Spider Monkey Optimization (SMO) Algorithm Based Innovative Strategy for Strengthening of Reliability Indicators of Radial Electrical System

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Reliability computation of a complex system is essential. A lot of research has been reported in literature for reliability improvement considering different issues. In view of above, method is shown for supreme modifications of indices of engineering structure. Engineering system considered is power system. Spider Monkey Optimization algorithm has been used for optimization of the objective function. A comparative analysis has been shown between the results obtained by Spider Monkey Optimization (SMO) algorithm and that of SL-PSO.

Keywords: Distribution systems, Spider Monkey Optimization algorithm, customer oriented indices, SL-PSO.

2021. In Raju Pal & Praveen K. Shukla (eds.), *SCRS Conference Proceedings on Intelligent Systems*, 247–252. Computing & Intelligent Systems, SCRS, India.
https://doi.org/10.52458/978-93-91842-08-6-24

1 Introduction

In literature a lot of discussion related to reliability is present [1-30]. Strengthening of reliability indices of radial electrical system such as failure rate or repair time is very important and essential. In this work, to solve the optimization problem, a new collective intelligence is used. This algorithm is based on the foraging nature of spider monkeys. In view of the above, this work describes an algorithm based on SMO technique used for the betterment of sample distribution system. Optimized values of indices are obtained using the SMO technique. The algorithm propose based on SMO is implemented on electrical distribution system, which is radial in nature. A comparative analysis has been shown between the results obtained by SMO algorithm and that of SL-PSO. Various statistical analyses also provided in the result.

2 Introduction to Reliability Indices

There are various important reliability indices. Availability also plays an important role and is also an important reliability parameter.

CE can be expressed:

(SAIFI):

$$\text{SAIFI} = \frac{\sum \lambda_{sys,i} N_i}{\sum N_i}$$

(SAIDI):

$$\text{SAIDI} = \frac{\sum U_{sys,i} N_i}{\sum N_i}$$

(CAIDI):

$$\text{CAIDI} = \frac{\sum U_{sys,i} N_i}{\sum \lambda_{sys,i} N_i}$$

Relation for system failure and unavailability is:

$$\lambda_{sys,i} = \sum_{k \in S} \lambda_k$$

$$U_{sys,i} = \sum_{k \in S} \lambda_k r_k$$

Energy based indices:

$$\text{AENS} = \frac{\sum L_i U_{sys,i}}{\sum N_i}$$

3 Problem Formulation

Aim can be expressed by the equation written below [31]

$$J = \sum_i \frac{\lambda_i^0 - \lambda_i}{\lambda_i - \lambda_{i,min}} + \sum_i \frac{r_i^0 - r_i}{r_i - r_{i,min}}$$

Where

λ_i^0 current failure rate of i^{th} segment

$\lambda_{i,min}$ minimum achievablefailure rate of i^{th} segment

λ_i modified failure rate of i^{th} segment

NC total number of distributor segments

r^0_i current repair time for i^{th} segment

r_i modified repair time for i^{th} segment

$r_{i,min}$ minimum achievable repair time for i^{th} segment

Constraints are:

$$SAIFI \leq SAIFI_d$$

$$SAIDI \leq SAIDI_d$$
$$CAIDI \leq CAIDI_d$$
$$AENS \leq AENS_d$$
$$\lambda_{i,min} \leq \lambda_i \leq \lambda_i^0, \qquad r_{i,min} \leq r_i \leq r_i^0$$

4 Spider Monkey Optimization (SMO): An Overview

A new method known as SMO is proposed [32]

