

OPTIMIZATION OF PID CONTROLLER FOR DOUBLE-LINK FLEXIBLE ROBOTIC MANIPULATOR USING METAHEURISTIC ALGORITHMS

ANNISA JAMALI†

*Department of Mechanical and Manufacturing Engineering, Faculty of Engineering,
Universiti Malaysia Sarawak,
94300 Kota Samarahan, Sarawak, Malaysia
E-mail: jannisa@unimas.my
www.unimas.my*

INTAN ZAURAH MAT DARUS, HANIM MOHD YATIM and MAT HUSSIN BIN AB TALIB

*Faculty of Mechanical Engineering,
Universiti Teknologi Malaysia,
81300, Skudai, Johor, Malaysia*

MUHAMAD SUKRI HADI

*Faculty of Mechanical Engineering,
Universiti Teknologi MARA,
40450, Shah Alam, Selangor, Malaysia*

This paper investigates the optimization approach of PID controller for double-link flexible robotic manipulator using metaheuristic algorithm. This research focus on population-based metaheuristic that is particle swarm optimization (PSO) and artificial bees algorithm (ABC) to tune the PID control parameters of the system. In the tuning process, the number of iteration was set and the number of particles was varied. The tuning process was interrupted once the convergence value of Mean Square Error (MSE) was achieved. For PSO, it was found that when the number of iteration increased, or the number of particles were set to higher values, there were no significant improvement of MSE. Results showed that 25 iterations were required for MSE to converge for hub angle and 20 iterations were required for MSE to converge for end-point acceleration. Meanwhile, it was discovered that ABC portrayed the same pattern with PSO whereby when the number of iteration increased or the number of colony sizes were set to higher values, there were no significant improvement of MSE. From the results, 15 iterations were required for MSE to converge for hub angle and 25 iterations were required for MSE to converge for end-point acceleration. The performance of the algorithm was validated by evaluating the performance of the controllers in comparison with the conventional controller that is Ziegler Nichols (ZN) in term of input tracking capability and vibration suppression for both links. The system managed to reach desired angle for both hub angle 1 and 2. Besides, vibration reduction shows great improvement for both link 1 and 2. This signifies that, the PSO and ABC algorithm are very effective in optimizing the PID parameters.

1. Introduction

The introduction of metaheuristics algorithm (MA) has brought the new avenue in the optimization problem. There are wide variety of MA. For instance, single based metaheuristics versus population based metaheuristics, local search versus global search, hybridization and memetic algorithms and parallel metaheuristics. Some of the optimization algorithm was inspired by biological processes that allow populations of organisms to adapt to their surrounding environment. These concepts were introduced by Charles Darwin back in the 19th century. The first proposal of algorithm was reported in the 60's by John Holland who introduced a Genetic Algorithm (GA). This pioneering work was the beginning of the new discovery of other optimization methods such as Differential Evolution, spiral dynamic