Turkish Journal of Computer and Mathematics Education Vol.12 No.10 (2021), 3872-3879

Research Article

Experimental Analysis of Hybrid UAV at Different Velocities

S.Mahendran[a], R.Asokan[b], V.Madhanraj[c], Abilash R.H[d], Ganesh G.B[e], Sunil Kumar S[f]

[a,b,c,d,e] Hindustan Institute of Technology and Science, Padur, Chennai

Article History: Received: 10 January 2021; Revised: 12 February 2021; Accepted: 27 March 2021; Published online: 28 April 2021

Abstract: The primary goal of this project is to constricting a hybrid UAV with both rotary and flapping wing. The primary objective of this project is to find the Lift in respect to RPM/Frequency in different modes of operation i.e. with operating only the propeller, flapping wing and with both propeller and flapping wing working simultaneously. For finding lift we will be using load cell. we will be studying the effect of a Flapping Wing when placed in Quadcopter and check whether the result have a positive effect or negative effects. The end result show's that there's a minute increase in lift when flapping wing is added to a quadcopter

Keywords: UAV (Unmanned Aerial Vehicle), Quardcopter, Ornithopter, lift, frequency, rpm

1. Introduction

An Unmanned Aerial Vehicle (UAV) or uncrewed aerial vehicles are also mentioned as unmanned aircraft it's commonly mentioned as a drone is an aircraft without a pilot on board. UAVs have many of the which include additionally a ground-based controller and a system of communications with the UAV. UAVs are used for observation and tactical components planning. This technology is now available to be used within the emergency response field to help the crew members. UAVs are classified supported the endurance, weight, and altitude range and support a large range of applications including military and commercial applications.

1.1 History

The earliest attempt to make a powered UAV was done by A. M. Lows "Aerial Target" in 1916.Low confirmed that Geoffrey de Havillands monoplane was the one that flew under control on 21 March 1917 using his radio system. The other British unmanned developments followed during and after World War I period leading to the fleet of over 400 Havilland 82 Queen Bee aerial targets that went into service in 1935.

Nikola Tesla developed a fleet of uncrewed aerial combat vehicles in 1915. These developments in the field also inspired the construction of the Kettering Bug by Charles Kettering from the Dayton Ohio and the Hewitt-Sperry Automatic Airplane. These aeroplanes are initially meant as an uncrewed plane that might carry an explosive payload to a predetermined target.

Film star and model-airplane enthusiast Reginald Denny invented the. first scaled down remote piloted vehicle was developed by in 1935.In 1940 Denny started the Radioplane Company and more models emerged during World War II they was used both to train antiaircraft gunners and to fly attack missions.

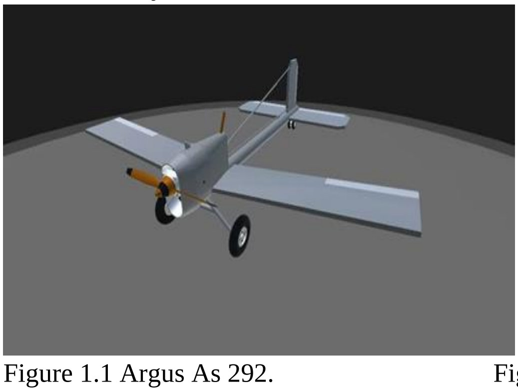


Figure 1.1 Argus As 292.

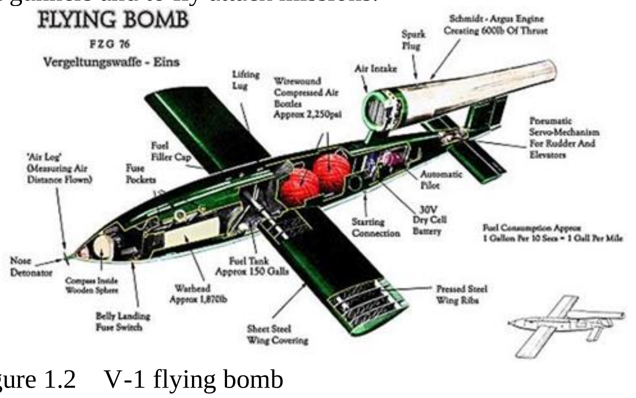


Figure 1.2 V-1 flying bomb

UAV aircraft such as the Argus As 292 and the V-1 flying bomb with a jet engine where produced and used by Nazi Germany during the war. After World War II the development continued in such vehicles

