

Servo Integrated Nonlinear Model Predictive Control for Overactuated Tilttable-Quadrotors

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RA-L Contribution

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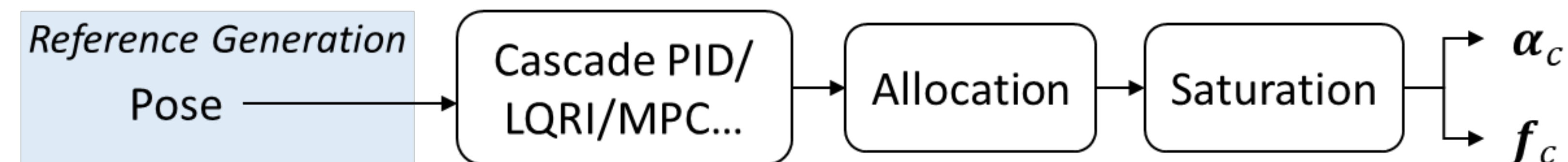
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Contributions

- **An NMPC framework for tilttable-quadrotors**, which considers the full dynamics and actuator constraints.
- **Explicitly consider the servo dynamics** inside the NMPC model, which is verified crucial for optimization convergence.
- **Implemented onboard with 100Hz control frequency**. To the authors' best knowledge, this is **the first time** an actuator-level NMPC is executed on real tilttable-quadrotors.

