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Tracking Trajectory of the SCARA Robot in adaptive Control using the Fractional Model Reference.

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Tracking Trajectory of the SCARA Robot in adaptive Control using the Fractional Model Reference

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Abstract—**Over the few last years the idea of introducing fractional calculus and systems in adaptive control has found a great interest, for the benefit one can win in the performances given by such systems. in this paper, a Fractional Model Reference Adaptive Control solution is proposed for reduce the delay time and the overshoot existing in classical control approach .**

Keywords-* *Fractional Adaptive Control, Approximation Methods, Method of Oustaloup, MRAC, SCARA robot

I. INTRODUCTION

Model Reference Adaptive Control (MRAC) is one of the most popular approaches of adaptive control, because of its simplicity and its high level of performance. The desired performance of this adaptive control scheme is specified by the choice of a reference model. Adjustment of parameters is achieved by means of the error between the output of the plant and the model reference output. Its ability to deal with unknown or slowly varying plants attracted many researchers, hwo attempted to emprove the robustness of MRAC to resolve practicle problems of industrial applications suffering from noises and perturbation effects. Various approaches were proposed to robustify this adaptive control algorithm [4, 5, 6, 7, 24].

Fractional calculus is a 300-years-old topic. The theory of fractional-order derivative was developed mainly in the 19th century. Recent books [2, 3] provide a good source of references on fractional calculus. However, applying fractional-order calculus to dynamic systems control is just a recent focus of interest [1,13, 25].

The earliest theoretical contributions to the field were made by Euler and Lagrange in the eighteenth century, and the first systematic studies seem to have been made at the beginning and middle of the nineteenth century by Liouville, Riemann, and Holmgren. It was Liouville who expanded functions in series of exponentials and defined the nth-order derivative of such a series by operating term-by-term as though n were a positive integer. Riemann proposed a different definition that involved a definite integral and was applicable to power series with non-integer exponents. It was Grünwald and Krug who first unified the results of Liouville and Riemann. Grünwald, by returning to the original sources and adopting as starting point the definition of a derivative as the limit of a difference quotient and arriving at definite-integral formulas for the nth-order derivative. Krug, working through Cauchy's integral formula for ordinary derivatives, showed that Riemann's definite integral had to be interpreted as having a finite lower limit while Liouville's definition corresponded to a lower limit $-\infty$.

The first application of the fractional calculus was made by Abel in 1823. He discovered that the solution of the integral equation for the tautochrone problem could be obtained via an integral in the form of derivative of order one half. Later in the nineteenth century, important stimuli to the use of fractional calculus were provided by the development by Boole of symbolic methods for solving linear differential equations of constant coefficients, or the operational calculus of Heaveside developed to solve certain problems in electromagnetic theory such as transmission lines.

In the twentieth century contributions have been made to both the theory and applications of fractional calculus by very well known scientists such as Weyl and Hardy (properties of differintegrals), Erd´ ely (integral equations), Riesz (functions of more than one variable), Scott Blair (rheology), or Oldham and Spanier (electrochemistry and general transport problems).

In the last decades of the last century there was continuing growth of the applications of fractional calculus mainly promoted by the engineering applications in the fields of feedback control, systems theory, and signals processing [.

The main contribution of this work is the use the fractional Model Reference Adaptive Control (MRAC) to reduce the delay time between the trajectory of scara robot and the reference trajectory.

This paper is structured as follows: Section 2 is an background on Model Reference Adaptive Control (MRAC) and MIT rule approach. Section 3 presents fractional order systems, and the fractional model reference adaptive control (FMRAC) with application time varying reference trajectory tracking in robotics are given in section 4. Finally, some concluding remarks with future work are presented in section 7.