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Design and Fabrication of Flexible Wing UAV

Selvakumar, R. Ramasamy
Department of Aeronautical Engineering
Nehru Institute of Technology, Coimbatore.
nitsaranya@nehrucolleges.com[1]

Introduction

Multi-purpose, compact unmanned aerial vehicles have been gaining remarkable capabilities in the last decades. They are important due to their abilities to replace manned aircrafts in many routine and dangerous missions, and to reduce costs of many aerial operations. These aerial robots can be utilized in a variety of civilian missions such as surveillance in disasters, traffic monitoring, law enforcement and power line maintenance. They are already being benefitted in military applications such as intelligence, surveillance, target acquisition, reconnaissance and aerial attacks. These application areas lead to more advanced research for increasing the level of autonomy and reducing the size of UAVs. UAVs can be classified into three main categories: fixed-wing UAVs, rotary-wing UAVs, and hybrid design UAVs. [14]

Existing models

Fixed wing UAVs constitute the richest group among these categories both in terms of research and utilization. They are able to fly for long duration at high speeds and their design is simple in comparison with the other types of UAVs. These advantages lead to a broad range of fixed wing UAV designs from RQ-4 Global Hawk with39.8 m wingspan to Aero Vironment Wasp with 72 cm wingspan. However, these UAVs suffer from the requirement of runways or additional launch and recovery equipment for takeoff and landing. Rotary wing UAVs, on the other hand, are advantageous since they do not require any infrastructure for takeoff and landing. They also do not need any forward airspeed for flight and manoeuvring, which makes them useful particularly in urban areas and indoors. This leads to a large variety of rotary wing UAVs ranging from Boeing A160 Hummingbird with 2948 kg flight weight to Seiko–Epson l Flying Robot with only 12.3 g flight weight. But they are mechanically complex and have low flight speeds and durations.[14]



Fixed Wing UAV Rotor wing Hybrid wing

Hybrid design UAVs join the vertical flight capabilities of rotary wing UAVs with the high speed long duration flight capabilities of fixed wing UAVs. Despite their increased mechanical complexity and more difficult control, they are very desirable for their ability
to act like both fixed wing and rotary wing UAVs, since this ability is very useful in various missions. Among these hybrid designs, tilt-rotor UAVs constitute an attractive research area due to their stability, energy efficiency and controllability. A large proportion of the research on these vehicles is on dual tilt-rotors such as Bell Eagle Eye, Smart UAV of KARI and BIROTANand dual tilt-wings such as HARVee and the UAV of University di Bologna. The dual rotor UAVs generally require cyclic control on propellers, which adds to the mechanical complexity, for stabilization and manoeuvring. To solve this problem there are also studies on tilt-wing UAVs such as Vz-22 experimental aircraft of US Aerospace.[14]

Disadvantages of Existing Models.

Fixed wing UAV’s

The UAV’s are used military for surveillance and intelligence process. The fixed wing requires runway for takeoff and landing, during surveillance the UAV will be loitering at target point to collect data. The collected data will not be clear and gives less information.

Rotary wing UAV’s

It has less manoeuvrability compared to fixed wing UAV’s. The velocity of the rotary less, In order to escape from enemies sight it should have high velocity to escape.

Tilt-Rotor UAV’s

In Tilt-Rotor UAV’s drag produced will be more during Takeoff and Landing. It has Lesser stability to climbing and descending.

Advantages of Tilt -Wing VTOL UAV

In order to overcome the disadvantages of the existing model we have chosen hybrid UAV. In hybrid acts as fixed wing as well as rotor wing. In surveillance, to attain the target the fixed wing manoeuvring is used. After reaching the target the wing tilted upward and hovers near the target and capture clear data. After the data are collected it return to fixed wing manoeuvring to escape from the target.

Selecting of Model

We have chosen 3D- Free style aerobatic model UAV for higher manoeuvrability and higher speed.

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Figure: 1

Design parameters

Overall length : 100cm
Wing span : 100cm
Wing area : $1851.85 cm^2$
Aspect ratio : 5.4
Root chord : 24cm
Tip chord : 12cm
Overall weight: 1.1Kg
Aileron area : $462.96 cm^2$
Vertical stabilizer area : $185.18 cm^2$
Horizontal stabilizer area : $370 cm^2$
Elevator area : $925.9 cm^2$
Ruder area : $925.9 cm^2$
Airfoil : NACA 23018

Construction Material Used

Electronic System

Engine: Motor If 2212/13 1000KV Up to Model Weight 800Gms

Specification

Motor size : 28*26mm
Shaft size : 3.175*37mm
Weight : 50g
Rpm : 1000
Max Power : 150W
ESC : 18A
Propeller : 11x7/10x5
Battery : 3s Li-Po

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Figure:1 Electric Motor

Electronic Speed Control: ESC RCFORALL 30 AMPS
Specification
Input voltage : DC 6-16. 8V (2-4S Lixx)
BEC : 5V 2amp
Running current : 30A (Output: Continuous 30A, Burst 40A up to 10 Sec.)
Size : 36mm (L) * 26mm (W) * 7mm (H).
Weight : 32g

Figure: 2 Propeller: Paired 2 Blade Propellers Rotating & Counter Rotating 10×4.5

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Figure: 3 Extended Wire

BATTERY: Battery lipo Gens Ace 3S (Rechargeable) 11.1V 25 C 2200 mAh

Specification

Rechargeable Lipo (Lithium Polymer) High Discharge /Fast Charge Batteries 3S 11.1V 2200mAh

Capacity : 2200mAh
Voltage : 11.1V
Max Continuous Discharge : 25C (55A)
Max Burst Discharge : 50C (110A)
Weight : 195 g
Dimensions : 105.68*34.15*25.71 mm
Balance Plug : JST-XH
Discharge Plug : 4.0mm banana or T plug
Charge Rate : 1-3C Recommended, 5C Max

Structural Materials

Balsa Wood:

• Light-weight wood.
• Stronger than coroplast, but not crash proof though.
• Stiffer than other available materials

Ceroplastic (Sun pack)

• Durable material.
• Stronger than Styrofoam but a bit heavier.
• Good choice for fuselage and crash-prone areas

Wing Construction

Several airfoils are cut from balsa wood

Airfoils are connected using balsa support rods the structure is partially covered with 1mm sheet balsa throughout the wing span (near the leading edge) Ailerons are also made in the similar way. Both the wings and ailerons are covered with heat shrinkcovering film (plastic film).

Conclusion

By using VTOL UAV the performance characteristic will be enhanced compare to the fixed wing and rotary wing UAV's. This UAV will do better surveillance of collecting clear information of the target quickly. If this VTOL UAV is implemented we can collect good amount of information for surveillance and intelligence process.

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