Base Station Localization using Social Impact Theory Based Optimization

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Abstract: The placement of BTSs is a tedious job for network designers. The problem considered in the research is to determine the optimal locations of BTSs to meet traffic demands. Optimal coverage of BTSs is essentially a resource allocation/optimization problem. The received power, path loss and attenuation are main parameters of considerations during the optimization. Okumara-Hata model is considered for parameters calculations. Social Impact Theory based Optimizer is investigated in the research to find optimal locations against Particle Swarm Optimization technique for same scenarios. Results were analyzed considering fixed population of mobile stations but with varying number of mobile stations. Power received from all the BS locations searched by SITO is greater than the power received from BS location searched by PSO. Also the signal which travels from location searched by SITO suffers lesser path loss and attenuation than the location searched by PSO. So SITO outperforms PSO in every respect. The results show that the SITO approach is effective and robust for efficient coverage problem of BTS location and is considered to give almost the optimal solution in wireless communication network.

Keywords: Base Station Localization, SITO (Social Impact Theory based Optimizer), Cellular Mobile Communication

I. INTRODUCTION

When the cellular concept was first proposed, BTS locations were usually selected according to a regular reuse pattern. With the growth of cellular technology, it is becoming increasingly important for any cellular operator to have a network which is not only better in terms of quality of service than its competitors but also is more profitable than the others. The cost involved in setting up a network and the quality of the service offered is directly proportional to the number of BTS installed, more BTS, more is the cost but better coverage at more infrastructural cost.

The placement of BTSs is a tedious job for network designers, the reason being the frequency channels becomes increasingly congested and propagation environments become more complex. The problem considered in the research is to determine the optimal locations of BTSs to meet traffic demands. Optimal coverage of BTSs is essentially a resource allocation/optimization problem. The received power, path loss and attenuation are main parameters of considerations during the optimization.

The paper trails as: Analysis of earlier work is specified in Section. II. Section III focuses on the formulation of the projected algorithm. Section IV here says a number of tentative results to display the performance of the new algorithm. In the end, conclusions are drawn in Section. V.

II. LITERATURE SURVEY

In [Singh and Kaur, 2013] authors considered how to optimally determine locations of Base Transceiver Station (BTS), such that, minimum number of BTS can be installed to cover larger number of subscriber at lesser infrastructural cost. Population based Evolutionary Algorithms (EAs) are developed by modeling the behaviors of different swarms of animals and insects, e.g., ants, termites, bees, birds, fishes. These EAs can be used to obtain near optimal solutions for NP-Hard arbitrary optimization problems. Artificial Bee Colony (ABC) algorithm is a metaheuristic search algorithm and is investigated, in this research, to localize BTSs so as to cover maximum number of subscribers. The results were then compared with K-Mean clustering method.

In [Awasthi and Arora, 2014] authors described that Radio Coverage in general gets affected by Antenna arrangements, Location of BTS and also the Performance of Base Station. Their search considered as how to locate the optimal location of Base Station Transceiver (BTS), so that with minimum number of BTS, maximum number of user can be covered at less infrastructural cost. The idea of Using Evolutionary algorithm is quite effective and efficient as these algorithms are developed by modeling the behavior of different swarm of animals and insects like ants, bees& birds. These algorithms can be used to determine the Optimal Location of BTS. In presented research, ABC algorithm was used to localize BTS so as to cover maximum number of Subscriber. The results were then also compared with GA algorithm.

In [Pereira et. al., 2014] authors showed the improvement of using Particle Swarm Optimization (PSO) for multiple Base Station (BS) placement in a metropolitan area. They evaluated the algorithm's performance using a combination of Shannon's capacity formula and Jain's index of fairness for two sets of traffic demand points, corresponding to an estimation of average and peak traffic, respectively. They showed results performed by using 8, 32, 128 and 256particles to place sets of new BSs versus number of iterations. They also exhibited potential optimal points for placement found by PSO. The optimization improved the average capacity by 17% with an increase on the number of BSs smaller than 10%.

