

Time-optimal Flying a VTOL Drone

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Topic and Motivation

- Minimum-time flight for vertical take-off and landing (VTOL) drone
- Push platform to its limits
- Use Cases:
 - Rescue
 - Delivery
 - Transportation

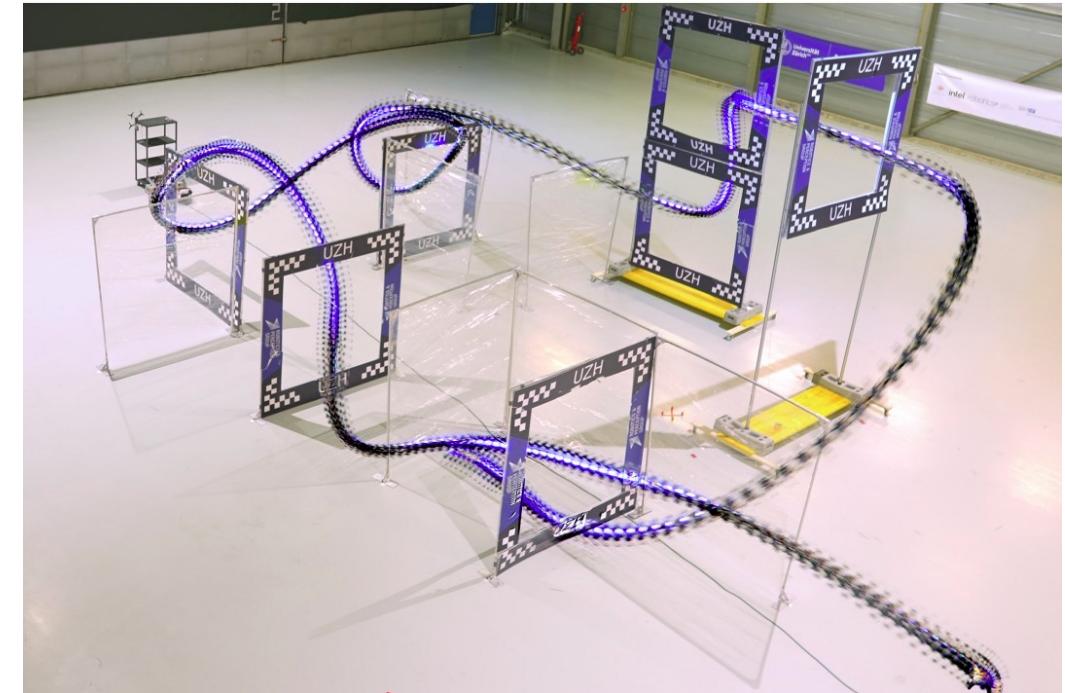
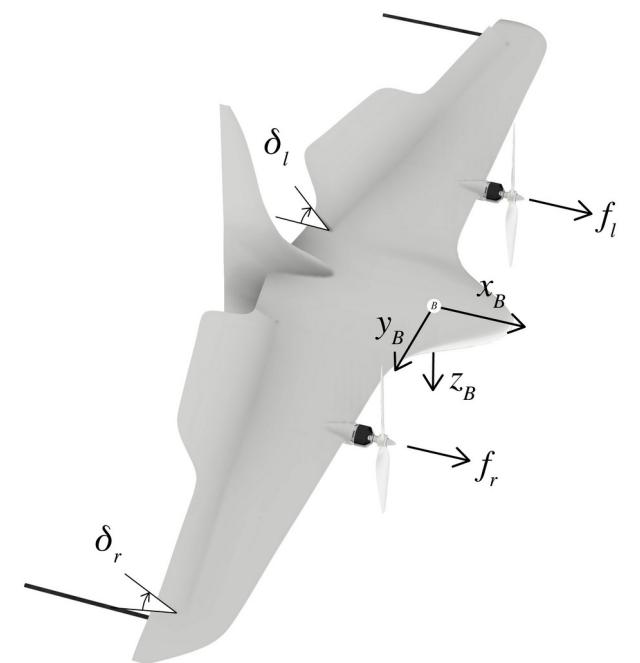
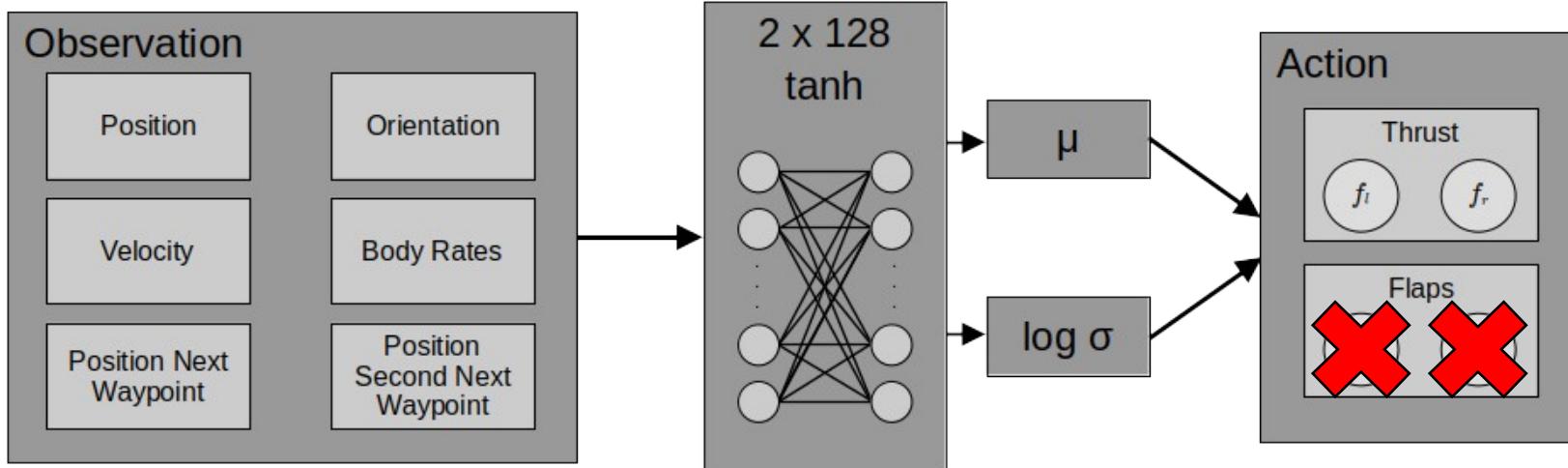


Fig. 1: Quadrotor races through a race track in the real world.