2 Components used in the designing of UAV

1. Motar
2. Battery
3. ESC (Electronic Speed Controller)
4. Propeller
5. Flapping Wing
6. Gears

2.1 Motar

A2212/8t is used in construction of UAV. It is a brushless out runner is a brushless out runner dc motor specifically made to power Quadcopters and Multi rotors. It is a 1800kV motor. It provides super power, brilliant efficiency and high performance. These motors are used in quadcopters which are medium sized with 8 inch to 10 inch propellers.

Specifications

- KV 1800
- No load Current 10 V : 0.5 A.
- Current Capacity is 12A/60s
- No Load Current at 10V: 0.5A
- Motor Dimensions are 27.5 x 30mm
- Shaft Diameter is 3.175mm.
- Minimum ESC Specification: 18A optimum 30 A

Figure 2.1 A2212/8t Motor

2.2 Battery

Lithium-based battery's are used in UAV systems because they have a higher energy density than the older nickel-based technologies so they can provide more useful power per unit weight. The battery used in our UAV IS lithium polymer LiPo with a capacity of 2200 mAh at 3S with 11.1V

Figure 2.2 Lipo Battery

2.3 ESC (Electronic Speed Controller)

Quadcopters uses 30 amp ESC Electronic Speed Controller with Connector. It provides better flight performance with better and faster motor speed control which is better were comparing to other available ESCs. . It works on 2S-3S LiPo batteries. The onboard BEC which provides regulated 5V and 2A max current to power the flight controller and other components onboard .This is useful when controlling our brushless motors with a 2S-3S LiPo

Figure 2.3 ESC

2.4 Propeller

We are using 1045(10×4.5) SF Props have high-quality propellers specially designed for quard-copter. To avoid whirlpool, quard-copter when flying with 1045(10×4.5) SF Props has 15° angle design in the end of the propeller. It has a Pitch of 4.5″, Shaft Diameter: 6 mm and a Total length of 10 inch / 254 mm.

Figure 2.4 Propeller

2.5 Flapping Wing

Ther are thee types of flapping wing comely used they are

1. orcon cambered thick wing
2. orcon cambered thin wing
3. orcon flat wing

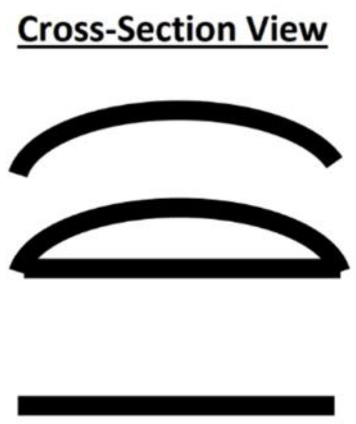


Figure 2.5 Cross Section of Flapping Wing

The above figure shows the cross section views of orcon cambered thin wing, orcon cambered thick wing and orcon flat wing respectively from research we have found that lift produced by orcon flat wing is positive while othe two mainly produces negative lift so we have selected orcon flat wing as over UAV's wing to produce maximum lift

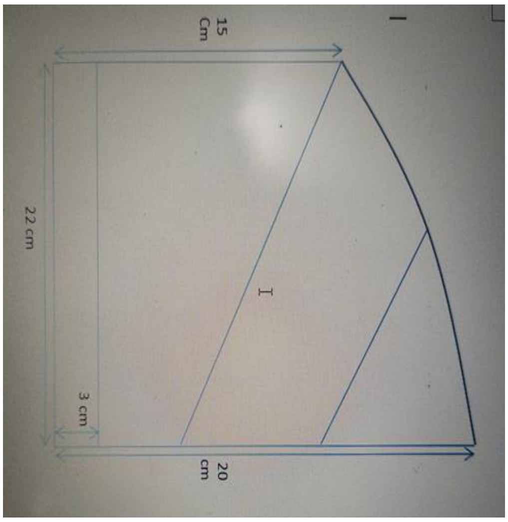


Figure 2.6 Dimensions of Orcon Flat Wing

Figure 2.7 Fabricated Orcon Flat Wing

2.6 Gears

Three gears are used in flapping wing mechanism

Figure 2.8 Gear Setup For Ornithopter

The driver gear which is the right end of the above diagram have 24 tooth the next gear have 38 tooth and then we again have a gear with 24 tooth and last we have a gear with 60 tooth

