

ChatGPT

Explore GPTs

Today

MPC Controller Cost Function

Yesterday

Minimize Loss with Adam

Minimize Loss with Adam

Minimize Loss with Adam

Previous 7 Days

Control Protocols Overview

Industry Sensors Overview

Previous 30 Days

Network MST Algorithms Comparison

Calculate Venturi Meter Diameter

MPC Algorithm for Overleaf

June

Entity Save Error Troubleshoot

Load Active Org Items

Upgrade plan

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3. Prediction Matrices

Construct the prediction matrices over the horizon N . Let \mathbf{X}_{pred} and \mathbf{U}_{pred} be the stacked state and control vectors over the horizon:

$$\mathbf{X}_{\text{pred}} = \begin{bmatrix} \mathbf{x}(1) \\ \mathbf{x}(2) \\ \vdots \\ \mathbf{x}(N) \end{bmatrix}, \quad \mathbf{U}_{\text{pred}} = \begin{bmatrix} \mathbf{u}(0) \\ \mathbf{u}(1) \\ \vdots \\ \mathbf{u}(N-1) \end{bmatrix}$$

Using the system dynamics iteratively, we get:

$$\mathbf{X}_{\text{pred}} = \Phi \mathbf{x}(0) + \Gamma \mathbf{U}_{\text{pred}}$$

where Φ and Γ are constructed as follows:

$$\Phi = \begin{bmatrix} A \\ A^2 \\ \vdots \\ A^N \end{bmatrix}, \quad \Gamma = \begin{bmatrix} B & 0 & 0 & \cdots & 0 \\ AB & B & 0 & \cdots & 0 \\ A^2B & AB & B & \cdots & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ A^{N-1}B & A^{N-2}B & A^{N-3}B & \cdots & B \end{bmatrix}$$

4. Cost Function in Quadratic Form

The cost function can be rewritten in a quadratic form involving \mathbf{U}_{pred} :

$$J = (\mathbf{X}_{\text{pred}} - \mathbf{X}_{\text{ref}})^T Q (\mathbf{X}_{\text{pred}} - \mathbf{X}_{\text{ref}}) + \mathbf{U}_{\text{pred}}^T R \mathbf{U}_{\text{pred}}$$

Substitute $\mathbf{X}_{\text{pred}} = \Phi \mathbf{x}(0) + \Gamma \mathbf{U}_{\text{pred}}$:

$$J = (\Phi \mathbf{x}(0) + \Gamma \mathbf{U}_{\text{pred}} - \mathbf{X}_{\text{ref}})^T Q (\Phi \mathbf{x}(0) + \Gamma \mathbf{U}_{\text{pred}} - \mathbf{X}_{\text{ref}}) + \mathbf{U}_{\text{pred}}^T R \mathbf{U}_{\text{pred}}$$

Let $\mathbf{e} = \mathbf{X}_{\text{ref}} - \Phi \mathbf{x}(0)$ the cost function simplifies to:

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