Implementation of Sweep Back and Polyhedral Wing in UAV

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Abstract- **This project presents the conceptual design and fabrication of an unmanned aerial vehicle with different profile shapes. Normally sweep back wing results only in reducing the drag and provides very less stability. For obtaining more stability we have implemented polyhedral wing along with sweep back wing in UAV. The sweep back wing is for reducing the drag and polyhedral wing provides more stability. The UAV was designed to monitor and surveillance both static and dynamic (movable) objects without utilizing expensive manned vehicles such as helicopters. The UAV was designed for use in remote and populated areas alike with a hook and cable landing as well as runway launch. This report contains a statistical analysis, preliminary calculations and configuration design. In addition, the designed UAV should be characterized by high-tech construction, safety, high flight technical and performance criteria. The design and creation of the UAV corresponding to the specified requirements and at the same time complex scientifically-practical task. In this project both hardware and drawings are available the latter is used for modelling the aircraft structure in the SOLID WORKS package. The model which is drafted in the SOLID WORKS package is then fired to the ANSYS 18.0 package.**

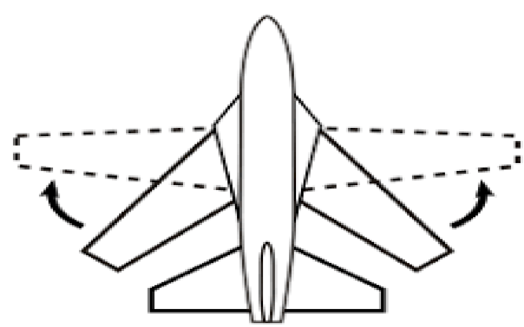
Index terms- **Sweep back wing, Polyhedral wing, unmanned aerial vehicle, stability.**

I.INTRODUCTION

An Unmanned Aerial Vehicle is an aircraft which flies without the pilot which means either by controlling from the ground by human operator or by autonomously by computers. There are different types of UAV's based on its configurations and application. The use of Unmanned Aerial Vehicles increasing day by day in every sector like Medical, Delivery, Aerial photography, Surveillance etc. In that surveillance plays a major role in military applications. For surveillance of static objects normal UAV can be used. But for surveillance of movable objects we are supposed to use different configurations of UAV. In that sweep back wing configuration plays major role. But the major disadvantage in the sweep back wing UAV is less stability. Usually polyhedral wing in aircrafts are provided for stability. So, for providing stability we have planned to implement polyhedral wing along with the sweep back wing configuration in a single UAV.

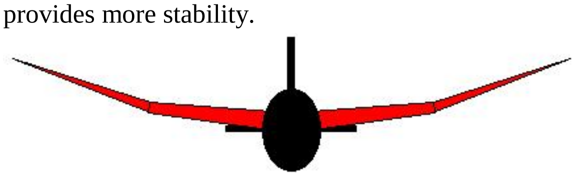
II. SWEEP BACK WING

Sweep back wing is an airplane wing, or set of wings, that may be swept back and then returned to its original straight position during flight. It allows the aircraft's shape to be modified in flight. The wing moves backward to reduce drag.



III. POLYHEDRAL WING

A Polyhedral wing is a wing that has dihedral in the center of the wing, and then has another upward dihedral somewhere out from the root of the wing. It provides more stability.

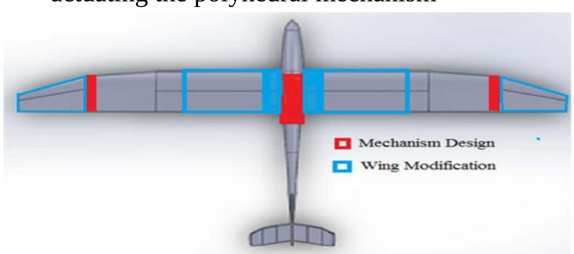


IV. OBJECTIVES

- To implement different wing configurations in a single UAV
- To provide more stability
- To reduce the drag
- To use for multipurpose like surveillance, follow up etc.

