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Fault section estimation in power system using Hebb's rule and continuous genetic algorithm

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ABSTRACT

In this paper a new approach for fault section estimation (FSE) in electrical power system is presented. We propose a procedure to obtain objective function (required for fault section estimation) using the Hebb's learning rule. The continuous genetic algorithm (CGA) optimization method is then employed to estimate the fault section making use of the objective function. The Hebb's learning law used in this paper gives, linear algebraic equations, to represent the targets in terms of the status of relays and circuit breakers (CBs). This gives a simple objective function, which leads to reduction in time required by the CGA to identify fault section. The CGA gives an advantage of requiring less storage than binary genetic algorithm (GA). Also the CGA is inherently faster than binary GA.

The proposed approach is tested on various systems, and is found to give correct results in all cases. Simulation results for two illustrations have been presented in this paper. The results show that the proposed approach can find the solution efficiently even in case of multiple faults or in case of failure of relays/circuit breakers. A comparison with artificial neural network (ANN) approach is also presented.

1. Introduction

Modern society depends heavily upon continuous and reliable availability of electricity. It has become important to maintain continuous supply of electricity round the clock. Also, no power system can be designed in such a way that it would never fail. So, one has to live with the failures (faults). To enhance the service reliability and to reduce power outages, rapid restoration of power system is needed. For restoration of supply, fault section should be estimated quickly and accurately. FSE identifies fault components in a power system using information of the operation of the protective relays and CBs. However this task is difficult, especially for the cases where the relay or circuit breaker fails to operate and for multiple faults [1]. Several methods have so far been developed for FSE [1–18].

Fukui, and Kawakami have presented an expert system which can estimate possible fault section [2]. Yang, Chang, and Huang have introduced the application of ANN for FSE [3]. They have used a system having similar profile as that of an expert system. Aygen et al. have used ANN with optimum number of neurons in the hidden layer for FSE [4]. For FSE, Cardoso, Rolim, and Zurn have modeled the protection system philosophy of busbars, transmission lines, and transformers with the use of two types of ANN [5]. The alarms corresponding to the operations of relays and CBs are the inputs to multilayer perceptron (MLP) neural network (trained with back propagation algorithm). The out put of MLP neural networks feed general regression neural networks which conclude whether the equipment is faulted or not. Wen, and Han have formulated the FSE problem as an 0–1 integer programming problem and have used GA technique to solve the problem [6]. They have further developed a mathematical model of the FSE problem using the time sequence information of the tripped CBs at the actuating time zone of any protective relay and have used refined genetic algorithm (RGA) to solve the FSE problem [7]. A new method to represent the probabilistic casualty relationship among section fault, protective relay action and CB trip, in a matrix form has been presented by Wen and Chang [8]. This has reflected, the structure and function of the protective relay system in a given power system, in a convenient mathematical form. The RGA was then used to solve the FSE problem. Wen, and Chang have also developed a mathematical model for FSE, based on the simulation of protection system behavior and the parsimonious set covering theory and have used tabu search based method and GA to solve the problem [9,10]. Lai, Sichanie, and Gwyn have proposed application of evolutionary programming (EP) to FSE in electrical power system [1,11]. They have also compared the application of GA and EP for FSE. Wen, Chang, and Tian have developed a modified abductive inference model for FSE, which can simultaneously take into account

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