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Abstract

Hybrid Particle Swarm Optimization and Manta Ray Foraging Optimization for Parameter Estimation of Induction Motors †

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Induction motors are extensively utilized across industries due to their robust efficiency, versatility, and cost-effectiveness, necessitating the precise parameter estimation of their equivalent circuit for effective operation and maintenance. Recently, metaheuristic algorithms have emerged as a powerful tool for this estimation task, offering advantages such as ease of implementation and rapid convergence to optimal solutions. This paper presents a detailed study employing two advanced hybrid metaheuristic techniques, Particle Swarm Optimization (PSO) and Manta Ray Foraging Optimization (MRFO), to enhance the accuracy of induction motor parameter estimation. These techniques, inspired by natural phenomena—PSO by the collective behavior of birds and MRFO by the foraging strategy of manta rays—are combined in a novel approach to refine the estimation process. The accuracy and precision of these hybrid metaheuristic algorithms are meticulously evaluated against traditional methods, using the sum of absolute deviations (SAD) between the motor's actual outputs and those predicted by the equivalent circuit model. The experimental outcomes demonstrate that the PSO-MRFO hybrid approach significantly surpasses the standalone PSO method, with a remarkably low SAD value of 0.2756, which signals a highly accurate estimation. In contrast, the PSO algorithm alone shows a reasonable but lower accuracy, with a SAD value reaching 0.6004. The findings underline the potential of hybrid metaheuristic algorithms to revolutionize the estimation of induction motor parameters, providing a highly accurate, reliable, and computationally efficient tool that could greatly benefit predictive maintenance and fault diagnosis in industrial applications. This advancement points towards the future of motor management, where sophisticated algorithms could lead to increased operational efficiency and reduced downtime.

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