The gear ratio of this gear system = 5:2

3 Weight Extimation

The estimated weight quard-copters can lift is

Lift at 3S with 1045 propeller for a single motor is = 1N

We are using 4 Motar so

Extimated lift produced is = 4N

The extimated weight the ornithopter can lift

$$L = \phi^2 \times \pi^2 \times f^2 \times CL \times \rho \times co. \times l^3 \times \frac{1}{3}$$

where φ0 is flapping angle, f is the flapping frequency, c0 is the chord length and l is the wing span length. CL is coefficient of lift. This equation is to be used as a rough estimate so that the dimensions and weight of the UAV could be measured

Parameters	**Values**	**Unit**
FlappingAmplitude	40	Deg
FlappingFrequency	500	Hz
LiftCoefficient	0.3	
AirDensity	1.225	Kg/m³
ChordLength	0.2	m
WingSpan	0.22	m
Lift	2.059	N

Table 1 Maximum Estimated Weight of UAV

So the maximum weight of the UAV must not exceed 2 Kg

3.1 Weight of the UAV

Components	**Weight**
ESC	20×5=100gms
Propeller	14×4=56gms
Battery	160gms
Circuitcomponents	200gms
Frame	400gms
Flappingwing.	200gms
Motar	52.7×5=363.5gms
Total	1404.5gms=1.5Kg

Table 2 weight of UAV

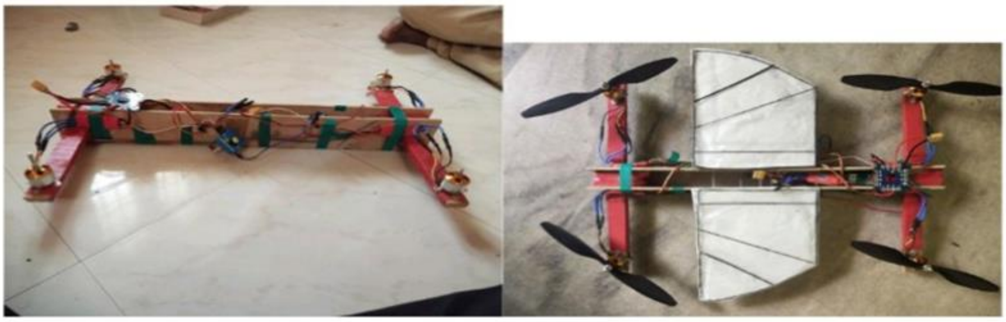


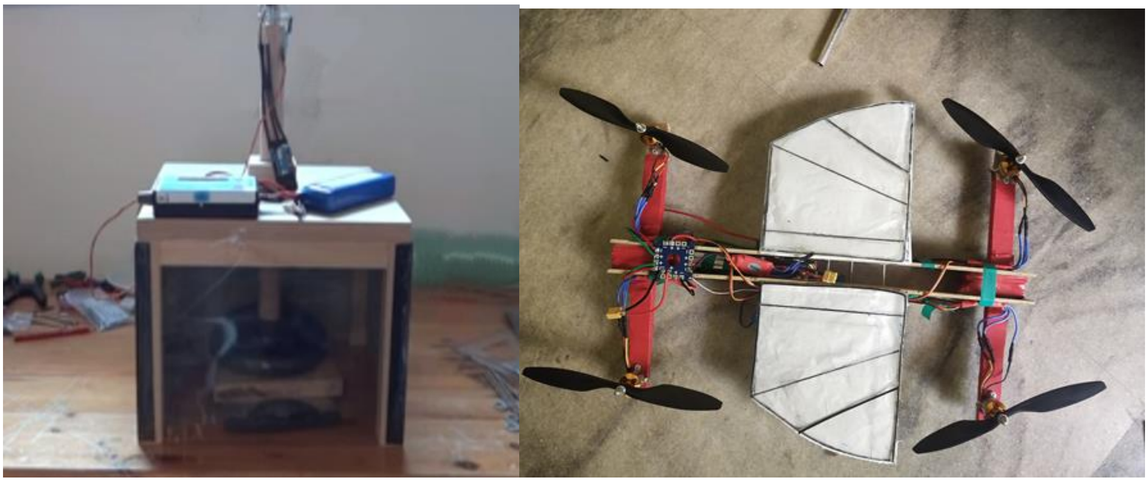
Figure 5.1,2 UAV

3.2 Experiment

The experiment is conducted for these category first it is Quadcopter in this only the propeller is run hear the value of the lift is noted for different RPM of the motor and the result is tabulated

