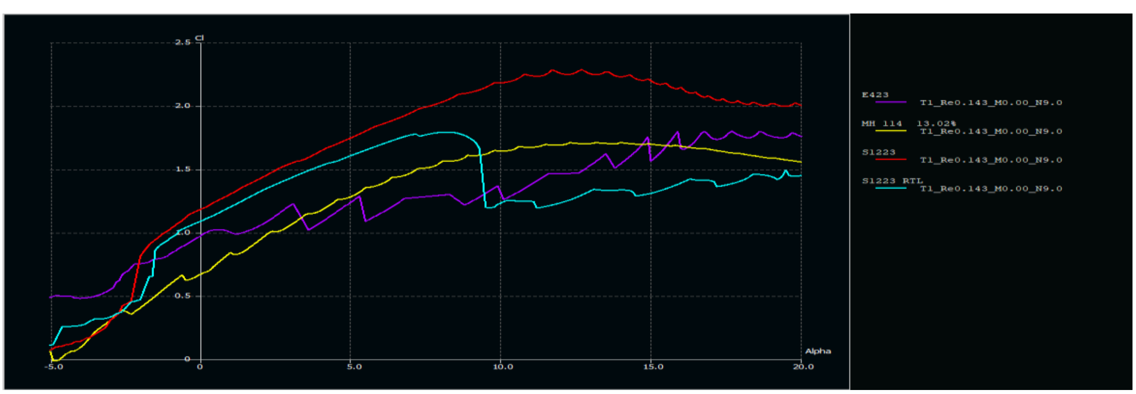


Fig 6. Coefficient of lift of E423, MH114, S1223, S1223-RTL at constant Reynolds number 142942.

In the next step, we compared the lift to drag ratios of the remaining airfoils. To maximize lift, the chosen airfoil should have minimum drag for a more efficient flight. Airfoil having lower lift coefficient and low lift-to-drag ratio that is S1223 RTL was not considered for further process.

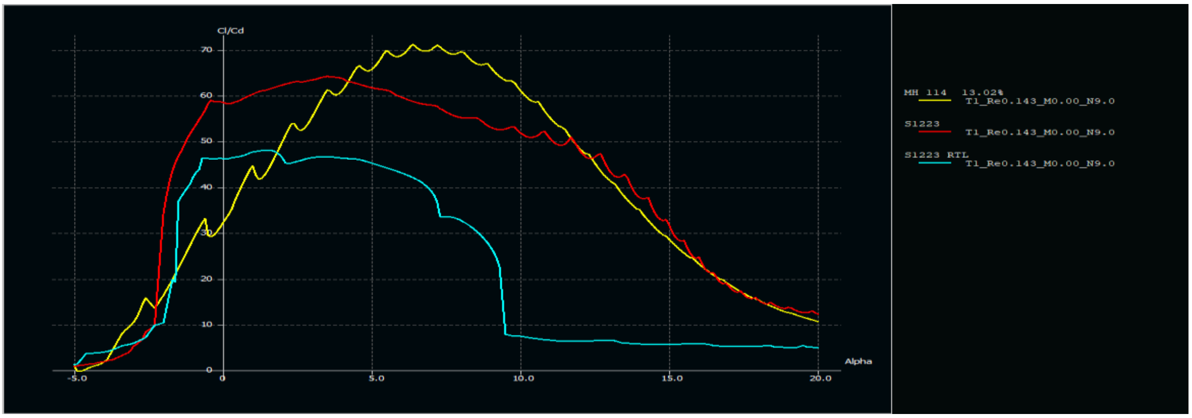


Fig 7. Lift-to-drag ratio of MH114, S1223, S1223-RTL at a constant Reynolds 142942

Although the maximum lift-to-drag ratio of MH114 is higher than that of S1223, we decided to evaluate the moment coefficients of the two airfoils to make the final selection. MH114 has a more desirable pitching moment coefficient than S1223 because a smaller pitching moment coefficient is advantageous as it requires a smaller horizontal stabilizer to achieve longitudinal stability, reducing aircraft structural weight. Thus accommodates greater payload capacity, giving it an advantage over the S1223 airfoil.

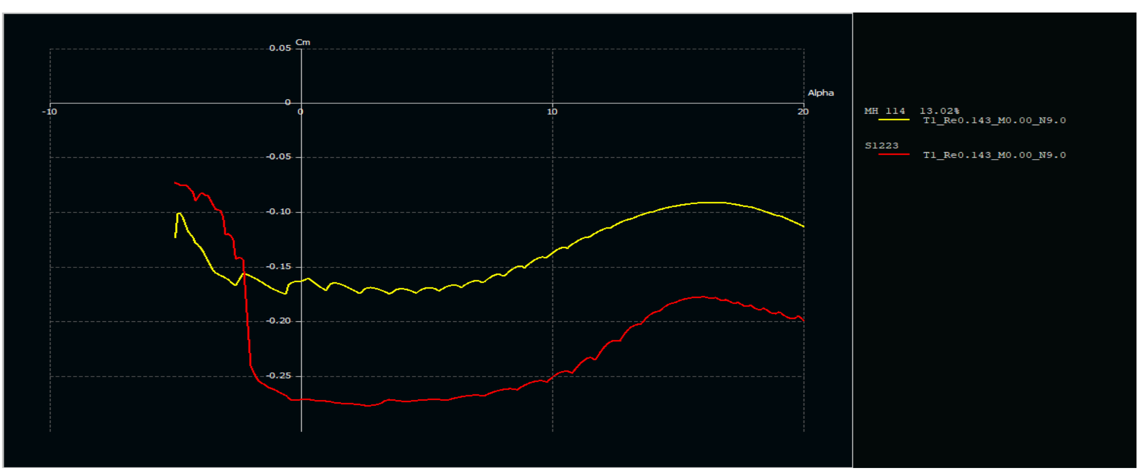


Fig 8. Moment coefficient of MH114 and S1223 at a constant Reynolds number 142942

2.3.3. WING DESIGN

- **AIRFRAME CONFIGURATION:** We used a weighted decision table to compare alternatives with respect to a different level of importance. The score is given between 1 to 5 for each criterion.

