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Performances Analysis of Fractional System using the Fractional order Adaptive PID controller

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Performances Analysis of Fractional System using The Fractional Order Adaptive PID controller

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Abstract. The applications of fractional order systems in a range of scientific fields have caught the attention of researchers, especially in control strategy. The current research work presents the use of the fractional adaptive PID controller approach, optimized by a genetic algorithm, to improve the performances (rise time, setting time, and overshoot) for fractional systems by introducing a fractional order integrator and differentiator in the classical feedback adaptive PID controller. To validate the arguments, the effectiveness and performance analysis of the proposed approach optimized by genetic algorithms have been studied in comparison to the classical adaptive PID controller. Numerical simulation and analysis are presented to verify the best controller. The fractional order adaptive PID gives the best result in terms of settling time, rise time, overshoot, and mean absolute error.

Keywords: Fractional System, Fractional Adaptive PID controllers, Genetic Algorithm, Comparative performance analysis.

1 Introduction

After L'Hospital and Leibniz's initial exchange of speculation, the field of mathematics known as fractional calculus was developed [1, 2]. The applications of fractional order differentiation have attracted the attention of researchers from a variety of scientific disciplines, especially from the fields of applied sciences [3,4]. Podlubny proposed the concept of FOPID controllers in 1997. He also showed how this form of controller responds more quickly than the classical PID controller when it is used for the control of fractional order systems [3,5].

It is well-known that to address the parametric uncertainty in both linear and nonlinear systems, the adaptive control method is one of the best control techniques being used so far. However, the focus was on the use of integer order systems to implement adaptive control methods [6,7]. Monje et *al.* [3] have reported the use of fractional calculus in conventional systems and control. The synchronization of chaotic systems with a fractional order operator as well as the creation of an adaptive sliding-mode controller for such systems have both been described using adaptive function projective and feedback control techniques [8]. The effect of the uncertain fractional order of chaotic systems can be controlled by adopting various practical methods such as an