# Optimization of Overcurrent Relays Coordination Using Artificial Hummingbird Algorithm (AHA)

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***Abstract*—Overcurrent relay coordination is crucial for ensuring the reliable and selective operation of power system protection. This project investigates the application of the Artificial Hummingbird Algorithm (AHA) in optimizing overcurrent relay coordination to minimize operation time while meeting selectivity criteria and operating limits. The AHA is a bio-inspired metaheuristic algorithm that mimics the movement patterns of hummingbirds. The mathematical formulation of AHA involves position update equations and exploration-exploitation balance. The project focuses on implementing AHA in a simulated 8-bus and 9-bus power system network. The simulation results demonstrate the effectiveness of AHA in achieving optimal coordination among the overcurrent relays, improving coordination accuracy, and reducing operation time. AHA is compared with conventional methods and other metaheuristic algorithms, highlighting its advantages in terms of convergence speed and coordination accuracy. The findings provide valuable insights into the potential of AHA as an efficient and effective approach for overcurrent relay coordination. This project contributes to the field of power system protection by presenting a novel algorithmic solution for improving coordination and reliability in power system networks.**

***Keywords—Overcurrent relay coordination, Artificial Hummingbird Algorithm (AHA), Metaheuristic algorithm, Power system protection, Optimization.***

## I. Introduction

Overcurrent relay coordination is a critical aspect of power system protection, aimed at ensuring the selective operation of relays to detect and isolate faults. The coordination process involves setting appropriate time-current characteristics for relays along with their associated protection zones to achieve effective fault discrimination. However, achieving optimal coordination poses significant challenges due to the complex nature of power system networks, diverse fault conditions, and the need to meet operational constraints.

In recent years, the field of optimization algorithms has witnessed remarkable advancements, providing powerful tools for solving complex coordination problems. Metaheuristic algorithms, in particular, have gained attention for their ability to explore large solution spaces and find near-optimal solutions. One such algorithm is the Artificial Hummingbird Algorithm (AHA), inspired by the foraging behaviour of hummingbirds.

The AHA mimics the dynamic movement and search strategies of hummingbirds, which exhibit a unique combination of exploration and exploitation behaviours [1]. By employing AHA, it is possible to effectively search the solution space, balance exploration and exploitation, and converge to optimal coordination settings for overcurrent relays. This project aims to investigate the application of the AHA in optimizing overcurrent relay coordination and evaluate its effectiveness compared to conventional methods.

The main objective of this project is to minimize the operation time of the relays while ensuring selectivity and adherence to operating limits. By leveraging the AHA's unique characteristics, such as randomization, local search, and information exchange, it is expected to achieve improved coordination performance. Additionally, the project seeks to assess the scalability and robustness of the AHA by implementing it in a simulated power system network comprising 8-bus and 9-bus configurations.

The remainder of this paper is organized as follows: Section II provides an extensive literature review on overcurrent relay coordination and the existing optimization techniques. Section III presents the methodology, including the mathematical formulation of the AHA and its implementation in the simulation environment. Section IV discusses the simulation results and evaluates the performance of the AHA in terms of coordination efficiency and computational requirements. Section V conducts a comparative analysis with conventional methods and other metaheuristic algorithms. Finally, Section VI concludes the paper, summarizes the findings, and suggests future research directions.

## II. Literature Review

Overcurrent relay coordination is a critical aspect of power system protection, aimed at achieving reliable and selective fault detection and isolation. Traditional coordination methods, such as time-current curve and impedance-based coordination, have been widely used. However, these methods suffer from limitations, such as reliance on trial-and-error approaches and inability to account for complex network conditions [1]

Genetic algorithms (GAs) have been employed for optimizing overcurrent relay coordination settings. These algorithms use principles inspired by natural selection and genetic inheritance to evolve a population of candidate solutions. The fitness of each solution is evaluated based on coordination criteria, and the best solutions are selected for reproduction, crossover, and mutation operations to generate a new population. The process continues until convergence to an optimal solution is achieved [2].

Particle swarm optimization (PSO) is another popular metaheuristic algorithm used for overcurrent relay coordination. PSO is based on the concept of simulating the collective behaviour of a group of particles moving through a multidimensional search space. Each particle adjusts its position based on its own experience and the best position found by the swarm. By iteratively updating particle positions, PSO aims to converge to the optimal coordination settings that minimize the objective function [3]

While these optimization techniques have demonstrated their effectiveness, each approach has its own advantages and

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