2.3.3.1. NUMBER OF WINGS:

<u>Methodology for choosing respective weighing factors:</u>

- LIFT - It is most important for any competition.
- DRAG - Comparatively less significant than lift.
- MANUFACTURABILITY – Considering cost and time.
- WEIGHT – least possible weight will be best to get high payload capacity.
- SPACE WITH CONTAINER – space in the container is also taken into account.

ATTRIBUTES	WEIGHTAGE	MONOPLANE 	BIPLANE 
LIFT	**30%**	**3**	**5**
DRAG	**20%**	**5**	**3**
MANUFACTURABILITY	**20%**	**5**	**3**
WEIGHT	**20%**	**5**	**3**
SPACE WITHIN CONTAINER	**10%**	**5**	**3**
TOTAL	**100%**	**4.4**	**3.6**

<u>Table 3. Selection of number of wings</u>

2.3.3.2. <u>VERTICAL WING PLACEMENT:</u>

- STABILITY – maximum weightage was given to stability because aircraft needs to be easily controllable.
- OPERATIONAL EASE – facilitates ease to load or unload payload.

- ➢ STALL SPEED – stall speed is given normal weightage as it has comparatively low impact.
- ➢ MANOEUVRABILITY – the manoeuvrability is given low weightage.

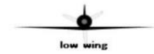
ATTRIBUTES	WEIGHTAGE	HIGH WING 	MID WING 	LOW WING 
STABILITY	**50%**	**5**	**4**	**3**
OPERATIONAL EASE	**20%**	**3**	**3**	**4**
STALL SPEED	**20%**	**4**	**3**	**2**
MANOEUVRABILITY	**10%**	**3**	**3**	**4**
TOTAL	**100%**	**4.2**	**3.5**	**3.1**

Table 4. Vertical Wing Placement

Although the stability of the high wing is maximum, and it is a suitable option, but due to the construction and design of the plane, the High wing doesn't fit and cannot serve the needful purpose in our design. Thus, mid-wing is preferred considering the stability and manoeuvrability of plane/RC.

2.3.3.3. WING PLANFORM

To obtain an initial size estimate for the wing, Our team evaluated the steady-level cruise trim condition, where the lift force is exactly equal to the aircraft weight. The lift coefficient is 0.7 at a zero angle of attack for MH114, and the estimated cruise velocity is 12 metres per second. Using the formulae, $L = \frac{1}{2}\rho V^2 C_l A$

We determined the minimum required wing area of approximately 0.154 square meters, which was rounded up to 0.18 square meters as a safety factor.

NOTE: Considering the box size limitations for the competition the wingspan was estimated as 1 meter, this gives a mean geometric chord of 0.18 meters.

By taking these dimensions as a reference, we used XFLR-5 to model and evaluate the aerodynamic performance of different wing shapes. The wing shapes which we tested were rectangular, elliptical, leading-edge tapered, swept-back, leading-edge semi tapered shape. The evaluation of wings was done at a constant speed of 12 meters per second using the MH114 airfoil profile.

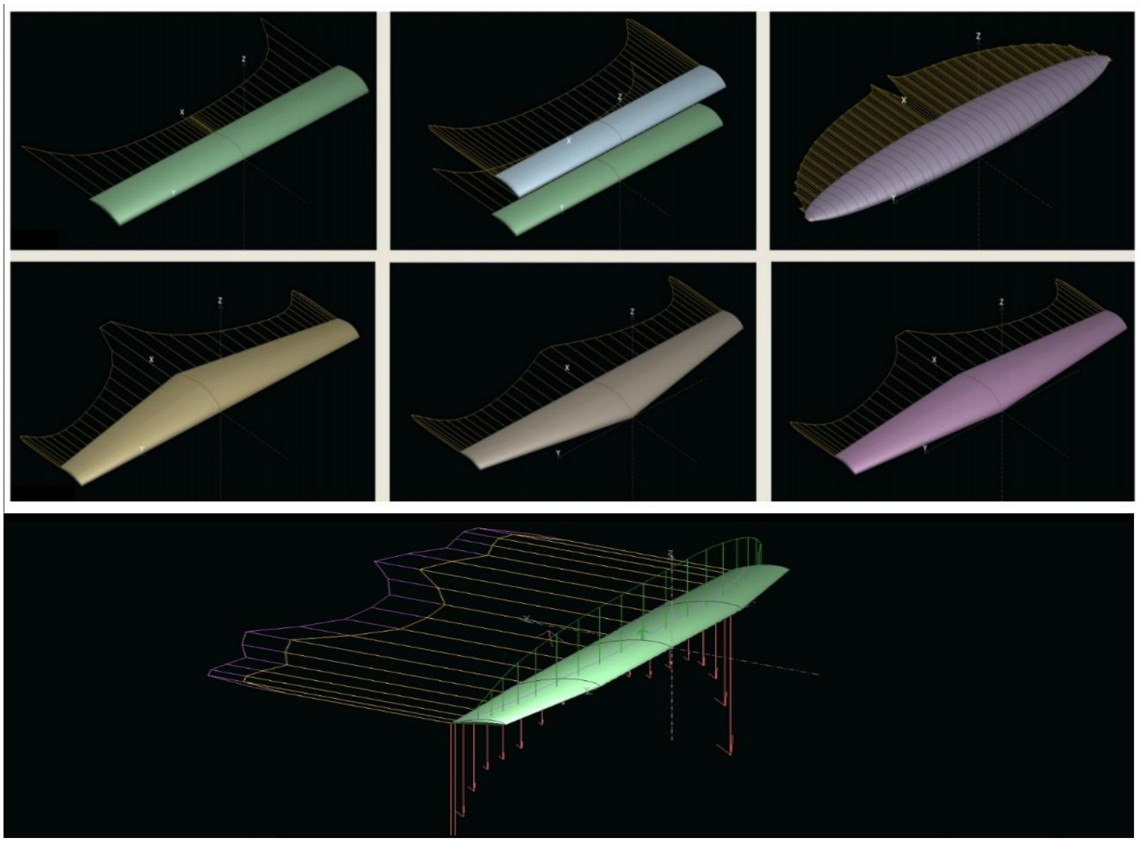
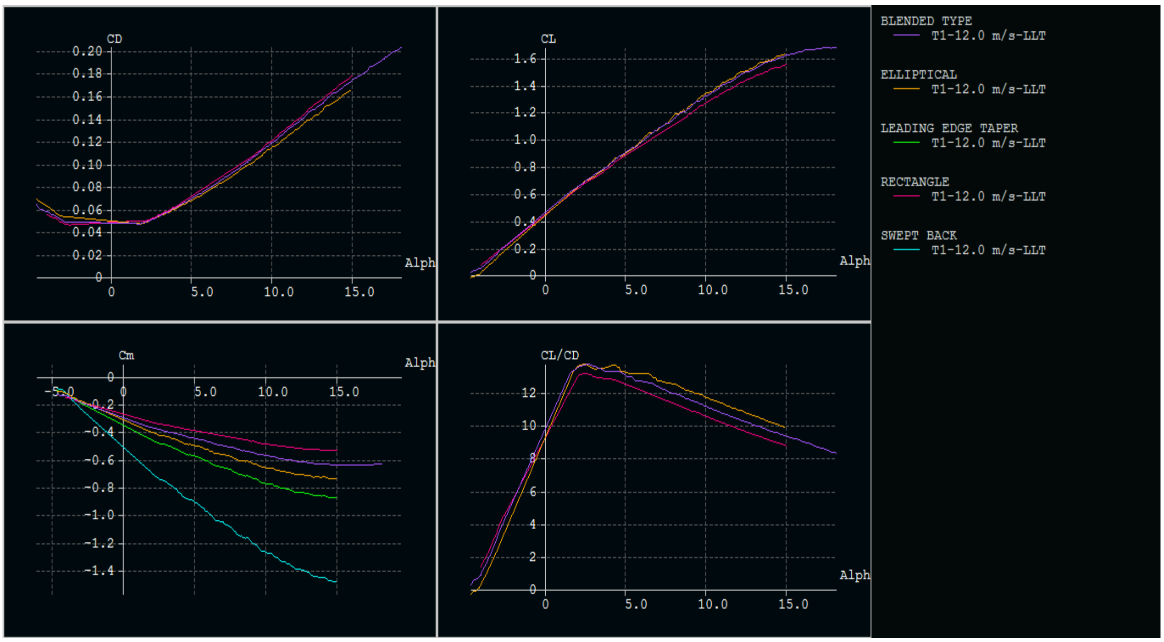