Others



Ours

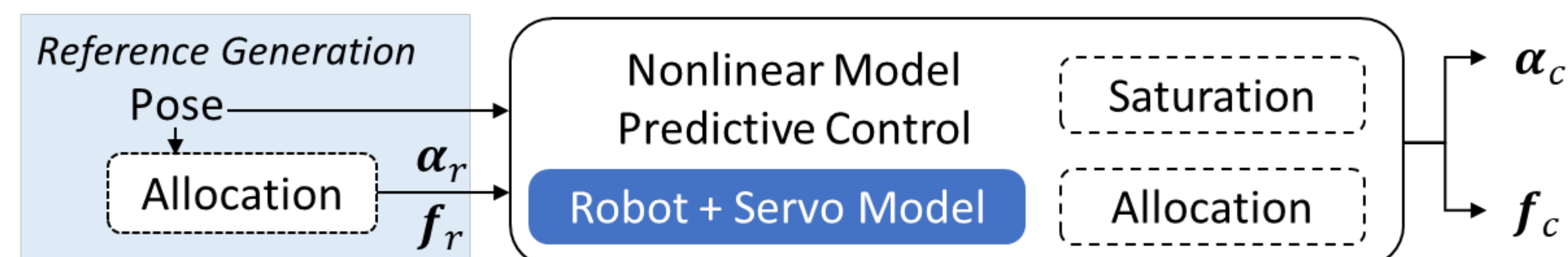


Fig. 1. The comparative workflows of others and ours

The Effect of Servo Dynamics

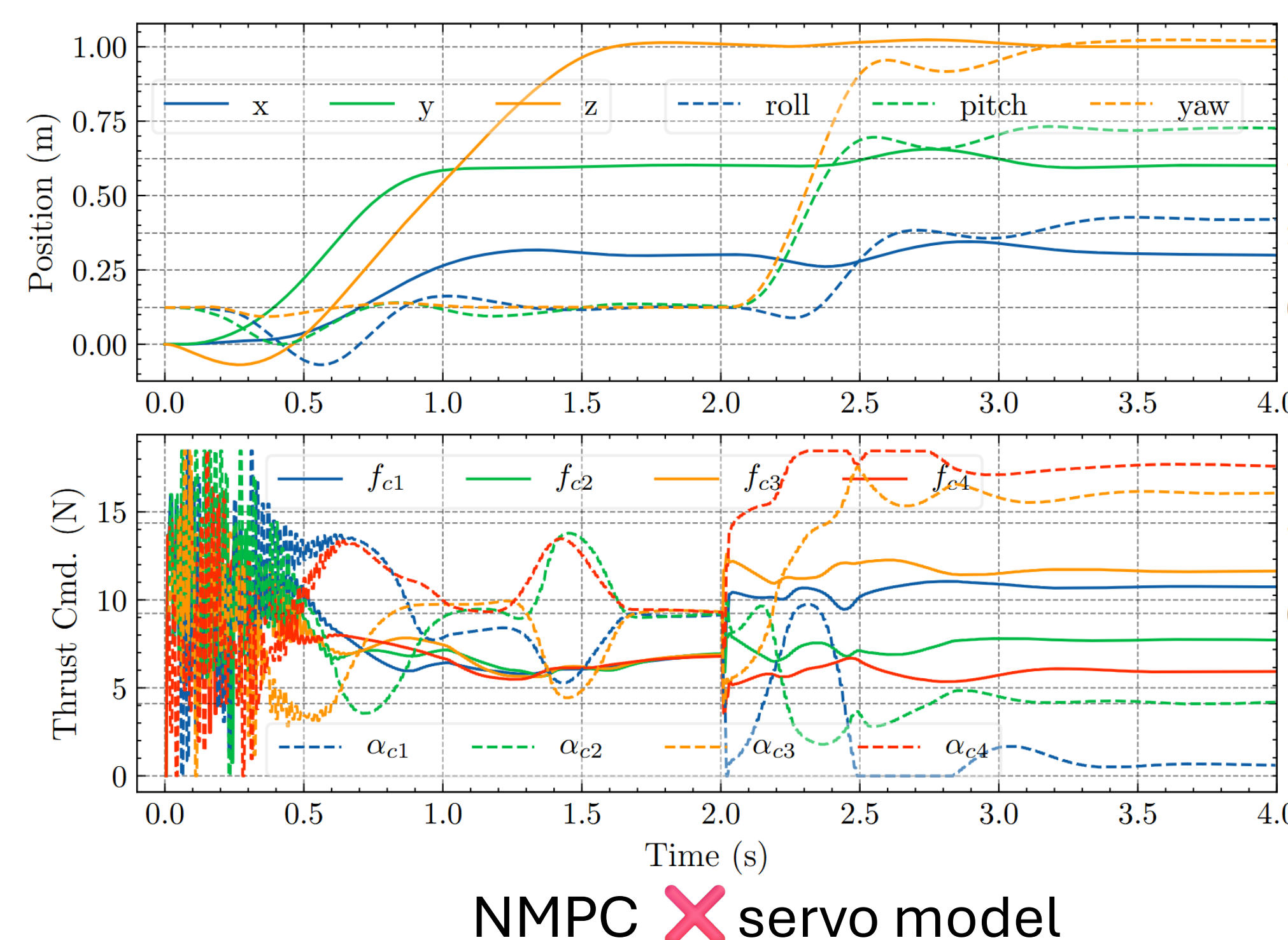