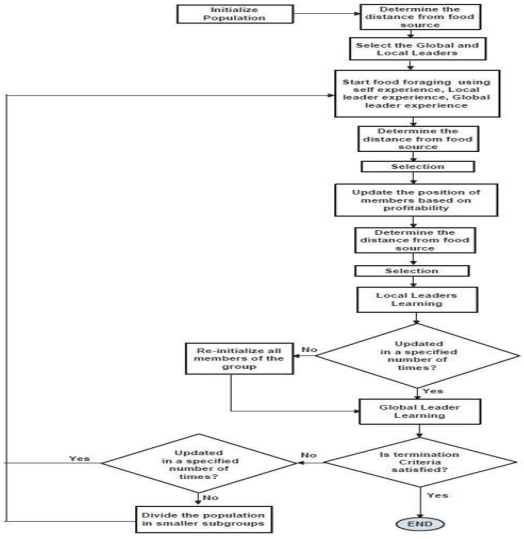

Fig. 1. Flow chart of Spider Monkey Optimization (SMO)

5 Results and Discussion

Result calculated by SMO is compared with SL-PSO results. The load points (LP) in the system are seven. In the system seven feeder segments are considered. Initial parameters for each DS are provided in [31]. Table 1 presents the statistics of best fitness function values as obtained using SMO and SL-PSO.

Table 1. Statistics of best fitness function values as obtained using Spider Monkey Optimization (SMO) algorithm and Social Learning Particle Swarm Optimization (SL-PSO) based on 30 numbers of runs.

Parameters	SMO	SL-PSO
Average value of best fitness function values	19.0418	19.0423
Standard deviation	0.0252	0.0253
Minimum value of best fitness function	19.0205	19.0207
Maximum value of best fitness function	19.1238	19.1235

Table 2 and Table 3 shows optimized values of indices by SMO and SL-PSO. Figure 2 shows indices calculated by SMO.

Table 2. Optimized values of failure rates and repair times as obtained by Spider Monkey Optimization (SMO) algorithm and Social Learning Particle Swarm Optimization (SL-PSO).

Variables	Magnitudes as obtained by SMO	Magnitudes as obtained by SL-PSO
1	0.2380	0.2381
2	0.0972	0.0975
3	0.2003	0.2004
4	0.1833	0.1835
5	0.1972	0.1973
6	0.1001	0.1003
7	0.1001	0.1004
r1	6.9289	6.9293
r2	7.7866	7.7869
r3	8.1585	8.1587
r4	11.7021	11.7028
r5	11.6379	11.6380
r6	7.9995	7.9998
r7	11.9928	11.9930
Objective function	19.0212	19.0228

Table 3. Current and optimized reliability indices.

S. No.	Index	Current values	Optimized values SMO	Optimized values SL-PSO	Threshold values
1	SAIFI	0.7200	0.5525	0.5526	0.5
2	SAIDI	8.4500	4.9956	4.9966	4
3	CAIDI	11.7361	9.2365	9.2366	8
4	AENS	26.4100	10.056	10.056	10

6 Conclusions

Energy & customer based reliability indices are of great importance in the predictive reliability and performance assessment of a distribution system. In this paper an algorithm for reliability enhancement of engineering system using SMO algorithm for optimum changes for rate of failure and time to repair is proposed. The results obtained with SMO have been compared with the results

obtained with the SL-PSO. Different statistical parameters such as average value, standard deviation has been obtained. Optimized values of rates of failure and times to repair by the SMO are also obtained. Various energy & customer based indices were also evaluated based on SMO. SMO has given good results then in comparison with the other proposed optimization algorithm.

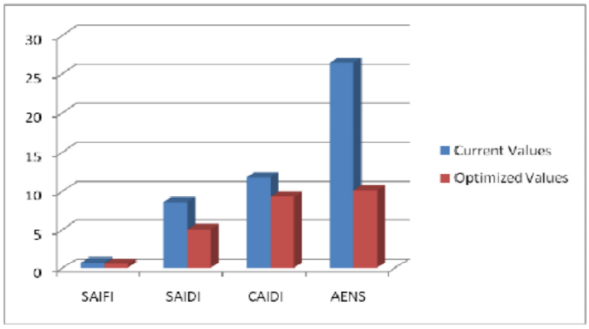

Fig. 2 Magnitude of the Current and optimized reliability indices.

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