Fig 9. Possible wing shapes in XFLR5

The figure shows the pitch moment, lift, drag properties of the evaluated wing designs generated by the XFLR5. Elliptical, leading taper, leading-edge semi tapered type, and swept-back wings have higher lift coefficient and higher lift-to-rag ratios than rectangular. Out of these, elliptical has the highest coefficient of lift and lift to drag ratio. But due to difficulty in manufacturing and fabrication, we eliminated this option and went for straight-edged wings, which could be easily manufactured. So, rectangular and elliptical wing shape were eliminated for further process.

The remaining three wing shapes produced similar coefficients of lift and drag curves. Since the leading edge semi tapered shape wing has a smaller pitching moment than the other two shapes, it has the most favourable aerodynamic properties and can be manufactured easily. Thus our team considered the leading edge semi tapered shape wing to be the most suitable shape for the aircraft wing.



<u>Fig 10. Polars of all types of wings using XFLR5</u>

2.3.4. <u>EMPENNAGE</u>

<u>The rationale for choosing respective weighing factors:</u>

- STABILITY AND CONTROL - Stable aircraft is given preference considering our mission requirements.
- WEIGHT - less weight is favourable.
- MANUFACTURABILITY - Ease of manufacturing is taken into account.
- Our team selected an H-Tail configuration with twin rudders, reducing the vertical stabilizer height, which tends to provide excellent controllability at normal speeds and help the aircraft become more stable.

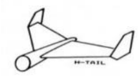
ATTRIBUTES	WEIGHTAGE	CONVENTIONAL 	H-TAIL 	V-TAIL 
STABILITY AND CONTROL	**50%**	**3**	**5**	**4**
WEIGHT	**20%**	**5**	**3**	**3**
MANUFACTURABILTY	**30%**	**5**	**4**	**3**
TOTAL	**100%**	**4**	**4.3**	**3.5**

Table 5. Selection of Empennage

2.3.5. MATERIAL REQUIREMENTS

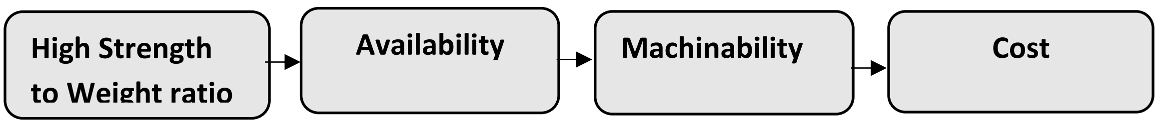


Fig 11. Material Requirements

Considering the above points, the following materials are used-

SR. No.	Components	Material used
1	Wing Ribs	Balsa Wood
2	Fuselage	Balsa wood
3	Tail Boom	Aluminium Rod
5	Empennage	Poly-Carbonate Sheet

Table 6. Materials Requirements.