$$\dot{\alpha} = \frac{1}{t_{\text{servo}}} (\alpha_c - \alpha)$$

Result:

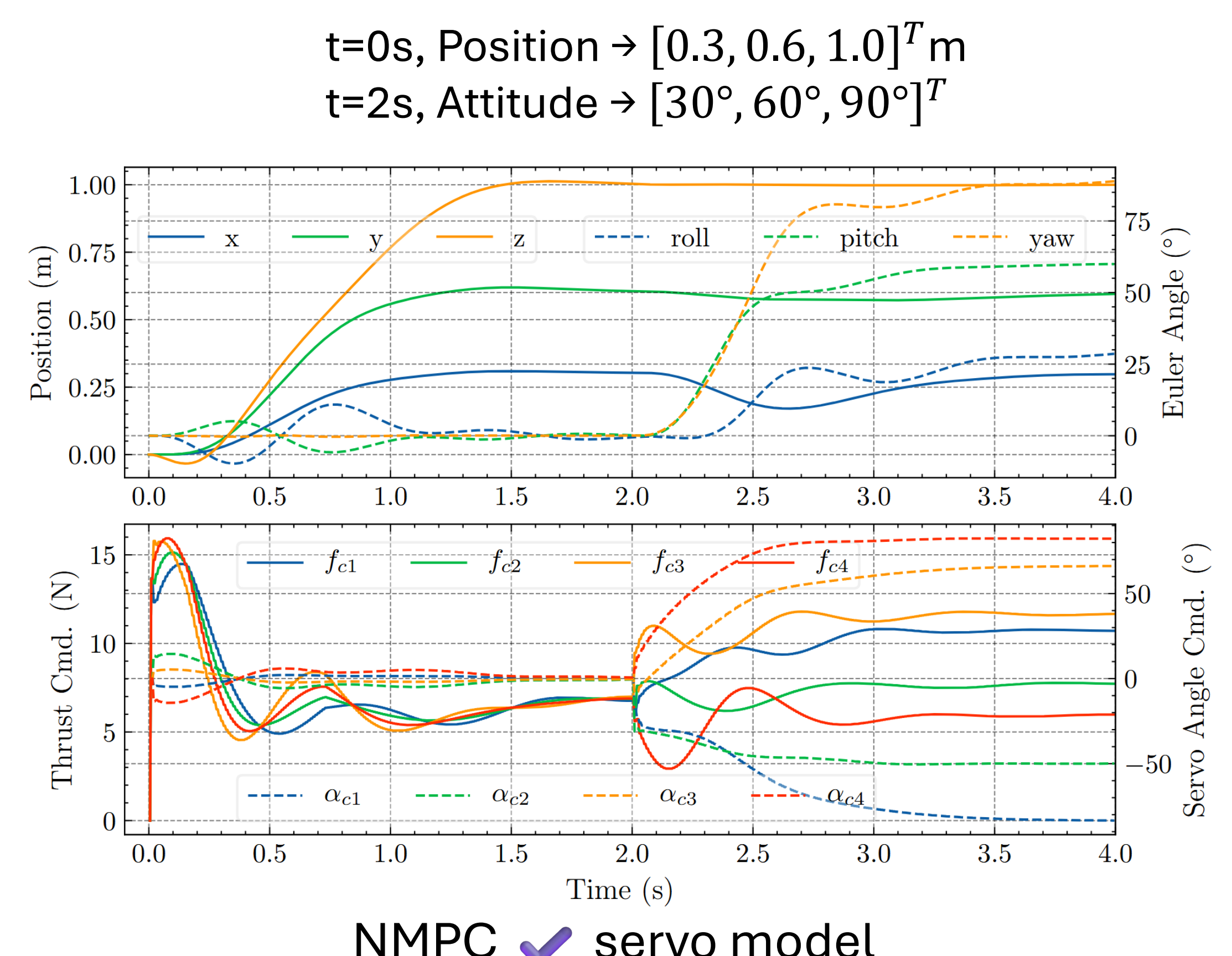
1. Servo model matters
2. Impact: Servo > Rotor