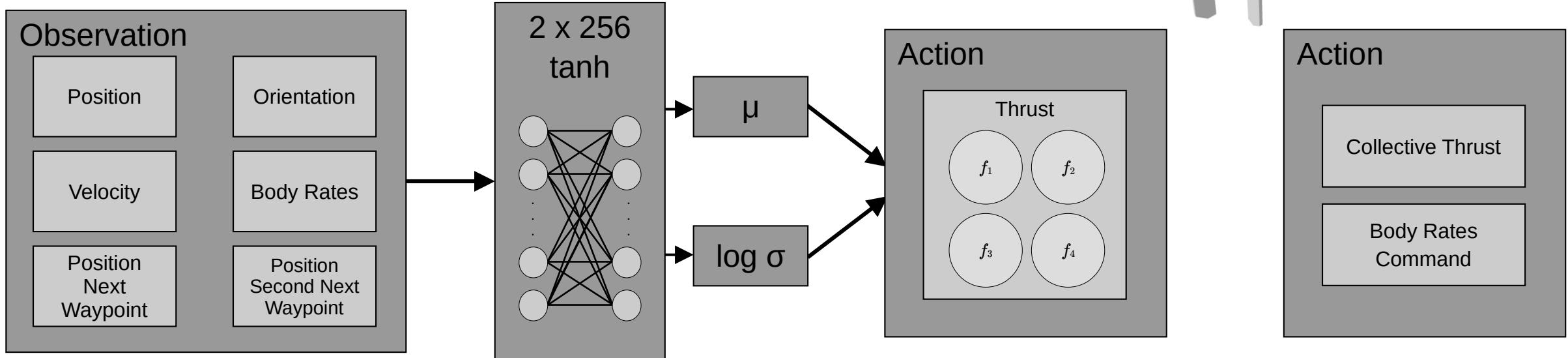
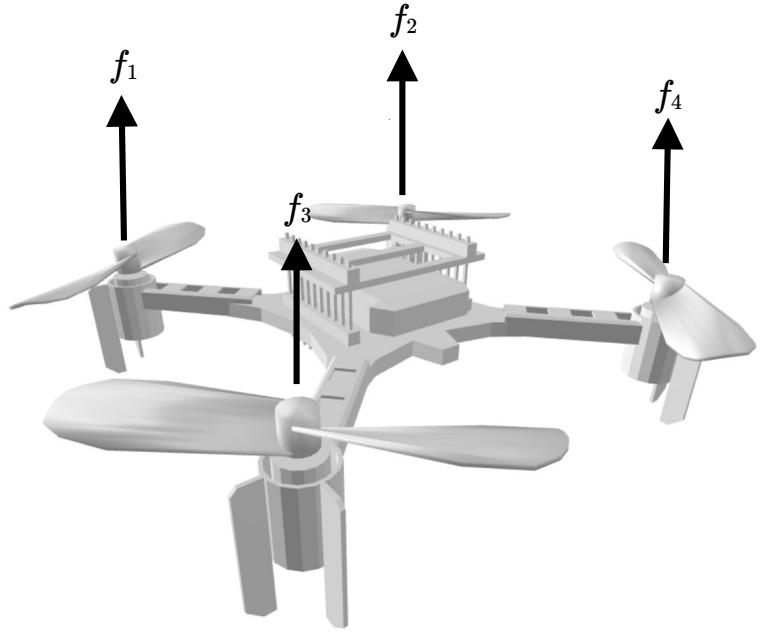
Our Approach in 2D

- Actor Critic with PPO
- Adam Optimizer



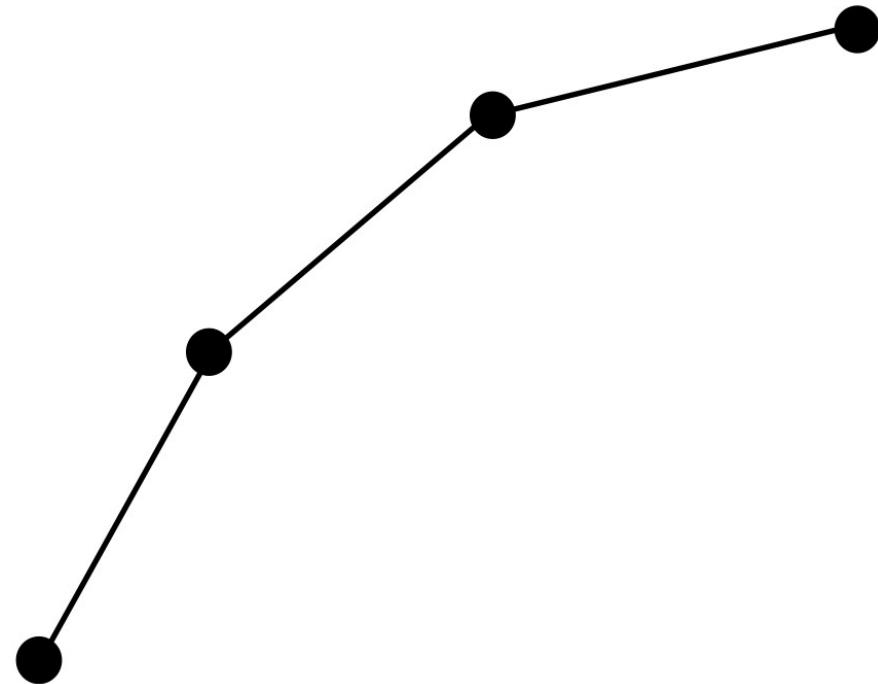
Our Approach in 3D

- Actor Critic with PPO
- Adam Optimizer



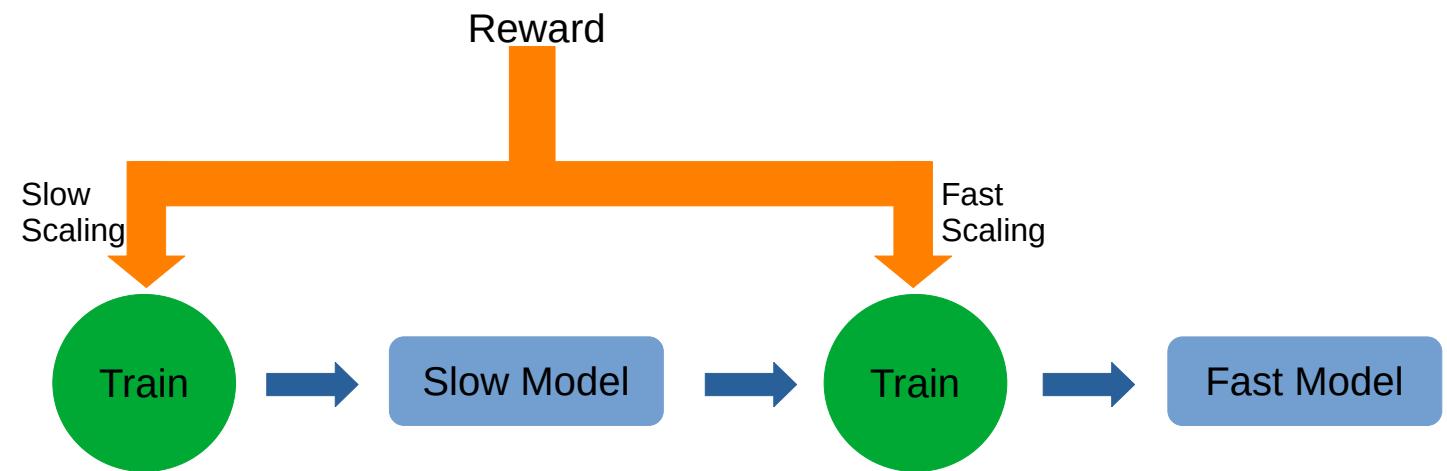
What has been done so far

- Problem reduced to 2D
- Stabilized slow and fast learning phases
- Generalize problem back to 3D