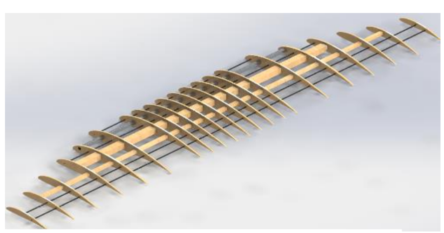


Fig 12. Wing Design

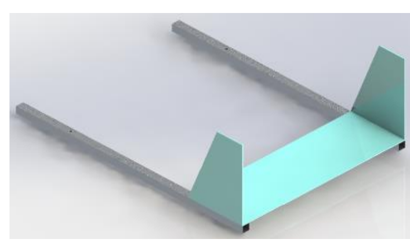


Fig 13. Empennage Design

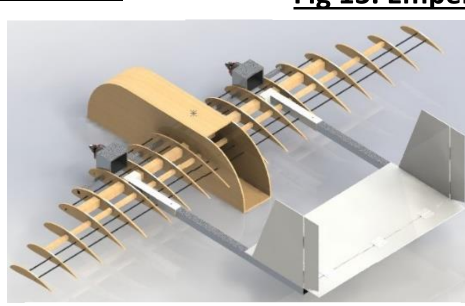


Fig 14. Aircraft Design

3. CALCULATIONS

3.1. AIRCRAFT SIZING

WIGN

- MONOPLANE
- HIGH WING
- LEADING EDGE SEMI TAPERED PLANFORM
- AIRFOIL - MH114

EMPENNAGE

- H- TAIL CONFIGURATION

PROPULSION CONFIGURATION

- DOUBLE TRACTOR CONFIGURATION

Fig 15. Final Configuration for Micro Class UAV.

3.1.1. STRUCTURE DETAILS

WING	
Aerofoil	MH114
Wingspan	39.37 in
Aspect ratio	5.56
Taper Ratio	0.52
Root Chord	8.27 in
Tip Chord	4.33 in
Area	279 in^2
AILERON SIZING	
Span	9.84 in
Chord	1.57 in
Aileron Area	15.5 in^2

FUSELAGE AND TAIL BOOM	
Fuselage Length	16.93 in
Tail Boom Length	8.66 in

HORIZONTAL TAIL	
Aerofoil	Flat Plate
Aspect Ratio	2.5:1
Span	14.76 in
Root chord	5.90 in
Tip Chord	5.90 in
ELEVATOR SIZING	
Span	14.76 in
Chord	1.48 in
Elevator area	21.79 in^2

VERTICAL TAIL	
Aerofoil	Flat Plate
Aspect Ratio	1.5:1
Span	5.91 in
Root chord	5.13 in
Tip Chord	2.76 in
RUDDER SIZING	
Span	5.91 in
Chord	1.48 in
Rudder area	8.73 in^2

Table 7. Structure Details

3.2. PROPULSION DESIGN:

The aircraft's empty weight was estimated as 9.51 N to ensure that the final aircraft accommodates the largest payload possible. Considering our application requirements, we assumed the payload of 7.65 N. We also assumed 0.6 as the Thrust to weight ratio of the aircraft.

3.2.1. MOTOR AND PROPELLER SELECTION:

The selection procedure starts with taking the maximum coefficient of lift results from the XFoil Direct Analysis. Using that maximum lift is calculated and hence the payload using the equation,

$$\textbf{Maximum lift} - \textbf{empty weight of plane} = \textbf{Maximum Load}$$

Then the thrust is calculated using the equation, $\textbf{Thrust} = \textbf{weight} * \left(\frac{\textbf{thrust}}{\textbf{weight}}\textbf{ratio}\right)$

Then using the static thrust equation,

$$F = 1.225\,\frac{\pi(0.0254\cdot d)^2}{4}\left[\left(RPM_{prop}\cdot 0.0254\cdot pitch\cdot\frac{1min}{60sec}\right)^2 - \left(RPM_{prop}\cdot 0.0254\cdot pitch\cdot\frac{1min}{60sec}\right)V_0\right]\left(\frac{d}{3.29546\cdot pitch}\right)^{1.5}$$

The propellor and corresponding motor are selected and verified using the motor-propellor datasheet by multiple iterations. Then corresponding other components are selected using maximum current and voltage like ESC, Battery, Time of flight, Battery Capacity, etc.

- **MOTOR**

  The motor of 1000KV has been used with a weight of 50gm. It has a peak efficiency of 1061KV when maximum current provided, i.e., 10.4 amp. The maximum power provided by the motor is 110 Watts which works on 8430 RPM. The motor used is the mini-outrunner brushless direct current motor.

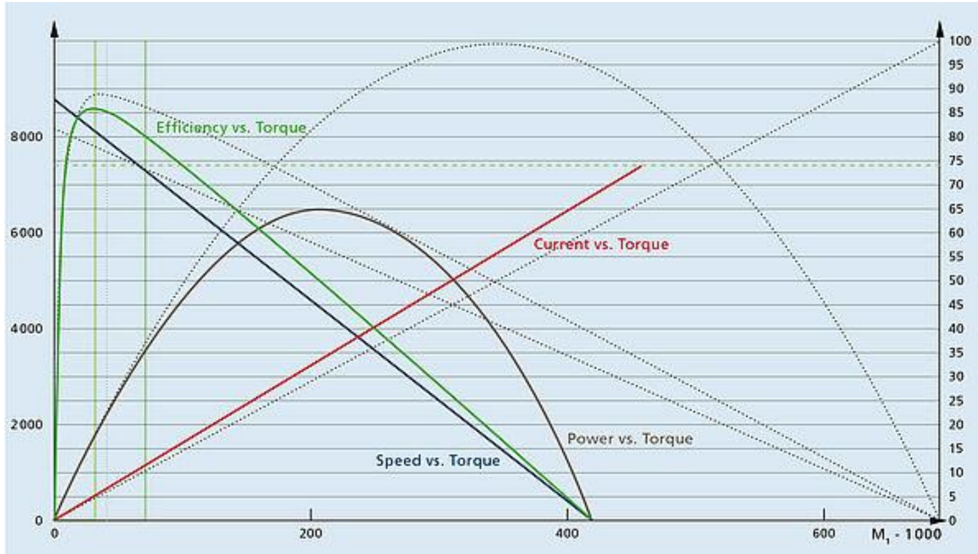


Fig 16. Motor Parameters

- **PROPELLER**

In addition to evaluating the thrust output of each motor in combination with different propeller sizes, the simulations evaluated the operating temperature and flight time that could be sustained. Safe motor operating temperature was an important factor when selecting a motor-propeller combination, as high operating temperatures can cause the motor to overheat, run less efficiently, and potentially damage itself.

The Propeller used here is 9*5.