III. PLANNING MODELS

Propagation in land mobile service at frequencies from 300 to 1800MHz is affected in varying degrees by topography, morphography, ground constants and atmospheric conditions. A very common way of propagation loss presentation is the usage of so called propagation curves. The most commonly used path loss models are:

***Okumura Model*:** Okumura developed an empirical model that is derived from extensive radio propagation studies in Tokyo. It is represented by means of curves with which is applicable for urban areas. For other terrain, Okumura has provided correction factors for three types of terrain:

a) Open Area: Corresponds to a rural, desert type of terrain.
b) Quasi Open area: Corresponds to rural, countryside kind of terrain.
c) Suburban area.

Hata Model: The model is an empirical formulation of the graphical path loss data provided by Okumura. Hata presented the urban area propagation loss as a standard formula and supplied correction equations for other types of areas [Hata, 1980].The general Path loss equation is given by (Okumara-Hata urban propagation model)

$$L_p = Q_1 + Q_2 \log f - 13.82 \log H_{bts} - a(h_m) + \{44.9 - 6.55 \log h_{bts}\} \log d + Q_0 \quad (1)$$

f =Frequency in MHz   d =distance between BTS and the mobile (1-20 Kms) H_{bts}=base station height (30 - 100 m)

a (h_m) = Correction required if mobile height is more than 1.5 meters and is given by:

$a(h_m) = \{1.1 \log f - 0.7\}h_m - \{1.56 \log f - 0.8\}$ for urban areas

$=3.2\{\log (11.75h_m)^2 - 4.97\}$ for Dense urban areas

h_m = mobile antenna height (1-10m)

Q_1 =69.55 for frequencies from 150 to 1000MHz

=46.3 for frequencies from 1500 to 2000MHz

Q_2 = 26.16 for 150 to1000 MHz

= 33.9 for 1500 to 2000 MHz

Q_o = 0 dB for urban

= 3 dB for Dense urban

IV. FITNESS FUNCTION AND PARAMETERS

The optimum location is finding out in the proposed research considering the three main parameters (a) Path loss, Lp (b) Attenuation, A(c) Power received, using (1), (2) and (3).

$$A = 42.6 + 20\log_{10} f + 26\log_{10} d \quad (2)$$

$$P_r = 10\log_{10} P_t - abs(L_p) \quad (3)$$

Where P_t = Transmit power f = Frequency d = distance between MS and BTS L_p = Path loss determined by equation (1)

The problem of finding the optimal location of any BTS within its coverage area can be articulated as a fitness function described by equation (4) to achieve large received power by Mobile Station, Less Attenuation and less path loss. So the objective function is maximized to achieve these objectives.

Maximum fitness, F, is achieved given by equation (4).

$$F = \frac{abs\ (Pr)}{LpXA} \quad (4)$$

V. PROPOSED ALGORITHM

In the proposed work location of Base Transceiver Station (BTS) is optimized using Social Impact Theory based Optimization Algorithm. Three main parameters; Path Loss, Attenuation, and Power Received by Mobile Station (MS) are considered for this problem of finding the optimized location. And optimal solution is find so that power received is maximum, path loss and attenuation is minimum. The algorithmic flow of work is shown in figure 1.