Reason:

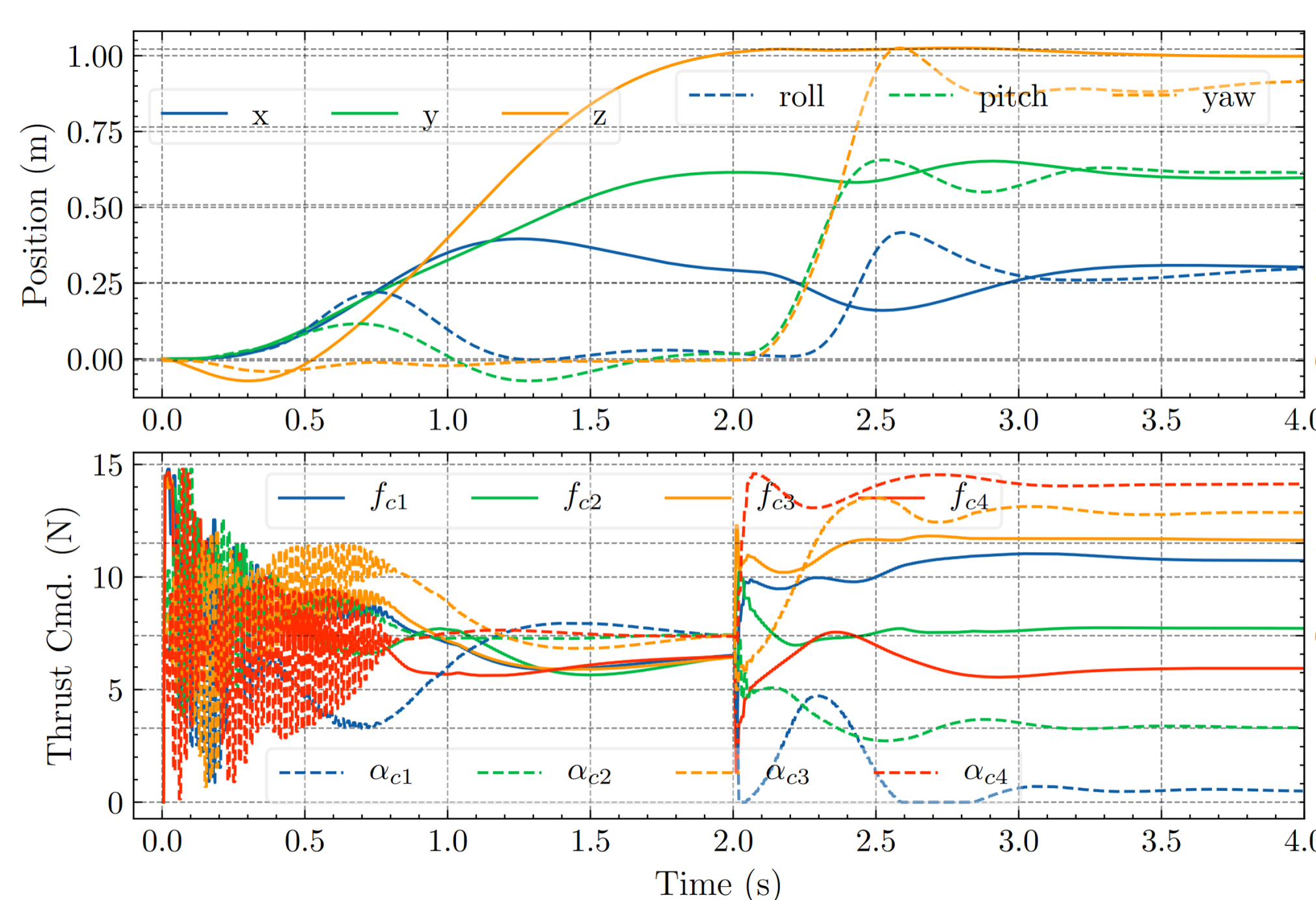
Servo model \approx
Continuity constraint



