Chapter 18
A Comparison for Optimal Allocation of a Reliability Algorithms Production System

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ABSTRACT

The most important phase in many industrial power applications is the design problem. Usually the demand increases randomly with time in the form of a cumulative demand curve. To adapt the power system capacity to the demand, new power architecture is predicted. To build this latter, the reliability optimization plays an important role to find the realizable power system architecture. This chapter describes and uses different meta-heuristics optimization methods to solve the redundancy optimization problem for multi-state series-parallel power systems. The authors consider the case where redundant power components are chosen to achieve a desirable level of reliability. The power components of the system are characterized by their cost, capacity, and reliability. The proposed meta-heuristics seek the optimal architectures of series-parallel power systems in which a multiple choice of components are allowed from a list of products available in the market. The approach has the advantage of allowing power components with different parameters to be allocated in power systems. To allow fast reliability estimation, a Moment Generating Function (MGF) method is applied. An illustrative example is presented.

1. INTRODUCTION

Electrical power productions systems are frequently built with electrical power components connected in series parallel arrangement. New system architectures have been considered as an important problem in power systems and in manufacturing systems. For instance, modifying an existing architecture, designing a new architecture and adding new components (reinforcement) belonging to the redundancy optimiza-

DOI: 10.4018/978-1-4666-7258-1.ch018

tion problem (ROP). This latter is a well-known combinatorial optimization problem where the new architecture is achieved by numerous discrete choices made from components available on the market.

This chapter describes and compares the implementation of some optimization algorithms as Particle Swarm, Harmony Search and Immune System (PSO, HS, IS) to solve the ROP involve the selection of electrical components and the appropriate levels of redundancy to maximize system reliability or minimize investment cost of series-parallel architecture, given architecture constraints (reliability, cost and performance). However, the capacity of many power production systems is defined by multiple heterogeneous units. In this situation, the system can have several levels of performance: from perfect working to total failure. In this case, it is considered as a multi-state system (MSS).

The MSS redundancy, addressed in this chapter is a common representation for many system design problems. The detailed seeks and allocation component method of system reliability discussed here is the designed to select the optimal solution in the context of reliability and/ or investment optimization of electrical power network analysis, given the overall restrictions on the system performance and cost. The problem is to determine which alternative (architecture) to select with the specified level of electrical device reliability, and what kind of components to use in order to achieve the minimal system investment or maximum system reliability.

This formulation of the redundancy allocation problem for series-parallel electrical network system, leads to the objective functions given by the components of each sub-system. In this work, the aim is to adapt different meta-heuristics which include a modern technique (Ushakov, 1973) to select and to evaluate the best architectures with minimal investment and/ or maximal reliability met the various constraints.

Literature Review

The vast majority of classical reliability or availability analysis and optimization assume that components and system are in either of two states (i.e., complete working state and total failure state). However, in many real life situations we are actually able to distinguish among various levels of performance for both system and components. For such situation, the existing dichotomous model is a gross oversimplification and so models assuming multi-state (degradable) (Maymin, 1973; Natvig, 1986, 1982; El-Neweihi, 1984) systems and components are preferable since they are closer to reliability.

Recently much works treat the more sophisticated and more realistic models in which systems and components may assume many states ranging from perfect functioning to complete failure. In this case, it is important to develop MSS reliability theory (Zeblah et al., 2010). In this chapter, an MSS reliability theory will be used, where the binary state system theory is extending to the multi-state case. As is addresses in recent review of the literature for example in (Ushakov et al., 2002; Levitin et al., 2001).

The problem of total investment-cost minimization, subject to reliability or availability constraints, is well known as the redundancy optimization problem (ROP). The ROP is studied in many different forms as summarized in (Tillman et al., 1977) and more recently in (Kuo et al., 1977). The ROP for the multi-state reliability was introduced in (Ushakov, 1987; Lisnianski et al., 1996; Levitin, 1997).

This chapter uses a different meta heuristic's (PSO, HS and IS) optimization approach to solve the ROP for multi-state system.