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A Piecewise Orthogonal Functions-Based Approach for Minimum Time Control of Dynamical Systems

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Abstract: This paper introduces a numerical technique for solving minimum time control problems. These problems are addressed to linear time invariant systems in feedforward and feedback control. The mathematical formulation of the control problem is expanded in several piecewise orthogonal bases, namely, the Walsh, block-pulse and Haar wavelets. Operational matrices are used to transform the integration procedure into a product. A numerical optimization problem is formulated to determine the final time and the control sequence (switching times) necessary to steer the system from an initial to a target position. The used numerical method shows that the employed piecewise orthogonal function generates better results than other functions.

Keywords: *orthogonal functions; operational matrices; minimum time control; linear systems; closed loop scheme.*

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1 Introduction

After the introduction of human operated machines, there was a need to enhance further the productivity and reduce costs. Therefore, automatic machines (i.e. robots) were designed and introduced. Today, many engineering systems, from manufacturing machines to vehicles and airplanes, require optimal control algorithms in order to operate efficiently. Pontryagin [1] developed the theoretical background needed to formulate and then solve these problems. Nevertheless, due to the nature of these engineering systems, finding a solution to these control problems remains a challenging task and requires multidisciplinary knowledge, from ordinary differential equation (ODE) discretization to optimisation so that to obtain a numerical solution. The control problems can be derived

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