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INTERNATIONAL INSTITUTE OF INFORMATION TECHNOLOGY HYDERABAD

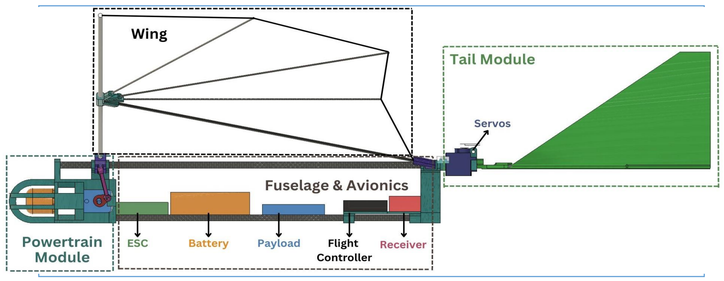
Design and Analysis of a Modular Flapping Wing Robot with a Swappable Powertrain Module

ABSTRACT

This study proposes a modular powertrain-based flapping-wing robot (FWR) as a versatile solution to a mission-specific switch between payload and range for the same FWR. As the flapping frequency and stroke amplitude are known to affect the flight characteristics of the FWR directly, we exploit this relation while designing the swappable powertrain with different motors and gear reduction ratios and 4-bar mechanism crank lengths to obtain the desired frequency and amplitude.

METHODOLOGY

The FWUAV features a modular powertrain with swappable motors and gear ratios to adjust flapping frequency and amplitude. Flight tests were manually controlled, with IMU and GPS logging pitch, roll, and velocity for performance evaluation.

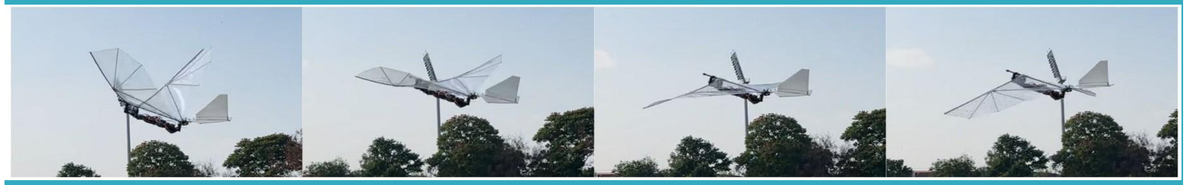


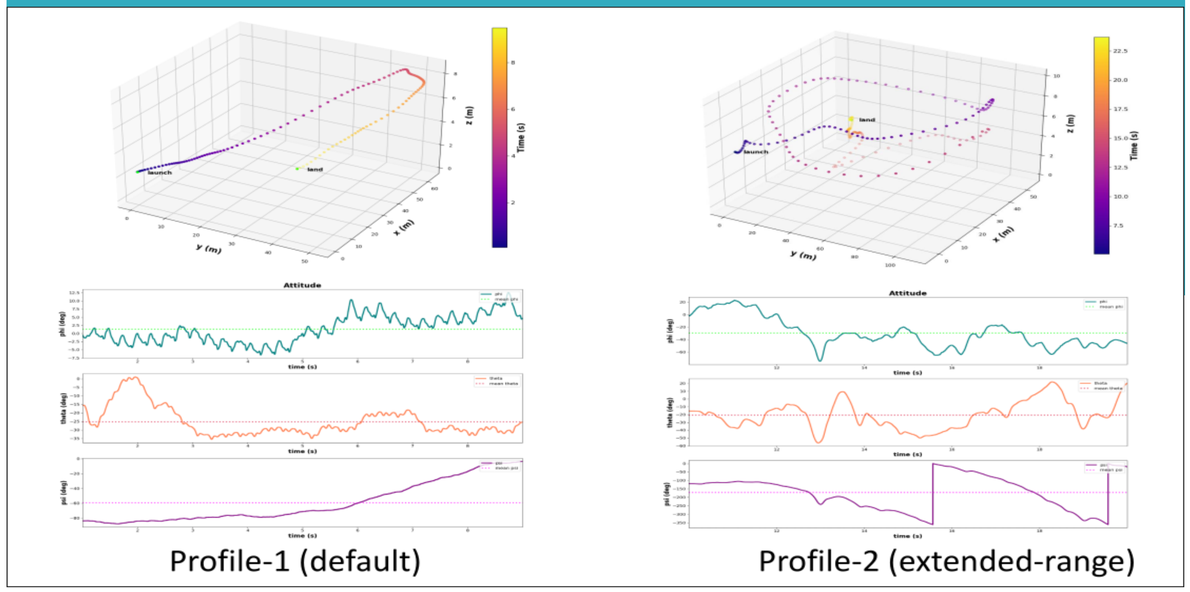
RESULTS

We manually controlled the FWR using a transmitter and recorded its IMU and GPS data. The default profile (with a 50 g dummy payload) showed a mid-flight pitch of ~30° and near-zero roll at 5.2 m/s, while the extended-range profile (with a 6×4 tandem propeller) had a ~20° pitch, non-zero roll, and 7.7 m/s.

Flap Cycle of FWUAV

The below pictures shows the flapping cycle of FWUAV in the default configuration.





Profile-1 (default) Profile-2 (extended-range)

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CONCLUSION FUTURE WORKS

We present a modular flapping wing robot with a swappable powertrain for mission-specific adaptability. Flight tests refined the design, and future work explores dielectric elastomer actuators for more efficient flapping motion.

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REFERENCES

Jae-Hung et al. (2023) review avian-inspired flapping mechanisms, advancing our understanding of flapping-wing design and performance.

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