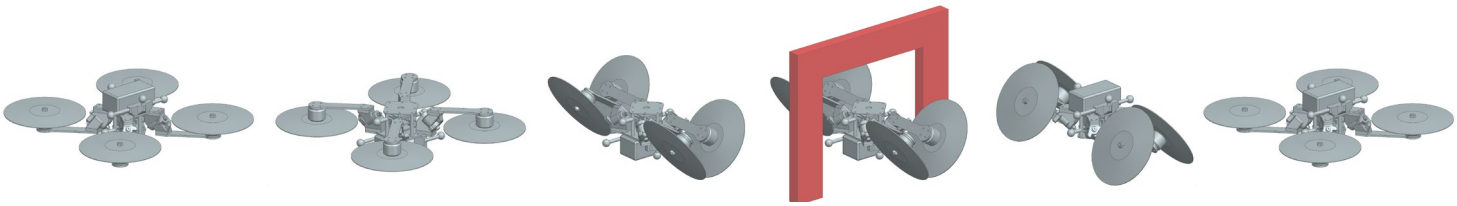
Fachhochschule Graubünden
University of Applied Sciences

FLIFO: A passively morphing drone for small gap traversal



Drones with large propellers are typically more efficient than drones with small ones. This can lead to design trade-offs when a drone is required to fit through small gaps. Morphing drones manage to sidestep this trade-off by temporarily morphing into smaller and less efficient configurations to traverse gaps. Here, a novel morphing drone design is presented that manages to shrink by an unprecedented 50% in width while maintaining full controllability. All without requiring any additional actuators.

Showcase video
youtu.be/km4emnqCqzE

40x Slow-mo video
youtu.be/oOH2R4ZKw6I

Crash reel
youtu.be/bIH9VZyr2X4

Project website
marcoruggia.ch/flifo

Marco Ruggia
Christian Bermes

Institute for Photonics and Robotics (IPR)
University of Applied Sciences of the Grisons

ARCHE Event 2024: Advanced Robotic Capabilities for Hazardous Environments

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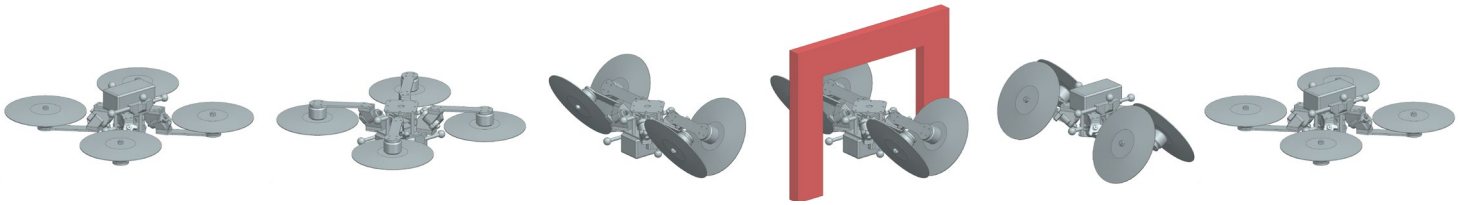
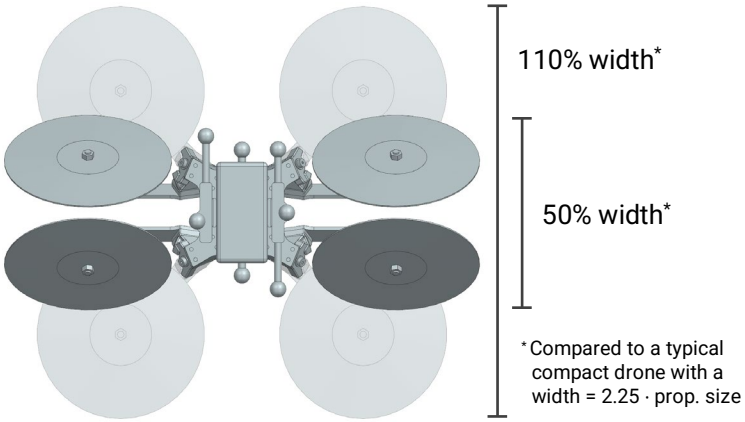
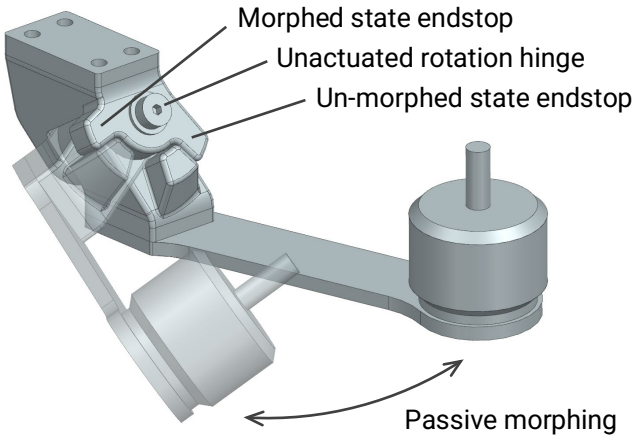