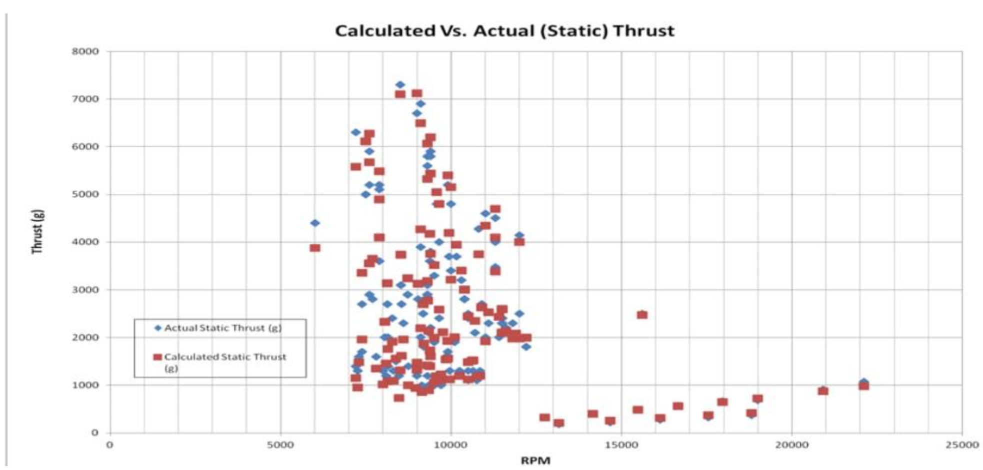


Fig 17. Thrust estimation of Propeller

- **BATTERY**

  A 3 cell battery has been used of 11.1 Volt. It has a dimension of 25*34*105 mm with 2200mAh.

- **ESC**

  Electronic Speed Control of a maximum of 30 Amps is used.

3.3. PERFORMANCE

3.3.1. PROPULSION PERFORMANCE

- **SERVO SIZING**

CONTROL SURFACE	AREA (in^2)	TORQUE REQUIRED (oz-in)	SERVO TORQUE(oz-in)
Aileron	15.50	2.49	16.66
Elevator	11.90	1.15	16.66
Rudder	11.16	1.08	16.66

Table 8. Servo Sizing

From the above table, it is verified that the servo used are adequately sized.

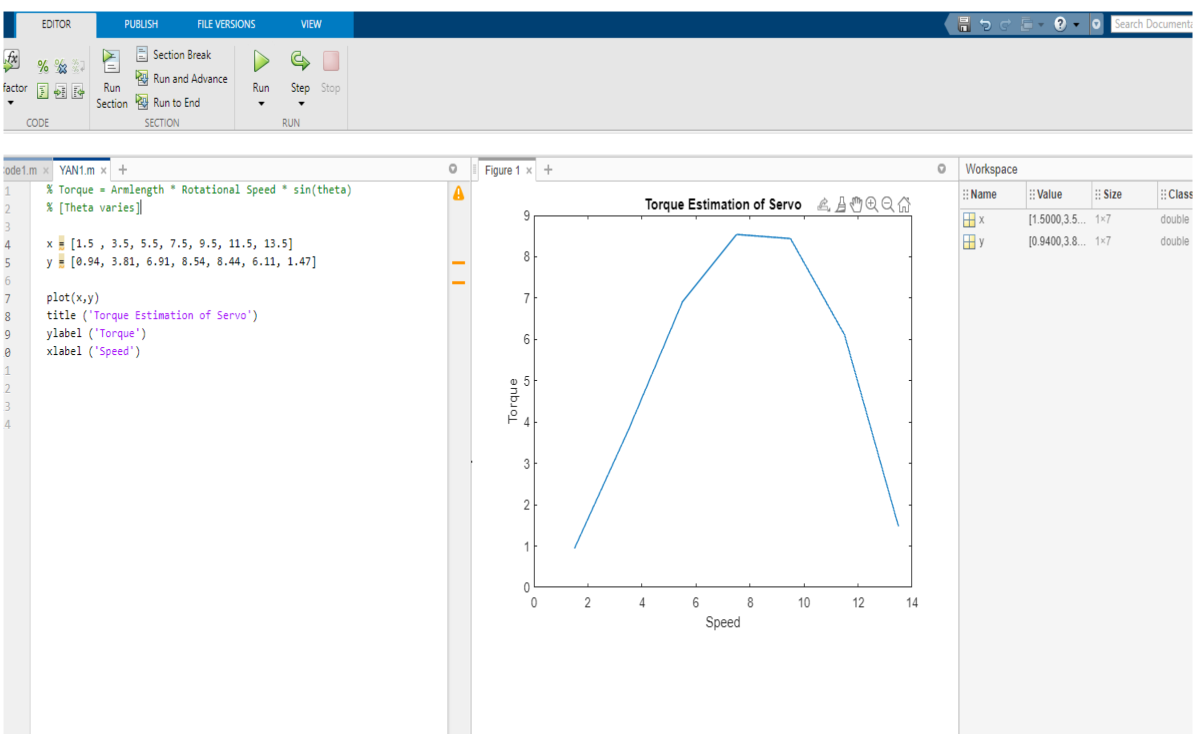


Fig 18. Torque estimation of Servo

3.3.2. AERODYNAMIC PERFORMANCE

Drag Estimation by component build up method

Description	*Skin Friction Coefficient (C_f)*	*Form Factor (FF)*	*S_{wet} / S_{ref}*	*Reynolds Number (R_e)*	*Interference Factor(Q)*
Wing	$6.6*10^{-3}$	1.28	2.045	143736	1
Horizontal Tail	$7.1*10^{-3}$	1.046	2.0005	103236	1.07
Vertical Tail	$6.88*10^{-3}$	1.06	1.993	119119	1.07
Fuselage	$5.59*10^{-3}$	1.63	1	317649	1

Table 9. Drag Estimation by component build-up method

- Oswald span efficiency factor (e) = 0.855
- Drag due to lift factor (K) = 0.067
- Thus the equation for co-efficient of drag is given by $C_d = 0.01579 + 0.0671*C_L$^2
- The graph of Drag vs Velocity is plotted as below with parameters;

  $S=180000mm^2$, $\rho = 1.225\ Kg/m^3$ and $C_d = 0.063$
- Therefore, $D = 0.007*V^2$