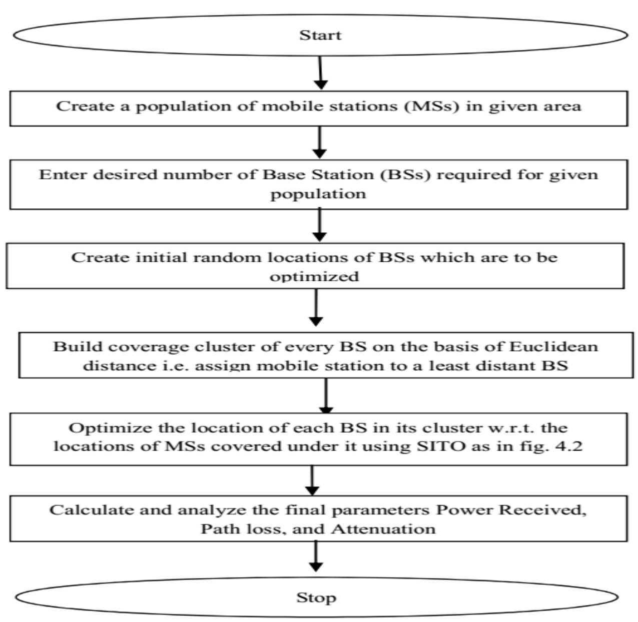

Figure 1: Algorithmic Flow of Proposed Work

An area of 100 X 100 is considered for deployment of network. In this area a population of mobile stations (MSs) is created. Then the desired number of Base Stations to cover the whole population is initially deployed on randomly selected locations. Then each MS is assigned under the least distant BS and hence coverage cluster of every BS is built on the basis of Euclidean distance. Then Social Impact Theory based Optimization algorithm as in figure 2 is applied to find the optimal location of each BS in its cluster with respect to the locations of MSs covered under it so that maximum fitness is achieved for the objective function represented by equation (4).

VI. RESULT AND DISCUSSION

To confine the performance analysis of the projected SITO algorithm in the BTS localization problem and to study its performance against PSO algorithm, experiments are performed using both algorithms for same scenarios. Results were analyzed considering fixed population of mobile stations but with varying number of mobile stations from 2 to 4. And here the results for the case of 3 BSs are discussed and compared. Figures 3 to 11 qualify the performance of SITO over PSO.

Figure 3 shows the random locations of population of 20 mobile stations and initial random locations of 3 base stations before optimization. And figure 4 and 5 describes the results after optimization. Fig. 4 shows the optimized locations of BSs searched by PSO and fig. 5 the optimized BS locations searched by SITO.
Figures 6 and 7 describes the statistical analyses of all the parameters Power received, path loss, and attenuation for all three BS locations searched by PSO and SITO respectively.

Table 1: Comparison of all Parameters of BS Locations Searched by SITO and PSO

Parameter	BTS	Proposed Algorithm (SITO)	Literature Algorithm (PSO)
Power Received	BTS 1	**374.0169**	165.3302
	BTS 2	**349.7211**	168.7956
	BTS 3	**374.4989**	144.2761
	Average	**366.079**	159.4673
Path Loss	BTS 1	**-453.3664**	-204.1951
	BTS2	**-429.0706**	-207.1928
	BTS 3	**-453.8484**	-163.5985
	Average	**-445.4285**	-191.6621
Attenuation	BTS 1	**68.8941**	127.2651
	BTS 2	**65.3886**	129.0312
	BTS 3	**68.9636**	103.3473
	Average	**67.7488**	119.8812

