

# PyBullet UAV Simulation Environment

## State Vector $x(t)$

Position:  $[x, y, z]$

Velocity:  $[vx, vy, vz]$

Angles:  $[\phi, \theta, \psi]$

Rates:  $[p, q, r]$

## Control Input $u(t)$

Thrust:  $T$

Roll rate:  $\omega_\phi$

Pitch rate:  $\omega_\theta$

Yaw rate:  $\omega_\psi$

## PyBullet Physics

RK4 Integration ( $\Delta t=1\text{ms}$ )

Rigid Body Dynamics

Motor Thrust Model

## Environment Features

Ground Effect Modeling

Aerodynamic Drag

Collision Detection

