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2021 IEEE International Conference on Computing, Power and Communication Technologies (GUCON 2021) -Report

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The 4th 2021 IEEE International Conference on Computing, Power and Communication Technologies (GUCON) was hosted by University of Malaya, Kuala Lumpur, Malaysia with 100% Financial Sponsorship of IEEE Industry Applications Society, USA on September 24-26, 2021. GUCON 2021 is a non-profit conference and it will provide an opportunity to the practicing engineers, academicians and researchers to meet in a forum to discuss various issues and its future direction in the field of Electrical, Computer & Electronics Engineering and Technologies. The conference aims to put together the experts from the relevant areas to disseminate their knowledge and experience for the relevant future research scope. The conference is financially sponsored by IEEE Industry Application Society USA. There are 12 tracks in the conference covering almost all areas of Electronics, Computer & Electrical Engineering.

This 4th version of GUCON received a massive response of 1386 papers from more than 37 countries and regions. More than 500 reviewers form all over the world completed the review process of these papers. Finally, 248 best quality papers have been accepted with peer reviewed process. The paper acceptance ratio is 17%. In this three day mega event 7 keynote sessions have been organized. The keynote speakers were all distinguished professors from all over the world (USA, Australia, UK, Italy, Canada, Estonia, Malaysia) including Vice President of IEEE Computer Society, USA. The conference was organized virtually on online WebEx platform adhering the Covid-19 pandemic guidelines. All 248 papers have been presented virtually in 35 technical sessions. Two session chairs were present in each of these 35 technical sessions.

The inaugural session of GUCON 2021, began with speeches of distinguished guest professors. The guests of honour present at the inaugural session Prof. Georges ZISSIS, Vice-President/Vice-Rector, Université Toulouse III, France; Prof. Kaharudin Bin Dimyati, Dean & Professor, Faculty of Engineering, Univerisiti Malaya, Malaysia; Prof. Saad Mekhilef, Distinguished Professor, Swinburne University of Technology, Australia; Prof. Vincenzo Piuri, (FIEEE), Professor, University of Milan, Italy; Dr. Tomy Sebastian (FIEEE), Director, Motor Drive Systems at Halla Mechatronics Bay City, Michigan, United States; Prof. Frede Blaabjerg (FIEEE), Professor, The Faculty of Engineering and Science Aalborg University, Denmark; Dr. Nishad Mendis, National Sales and Engineering Leader - Renewable Energy, Bureau Veritas Group Greater Melbourne, Australia; Prof. Valentina E. Balas, Professor of Automation and Applied Informatics, Aurel Vlaicu University of Arad, ROMANIA; Prof. Danny Sutanto, Professor, Power Engineering University of Wollongong, Australia; Prof. Fushuan Wen (FIEEE), Professor in Energy Systems, Tallinn University of Technology (TalTech), Estonia; Prof. S P Chowdhury, Professor, Tshwane University of Technology, South Africa; Prof. Bhim Singh (FIEEE), Professor, IIT Delhi, India. The vote of thanks was given by Prof. Venkatesh Babu, Pro-Vice Chancellor, Galgotias University, India.

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Design and Performance Analysis of Optimized Fractional Order PID Controller for Magnetic Levitation System

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***Abstract*—Incorporation of fractional order calculus in conventional integer order control system design algorithm, makes the existing control system more efficient & robust. Fractional order PID (FOPID) controllers possess two additional design parameters to better adjust and control the dynamical properties of a complex control system. The objective of this work is to compare the performances of FOPID with the integer order PID (IOPID) while controlling the position of a metallic ball in a Magnetic Levitation System (MAGLEV), which is unstable & highly non-linear system. To explore a suitable control option, the parameters of both FOPID & IOPID have been optimized by three different metaheuristic optimization algorithms namely, Bird Swarm Algorithm (BSA), Elephant herding Optimization (EHO) & Grey wolf Optimization (GWO). The simulation & real time results show that optimized FOPID controllers exhibit better transient and steady-state responses than conventional IOPID controllers irrespective of optimization methods used for tuning. It can also be concluded that GWO based control algorithm performs better than other two algorithms.**

Keywords*— *Fractional order PID, grey wolf optimization, integer order PID, magnetic levitation system, meta-heuristic optimization, real-time implementation

I. INTRODUCTION

Among the recently developed engineering technologies, Magnetic Levitation System (MAGLEV) [1] is one of the most interesting researched field with a diverse area of applications in the modern civilization. In the Magnetic Levitation technology, electromagnetic forces are required to levitate a ferromagnetic object in the air and to hold the object at a desired equilibrium position. Since no mechanical support is required to suspend the object, this system is free from friction & mechanical wear and tear problem. These fascinating features make the MAGLEV system perfect for applications like transportations systems (high speed Maglev trains), active magnetic bearings, magnetically levitated wind turbines, electromagnetic Aircraft launch systems and many more. Considering such a wide range of industrial applications, scientists are putting a lot more research efforts to improve the dynamic performance of the system and employ sophisticated technologies so as to meet the modern day requirements of humankind.

Analysing inner dynamics of the magnetic levitation system it can be conferred that the system is highly non-linear and intrinsically unstable. Controlling of such unstable system is quite difficult and a proper control algorithm must be implemented so that the system performance meets the desired specifications as well as improves stability criteria. A literature survey is carried out to explore various aspects of controller design for MAGLEV systems. For simultaneous improvement of system performance and stability, researchers have implemented an inner current control loop with PI-controller and outer position control loop with lead controller [2]. A piecewise linear control scheme [3] is employed for a system with large air-gap and operating at multiple equilibrium points.

Robust linear controllers like μ-synthesis [4], Q-parameterization, H_2 and H_∞ control [5] are utilized to deal with a wide range of parameter variations and plant uncertainties. Besides linear controllers, some researchers have proposed non-linear controllers namely sliding mode control [6], feedback linearizing control [7], gain scheduling control [8] and phase plane based control algorithm. These type controllers can overcome the inherent non-linearity property of MAGLEV systems.

PID controllers are suitable option for the control system designers in many practical process control action. The internal structure of PID controller is relatively simple and can be easily implemented in real-time. LQR based optimal PID tuning strategy is demonstrated in [9]. In [10], an adaptive PID controller with fuzzy compensator is designed and implemented for MAGLEV system. Real-time PID tuning method based on PSO algorithm is proposed in [11]. Genetic algorithm (GA) based optimized PID controller for MAGLEV is devised in [12]. Decentralized PID controller with extremum seeking optimization is developed in [13]. In [14], Grey wolf optimization (GWO) based optimized integer order PID (IOPID) controller for MAGLEV is proposed.

In recent times fractional order calculus is extensively applied in various fields of science and mathematics which is now extended to control system design in the form of fractional order PID (FOPID) controller as evidenced by pioneering work of Podlubny [15]. FOPID is used for levitation of magnetic disk in [16]. In [17], authors used optimized FOPID controller for levitation of ferromagnetic sphere through air-space. Digital FOPID controller is proposed in [18]; whereas numerical search method of designing FOPID controller is demonstrated in [19] for magnetic levitation system.

In this work, both integer & fractional order PID controller design methodology are demonstrated for levitation and control of a ferromagnetic object (a steel ball) at a desired position. To achieve superior controller