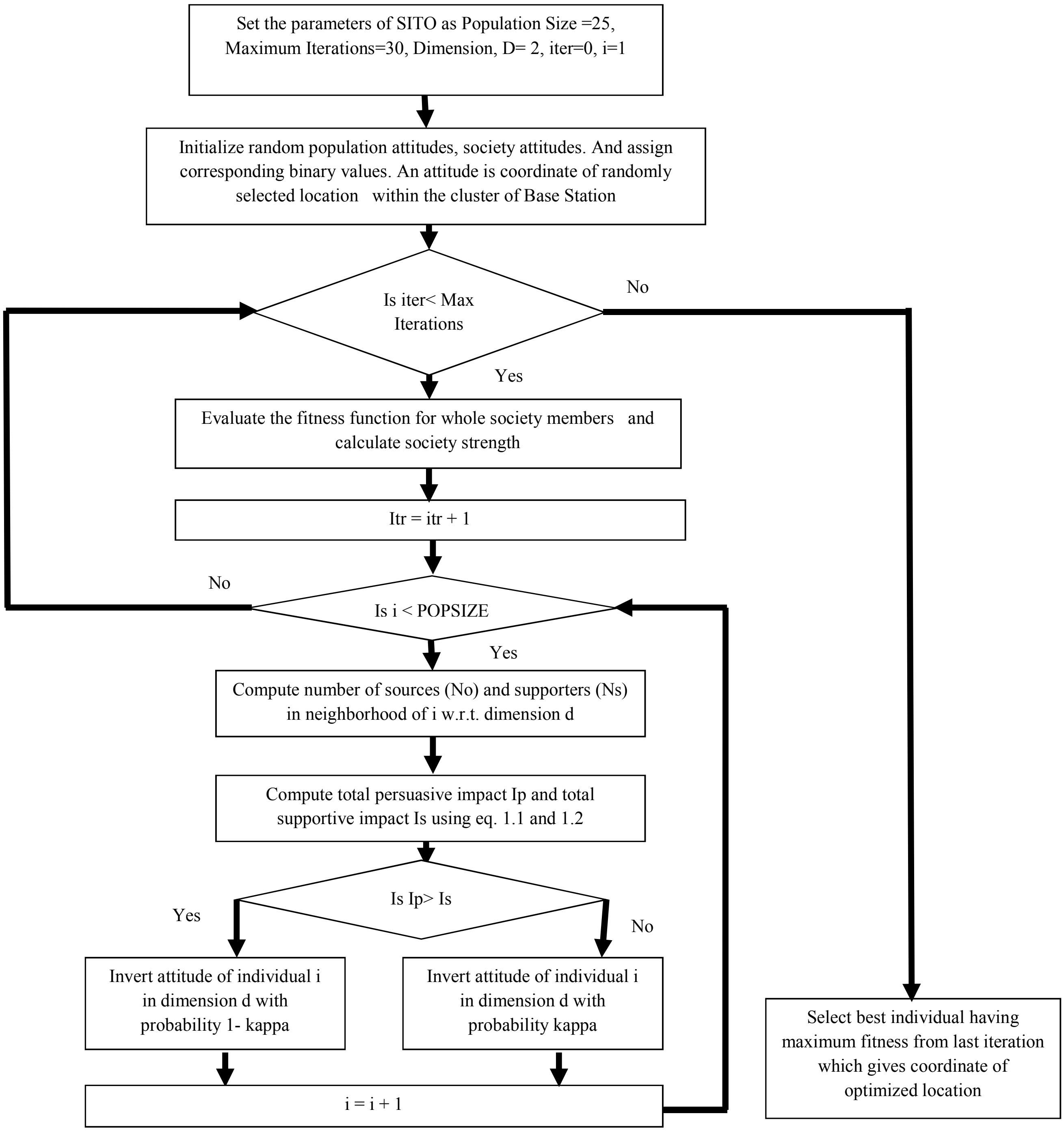

Figure 2: Flow chart of Location Optimization using SITO in Projected Research

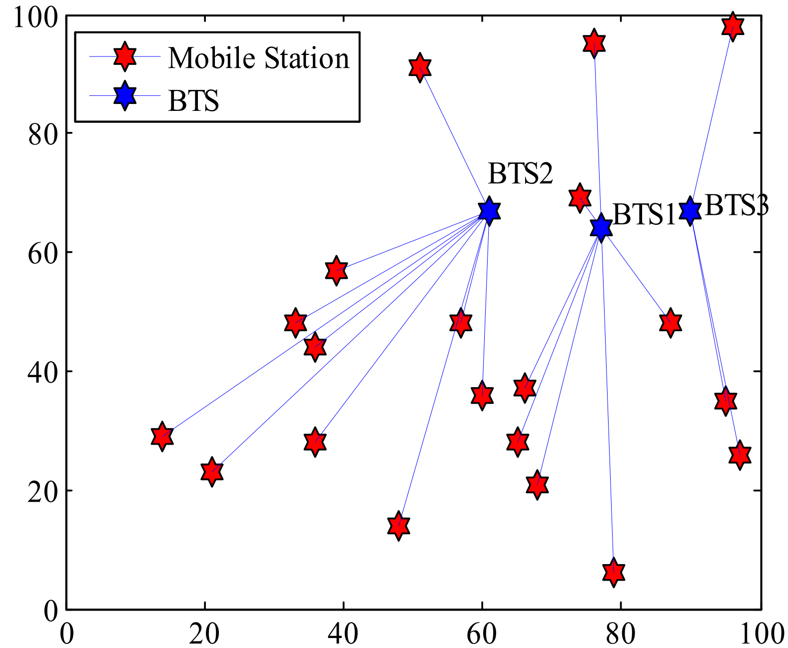

Figure 3: Initial Random Base Station Location and Cluster Formation (3 BS and 20 MS)