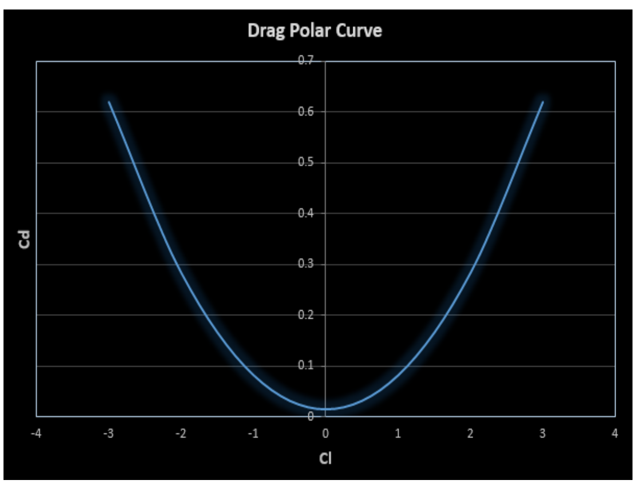


Fig 19. Drag Polar Curve

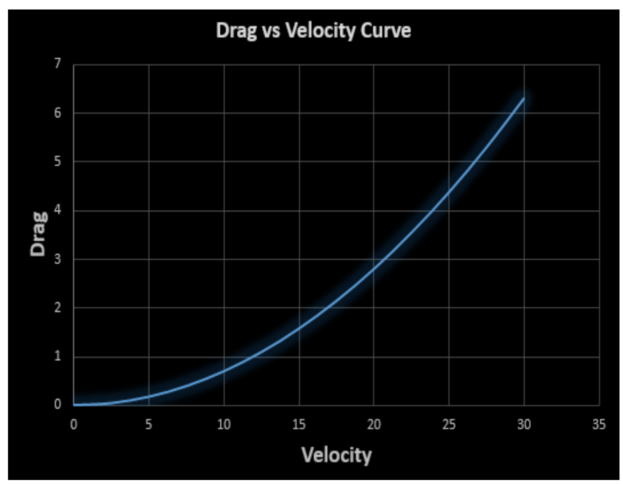


Fig 20. Drag(N) vs Velocity(m/s) Curve

- **PERFORMANCE PARAMETERS**

  - $Max\,\frac{Cl}{CD}$ = 13.83
  - V_{Stall} = 8.8 m/s
  - $\frac{T}{W}$ Ratio = 0.6
  - V_{max} = 12 m/s
  - $(W_L)_{max}$ = 9 kg/m2

3.4. STABILITY AND CONTROL

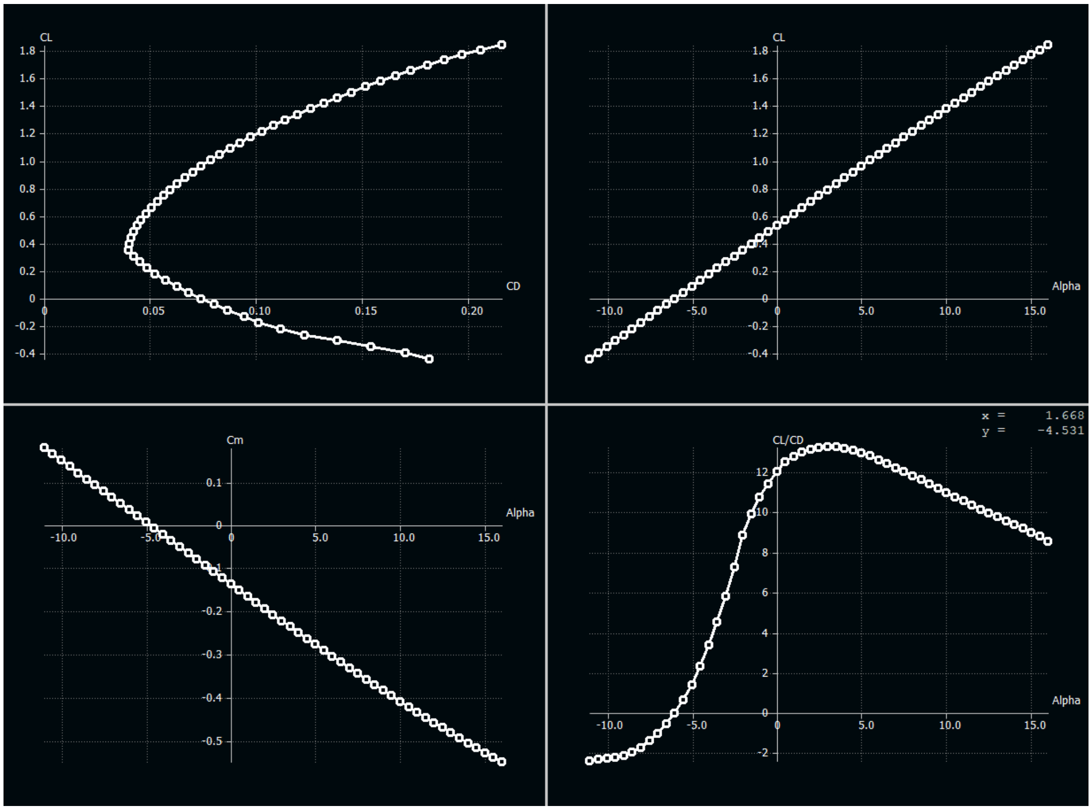


Fig 21. Stability Curve

The graphs plotted in XFLR5 show that the design is stable and will have sufficient control.