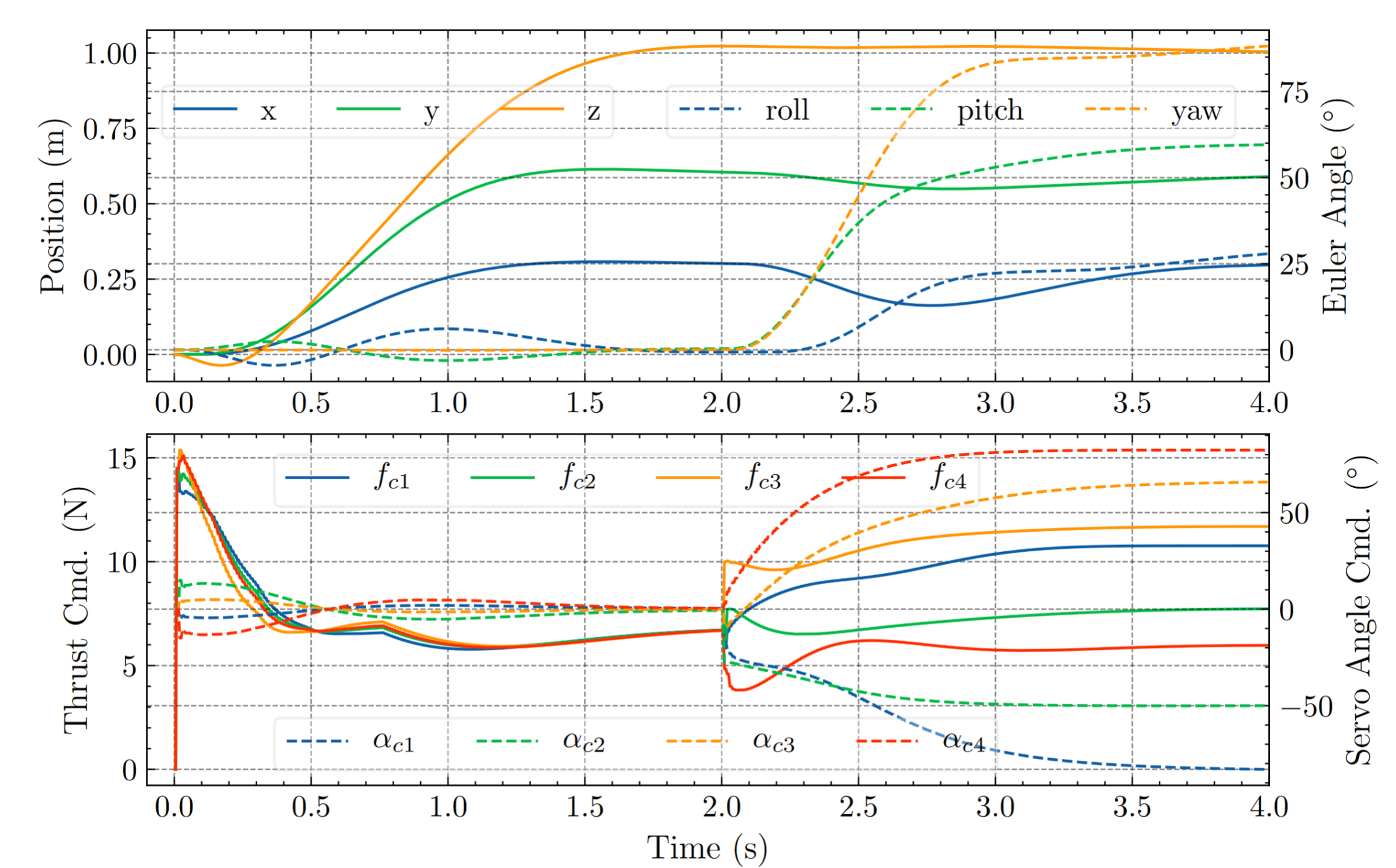
NMPC \times servo model



NMPC \checkmark servo model



NMPC \checkmark thrust model & \times servo model



NMPC \checkmark thrust model & \checkmark servo model

