Intro to UAV Design - Assignment 3
Hybrid VTOL UAVs

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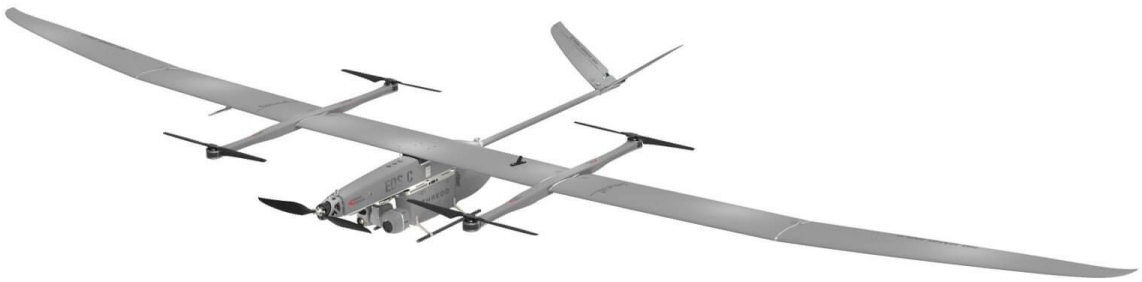
Q2 (5 UAVs are listed)

Hybrid VTOL UAV Market Survey - 1 - Quantum Systems Trinity F90+
https://hitecnology.com/drones/quantum-systems-trinity-vtol-fixed-wing-mapping-uav

Specifications:

- Weight with Standard Camera = 11.0 lbs. (5.0 kg)
- Material = Durable Elapor® Foam / Carbon Fiber Structure
- Wing span = 7.48 ft. (2.394 m)
- Endurance (flight time) = 90 Minutes
- Max. Range (Area) = 100 km = 700 ha
- Cruise Airspeed = 38 MPH (17 m/s)

Hybrid VTOL UAV Market Survey - 2 - EOS C Hybrid Fixed-Wing VTOL UAV
https://threod.com/wp-content/uploads/2020/06/EOS-C-VTOL-UAS-datasheet.pdf

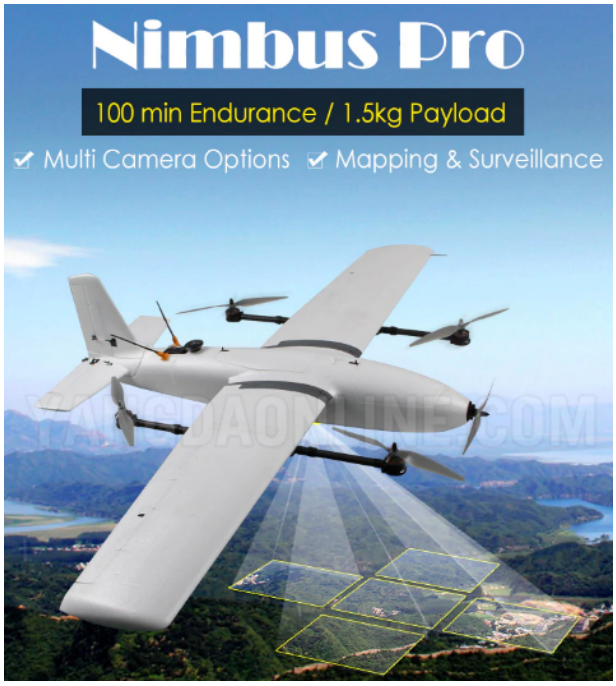


Specifications:

- Dimensions = 4760 mm wingspan x 1830 mm length
- Weight = 11-13kg
- Endurance = 2 h VTOL, 3 h fixed wing
- Max payload = 1 kg
- Cruise speed = 18 m/s (Air speed = 50-100 km/h, wind penetration 16m/s)
- Range (max distance) = 120 kmph
- Max take off altitude = 3500 m

Hybrid VTOL UAV Market Survey - 3 - Nimbus Pro VTOL

https://www.yangdaonline.com/yangda-nimbus-pro-vtol-fixed-wing-drone-for-mapping-and-surveillance/



Required Specifications:

- Max Takeoff Weight 8.6 kg
- Weight without battery and payload 4.03kg
- Wingspan 1950 mm
- Length 1,300 mm
- Max payload (battery included) 4.57kg
- Endurance (no payload) 100 minutes
- Cruise speed 72km/h
- Max speed 90km/h
- Package size 135 * 41 * 40 cm

Other useful specs:

Battery weight (Tattu 6S 25000mAh) 2.56kg

Suggested payload weight 1.5kg

Stall speed 39.6km/h

Hybrid VTOL UAV Market Survey - 4 - ALTI Transition

https://geo-matching.com/uas-for-mapping-and-3d-modelling/transition-commercial-vtol-uas

https://altiuas.com/

Specifications:

- Max. payload = 1.5 kg
- Max. speed =72 kmph
- Max. height above sea level = 4000 m
- Wing span = 300 cm
- Weight = 5.6 kg
- Max. wind speed = 10 m/s
- # rotors = 5
- Height = 52 cm
- Endurance = 12 h

Hybrid VTOL UAV Market Survey - 5 - YANGDA FW-320 FIXED WING VTOL
https://www.yangdaonline.com/yangda-fw-320-fixed-wing-vtol-plane/

Specifications:

- Max takeoff weight 23kg
- Weight w/o battery and payload 9.76kg
- Wingspan 3,200 mm
- Length 1,200 mm
- Height 500 mm
- Endurance (23kg take-off weight) 2.5 hours
- Cruise speed 78-90km/h
- Max speed 100km/h
- Operating Altitude(Max.) 3,500m

More useful specs:
Frame weight 3.2kg
Max payload (battery included) 13.24kg
Battery weight (Tattu 6S 32000mAh) 7.2kg
Suggested max payload weight 5kg
Stall speed 57.6km/h
Anti-wind capability 43.2km/h

Q1

Major Differences between Fixed wing/Multirotor and Hybrid VTOLs - Design based

1. **Transition Dynamics:** These are not addressed in Fixed wing and multirotor UAVs.

2. **Effect of propeller flow on the wing:** The arrangement of the propellers in multirotors is on the top of the body of the uav and generally symmetrically covers the body. But in Hybrid VTOL the propellers (#2) are in the front in a forward pointing kind of manner. For fixed wings, generally there is a propeller (#1) at the nose of the aircraft. We can see that the air flow due to these different propellers is different and therefore, the effect on the lift generated by the front portion of the wing will be different. They are designed in such a way that when the propellers are turned off in the cruise phase of the hybrid UAV, they don't interfere with the lift and they contribute to very little drag.

   Minimal number of rotors - efficiency is higher for hybrid vtols. We use them in spite of their complexity in making them fly (about 10 kg weight aircraft).

3. **Adjustment of Center of Gravity (CG):** We need the CoG to be ahead of Centre of Pressure to account for pitching movement. We need to place components such that we balance this factor. This is more or less easy to design in multirotor/fixed wing, especially due the availability of designs and good databases so far.

4. **No extensive design and flight database:** We do not know to a good extent if a particular hybrid VTOL design will work or not with confidence, as there is not much data available and also there is no such thing as a standard design for a hybrid UAV. We can say this aircraft design is comparatively new, and it demands a new kind of

design for different applications, therefore involves a lot of extensive work compared to the other two aircrafts.

Performance based differences and comparisons:

1. Enhanced safety when compared to fixed-wing aircraft: In case of emergency landing, we can change the phase of flight from cruise to hover (by transitioning from fixed wing to quadrotor) and land at the nearest possible point (based on gliding). That is there is no spatial (therefore, temporal also) lag.
2. Fixed wing UAV's inability to hover makes applications like aerial photography difficult compared to the other two. They are more costly, take off and landing needs runway whereas Hybrid and multirotor don't.
3. The downside of multi-rotors is their limited endurance and speed, small payload capacity, making them unsuitable for large scale aerial mapping, long endurance monitoring and long distance inspection.
4. Multirotor UAVs are good in their ease of use, accessibility and camera operation, missions within confined areas, etc, unlike the fixed wing UAVs which are harder to operate and need more training.
5. The disadvantages in both these kinds of aircraft are tackled in hybrid VTOLs. But still, they are under development and not perfect at either hovering or forward flight. Therefore, which one to choose is entirely dependent on the application.