

High-Precision Trajectory Tracking in Changing Environments Through \mathcal{L}_1 Adaptive Feedback and Iterative Learning

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Additional contributions from Dave Kooijman

ICRA Spotlight Talk

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Motivation



Different systems

Goal: achieve **high tracking performance**



Varying payloads

Wind

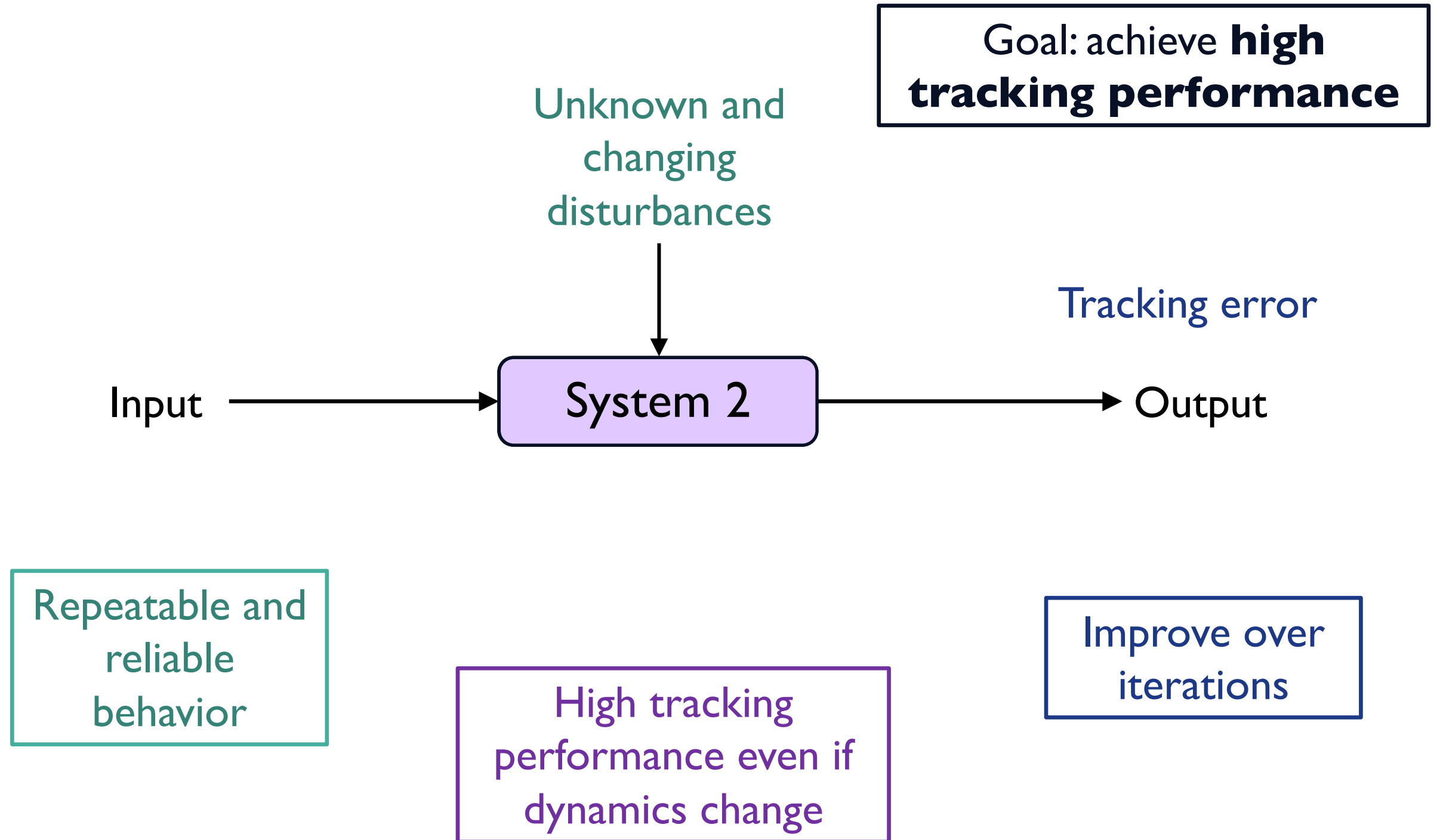
Unknown and changing disturbances

Tracking error



Varying topology

Varying weather





Proposed Approach

Repeatable and reliable behavior

\mathcal{L}_1 Adaptive Controller

- Define a reference (desired) behavior.
- Stay provably close to reference model.

$$\|System Output - Reference Model Output\| < \gamma \propto \sqrt{\frac{1}{\Gamma}}$$

- Zero tracking error not guaranteed.



