Available online at www.sciencedirect.com

ScienceDirect

Energy Procedia 74 (2015) 547 – 554

Energy Procedia

International Conference on Technologies and Materials for Renewable Energy, Environment and Sustainability, TMREES15

Budgetary and Redundancy Optimization of Heterogeneous Series-Parallel Power Systems under Availability Constraints

Khaled Guerraiche[a,*], Mostefa Rahli[a], Abdelkader Zeblah[b], Latifa Dekhici[a]

[a]University of Oran USTO, Engineering Faculty, Electrical Department, B.P. 1505 El Mnaouar, Oran, Algeria
[b]University of Sidi bel abbes, Engineering Faculty, Electrical Department, B.P. 89, sidi jilali,Sidi Bel abbes, Algeria

Abstract

This paper intends to resolve a redundancy optimization problem (ROP) using a recent bio-inspired metaheuristic which is Bat Algorithm (BA). The problem consists on selecting the appropriate components from a power system so to minimize investment cost. The selection must also satisfy a required reliability constraint. The optimization of multi-state series–parallel power system subject to this kind of common cause failures can be formulated into a nonlinear mathematic model. The series-parallel electrical availability system measurement leads into extensive computational process, which can slows down the optimization algorithm. That why, a commonly employed Universal Generation Function (UGF) is implemented. Experimental results on illustrative example show how Bat algorithm can yields to the optimal design and gives good results in an insignificant processing time.

Peer-review under responsibility of the Euro-Mediterranean Institute for Sustainable Development (EUMISD)

Keywords: Bat algorithm(BA); Series-Parallel Power System; Reliability; Power System design; Universal Moment Generating Function (UMGF).

* Corresponding author. Tel.: +213-561-980-887.
*E-mail address:*khguerraiche@yahoo.fr

Peer-review under responsibility of the Euro-Mediterranean Institute for Sustainable Development (EUMISD)
doi:10.1016/j.egypro.2015.07.748

1. Introduction

Optimization is a field of sciences in which the best values of problem parameters are explored under specified conditions i.e. basically it targets to find those particular parameter values which enable an objective function to generate the minimum or maximum value under constraints [1,2,3]. Nowadays, many well-know optimization methods are nature-inspired. They have been developed by imitating the successful characteristics of natural systems and. Among these nature-inspired algorithms, most are bio inspired. Their fundamental principles are based on the evolutionary characteristics or on behaviors of biological systems. A popular subset of bio-inspired algorithms can be called swarm intelligence-based algorithms because they have been developed by drawing inspiration from the so-called swarm intelligence (SI) [4].

The bat algorithm (BA) is a very interesting approach recently proposed by Yang [5]. It is based on the nature behavior of micro-bats when looking for food. Micro bats use echolocation to guide their search. They generate sound waves with some given frequencies and pulse rates when they tend to get close to their prey. The pulse rate increases, while the loudness decreases. A bat algorithm idealizes these features for solving combinatorial and continuous optimization problems, i.e., the bats design parameters are bat positions and the prey is the objective [6].

This paper intend to adapt bat algorithm to the redundancy optimization problem and specifically to series-parallel power systems cost minimization under availability constraint. An Universal moment Generation Function (UMGF) is also implemented to evaluate solution reliabilities.

For that, after introducing the problem nomenclature, power system redundancy problem is described with mathematic formulation in the second section. In the third section, the reliability measurement choice is directed to the UMGF (or u-transform) approach. The fourth section details bat algorithm, their principles and pseudo code. Finally, computational results are illustrated in an example.

Nomenclature

i,j,l: Respectively indices of series, versions and demand period interval

N: Number of series i

C_{ij}: Cost of electrical component j of type i

V_i: Number of Available electrical components technologies of type i

k_{ij} : Number of occurrence of component j in series i

Ξ_{ij}: Performance of power component j of type i

A_{ij}: Reliability of power component j of type i

A_0 : Minimum avaibility required

M: Number of demand period interval

K_{max}: Maximum number that can be taken from each component j

P_i: Performance probability of i^{th} device

Q_i: Performance probability of j^{th} device

W: Demand levels

$\Im$ **:** Operator for parallel device

δ **:** Operator for series device