Training Strategy

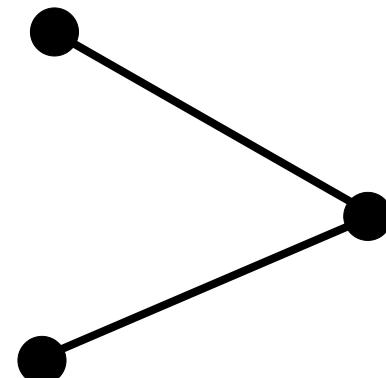
- Two Phases: Slow and Fast
- Slow: Learn to follow path
- Fast: Time optimality



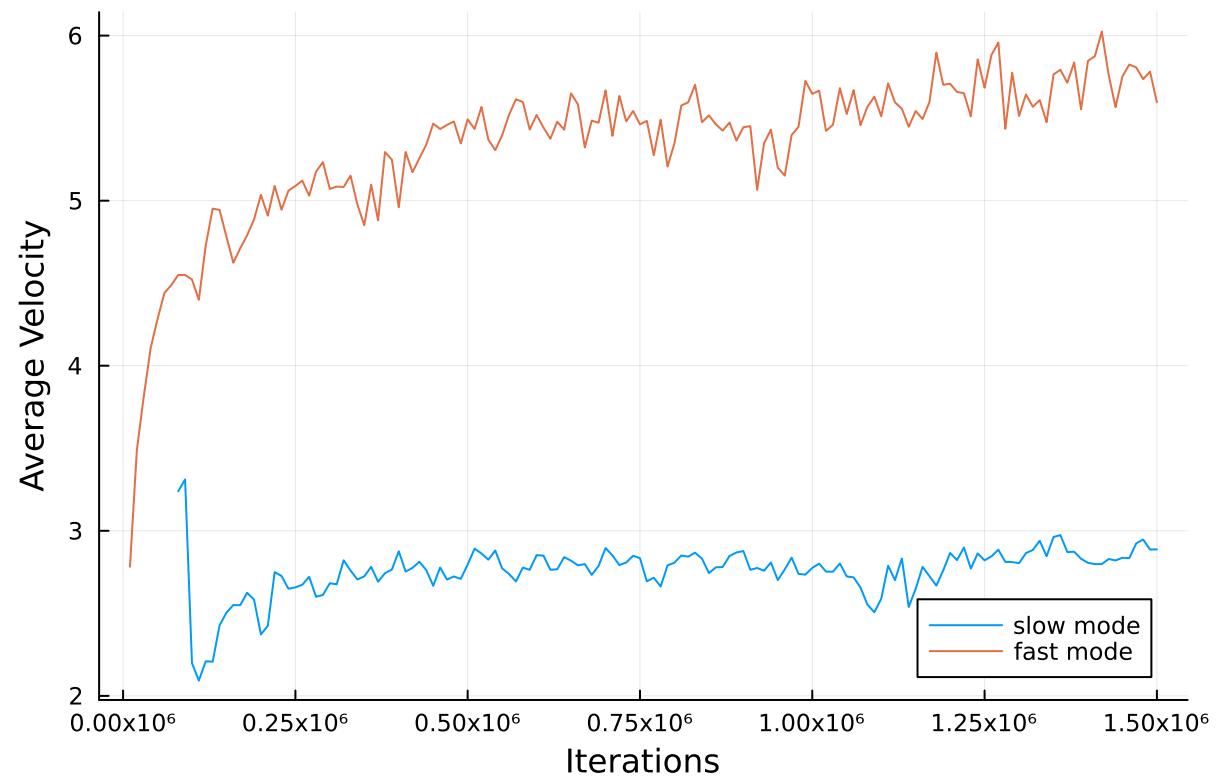
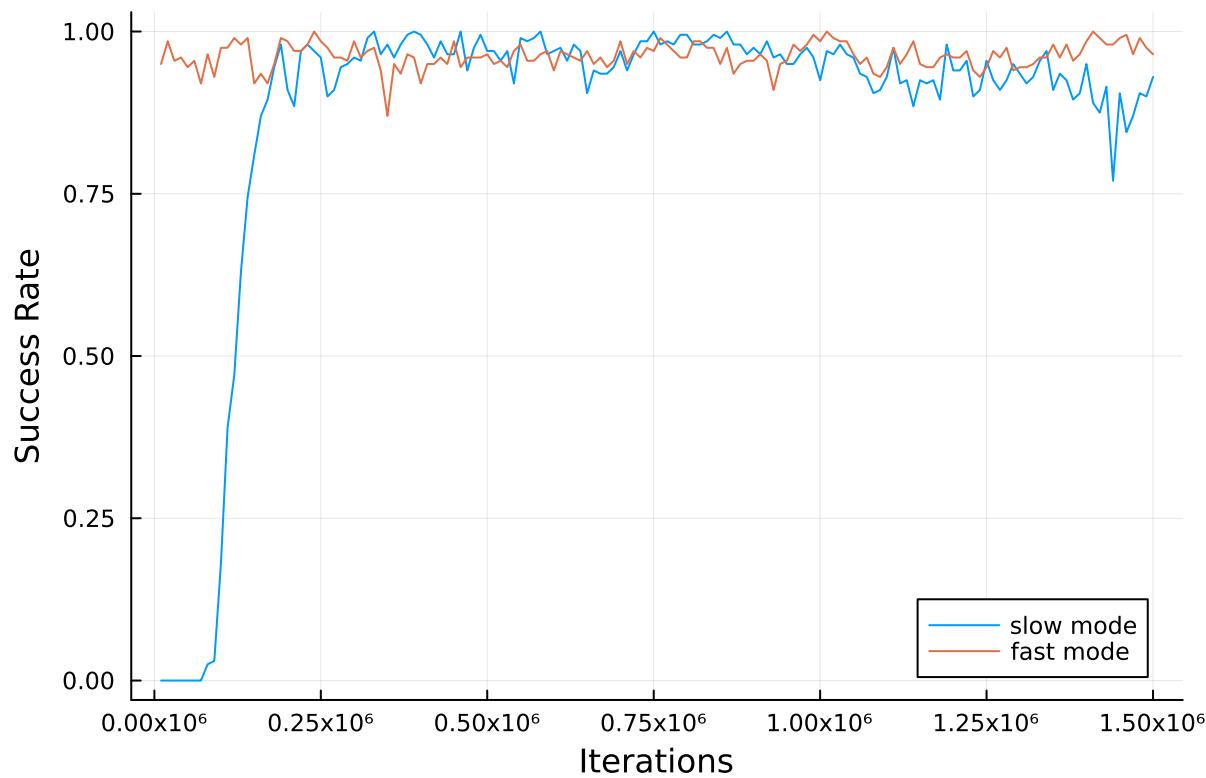
Reward Function

$$r(t) = \boxed{k_p \cdot \Delta progress(t)} + \boxed{k_s \cdot progress(t)} + \boxed{k_{wp} \cdot r_{wp}} - \boxed{k_\omega \cdot \|\omega\|} - \boxed{fall}$$

