Quasi Oppositional—Manta Ray Foraging Optimization and Its Application to PID Control of a Pendulum System

Ahmad Azwan Abdul Razak, Ahmad Nor Kasruddin Nasir, Nurul Amira Mhd Rizal, Nor Maniha Abd Ghani, Mohd Falfazli Mat Jusof, and Mohd Ashraf Ahmad

Abstract This paper presents an improved version of Manta Ray Foraging Optimization (MRFO). MRFO is relatively a single objective optimization algorithm. It was inspired from the behavior of a cartilaginous fish called Manta Ray. Manta Ray applies three strategies in searching foods which are chain, cyclone and somersault foraging. From the study, MRFO is a relatively new developed algorithm and has low convergence rate. However, MRFO has potential to be improved in that aspect. In the meanwhile, Opposition-based Learning (OBL) is a well-known technique in increasing the convergence rate. Therefore, a type of OBL namely Quasi Oppositional-based Learning will be adopted into MRFO in order to increase the possibility of finding the solution by considering the opposite individual location of fitness. This version of MRFO is called as Oppositional-based MRFO (OMRFO). Further, OMRFO was performed on several benchmark function. A statistical non-parametric Wilcoxon Test was conducted to analyze the accuracy of MRFO and OMRFO. Furthermore, the proposed algorithm was applied to an inverted pendulum system. Result from shows that performance of OMRFO is significantly outperformed MRFO after tested in the benchmark functions.

Keywords Single-objective · Optimization · Manta ray · Quasi-opposition-based learning · PD-controller · Convergence · Accuracy · Spiral · Inverted pendulum

1 Introduction

Optimization algorithm is a tool that used in solving many complex problems including in practices of science, engineering and social science studies [1]. Optimization algorithms can provide a reliable solution in order to operate any application

A. A. Abdul Razak (✉) · A. N. K. Nasir · N. A. Mhd Rizal · N. M. Abd Ghani · M. F. Mat Jusof · M. A. Ahmad
Faculty of Electrical and Electronics Engineering Technology, Universiti Malaysia Pahang, 26600 Pekan, Pahang, Malaysia

A. N. K. Nasir
e-mail: kasruddin@ump.edu.my

K. Isa et al. (eds.), *Proceedings of the 12th National Technical Seminar on Unmanned System Technology 2020*, Lecture Notes in Electrical Engineering 770,
https://doi.org/10.1007/978-981-16-2406-3_69