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Controlling of Plate and Ball System with a Nonlinear RHC Approach with a Compromised Length of Time Subintervals

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Abstract

Document Sections

- I. Introduction
- II. Plate and Ball Dynamics
- III. Receding Horizon Control
- IV. Model-Free Test for Time Subintervals
- V. Simulation Results

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- Authors
- Figures
- References
- Keywords
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Abstract: Receding Horizon Control (RHC) or model pre-dictive control (MPC) is an attractive control method which can treat large number of nonlinear state and control variables at same time in a certain system. In nonlinear RH C, we solve a nonlinear programming (NLP) problem that is resulted from dividing a predefined prediction horizon, of the formulated nonlinear optimal control problem, into an equal finite time subintervals. However, one of the RHC problems is to determine this finite number of the subintervals. This work will use a recently-developed off-line tester for choosing the size of the time subintervals of the optimal control problem of the nonlinear plate and ball system. This tool will ease this problem by choosing a 'compromise' number of time subintervals, or a length of each subinterval, with a needed of objective cost of the optimal problem, accuracy of the state and control profiles, number of iterations of the used nonlinear programming solver as well as the computational expense. Results that indicate the effectiveness of applying this tool to the solution of optimal control problem of plate and ball system is presented which was done using C++ as well as Matlab frameworks.

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Contents

I. Introduction

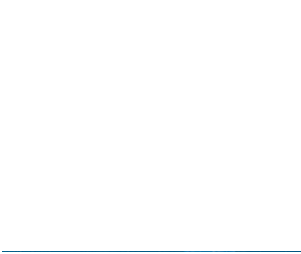
Nonlinear and inherently unstable systems take always high attention by control engineers. The goal in most cases is to find a control law for the system that brings it to the stable state, at the same time, this control law is preferably to be simple, reliable, accurate and not expensive. Examples for these systems are, but not limited to, single-, twin-, double-inverted pendula on a moving cart, beam and ball system, plate and ball system.. etc [1]. The plate and ball system is one of a popular system that is a generalised of the traditional beam and ball system. The plate and ball system consists of rigid horizontal and rectangular (or square) plate which its angles can be changed above and under horizontal around two axes and as shown in Fig. 1. In the case of one or both angle size and/or the plate is changed and/or even a force (disturbance force) is applied to the ball, this cause the ball runs away from the borders of the plate. To restore the plate to a predefined point (position) the angles and/or must be changed considerably to substitute this disturbance. The angles and can be changed using a four-bar linkages that are actuated by servo motors as shown in Fig. 2. Here only the four bar-linkage of plate and ball system in the y-axis is only shown since a similar mechanism is used for the x-axis. On the other hand, to specify the position of the ball on the plate, a capacitive or inductive touch-screen is mounted on the plate and a metallic ball is used.

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- Figures
- References

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