Improve over iterations

Iterative Learning Controller

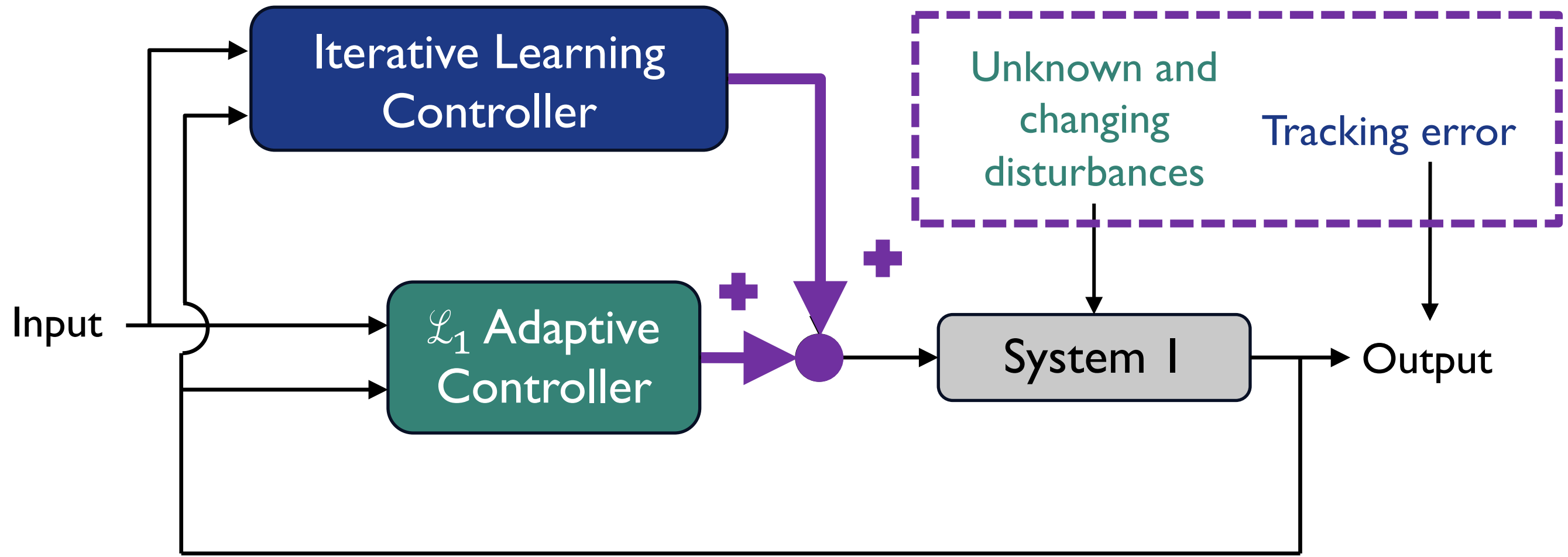
- Can compensate for systematic tracking errors.
- Learns through repetition.
