Mid-term presentation

The Quadrocopters

Technische Universität München

22. Mai 2015

1. Realtime Optimization Approach

Realtime

y, s, q erklären

Minimization Problem

$$\min_{\substack{s_k,\dots,s_N \\ q_k,\dots,q_{N-1}}} \sum_{i=k}^{N-1} F_i(s_i, q_i) \quad s.t. \left\{ \begin{array}{c} x_k - s_k = 0 \\ h_i(s_i, q_i) - s_{i+1} = 0 \quad \forall i = k, \dots, N-1 \end{array} \right.$$

$F_i(s_i, q_i)$	discretized goal function
$x_k - s_k = 0$	expected state should be the real state at time k
$h_i(s_i, q_i)$	solution of the ODE at time i

The Lagrangian

$$L^k(y) = \sum_{i=k}^{N-1} F_i(s_i, q_i) + \lambda_k^T(x_k - s_k) + \sum_{i=k}^{N-1} \lambda_{i+1}^T(h_i(s_i, q_i) - s_{i+1})$$

We are looking for y^* satisfying the KKT conditions.

$$\Rightarrow \nabla_y L^k(y^*) = 0$$

The SQP method

How do we find y^*?

$$y_{k+1} = y_k + \alpha_k \Delta y_k$$

$$\Downarrow$$

$$\min_{\Delta y} = \frac{1}{2} \Delta y^T A_k \Delta y + \nabla_y F(y_k)^T \Delta y$$

$$\Downarrow$$

$$A_k := \nabla^2_{y_k} L(y_k).$$

Newton-Raphson

$$y_{k+1} = y_k + \Delta y_k$$
$$\nabla_y L^k(y_k) + J^k(y_k)\Delta y_k = 0$$

$J^k(y_k)$ Approximated Hessian $\nabla^2_{y_k} L(y_k)$

$\alpha_k = 1$

Riccati Recursion

This formulation still depends on x_t ...

$$
J^k(y^k) = \begin{pmatrix}
 & -E & & & & & & \\
-E & Q_k^H & M_k^H & A_k^T & & & & \\
 & (M_k^T)^H & R_k^H & B_k^T & & & & \\
 & A_k & B_k & & -E & & & \\
 & & & -E & Q_{k+1}^H & M_{k+1}^H & A_{k+1}^T & \\
 & & & & (M_{k+1}^T)^H & R_{k+1}^H & B_{k+1}^T & \\
 & & & & A_{k+1} & B_{k+1} & & \\
 & & & & & & & \ddots \\
 & & & & & & \ddots & Q_{N-1}^H \\
 & & & & & & & (M_{N-1}^T)^H \\
 & & & & & & & A_{N-1}
\end{pmatrix}
$$

Finite Horizon