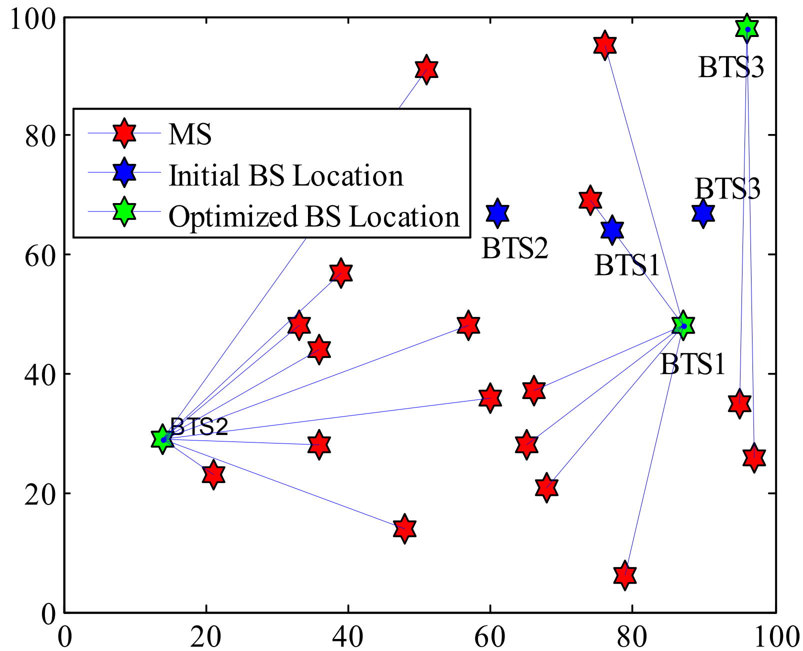

Figure 4: Optimized Locations of all Three Base Stations Searched by PSO

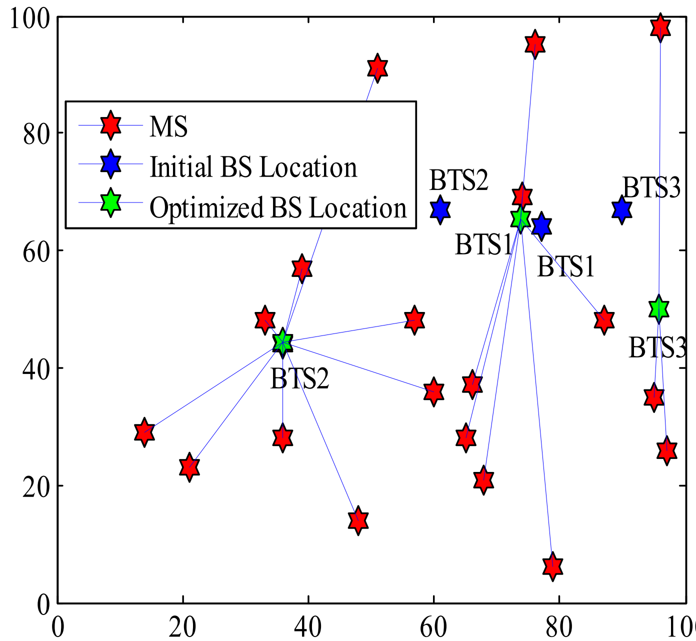

Figure 5: Optimized Locations of all Three Base Stations Searched by SITO

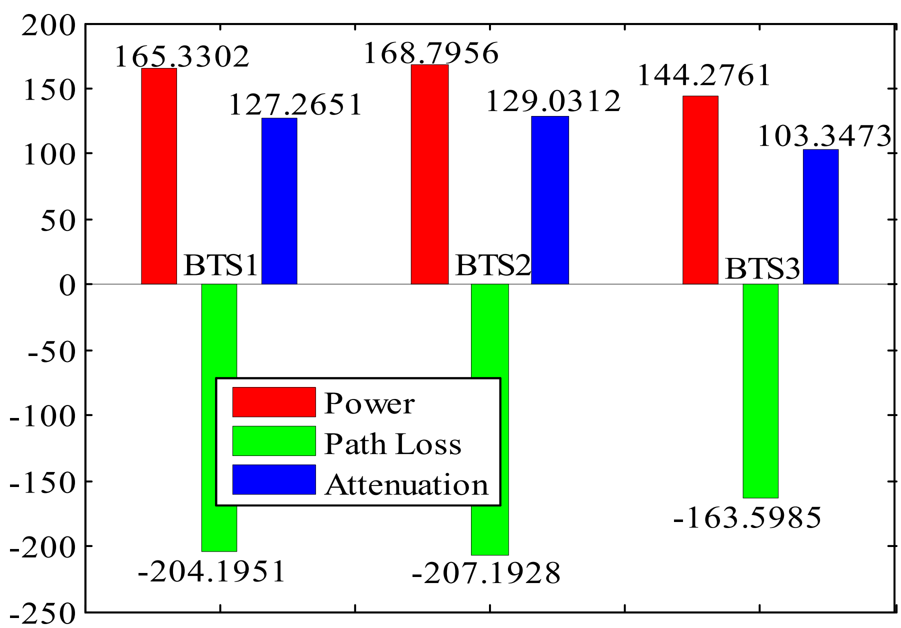