- Fast convergence.



High tracking performance even if dynamics change

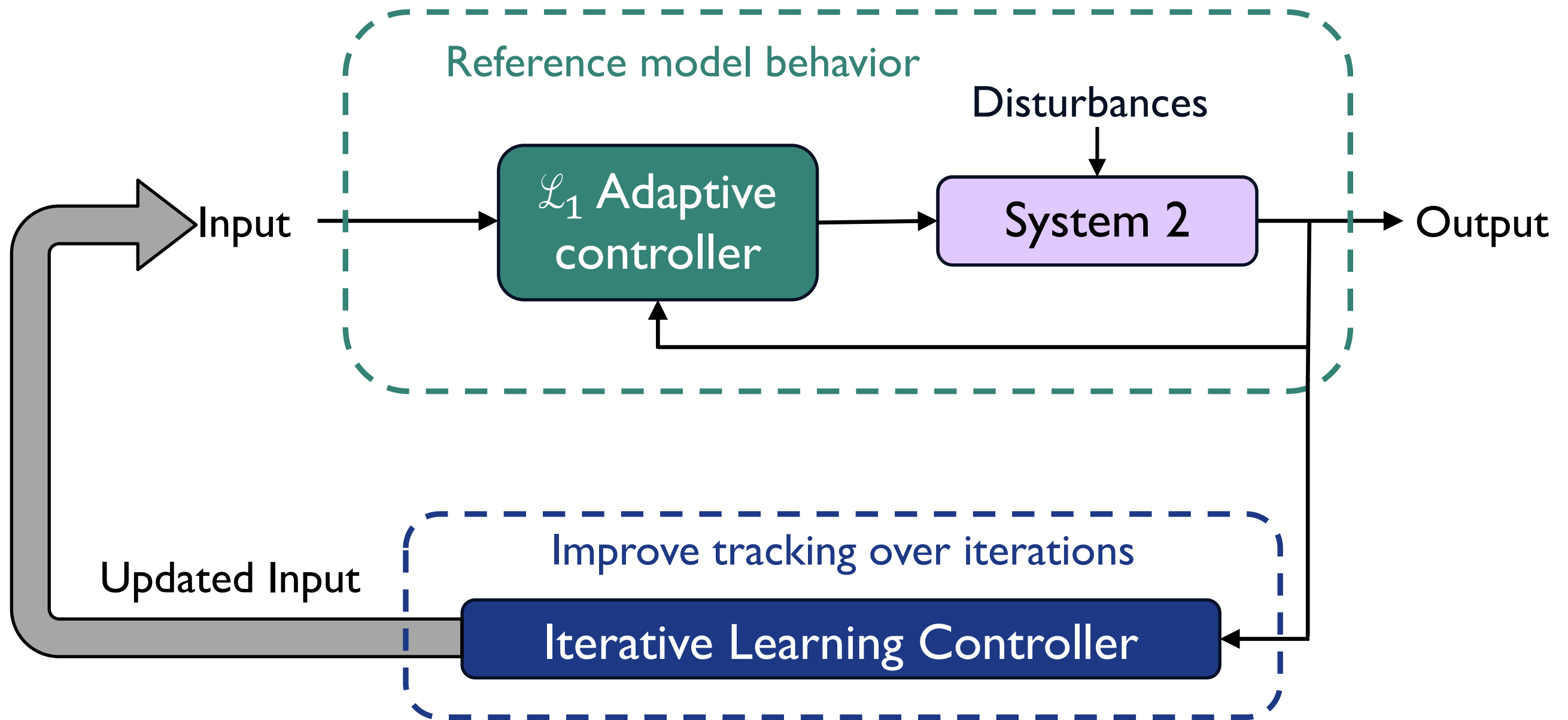
- No re-learning if system or dynamics change.

