Optimal Combined Overcurrent and Distance Relays Coordination Using a New Genetic Algorithm Method

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***Abstract*—Several optimal coordination of overcurrent relays have been done in the past by using linear programming such as simplex, two-phase simplex and dual simplex and also intelligent optimization techniques such as genetic algorithm (GA) techniques. In this paper, a powerful optimal coordination method based on GA is introduced. The objective function (OF) is developed in a such way that in addition to the coordination of overcurrent relays, the coordination of overcurrent and distance relays is also achieved. In other words, the novelty of the paper is the modification of the existing objective function of GA, by adding a new term to OF to fulfill the coordination of both overcurrent and distance relays. The method is applied to two power network systems and from the obtained results it is revealed that the new method is efficient and accurate.**

***Index Terms*—Overcurrent Relay, Distance Relay, Optimal Coordination, Genetic Algorithm.**

I. INTRODUCTION

Overcurrent (OC) and distance relays are commonly used in transmission and subtransmission protection systems [1]. To consider comprehensive coordination, all the distance and overcurrent relays when one of them is considered to be the main relay and the other is backup, must be coordinated.

When both main and backup (M/B) relays are distance relays, the impedances of the three zones of relays are calculated considering all conditions of the interconnected network such as connection and disconnection of generators and lines [2].

For overcurrent relays the optimal coordination has been performed using linear programming techniques, including simplex [3], two-phase simplex [4] and dual simplex [5] methods. In reference [6] also, optimal solution is made by constraints only. The disadvantage of the above optimization techniques is that they are based on an initial guess and may be trapped in the local minimum values [7]. Intelligent optimization techniques such as genetic algorithm (GA) can adjust the setting of the relays without the mentioned difficulties.

In these methods the constraints are included in objective function [7]. The optimal coordination in [8] has been done by a method based on GA and in [9] by an evolutionary algorithm. These methods have two problems. One of them is miscoordination and the other is not having the solution for relays with both discrete and continuous time setting multipliers (TSMs). In [7] the mentioned problems have been solved.

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In the cases that the distance relay is considered to be main and the overcurrent one is the backup relay, it is necessary to find the critical fault locations. The critical fault locations are the locations at which, the discrimination time (Δt) between the backup and main relays is at its minimum. The coordination is made based on the constraints derived from the values of Δt for critical fault locations.

In [1] & [10] coordination of overcurrent, distance and circuit breaker failure (CBF) relays has been done using linear programming techniques.

In this paper a new optimal coordination method based on GA is introduced. The objective function (OF) is developed by adding a new term that is the constraint related to the coordination of the distance and overcurrent relays when a fault occurs at the critical locations.

II. REVIEW OF RECENTLY DEVELOPED GA FOR OPTIMAL OC RELAY COORDINATION

GA like all other optimization methods needs initial values which are chosen randomly. TSMs of relays are the unknown quantities in the optimization problem. Therefore, the TSMs with respect to the number of relays are considered as the genomes of the chromosomes in GA. In other words, some TSMs' sets, i.e. (TSM_1, TSM_2, TSM_3, …, TSM_n), (TSM'_1, TSM'_2, TSM'_3, …, TSM'_n), … belonging to relay set (R_1, R_2, R_3, …, R_n) are initially randomly selected. The structure of the chromosome is shown in Fig. 1. The number of TSMs' sets is referred as the population size. Then, after each iteration, the new TSMs' sets belong to relays R_1 to R_n are given to the algorithm. The process is terminated when the number of iterations becomes equal to the generation size [7].

To evaluate the goodness of each chromosome, it is essential to define an OF. The purpose of optimization is to minimize the OF. The chromosomes are evaluated regarding the OF and the chromosomes which have more effectiveness

R1	R2	R3	…	Rn
TSM1	TSM2	TSM3	…	TSMn

Fig. 1. Structure of Chromosome