Second only the flapping Wing of the UAV is operated and the lift is noted with respect to the frequency of the flaps

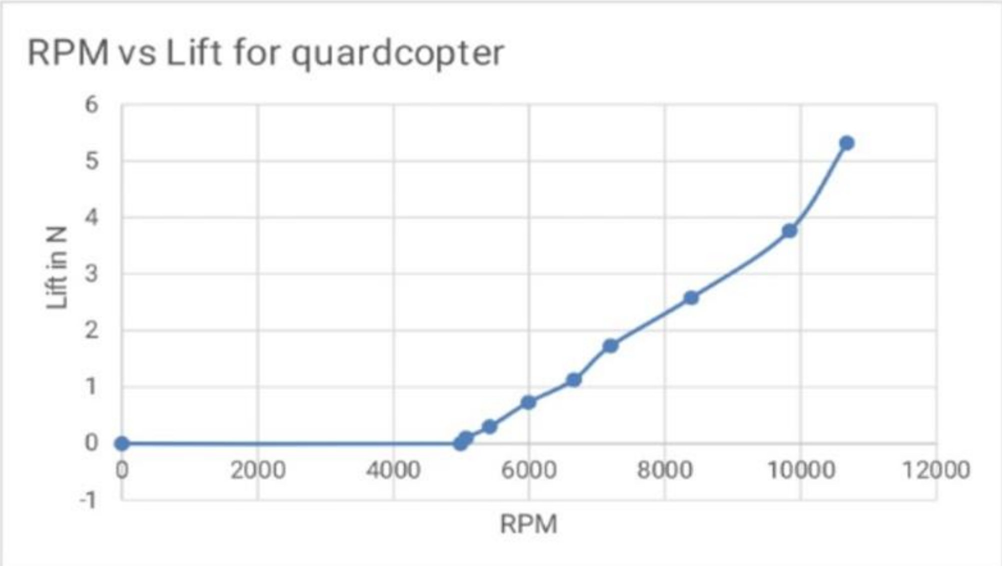
The both the propeller and flapping wing of the UAV is operated and the lift is noted down for the different RPM of the motor.



3.3 Result

RPM	LIft(N)
0	0
4990	0
5070	0.1
5420	0.3
5990	0.73
6660	1.13
7200	1.73
8390	2.58
9840	3.77
10680	5.32

Table 3 noted down value of RPM and lift for Quadcopter



Graph 1 Result of RPM And Lift For Quadcopter

From graph 1 we can understand that the lift produced by the four rotars is gradually increases as rpm increases and lift increases rapidly when rpm increases above 9000 after a certain range this is due to the Weight of the UAV

frequency	lift(N)
50	0.2
250	1.3
500	3.2

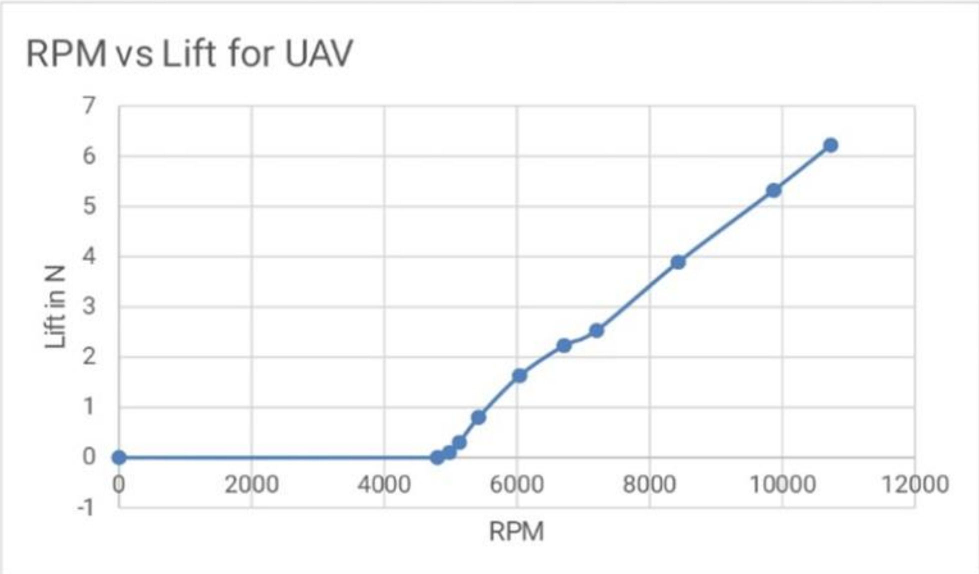
Table 3 Noted Down Value of RPM And Frequency For Ornithopter

