TinyMPC: Model-Predictive Control on Resource-Constrained Microcontrollers

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publicly available

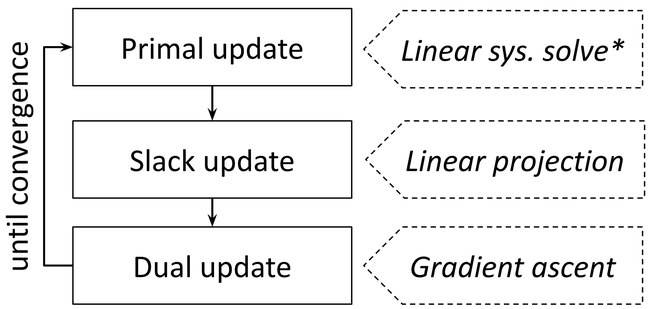
Model-predictive control is **powerful** but **computationally demanding**.

MPC is a powerful tool for controlling dynamic robotic systems subject to complex constraints.

- Objective *(Quadratic)*: Minimize trajectory tracking errors, control efforts.
- Constraints *(Linear)*: Respect robot model, actuator limits, avoid obstacles.

MPC is computationally demanding, often **impractical** to implement on small, **resource-constrained platforms**.

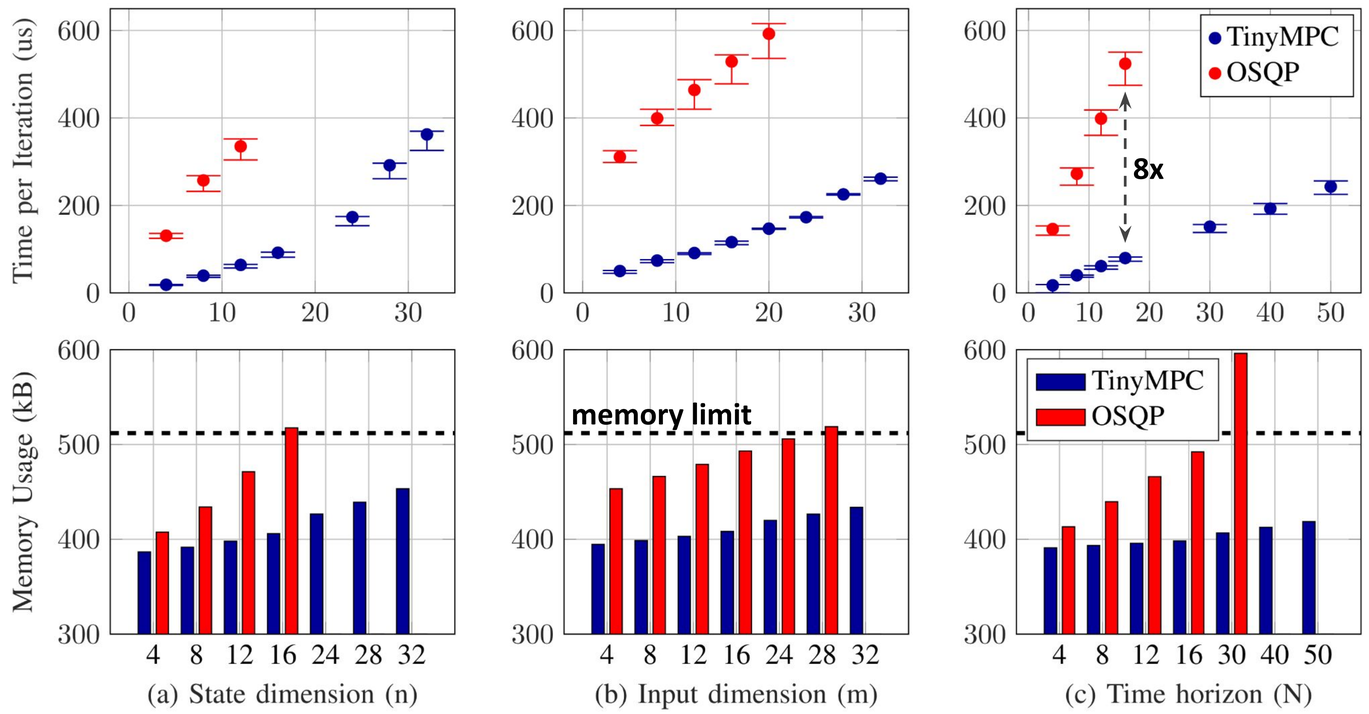
We present TinyMPC, a **novel quadratic programming algorithm** optimized for model-predictive control.



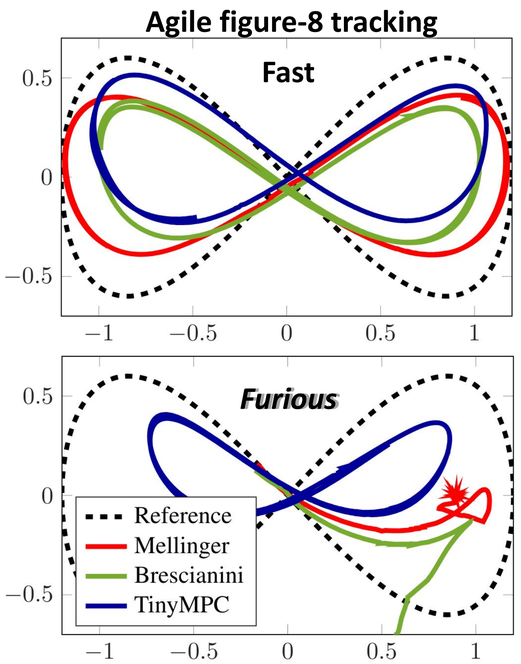
We **accelerate and compress** the ADMM algorithm [1] by **exploiting the structure**.

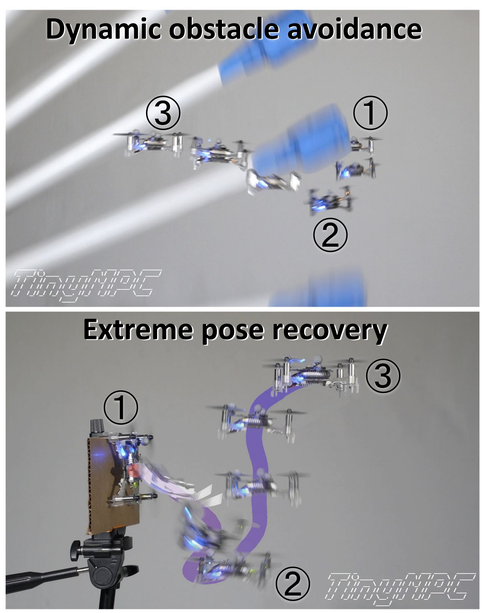
- Offline design: Uses infinite-horizon LQR, precomputes and stores a **small** number of variables.
- Online adaptation: Uses **fast** matrix-inversion free computations and linear projections within ADMM.

TinyMPC shows a **higher speed and smaller memory footprint**, compared with the state-of-the-art OSQP [2] on **microcontrollers**.



TinyMPC enables **real-time optimal control** on tiny robots such as the **Crazyflie**.





[1] S. Boyd, et al., "Distributed optimization and statistical learning via the alternating direction method of multipliers"
[2] B. Stellato, et al., "Osqp: An operator splitting solver for quadratic programs"

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