V. METHODOLOGY

- Already there is an existing model of sweep back wing configured UAV which has less stability. SO, we took the existing model as our reference and implementing the polyhedral wing configuration in the same UAV.
- For polyhedral configuration, we used 25g flat wing servo which placed at the wing tip for actuating the polyhedral mechanism



- Placing the servos at the wing root for sweep back performance and placing servos at the wing tip for polyhedral actuation.
- For more actuating performances, we are using 6channel transmitter for actuating both sweep back and polyhedral configuration.

IV. COMPONENTS USED

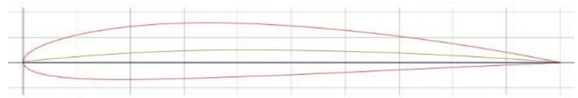
S. NO	NAMEOFTHE COMPONENT	QUANTITY (no’s)
1	850KV BLDC MOTOR	1
2	40amp electronic speed controller	1
3	9gram metal gear servo	6
4	25gram metal gear servo	2
5	6channel transmitter/receiver	1
6	2200mah Li-Po battery (3cell)	1
7	Propeller (11x6)	1
8	Fiber tape (25mm)	1
9	Carbon rod (5x3x1000) mm	2
10	Landing gear set	1
11	Depron sheet (1000X1000) mm	5
12	Hinges	10
13	Control horns	8
14	Clives	10

V. DESIGN PARAMETERS

1. AIRFOIL NOMENCLATURE

As per the existing model, we took airfoil as same as previous model. We tookNACA 2.5411 - NACA 2411 airfoil.

Max thickness 11% at 29.5% chord. Max camber 2.5% at 39.6% chord



2. FUSELAGE

Length- 1000 mm

Hieght-80mm

3. WING

Aileron chord - 40mm

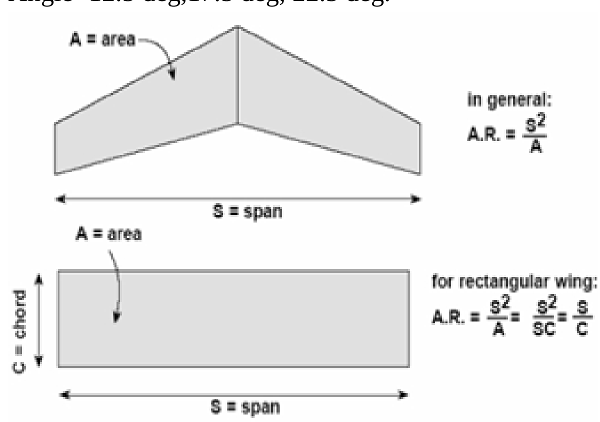
Aileron length – 600 mm

Rectangular wing:

- Span – 1500mm
- Root Chord – 510mm
- Tip chord - 160mm

Trapezoidal wing:

Angle- 12.5 deg,17.5 deg, 22.5 deg.



Polyhedral wing:

- Root Angle – 5 deg
- Tip Angle – 25 deg

4. TAIL

Horizontal stabilizer:

Length – 400mm

Chord – 160mm

Elevator length – 20mm

Elevator Chord -55mm

Vertical stabilizer:

- Length - 100mm

- Chord – 160mm
- Rudder Length – 80mm
- Rudder chord -50mm

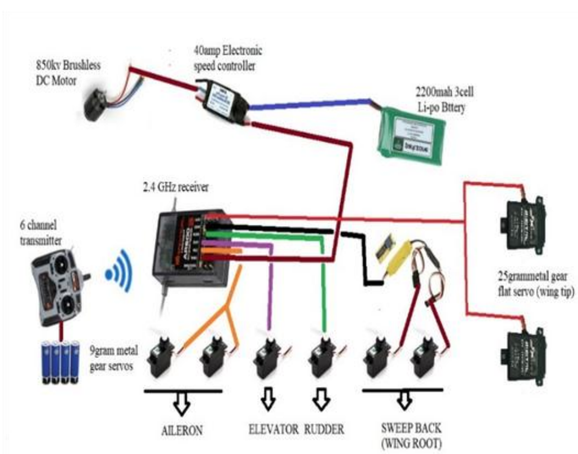
VI. WEIGHT ESTIMATION

The weight of the each and every component is added to calculate the overall weight of the UAV