Graph 2 Result of RPM And Frequency For Ornithopter

From graph 2 we can understand that the lift produced by the flapping wing is gradually increases at a steady rate frequency of the flaps increases

RPM	Lift(N)
0	0
4800	0
4980	0.1
5130	0.3
5420	0.8
6040	1.63
6710	2.23
7200	2.53
8430	3.89
9870	5.32
10730	6.22

Table 3 noted down value of RPM and lift for Quadcopter



Graph 3 Result of RPM And Lift For UAV

From graph 3 we can understand that the lift produced by the UAV is gradually increasesas rpm increases after a certain range this is due to the Weight of the UAV

4 Conclusion

The load cell experiment was conducted and the values of speed of motor in rpm and lift where obtained they are tabulated and graphed. The conclusions were obtained by studying the graphs are

1. The lift produced by the four rotors is gradually increases as rpm increases. The lift produced is zero until 5000 rpm
2. The lift produced by the flapping wing is a line when comparing it to rotors it produces less lift for the given rpm of motor
3. The lift produced by the UAV gradually increase after 4900 rpm which is lesser than that of Quadcopter

Therefore we can conclude that there's a small increases in lift with flapping wing compared to when there's no flapping wing

References

1. Rotary vs. Flapping-Wing Nano Air Vehicles Comparing Hovering Power 2010 by Zhen Liu, Jean Marc.
2. Flight Control of a Rotary wing UAV including Flapping 2011 by Dynamics by Bilal Ahmed, Hemanshu R. Pota.

3. Eisenbeiss, H. (2004). A mini unmanned aerial vehicle (UAV): system overview and image acquisition. International Archives of Photogrammetry. Remote Sensing and Spatial Information Sciences, 36(5/W1), 1-7.
4. Adams, S. M., & Friedland, C. J. (2011, September). A survey of unmanned aerial vehicle (UAV) usage for imagery collection in disaster research and management. In 9th international workshop on remote sensing for disaster response (Vol. 8).
5. Conceptual Design of Hybrid UAV published on 2015 by B.Venkata Sai Anoop, T.V.Vineeta, A.Sai Kumar , V.V.S.Nikhil Bharadwaj.
6. Wind Tunnel Experiment of Blended Wing Body (BWB) Unmanned Aerial Vehicle (UAV) at Mach 0.1 and Mach 0.3 2018 by Wirachman Wisnoe, Rizal Effendy Mohd Nasir, Wahyu Kuntjoro, and Aman Mohd Ihsan Mama.
7. Nebiker, S., Annen, A., Scherrer, M., & Oesch, D. (2008). A light-weight multispectral sensor for micro UAV—Opportunities for very high resolution airborne remote sensing. Int. Arch. Photogramm. Remote Sens. Spat. Inf. Sci, 37(B1), 1193-1200.
8. Salih, A. L., Moghavvemi, M., Mohamed, H. A., & Gaeid, K. S. (2010). Flight PID controller design for a UAV quadrotor. Scientific research and essays, 5(23), 3660-3667.
9. A Survey of Hybrid Unmanned Aerial Vehicles 2020 by Adnan S. Saeeda, Ahmad Bani Younesb, Chenxiao Caic, Guowei Caid.
10. Wind Tunnel Testing and Performance Modelling of Rotar for UAV 2018 by Sean J. Freeman.