Figure 6: Power Received, Path loss, and Attenuation for all Three BS Locations Searched by PSO

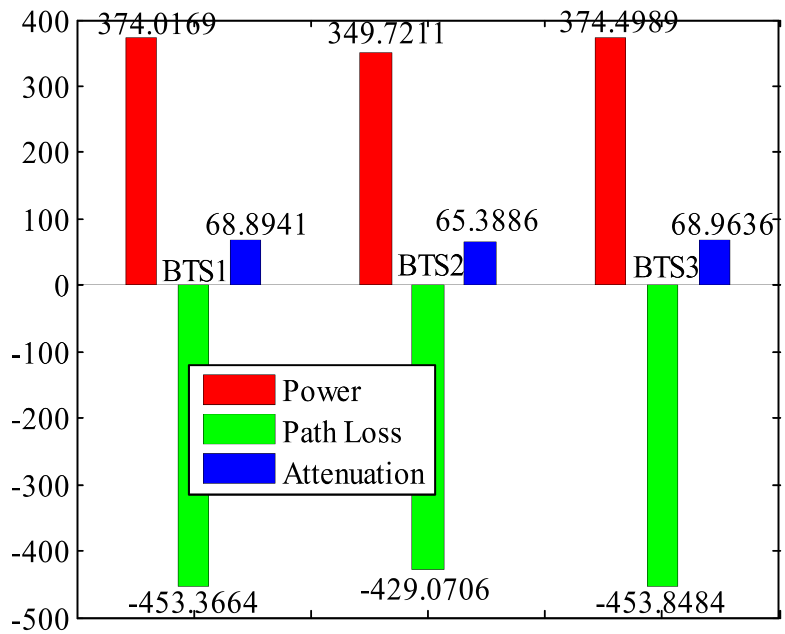

Figure 7: Power Received, Path loss, and Attenuation for all Three BS Locations Searched by SITO

