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Editorial

Special Issue on Algorithms for PID Controllers 2021

Ramiro S. Barbosa * and Isabel S. Jesus

GECAD—Research Group on Intelligent Engineering and Computing for Advanced Innovation and Development, Department of Electrical Engineering, Institute of Engineering—Polytechnic of Porto (ISEP/IPP), Rua Dr. António Bernardino de Almeida, 431, 4249-015 Porto, Portugal
* Correspondence: rsb@isep.ipp.pt

1. Introduction

The PID is the most common type of algorithm used in control system applications. It is widely used in industry, mainly because it is simple, easy to implement and gives satisfactory results for most of the applications. Thus, despite being invented several decades ago, it is still a useful and state-of-the-art algorithm when the feedback control of dynamic systems is concerned. Several modifications have been proposed over time regarding its structure and techniques applied to improve its performance and to keep it an up-to-date controller.

This Special Issue aimed to present the most recent developments in the theory and applications of PID controllers. The focus was on reporting theoretical and applied research results in control structures, optimization techniques, metaheuristic algorithms, tuning methods, digital implementations, and applications of the PID algorithm, among others, and in the use of current techniques of artificial intelligence such as machine learning, deep learning, and reinforcement learning.

The articles of this Special Issue provide some new results and represent a step towards the development and application of PID controllers.

2. Special Issue

The Special Issue comprises six research articles that present some advances on the theory and applications of PID controllers. The authors in paper [1] present an artificial eukaryotic flagellum (AEF) swimming robot made up of IPMC segments for the study of planar wave generation for robot propulsion via single and distributed actuation. A controller robust to gain variations is tuned to control link deflection, regardless of link length, and enabling the implementation of a distributed actuation with the same controller design. For that purpose, two control strategies were proposed: a classical PID controller and a non-integer-order integrator. This article provides a different perspective from those presented in other works, addressing the design of a small-scale swimming robot whose links are integrated into the same piece of material and can work as actuators or passive flexible links. In paper [2], the authors investigate the containment control problem of discrete-time, first-order, multi-agent systems composed of multiple leaders and followers by using a proportional-integral (PI) coordination control protocol. The proportional term ensures the realization of the containment, and the integral term guarantees the rendezvous. It is proven that the proposed protocol drives followers with unconnected topology to converge to the convex hull of the leaders. In [3], the authors present a new coronavirus optimization algorithm (CVOA) to tune a PID controller to track a preselected reference speed of a brushless DC (BLDC) motor under several types of disturbances. The algorithm simulates how the coronavirus (COVID-19) spreads and infects healthy people. The advantage of CVOA is that its parameters can adapt according to disease statistics to prevent the need for trial and error that occurs when designers initialize these parameters with arbitrary values. In addition, the algorithm has the ability to end after several iterations when the infected population cannot infect new individuals. The results proved that the CVOA-based PID controller has the best performance among other

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techniques, such as the genetic algorithm (GA) and Harmony Search (HS) optimization. The authors in [4] propose the parameter optimization of the flight control system of a single-rotor, medium-scale rotorcraft. A six degrees-of-freedom (DOF) nonlinear mathematical model of a rotorcraft and the design of a closed-loop flight control system for a rotorcraft based on six concurrent PID controllers are developed. A comparative study of computational intelligence optimization algorithms is also performed to find the best PID controller parameters for a given flight regime. These techniques include particle swarm optimization (PSO), genetic algorithm (GA), ant colony optimization (ACO), and cuckoo search (CS). It was observed that the optimized PID controllers are effective around the trim point for which they were developed, with ACO-PID performing better for hovering and GA-PID for forward flight. However, the ACO-optimized controller can outperform the other optimization algorithms both in holding the trim state and recovering from external disturbance. In [5], the authors present an improved Quasi-Affine Transformation Evolutionary (QUATRE) algorithm for the parameter tuning of PID controllers. The accuracy of the algorithm was improved by using an adaptive mechanism adjusting control parameters online and a linear population reduction strategy. The proposed algorithm is compared with the PSO and the standard QUATRE algorithm. It was concluded that the new approach is better than PID parameter tuning using PSO and the original QUATRE algorithm, showing less overshoot and a shorter rise time, which makes the whole control system more stable, thus proving that the PID parameter tuning method based on the improved QUATRE algorithm is more effective. The authors in [6] use two different methodologies to investigate the use of the maximum power point tracking (MPPT) technique in a photovoltaic (PV) system composed of five solar panels in series. The first considered a traditional Perturb and Observe (P&O) algorithm, and the second applied a Fuzzy Logic Controller (FLC) that uses fuzzy logic concepts to improve the traditional P&O. Both methods were implemented in a boost converter. A study is performed to see if the intelligent MPPT method can be more efficient, stable, and adaptable than a traditional MPPT method in varying environment conditions, namely, solar irradiation and/or environmental temperature and also to analyze their behavior in steady-state conditions. It was shown that the proposed fuzzy logic enhanced P&O, which is a P&O algorithm improved with a fuzzy logic algorithm, increases the performance of the P&O algorithm, enabling the system to adapt faster to variable environmental conditions, leading to a faster MPP and an equal performance in steady-state conditions when the MPP is reached, and thus to higher generated energy.

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