- **PRESSURE DISTRIBUTION OVER THE WING AND TAIL**

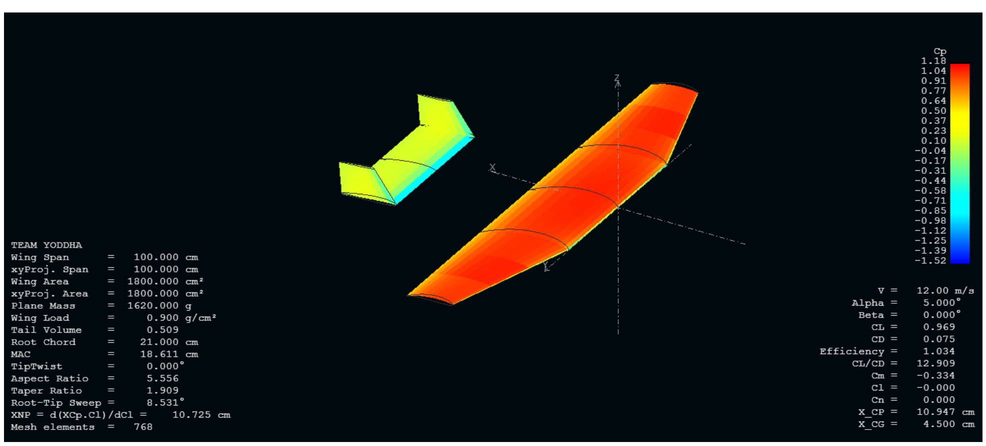


Fig 22. Pressure Distribution Curve

3.5. FABRICATION METHODS

- Designing the aircraft requires manufacturing processes such as laser cutting, sanding, glueing. Firstly, The aircraft plan form is made on paper and then positioned.
- The airfoils and some other plane components (composed of balsa) are obtained through laser cutting as accuracy is an important factor while designing a plane.
- Some components of the plane, like bulkier spars and blocks made of balsa, could not be obtained through laser cut. They are cut, sanded and glued manually.

Fig 23. Balsa Rib

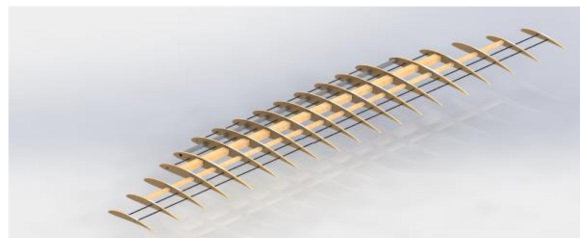


Fig 24. Aircraft Wing

- The grain of the wood while assembling is aligned in the same direction for each piece.
- All metal used in the plane and electronic component are tested and mounted on the plane.
- The aircraft is divided into two parts: The empennage along with tail boom is integrated into the wing and fixed through L shape using nuts and bolts.
- The Propeller is mounted on the motor shaft with a safety nut.
- Finally, the wing is covered using UltraCote, which provides good strength to the wing.

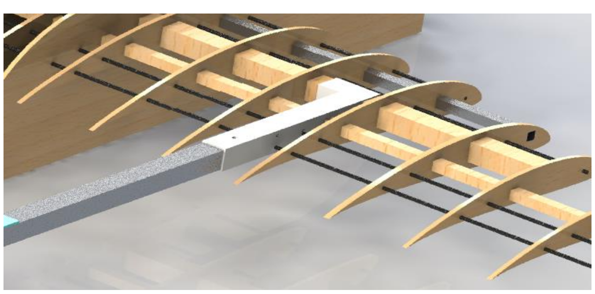


Fig.25 Tail boom connected to wing

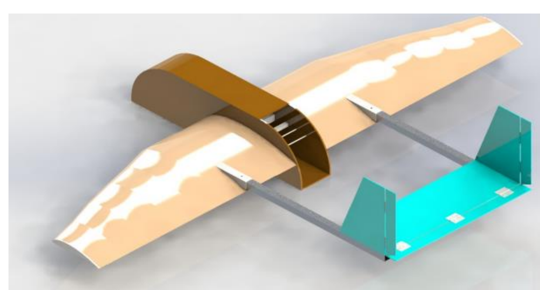


Fig.26 Wing covered by ultracote

4. INNOVATIONS

4.1. INTRODUCTION

RC planes for vegetation mapping require large capacities of batteries and longer battery life for an extended time of flight. We can’t increase the battery capacity as according to this competition we are restricted to use LiPo 3-cell battery pack only. That’s why here we are proposing Battery Management System (BMS) as our innovation. The inter-cell voltages in this configuration can become unbalanced due to the electrochemical side reactions that occur when charging/discharging and the impedance differences between the battery cells. Moreover, overcharging the battery causes the active material to evaporate, which increases the pressure inside the battery and also increases the corresponding risk of an explosion. Similarly, over-discharging damages the gap structure in lithium-ion batteries, thereby reducing the battery lifetime. Thus, to prevent excessive overcharge/discharge and variable cell voltages, a cell balancing system is essential.

Demands for RC planes with long flight times are increasing significantly in commercial applications. One of the main issues about RC planes is their power management. However, these devices are powered by a high energy density lithium battery, but a flight time range is not much. Increasing the battery energy storage capacity to achieve more flight time is not usually a good idea due to the additional weight in RC planes. To solve this issue, BMS is proposed to predict the maximum available energy of the battery pack to make the best decision for maintaining the battery overcharging and discharging rate. The proposed BMS can not only increase the performance and life of the battery system but also can estimate the battery cells state of charge.

Using the proposed BMS, the voltage deviation would be reduced, the depth of discharge would be improved, thereby improving the efficiency compared to when only a LiPo battery is used.

4.2. APPLICATION

- The Battery Management system proposed by us helps increase the battery life considerably, thus increasing the time of flight for the RC, assisting in durable monitoring and mapping of vegetation.
- BMS also protects the LIPO 3-cell battery used in RC and prevents the damage of electronic components within.
- To prevent excessive overcharging/discharging and uneven cell voltages in the RC, a cell balancing system is essential.
- The proposed system has an accurate estimation of the maximum available energy, and therefore accurate flight time prediction, enabling efficient monitoring.