NAME OF THE PART	NO'S	ESTIMATED WEIGHT
850KV BLDC MOTOR	1	136gms
40amp electronic speed controller	1	40gms
9gram metal gear servo	6	6x14=84gms
25gram metal gear servo	2	2x25=50gms
2200mah Li-Po battery (3cell)	1	190gms
Propeller (11x6)	1	20gms
Carbon rod (5x3x1000) mm	2	2x225=550gms
Landing gear set	1	150gms
Depron frame	1	1100gms
Hinges	10	10x5=50gms
Control horns	8	8x10=80gms
Clives	10	10x5=50gms
TOTAL		2500gms

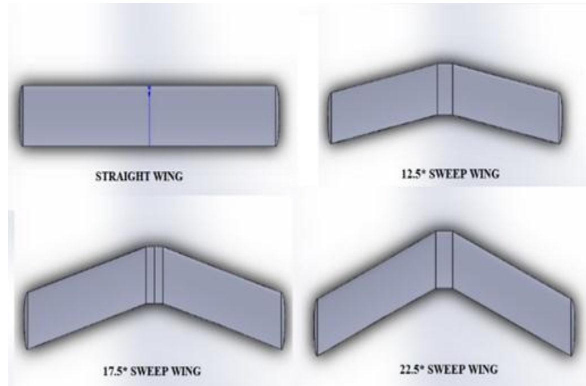
The overall weight of the UAV comes around 2500gms without any payload. When considering the payload, it comes around 2700-2800gms.

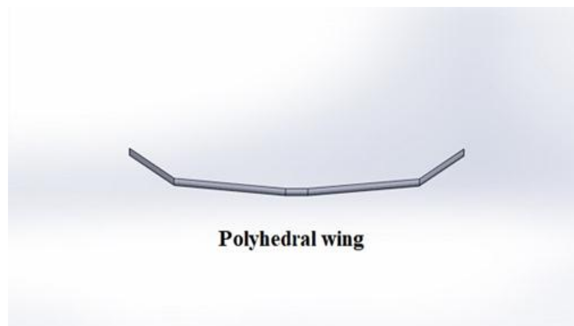
VII. ELECRONIC CONNECTIONS



VIII. DESIGN AND ANALYSIS OF WING CONFIGURATIONS

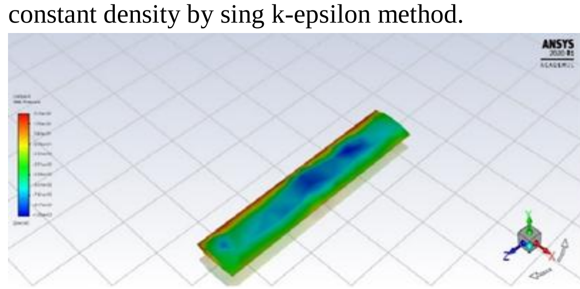
The designing and assembling of each part have done in SOLIDWORKS 18.0 package and analyzed in ANSYS 18.0 (fluent). Here we have 5 different wing profiles as straight wing, 12.5 deg sweep, 17.5 deg sweep, 22.5 deg sweep and polyhedral wing. Design and analysis of each wing as follows:



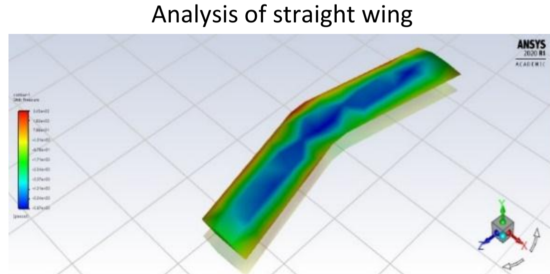


The Flow analysis of each wing configuration is as follows:

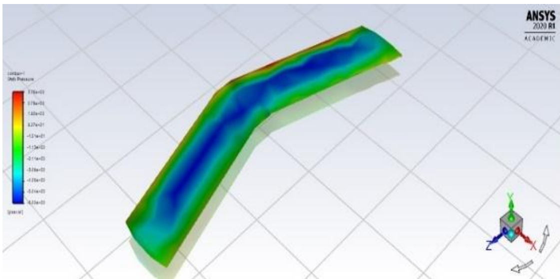
The flow analysis of each wing carried out at two different velocities as 50m/h and 100m/h at the constant density by sing k-epsilon method.



