The Zot Tailsitter: Design of A VTOL Aircraft for the AUVSI-SUAS Competition

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OVERVIEW

UAV Forge and Competition: "UAV Forge is an interdisciplinary engineering design project dedicated towards creating a fully autonomous unmanned aerial vehicle (UAV) to compete in the AUVSI-SUAS 2021 Competition. The mission characteristics are motivated by the concept of autonomous unmanned aerial and ground vehicles performing payload delivery. Unfortunately, due to the coronavirus pandemic, AUVSI has entirely canceled the 2021 UAV competition, however we will continue building and improving our design, and produce a drone which meets competition requirements." - UAV Forge

Existing UAV Forge designs:

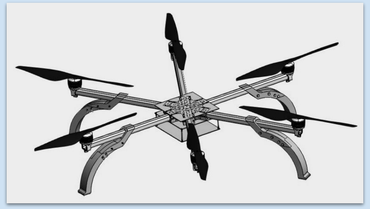

Fig. 1: UAV Forge Hexacopter 2021

Tailsitter solution: A tailsitter is a drone that can take-off and land vertically (VTOL) and transition between hover and horizontal flight like a traditional fixed wing aircraft.

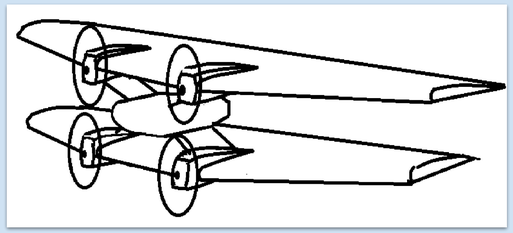

Fig. 2: Zot Tailsitter Final Design

"VTOL tailsitters deliver usability and reliability that is hard to match. *Simple and light construction* reduces the potential for human error and mechanical failure, ensuring a *faster, more reliable, and safer* drone survey mission." - Wingtra

DESIGN CRITERIA

Flight time	10 min
Flight Height	10 ft
Control Range	0.5 mi
Payload	Min. 2 lb
Budget	$1000

FINAL DESIGN & PROPULSION ANALYSIS

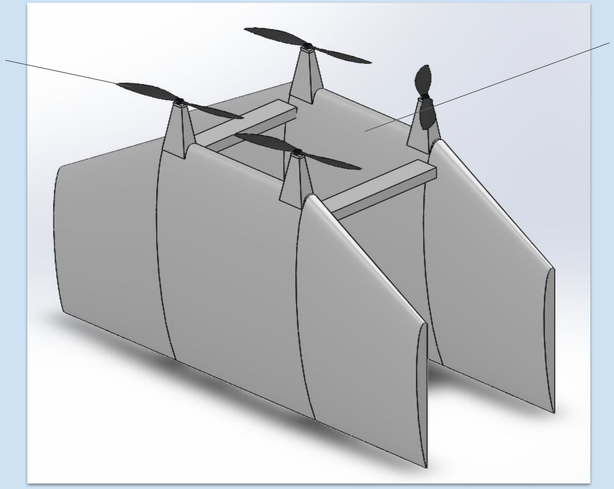

Fig 3: Zot Tailsitter CAD Model

Motor and propellers chosen using the following analysis:

Thrust to weight ratio, TWR = T/W where T is the thrust force and W is the total weight of the drone.

- TWR must be > 1 in order to fly. To be safe, TWR = 2 is chosen as a minimum to hover with the payload.
- Thrust produced by four motors is 100 N.
- Weight of model is at most 50 N for TWR ≥ 2.

* Will be attached to fuselage.

HARDWARE PERFORMANCE

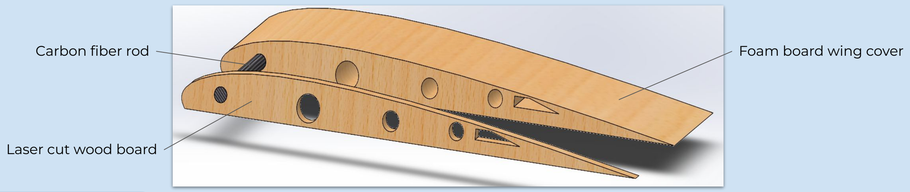

Fig. 4: Breakdown of Wing

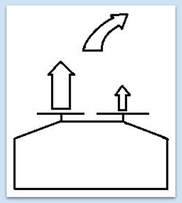

Fig 5: The yaw of the aircraft is achieved by the discrepancy of thrust in motor pairs. (edited)

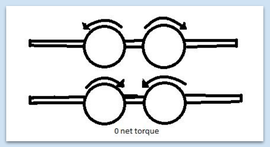

Fig 7: When roll is not needed, the propeller pairs spins in opposite direction, producing 0 net torque.

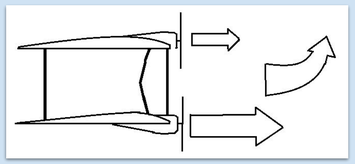

Fig 6: The pitch of the aircraft is achieved by the discrepancy of thrust in motor pairs.

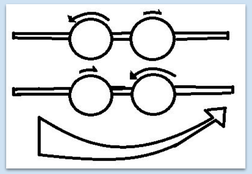

Fig 8: The roll axis control is achieved by reducing output on the one of the 2 diagonal motor pairs.

TIMELINE

Fall Quarter:

- Preliminary research and design phase
- Design concept finalized
- BOM finalized

Winter Quarter:

- Implementation phase (purchasing, assembly, fabrication)
- Verification against requirements
- Operating systems and sensors calibrated and tested
- Flight time testing and weight adjustments

FUTURE IMPROVEMENTS

Larger payload
Accommodate for heavier packages (10 lb).

Navigation
Add GPS, cameras, and sensors as part of competition requirements.

IMPACT ON SOCIETY

- No gas emission, designed to run on batteries.
- Will ideally be used to transport packages, further minimizing fuel usage.
- Advocate for further research in UAV technology.
- Potentially brings closer a future logistic network system consisting of autonomous drones, further streamlining the current carrier service.

ACKNOWLEDGEMENTS

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REFERENCES

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