5. USE OF COMPUTER-AIDED TOOL

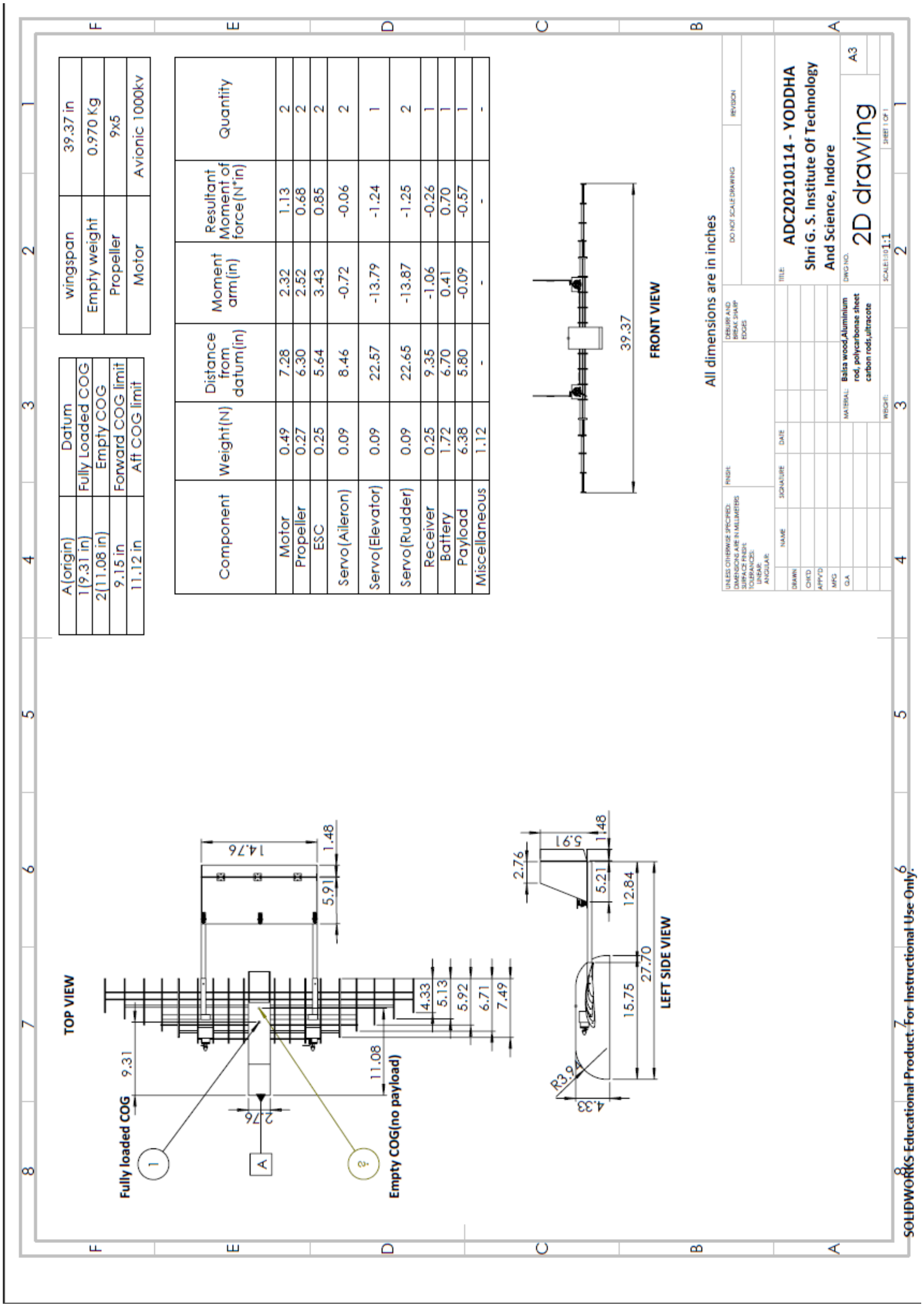
- **XFLR5** – Analysis tool for airfoils, wings and planes, operating at low Reynolds Number. This software Aided us in wing design selection, analysis of wing stability and capabilities.
- **MATLAB** – The software aided us in analysing various electronic parameters like torque, thrust, power, and efficiency of a servo, propellor, and motor.
- **Solid Works** – A solid modelling computer-aided designing and an engineering computer program that aided us to prepare the CAD model and 2-D drawing.

6. WEIGHT BUILD UP

Sr. No.	Components	Weight (kg)
1	**Motor*2**	0.100
2	**Propeller*2**	0.056
3	**ESC*2**	0.050
4	**Receiver**	0.025
5	**Battery**	0.175
6	**Wing**	0.200
7	**Fuselage**	0.050
8	**Tail Boom * 2**	0.110
9	**Horizontal Tail**	0.020
10	**Vertical Tail**	0.025
11	**Servos * 5**	0.045
12	**Miscellaneous weight**	0.114
		TOTAL = 0.970

Table 10. Weight Build-Up

7. 2D DRAWING AND WEIGHT DATASHEET



A(origin)	Datum
1(9.31 in)	Fully Loaded COG
2(11.08 in)	Empty COG
9.15 in	Forward COG limit
11.12 in	Aft COG limit

wingspan	39.37 in
Empty weight	0.970 Kg
Propeller	9x5
Motor	Avionic 1000kv

Component	Weight(N)	Distance from datum(in)	Moment arm(in)	Resultant Moment of force(N*in)	Quantity
Motor	0.49	7.28	2.32	1.13	2
Propeller	0.27	6.30	2.52	0.68	2
ESC	0.25	5.64	3.43	0.85	2
Servo(Aileron)	0.09	8.46	-0.72	-0.06	2
Servo(Elevator)	0.09	22.57	-13.79	-1.24	1
Servo(Rudder)	0.09	22.65	-13.87	-1.25	2
Receiver	0.25	9.35	-1.06	-0.26	1
Battery	1.72	6.70	0.41	0.70	1
Payload	6.38	5.80	-0.09	-0.57	1
Miscellaneous	1.12	-	-	-	-

8. CONCLUSION

In the duration of the project, we accomplished our goal of designing the RC Plane, which is the High wing monoplane with H-Tail double tractor configuration twin rudders, thereby reducing the vertical stabilizer height, which tends to provide better controllability at normal speeds as well as helps the aircraft to be more stable. The design is capable of solving the problems such as improper utilization of soil cover, dried-out flora in urban and non-urban areas by using vegetation maps created by analysing aerial photographs taken by a UAV. Hence, we believe our design assures all the requirements. Based on all the analysis and simulations through multiple software's, the aircraft would be able to perform as intended.

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