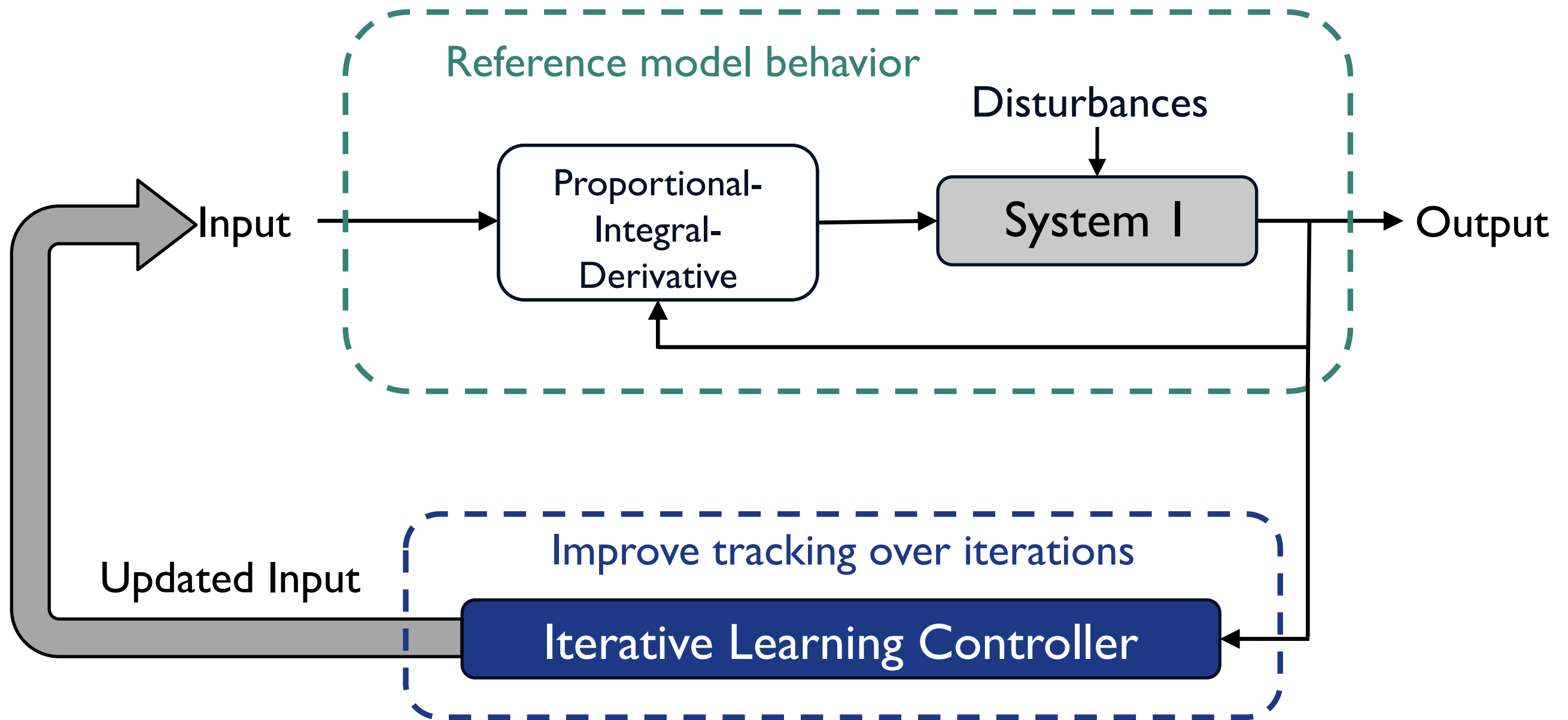




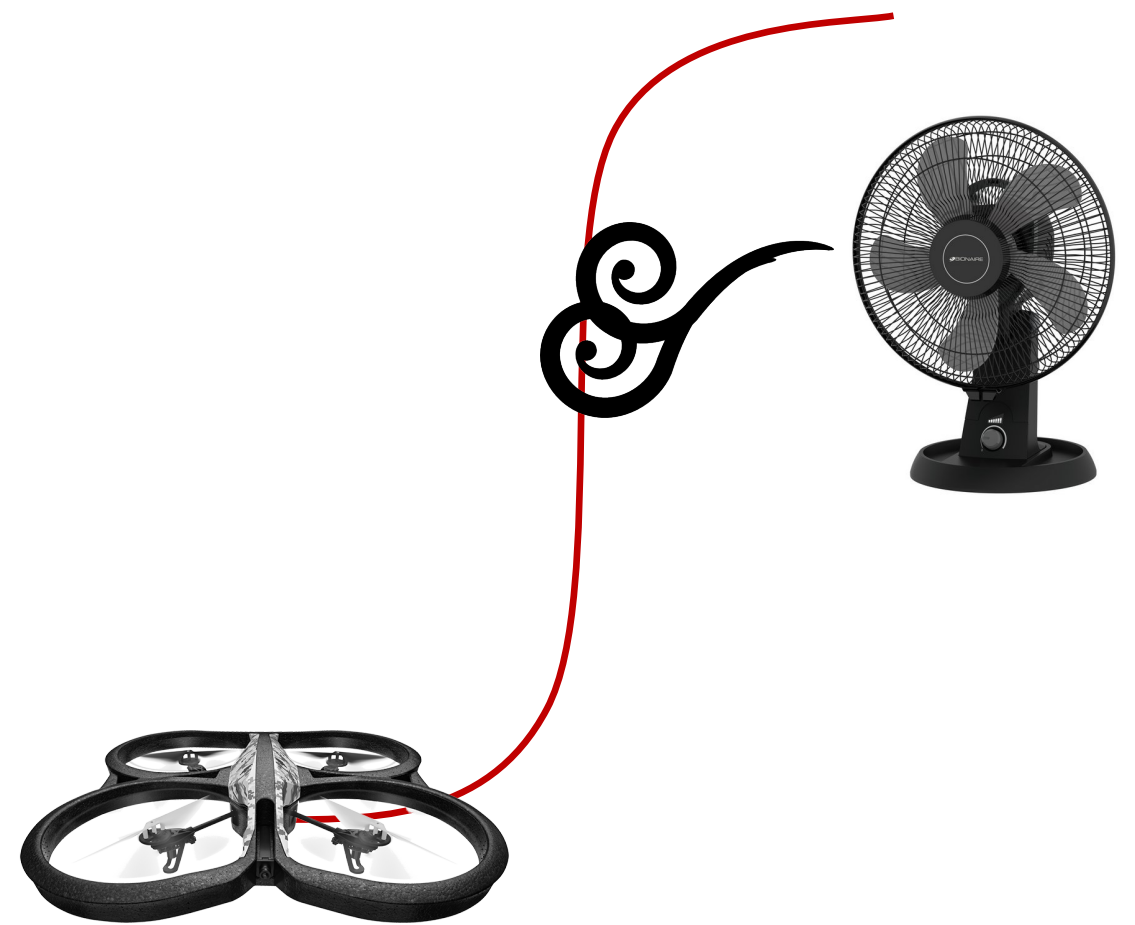
