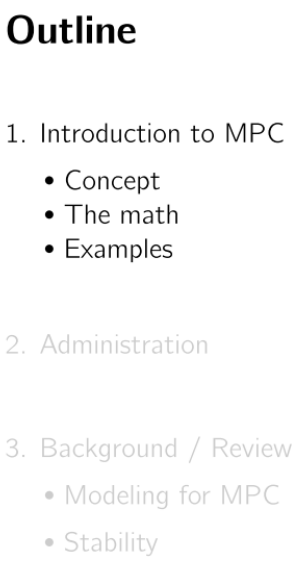
01_Introduction

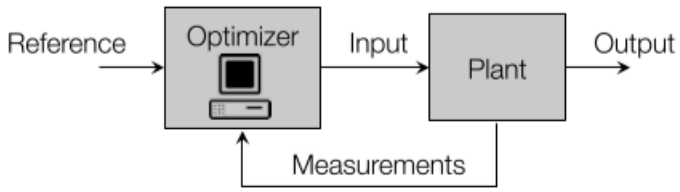


1. Introduction to MPC

1.1. Concept

MPC vs Classical Control Loop

Compared Classical Control Loop, in MPC, the controller is replaced by an optimizer program



Receding Horizon Control

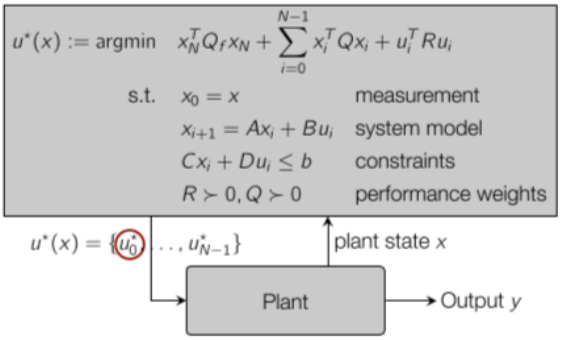
In MPC, each timestep, we optimize a horizon with length N, but we only implement the first control action

The Receding Horizon Control somehow introduces feedback.

Constraints in Control

For control and constraints, optimal solution often appears near constraints

1.2. Mathematical Formulation



Key Composition in the Formulation Model

$$
\begin{aligned}
u^*(x) := \text{argmin} \quad & x_N^\top Q_f x_N + \textstyle\sum_{i=0}^{N-1} x_i^\top Q x_i + u_i^T R u_i \\
\text{s.t.} \quad & x_0 = x && \text{measurement} \\
& x_{i+1} = Ax_i + Bu_i && \text{system model} \\
& Cx_i + Du_i \leq b && \text{constraints} \\
& R \succ 0, Q \succ 0 && \text{performance weights}
\end{aligned}
$$

Procedure

- Measure/Estimate Current State
- Calculate the optimal input sequence for the whole horizon N
- Only implement the first action in the sequence

1.3. Main Challenges

- **Feasibility**: Sometimes the constraints cannot be fully satisfied at the same time

- **Implementation**: May not guarantee real-time control
- **Robustness**: The system may not be stable with disturbance and uncertainty
- **Stability**: Convergence may not be guaranteed