Width reduction when morphed:

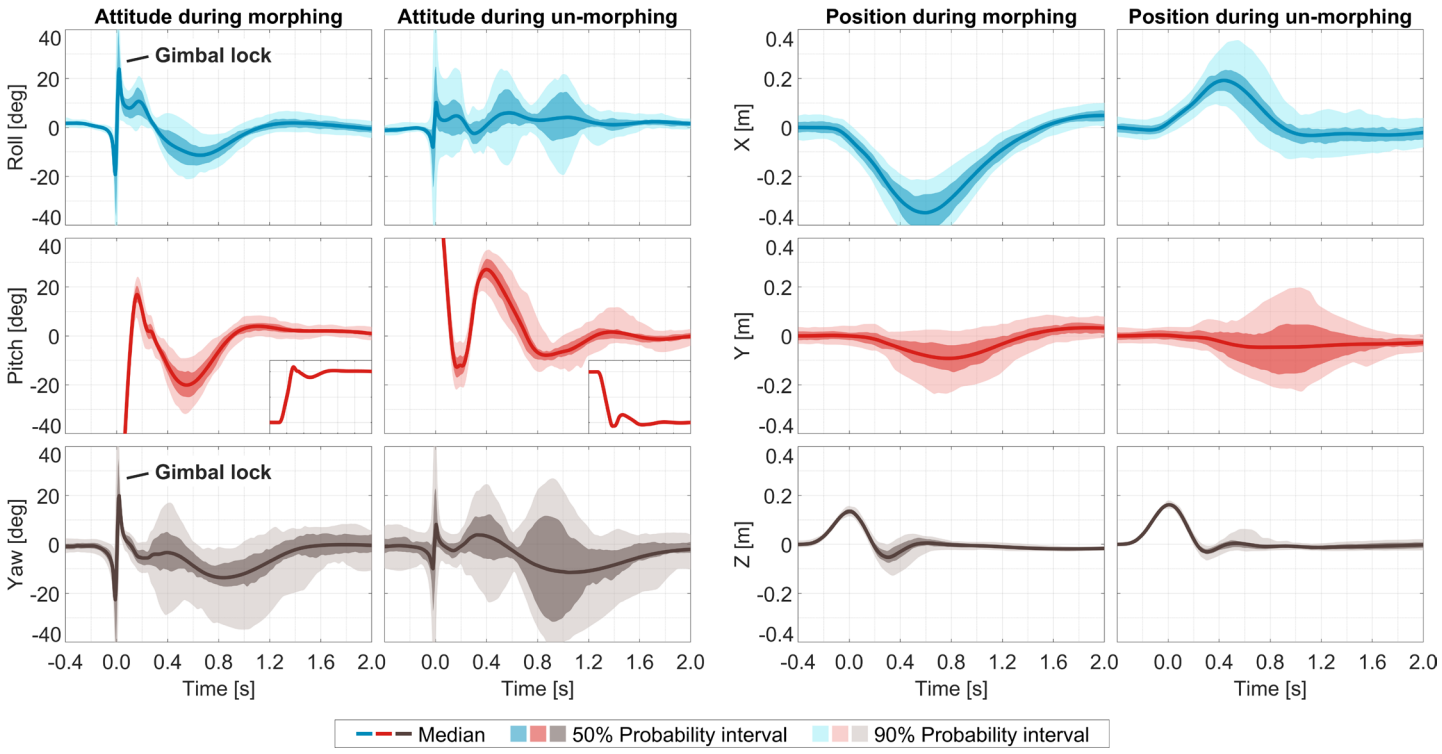


Passive morphing mechanism:



Morphing / un-morphing transition trajectories:

(analysis of 118 consecutive transitions)



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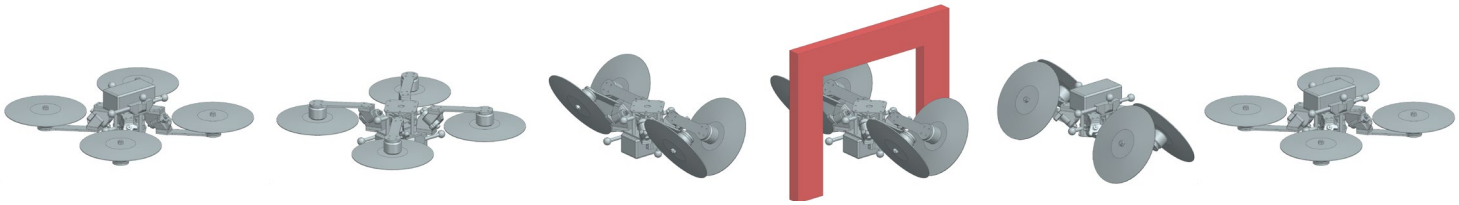