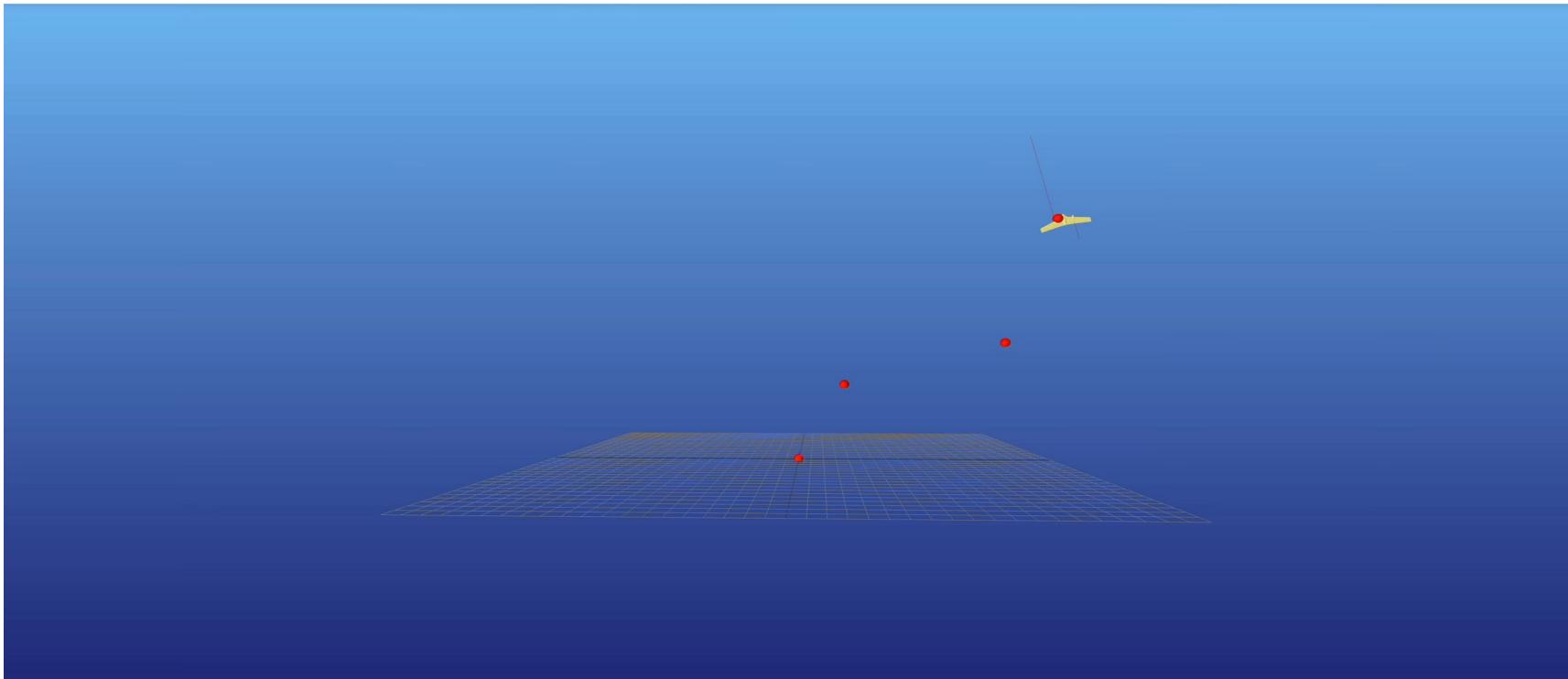
- Encourage line progression
- Encourage reaching points
- Penalize spinning
- Penalize inactivity