Fig. 2. The comparative analysis of NMPC with and without the servo/thrust model

Robot

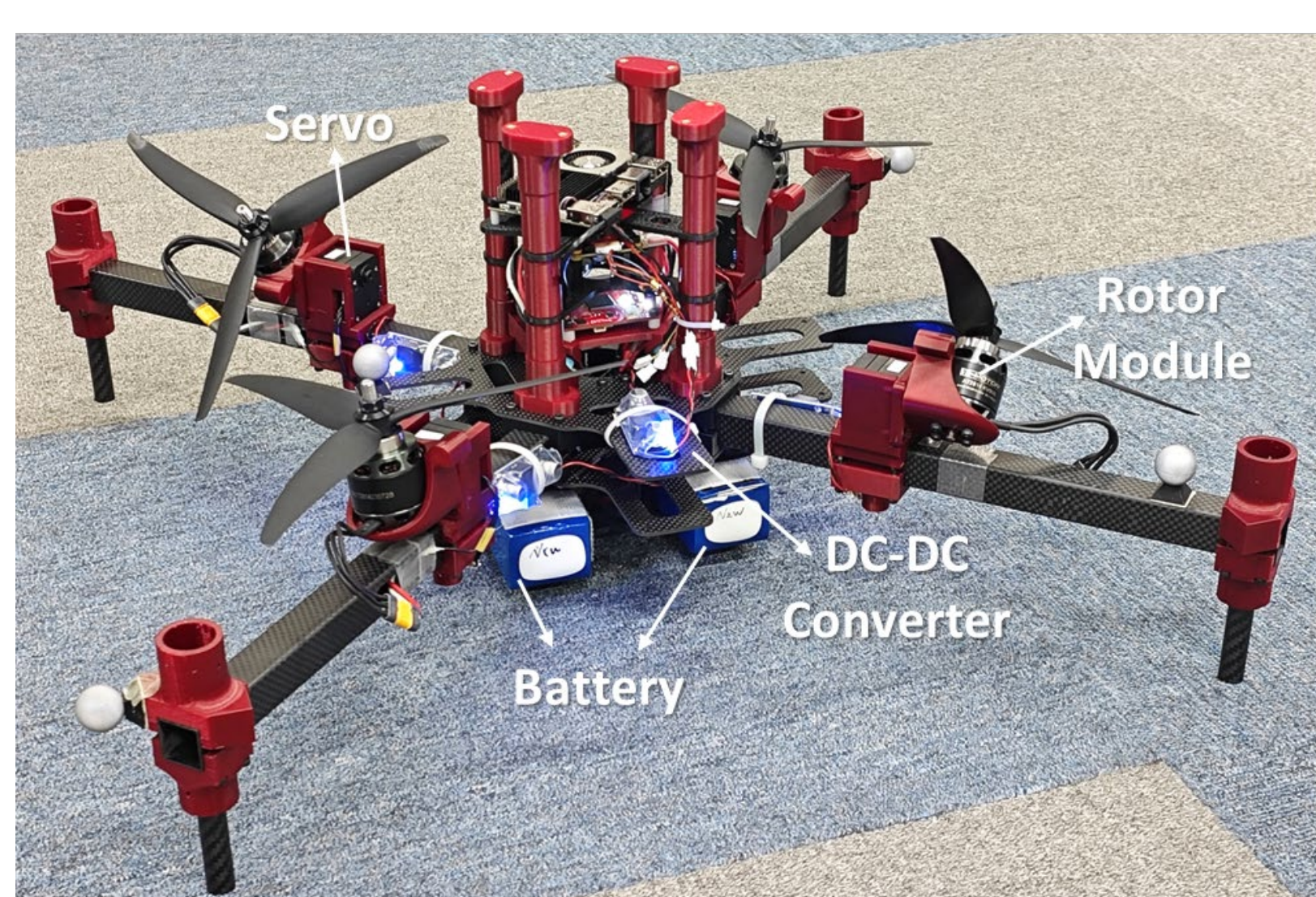


Fig. 3. A self-build tilttable-quadrotor