Control effectiveness in normal flight:

$$\begin{bmatrix} M_{roll} \\ M_{pitch} \\ M_{yaw} \\ F_{up} \end{bmatrix} = \begin{bmatrix} -1.21 & +1.21 & +1.21 & -1.21 \\ -1.21 & +1.21 & -1.21 & +1.21 \\ +0.17 & +0.17 & -0.17 & -0.17 \\ +13.1 & +13.1 & +13.1 & +13.1 \end{bmatrix} \begin{bmatrix} u_1 \\ u_2 \\ u_3 \\ u_4 \end{bmatrix}$$

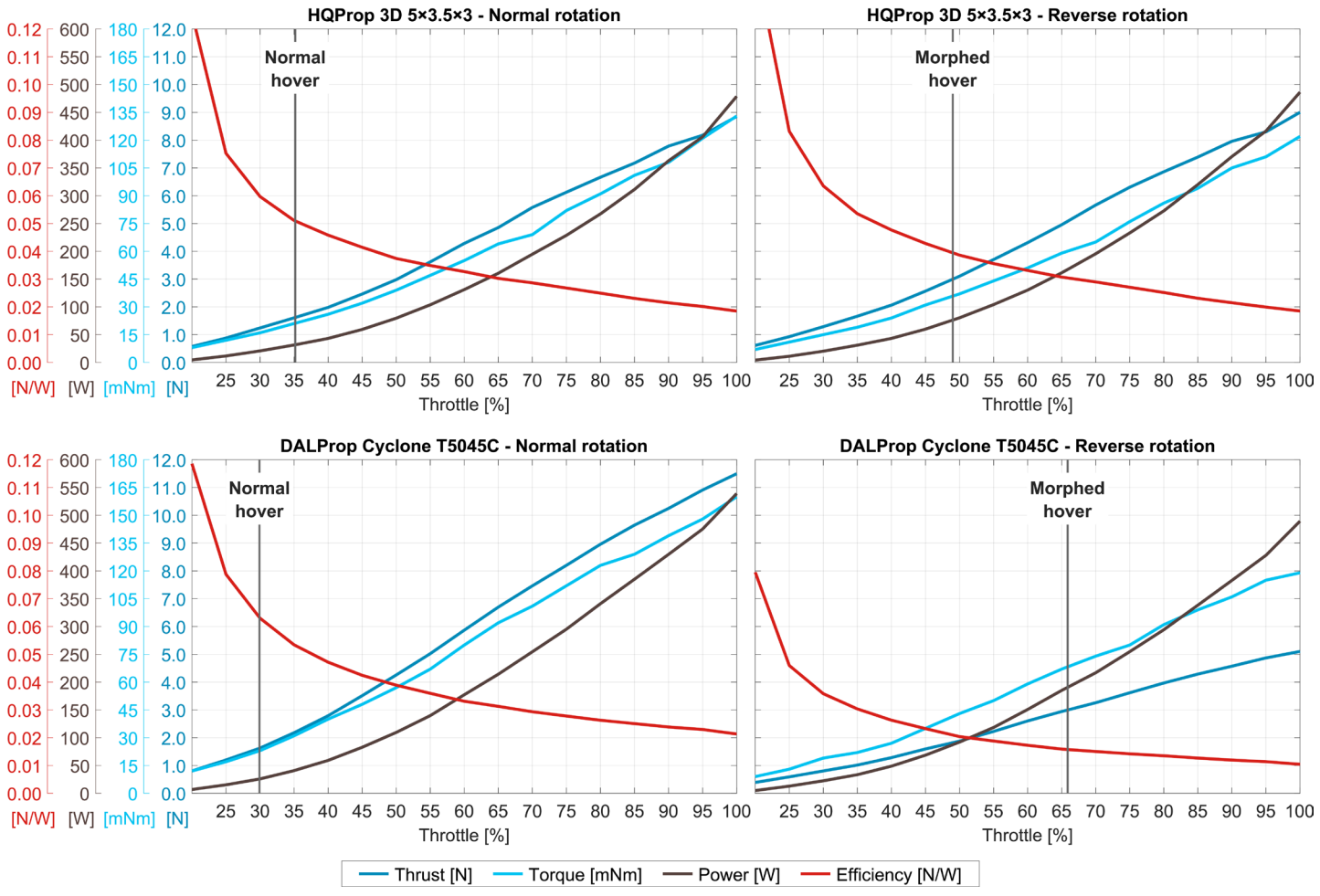
Control effectiveness in morphed flight:

$$\begin{bmatrix} M_{roll} \\ M_{pitch} \\ M_{yaw} \\ F_{up} \end{bmatrix} = \begin{bmatrix} -0.36 & +0.36 & +0.36 & -0.36 \\ -0.92 & +0.92 & -0.92 & +0.92 \\ -1.15 & -1.15 & +1.15 & +1.15 \\ +6.75 & +6.75 & +6.75 & +6.75 \end{bmatrix} \begin{bmatrix} u_1 \\ u_2 \\ u_3 \\ u_4 \end{bmatrix}$$

($M_{roll}, M_{pitch}, M_{yaw}$: Body torques [Nm] F_{up}: Body upward thrust [N] u_{1-4}: Motor throttles [-1 to 1])

Performance of two propeller options:

(measured on a thrust-stand for propellers rotating both ways)



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