RESULTS 2D

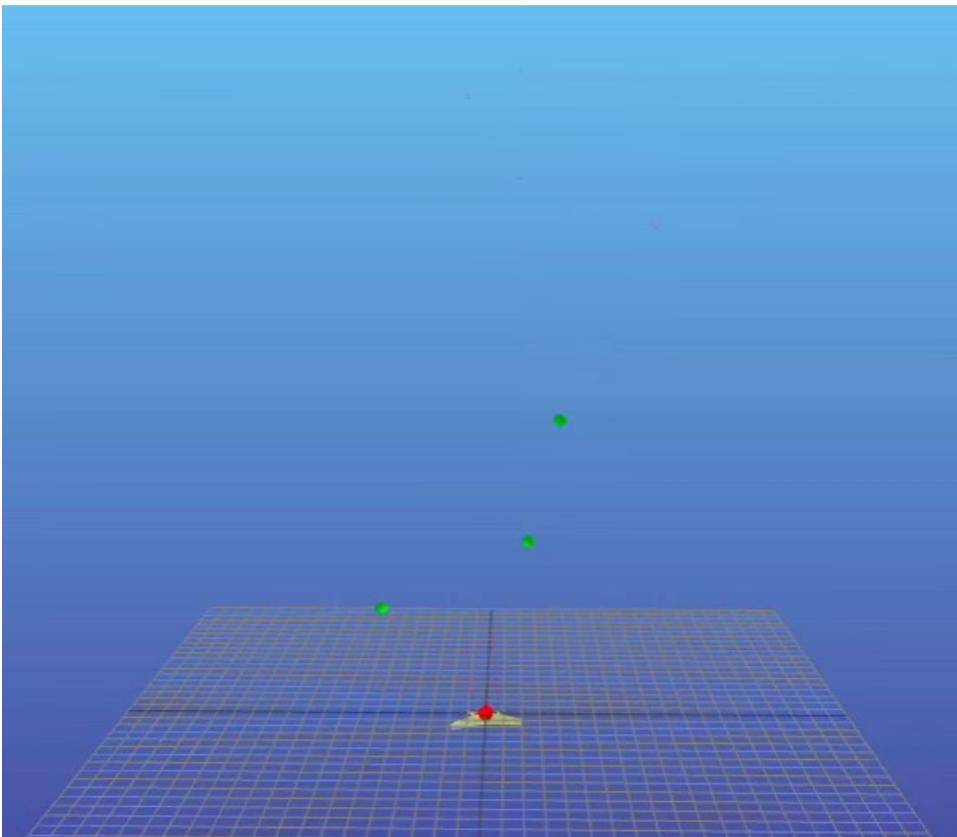


OLD FAST VIDEO 2D



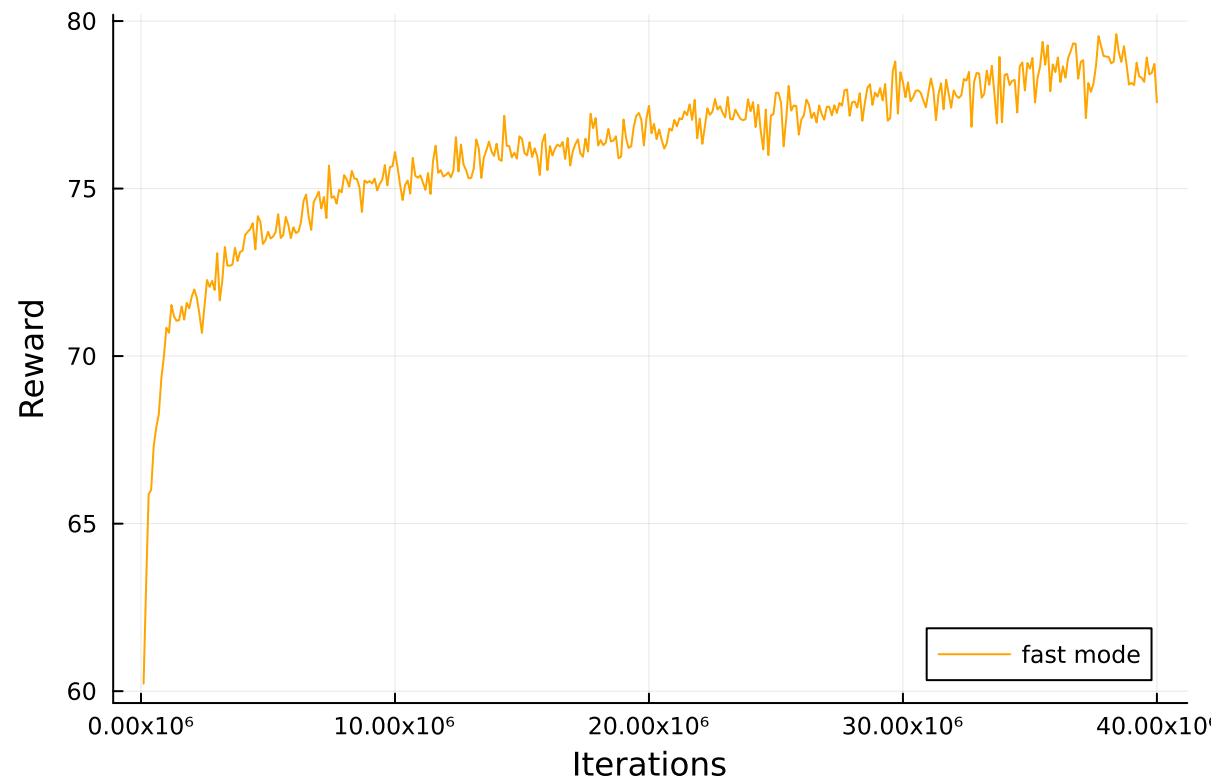
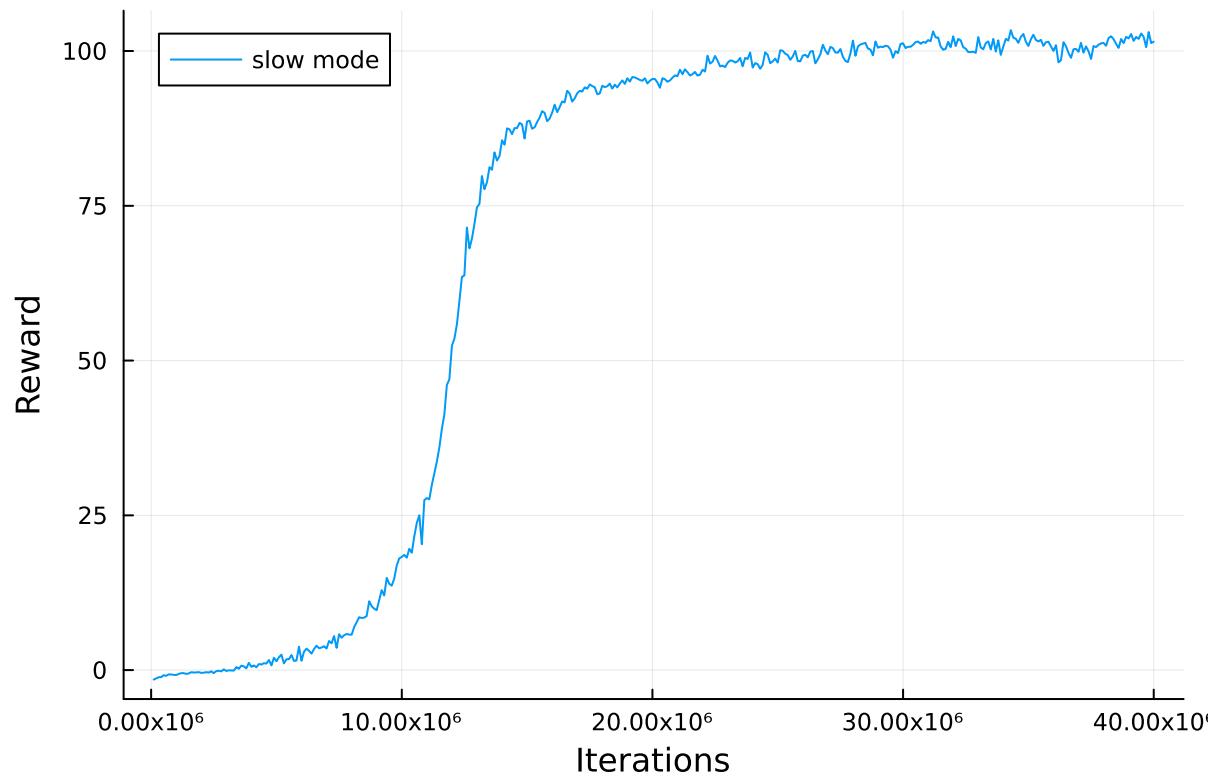
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NEW FAST VIDEO 2D