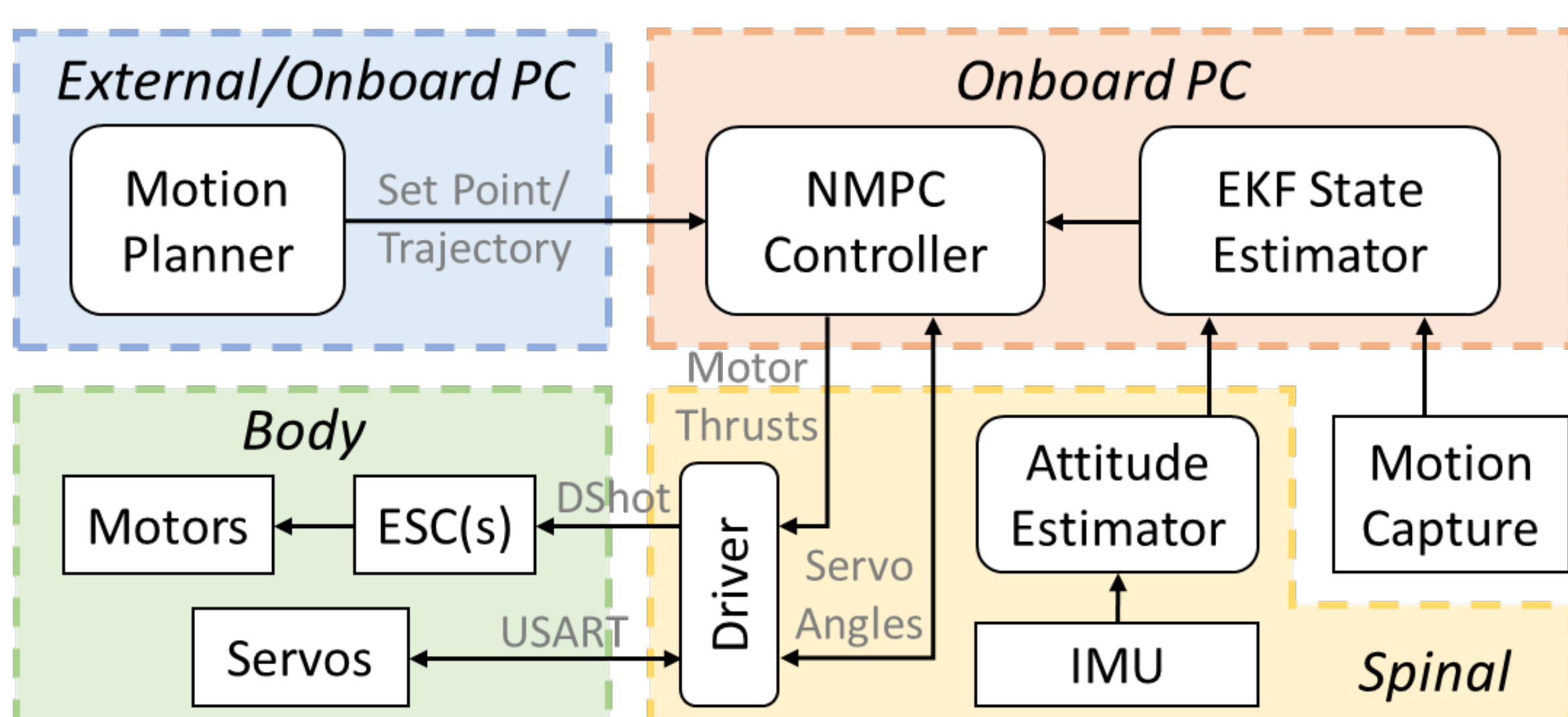


Fig. 4. Information flow among main modules

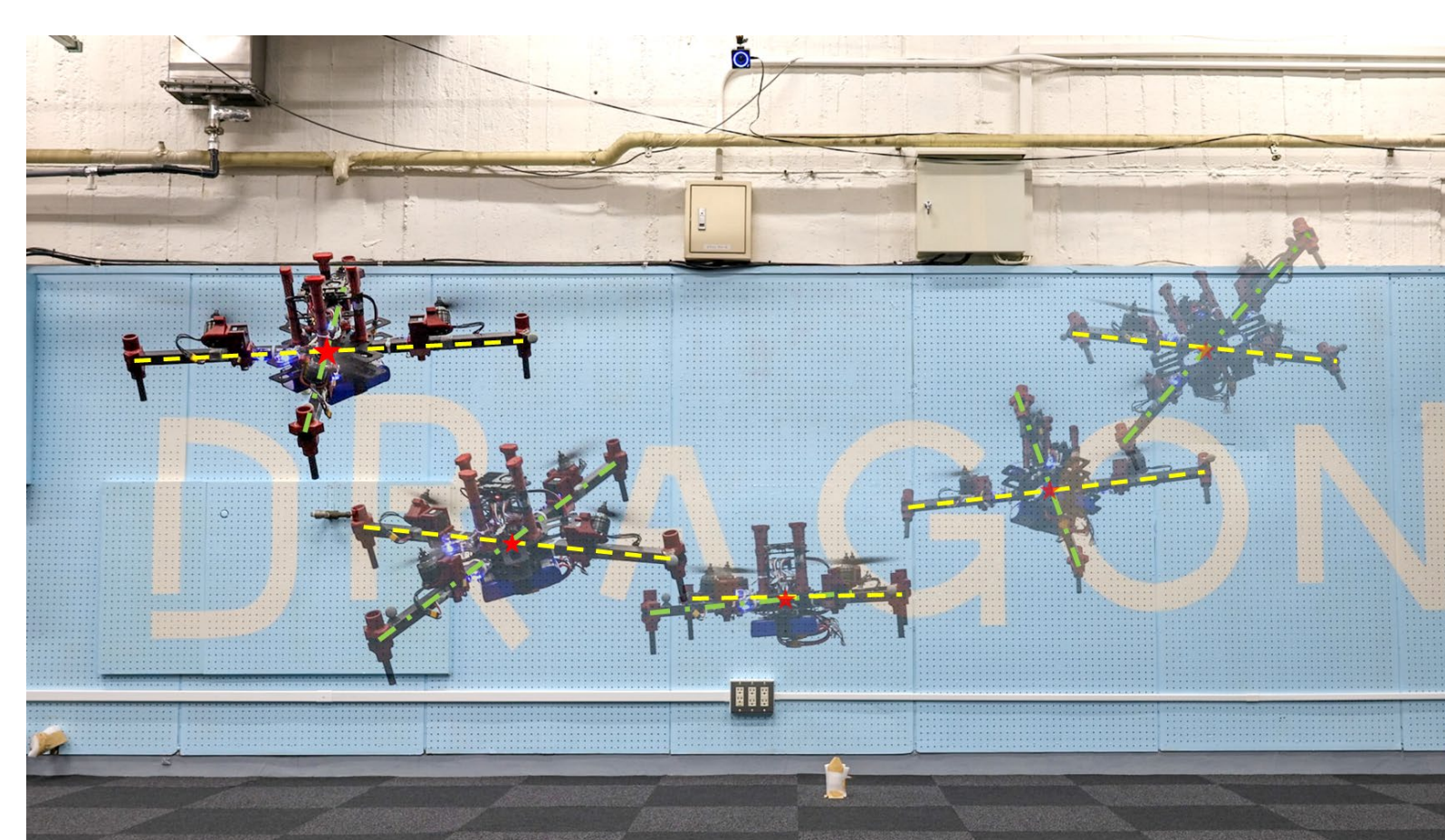


Fig. 5. Real-world flight

Experiments

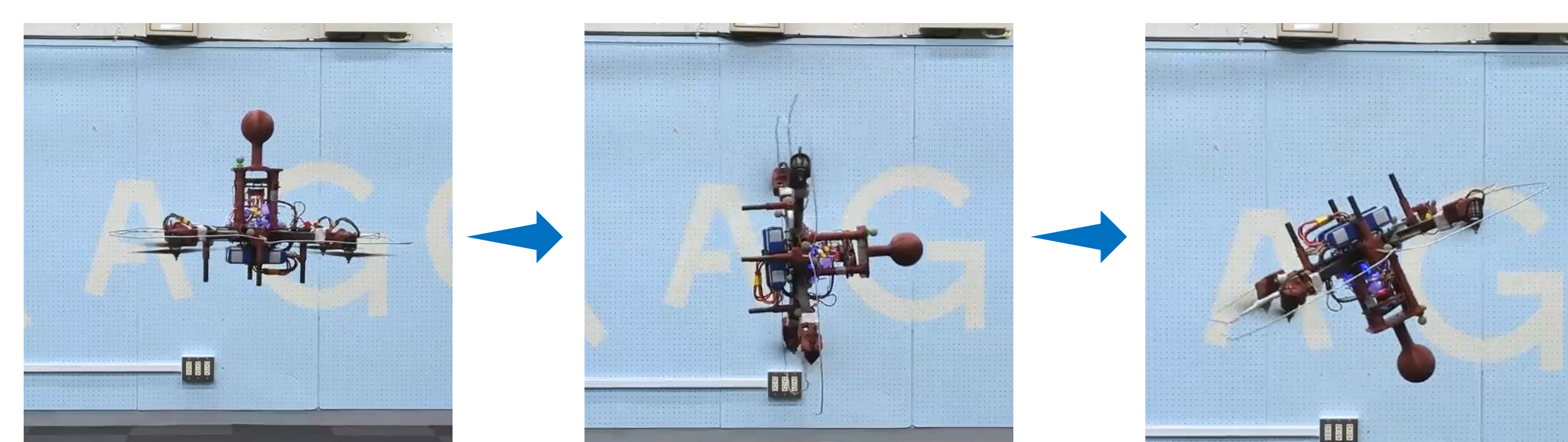