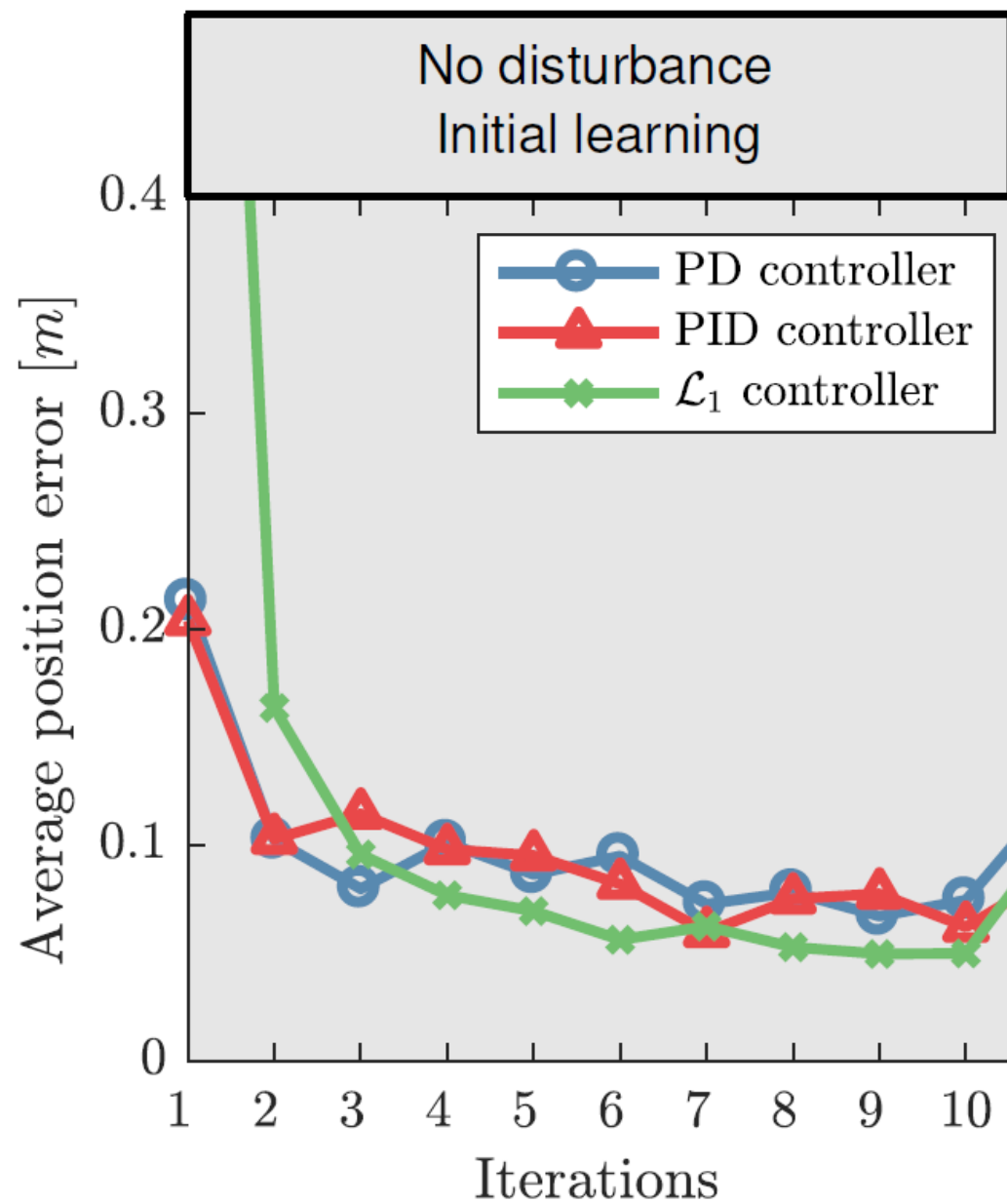
Simulation results