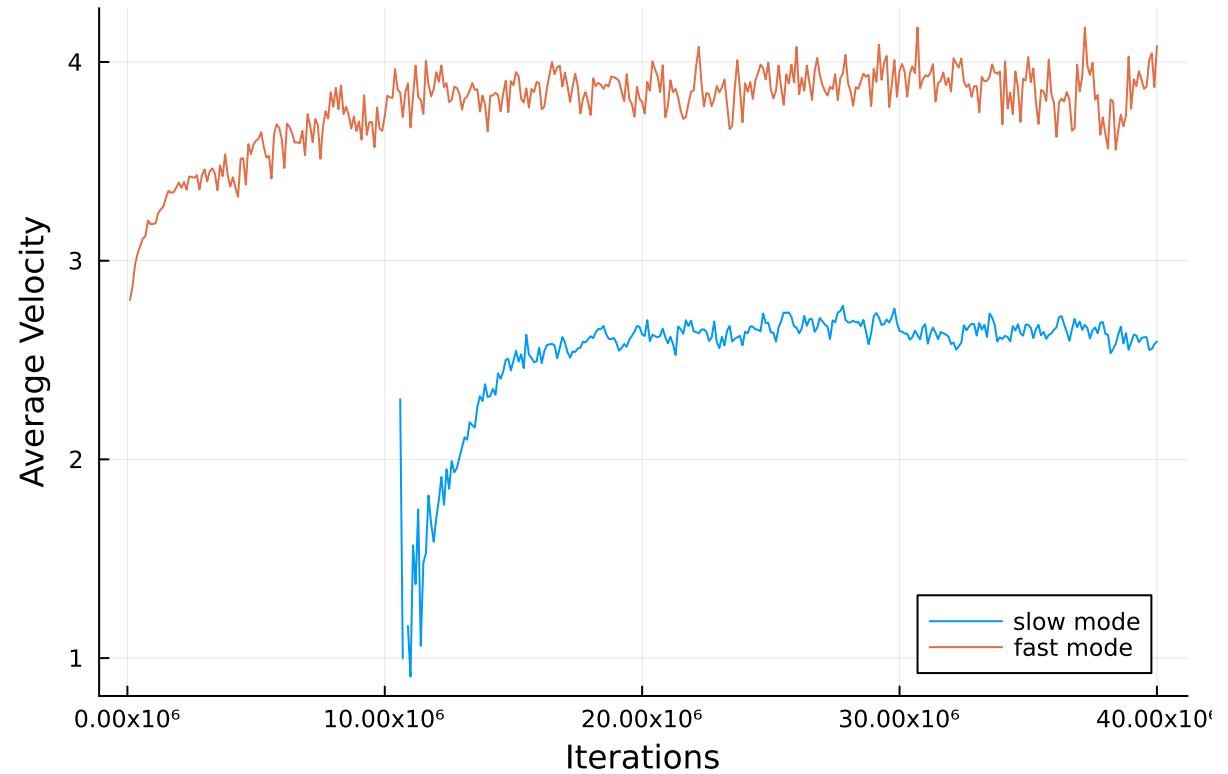
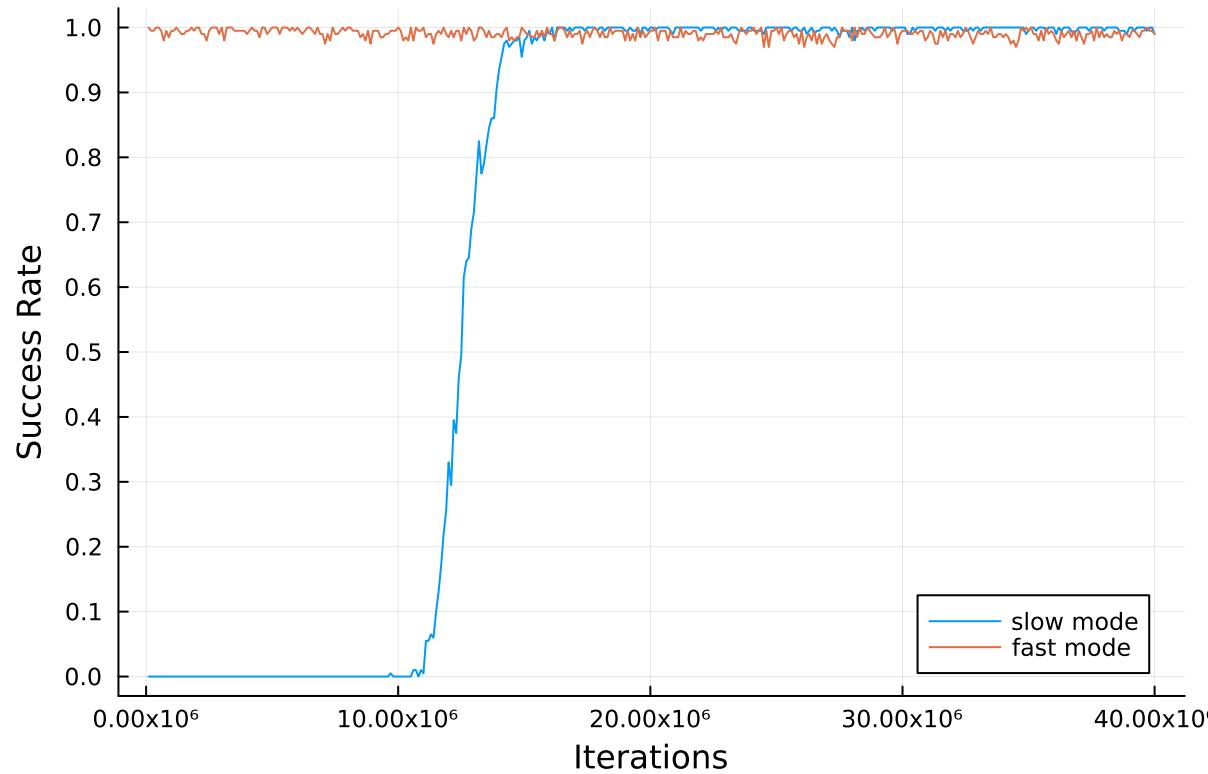