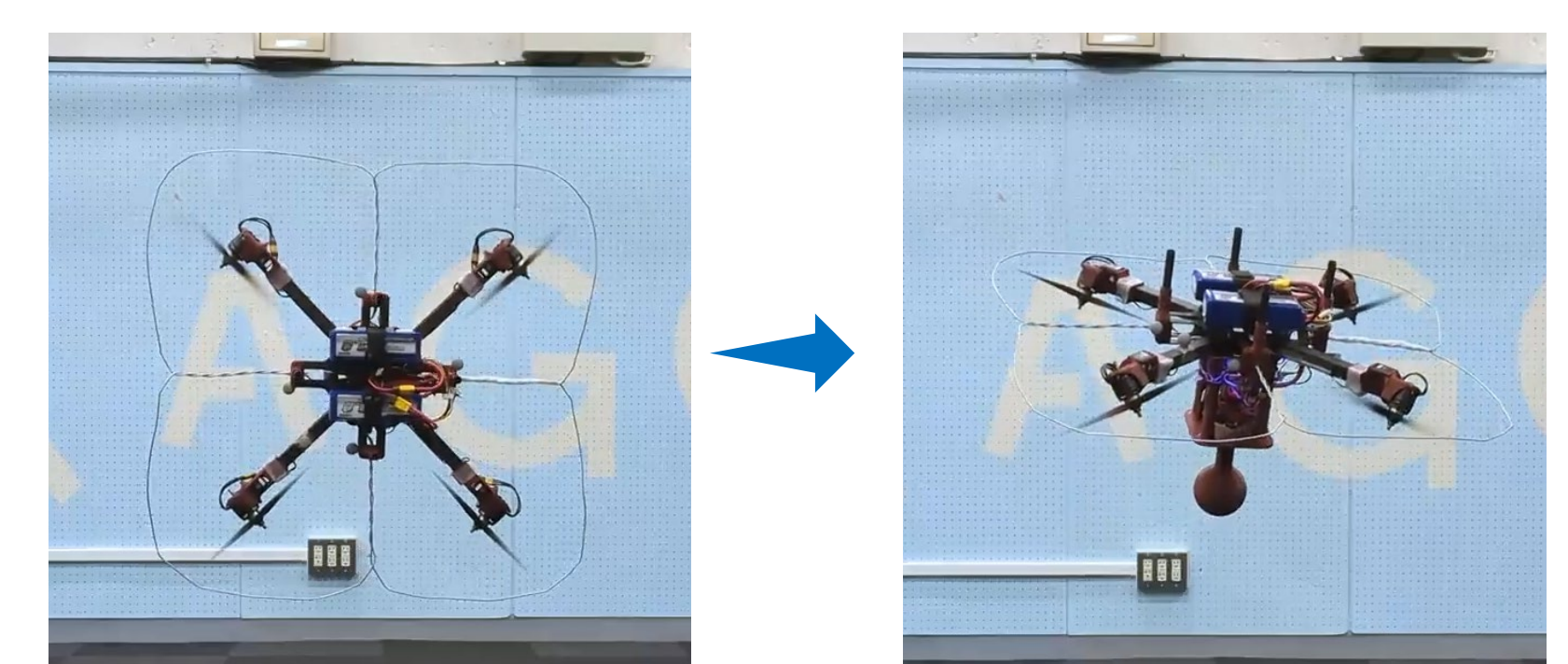


Fig. 6. Omnidirectional trajectory tracking

Future Work

- Handle external disturbances
- React for external wrench
- Extend to more tilttable robots

