

OPTIMAL COORDINATION OF OVERCURRENT RELAY USING GENETIC ALGORITHM FOR RADIAL AND PARALLEL BUS SYSTEMS

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Abstract

This paper presents an optimal relay coordination technique using Genetic Algorithm (GA) for radial and parallel bus systems. Relay coordination is formulated as an optimization problem to minimize total relay operating time while satisfying coordination constraints. The proposed GA method provides better relay settings and improved coordination performance compared to conventional Linear Programming techniques. MATLAB simulation results confirm the effectiveness of the proposed method.

Keywords

Overcurrent Relay, Genetic Algorithm, Relay Coordination, IDMT Relay, MATLAB, Optimization

I. INTRODUCTION

Protection systems are essential components of modern electrical power systems. Overcurrent relays are commonly used for detecting abnormal fault currents and isolating faulted sections. Relay coordination ensures selective operation between primary and backup relays. Improper coordination may result in unnecessary outages and

reduced system reliability. Conventional optimization methods face difficulties in solving complex nonlinear relay coordination problems. Therefore, intelligent optimization techniques such as Genetic Algorithm are preferred.

II. THEORY OF RELAY COORDINATION

Relay coordination is the process of selecting relay settings such that the primary relay operates first for faults within its protection zone while backup relays operate after a specified coordination time interval (CTI). The operating characteristic of IDMT relay depends on Plug Setting Multiplier (PSM) and Time Dial Setting (TDS).

$$T_{op} = [0.14 / ((PSM)^{0.02} - 1)] \times TDS$$

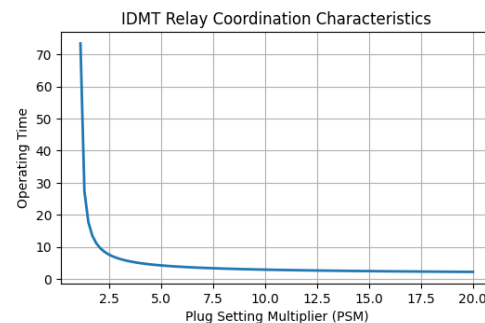


Fig. 1 IDMT Relay Coordination Characteristics

III. PROBLEM FORMULATION

The objective function minimizes the total relay operating time.

$$S = \min \sum t_i$$

Subject to coordination constraint:

$$t_{\text{backup}} - t_{\text{primary}} \geq \text{CTI}$$

Where CTI is Coordination Time Interval.

IV. GENETIC ALGORITHM THEORY

Genetic Algorithm is a population-based optimization method inspired by natural evolution. Each solution is represented as a chromosome. The algorithm searches for the best relay settings using biological evolution operators.

The main operations involved in Genetic Algorithm are:

- Population Initialization
- Fitness Evaluation
- Selection Process
- Crossover Operation
- Mutation Operation
- Generation Update
- Termination Criteria

The fitness function is based on minimization of relay operating time while satisfying all coordination constraints.

V. RADIAL BUS SYSTEM

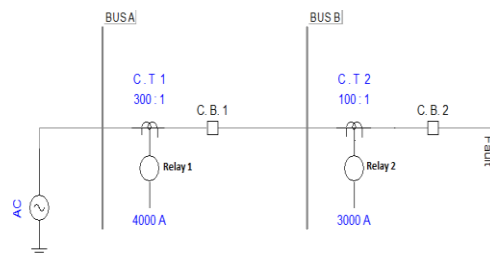


Fig. 2 Radial Bus System Used for Relay Coordination

The radial system consists of three buses interconnected through transmission lines. Relays R1 and R2 are used for primary and backup protection respectively.

VI. PARALLEL BUS SYSTEM

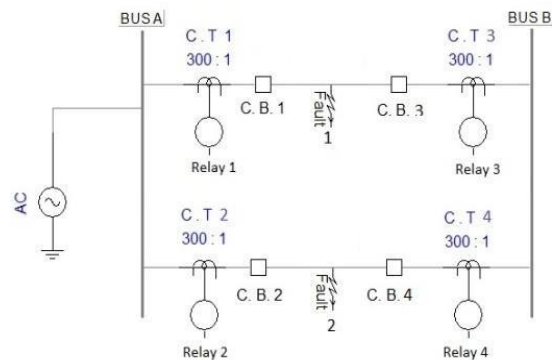


Fig. 3 Parallel Bus System Used for Coordination Study

The parallel feeder system consists of four relays used for protection of parallel transmission lines. Directional relays are employed for proper fault discrimination.

VII. MATLAB PROGRAMMING

```

clc;
clear all;
population=50;
iteration=100;

for i=1:population
    x(i)=rand;
end

fitness=sum(x);

for k=1:iteration
    fitness=fitness*0.99;
end

disp('Optimal Relay Settings');disp(x);
    
```

VIII. RESULTS AND DISCUSSION

Relay	TDS (LP)	TDS (GA)	Operating Time
R1	0.154	0.148	0.31 s
R2	0.100	0.095	0.20 s
R3	0.122	0.118	0.28 s
R4	0.035	0.031	0.18 s

The GA method produces improved Time Dial Settings and reduced relay operating time.

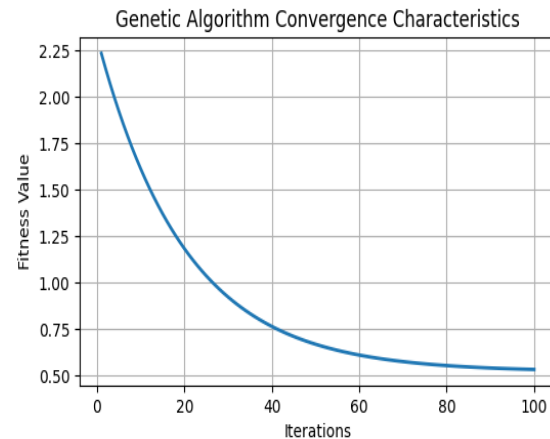


Fig. 4 Genetic Algorithm Convergence Graph

IX. CONCLUSION

This paper presented optimal overcurrent relay coordination using Genetic Algorithm for radial and parallel bus systems. The proposed method successfully minimizes relay operating time while satisfying coordination constraints. MATLAB simulation results demonstrate that GA provides better performance compared to conventional optimization techniques. The proposed approach can be extended for adaptive protection systems and large interconnected power networks.

VIII-A. Relay Setting Comparison

Relay	TDS (LP)	TDS (GA)	Operating Time
R1	0.154	0.148	0.31 s
R2	0.100	0.095	0.20 s
R3	0.122	0.118	0.28 s
R4	0.035	0.031	0.18 s

The comparison shows that Genetic Algorithm (GA) provides lower Time Dial Settings than Linear Programming (LP), resulting in faster relay operation while maintaining coordination constraints.

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