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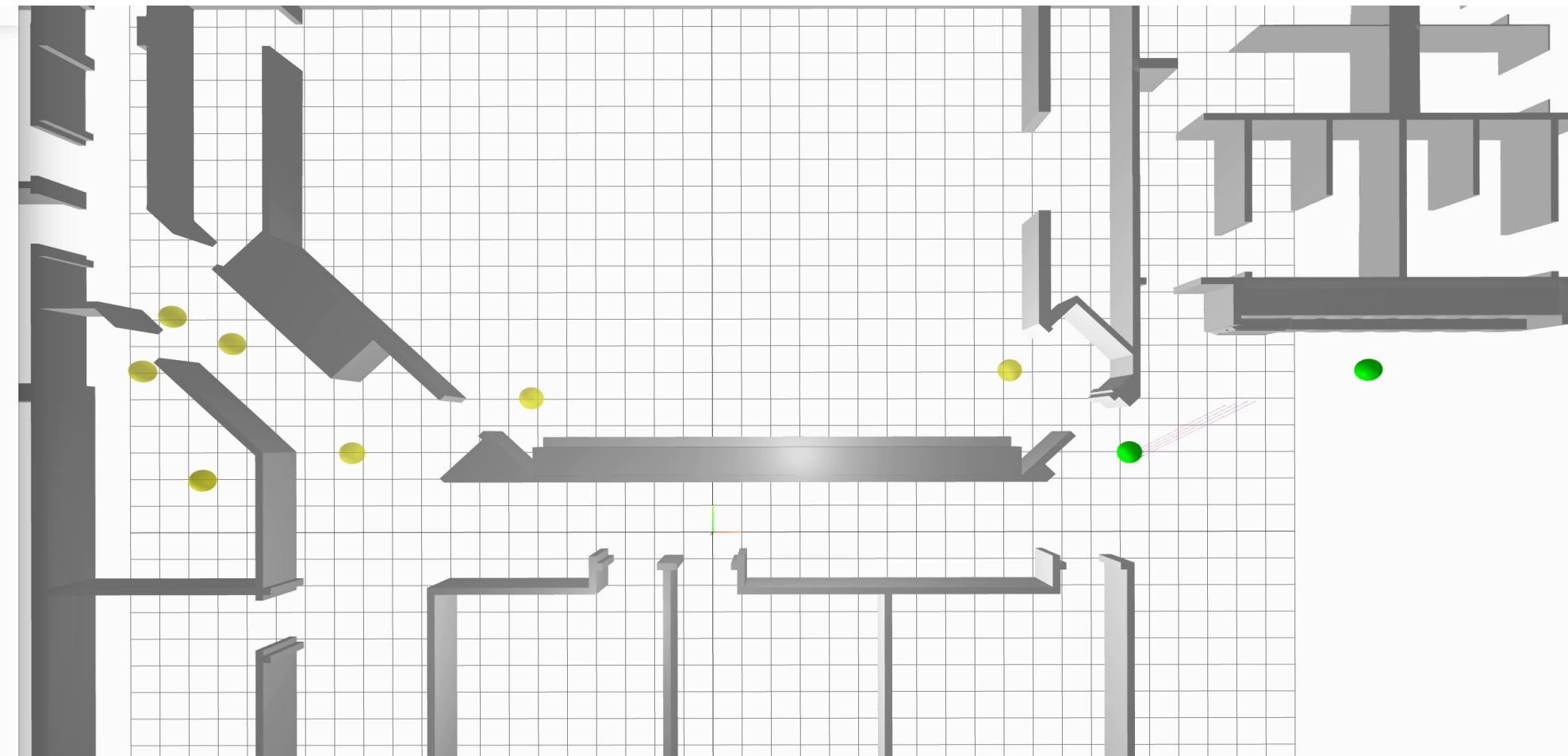
RESULTS 3D



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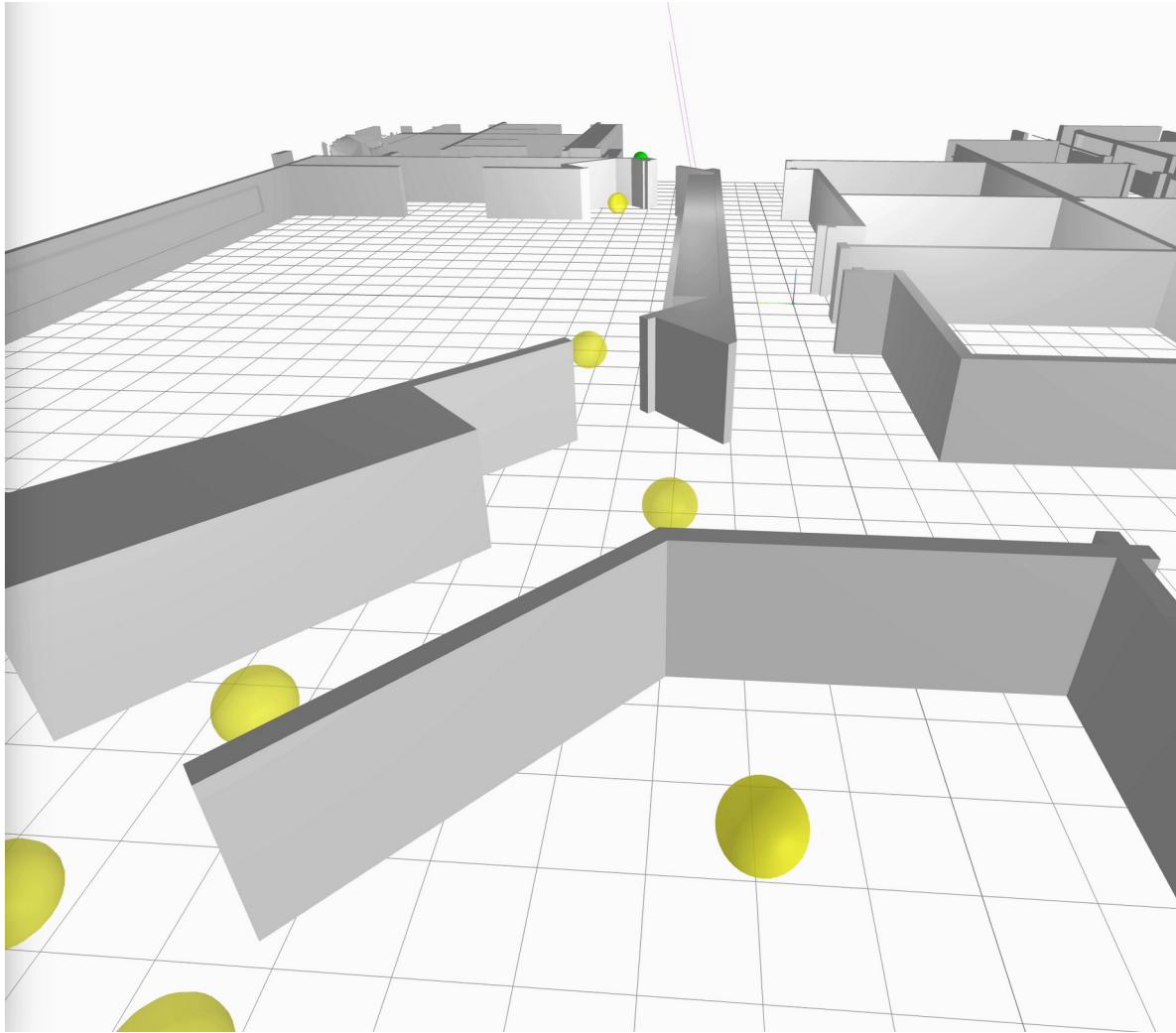