[6] B. Altin and K. Barton, "Robust iterative learning for high precision motion control through L_1 adaptive feedback," *Mechatronics*, vol. 24, no. 6, pp. 549–561, 2014.



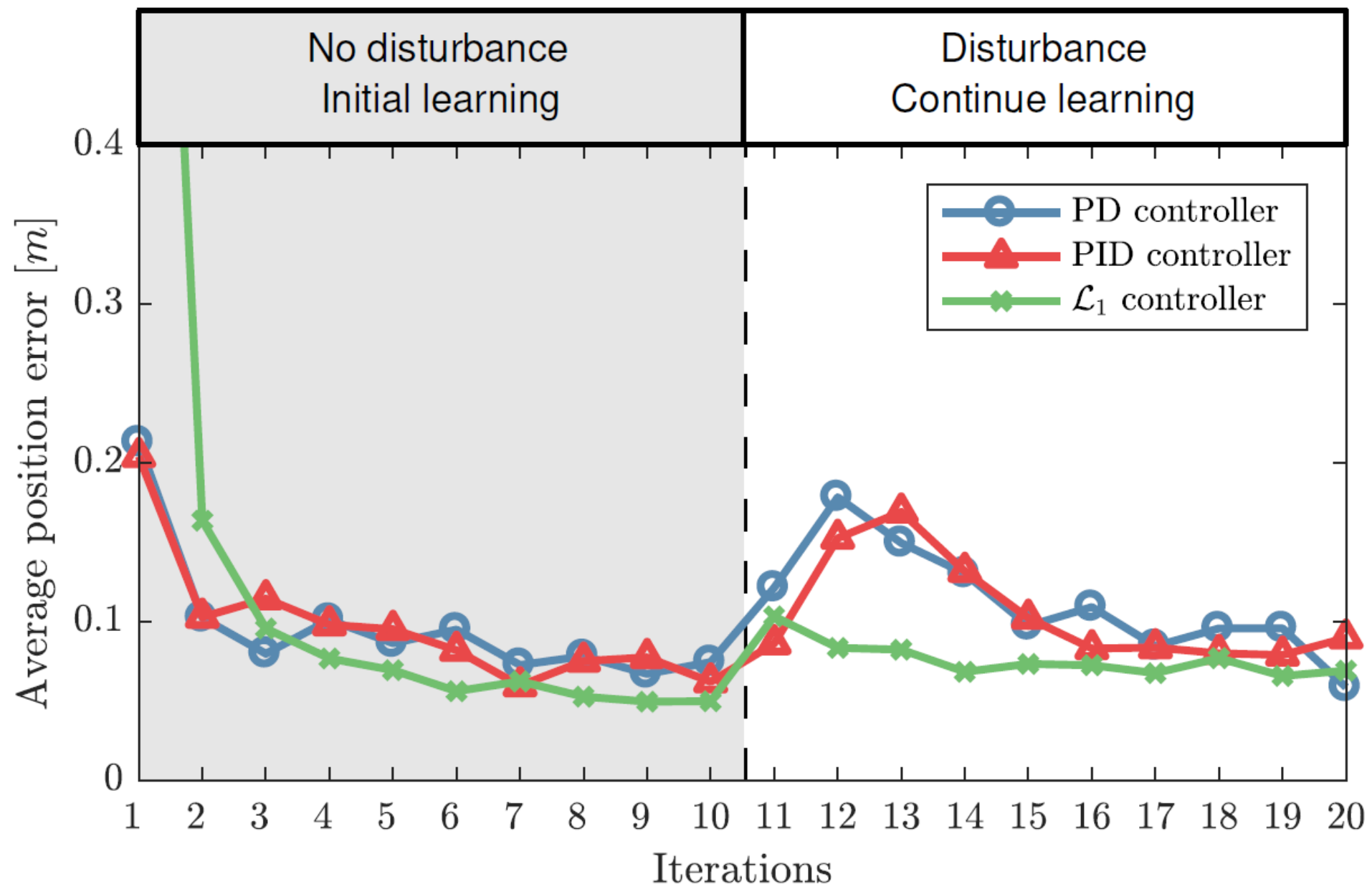


Unknown and changing disturbances: Wind



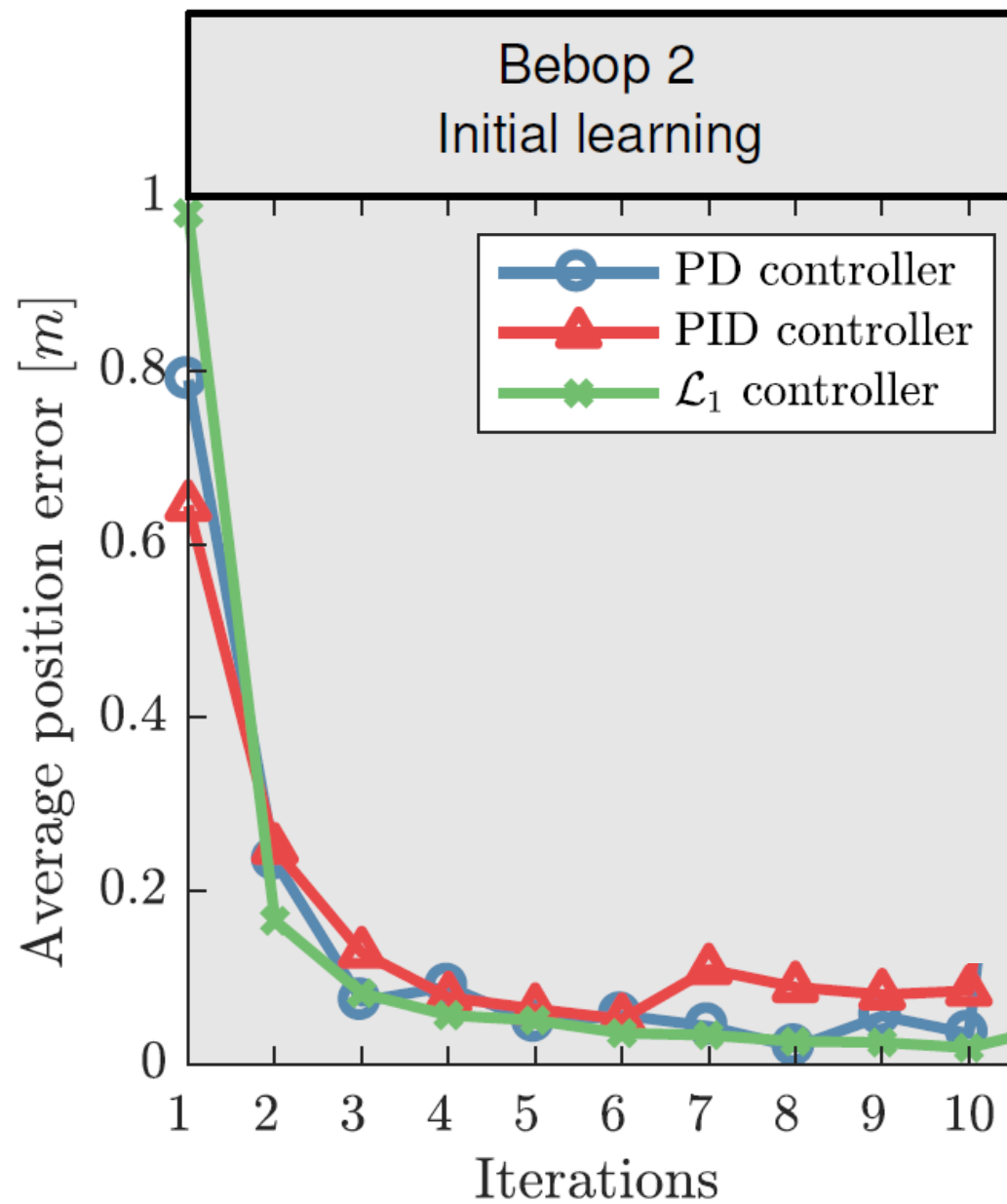
Contributor: Dave Kooijman

Unknown and changing disturbances: Wind