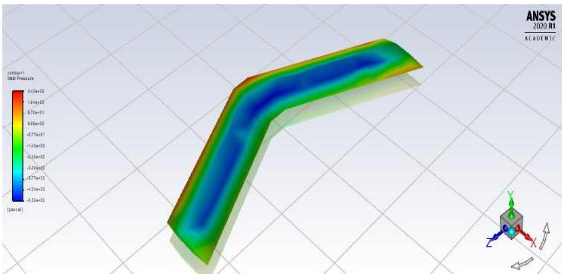
Analysis of straight wing



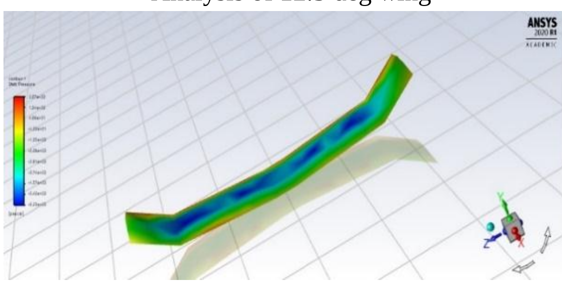
Analysis of 12.5 deg wing



Analysis of 17.5 deg wing

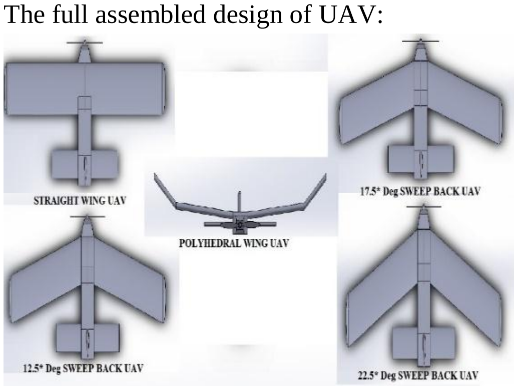


Analysis of 12.5 deg wing



Analysis of polyhedral wing

The full assembled design of UAV:



Assembled design of UAV

In the analysis of all wing, we yield different C_d and C_L values for different wing configurations. They are tabulated below in the result.

IX. RESULT AND DISCUSSION

As the result of fluent analysis of the wing configurations, we have reduced the drag and also the polyhedral wing results in the increasing in lift which provides more stability for better maneuvering and hovering performances.

Table 1: Co-efficient of lift and drag at velocity 50 m/h

Content	C_L	C_d
Straight wing	1.78	0.072
12.5 Deg sweep	1,14	0.069
17.5 Deg sweep	1.21	0.064
22.5 Deg sweep	1.26	0.06
Polyhedral wing	2.23	0.15

Table 2: Co-efficient of lift and drag at velocity 50 m/h.

Content	C_L	C_d
Straight wing	2.34	0.053
12.5 Deg sweep	2.06	0.039
17.5 Deg sweep	1.91	0.034
22.5 Deg sweep	1.73	0.03
Polyhedral wing	3.43	0.23

In the above result, three types of wing configurations results in reducing the drag which employed for surveillance of movable objects and the polyhedral configuration results in more stability which employed for better maneuvering, hovering and surveillance of static objects.

X. CONCLUSION

The implementation of polyhedral wing along with the sweep back wing has successfully completed in both practical and analytical modes. Here we successfully reduced the drag by sweep back configuration which enables the UAV to increase its speed and also increased the stability by successful implementation of polyhedral in it. This UAV model reduces the usage of man power and also makes easier to achieve more performances in a single futured UAV. This UAV can be employed in civil aviation purposes and also for military purposes.

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