Office Test: PID Controller



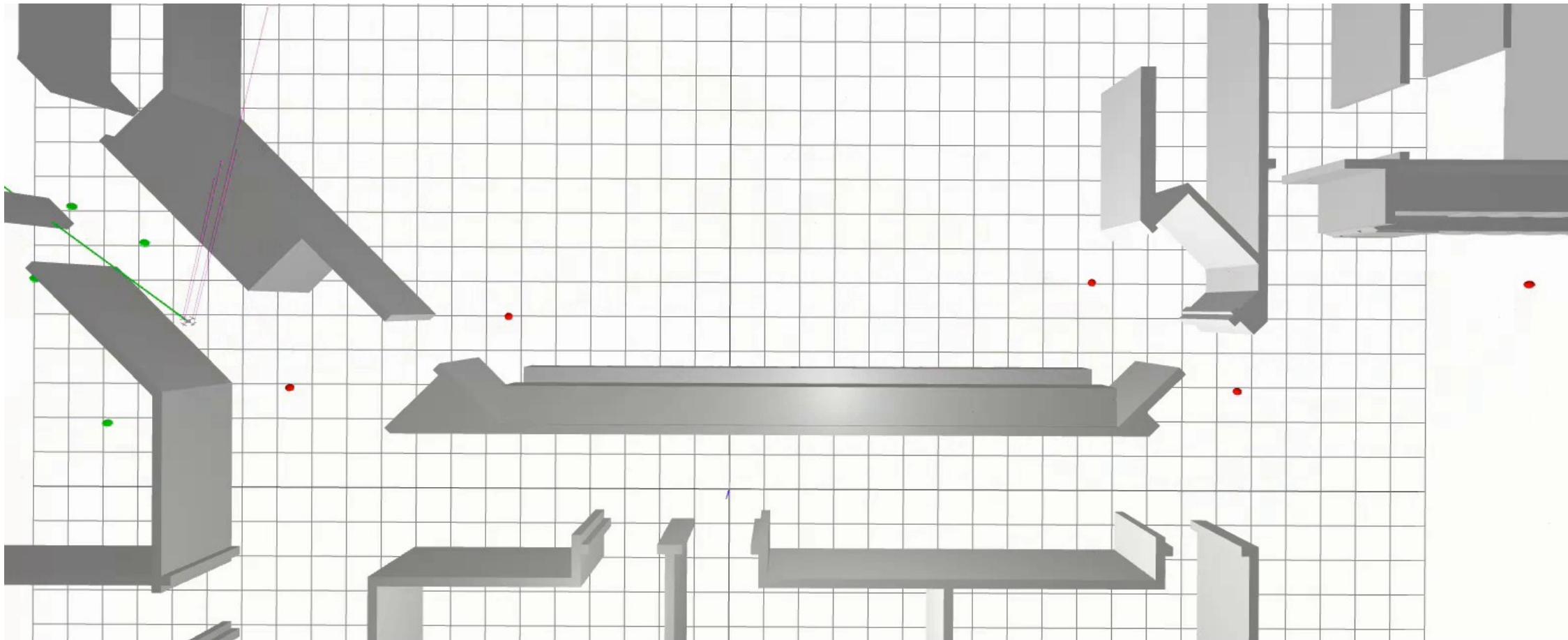
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Office Test: PID Controller



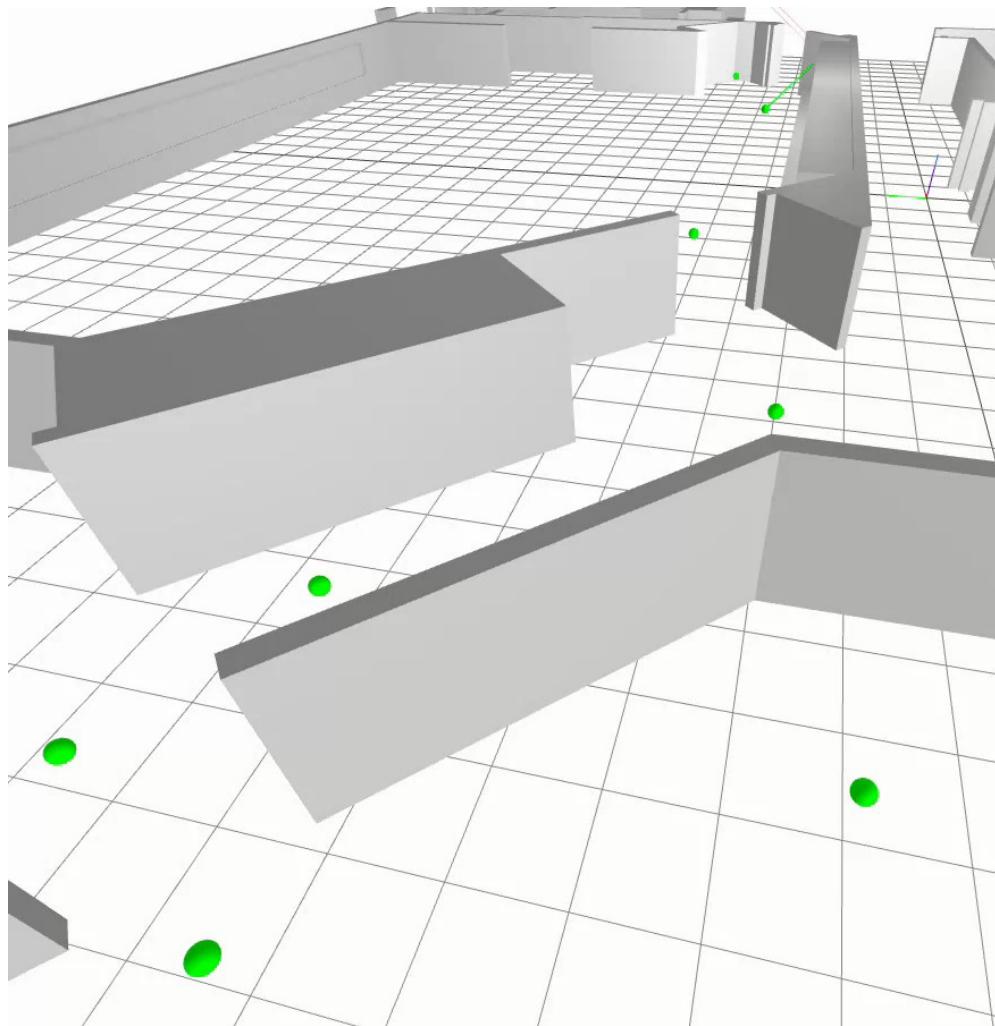
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Office Test: Our Model



<https://youtu.be/3h-mQVTZs7Q>

Office Test: Our Model



<https://youtube.com/shorts/e70y345T-nc?feature=share>

Possible Further Research