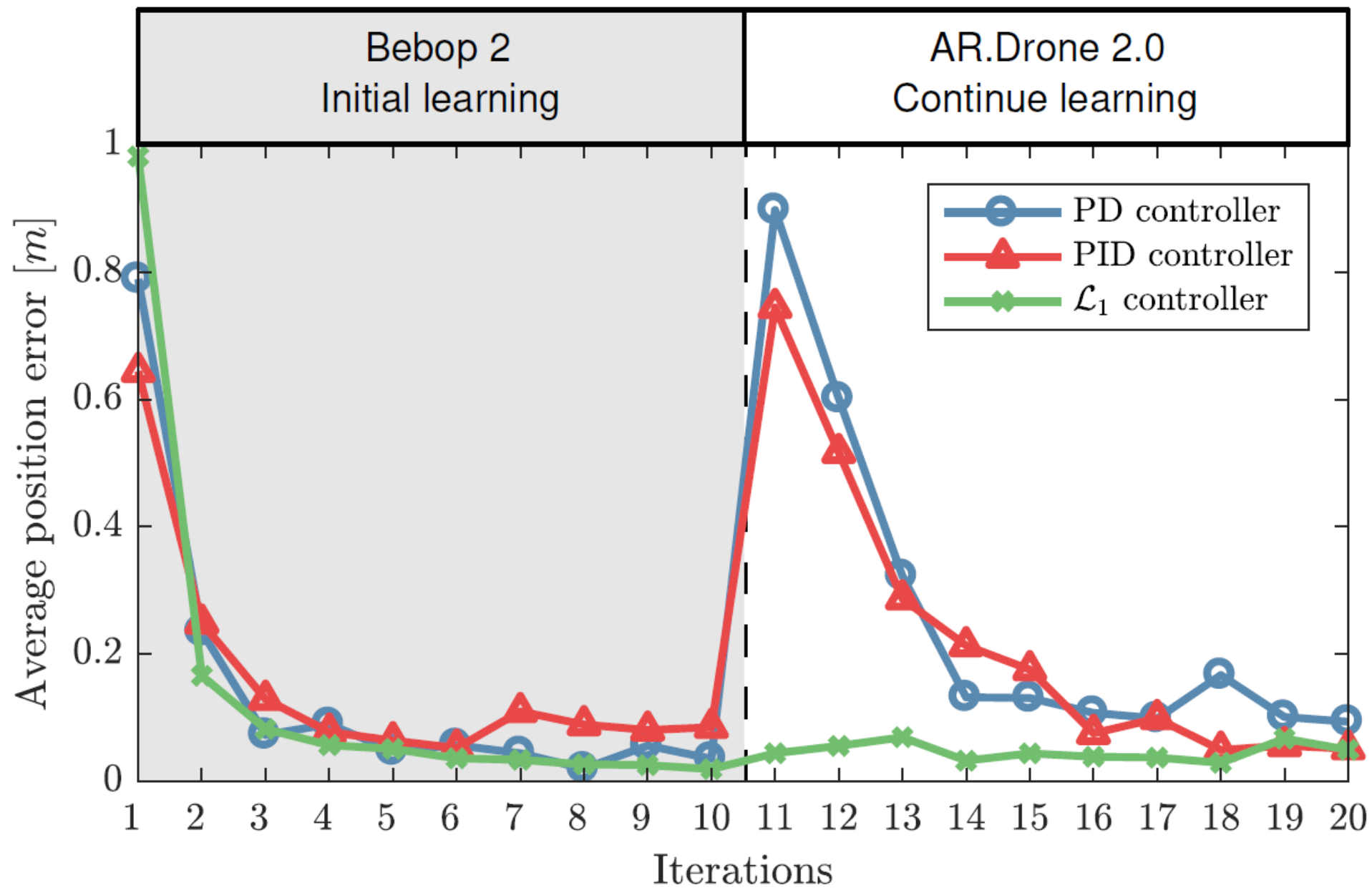
Contributor: Dave Kooijman

Transfer learning: no need to relearn

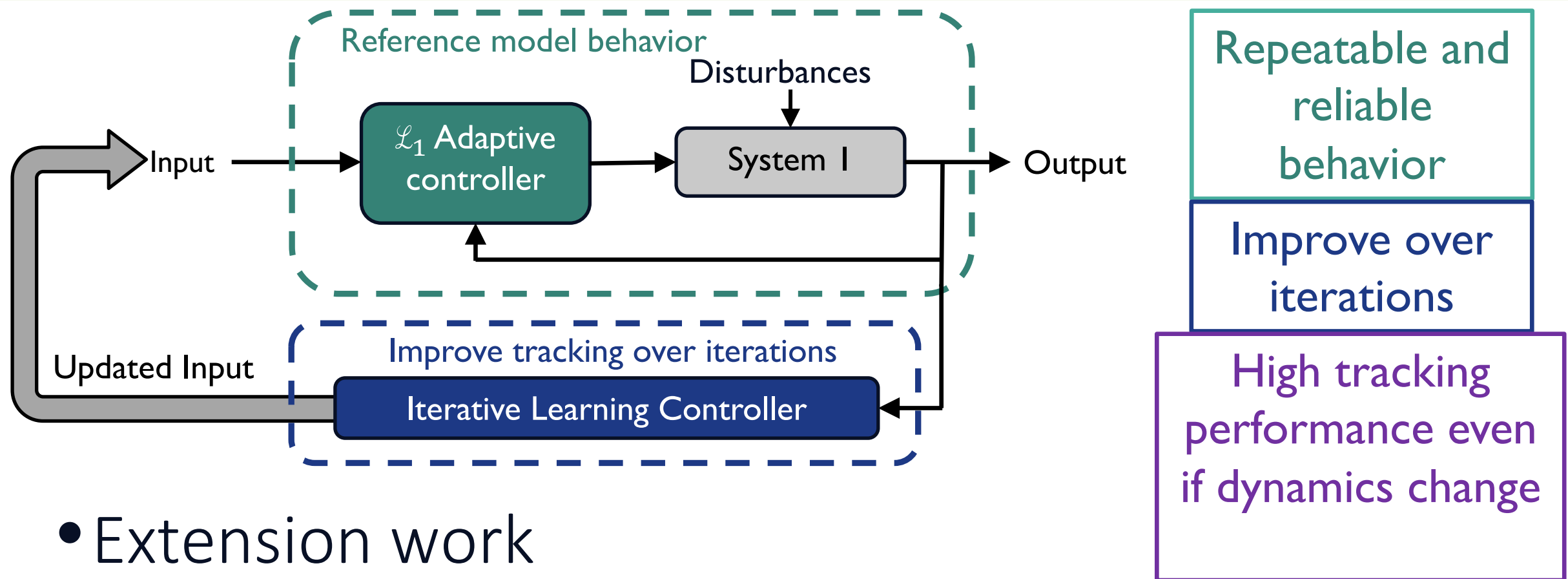


Contributor: Dave Kooijman

Transfer learning: no need to relearn



Contributor: Dave Kooijman



• Extension work

K. Pereida, D. Kooijman, Rikky R. P. R. Duivenvoorden, and Angela P. Schoellig, “*Transfer Learning for High-Accuracy Trajectory Tracking Through \mathcal{L}_1 Adaptive Feedback and Iterative Learning*”, submitted to International Journal of Adaptive Control and Signal Processing.

- Transfer learning from simulation to real system.
- Use reference model to calculate input.



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Thank you!

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