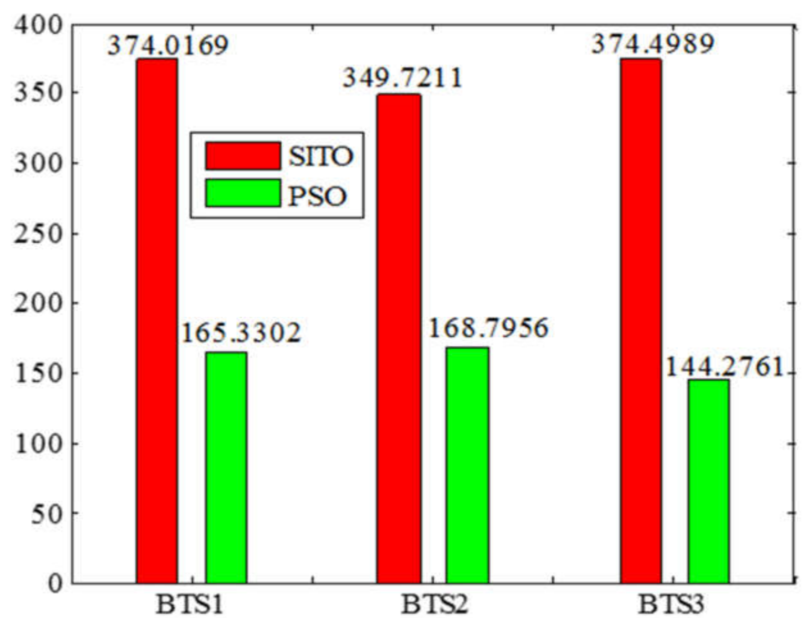

Figure 8: Power Comparison for all Three BS Locations Searched by SITO and PSO

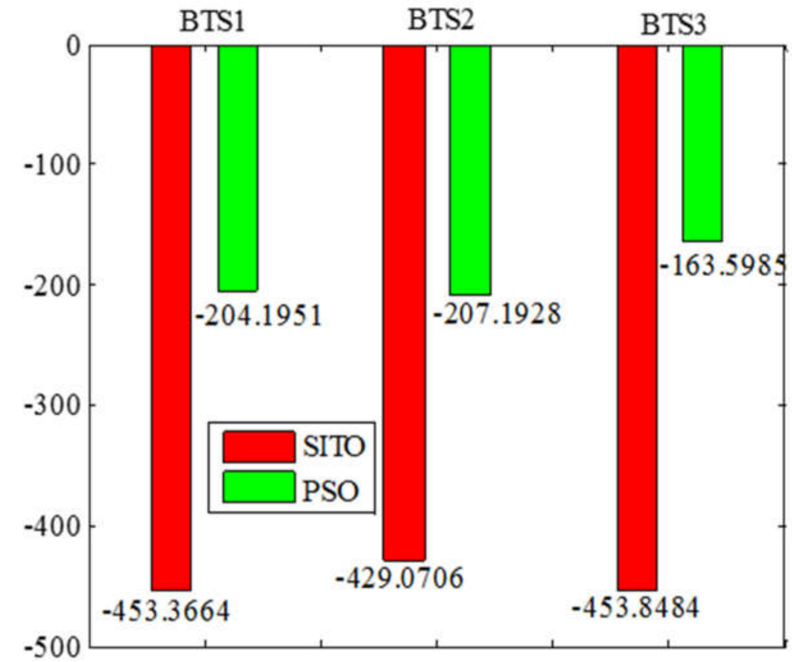

Figure 9: Path Loss Comparison for all Three BS Locations Searched by SITO and PSO

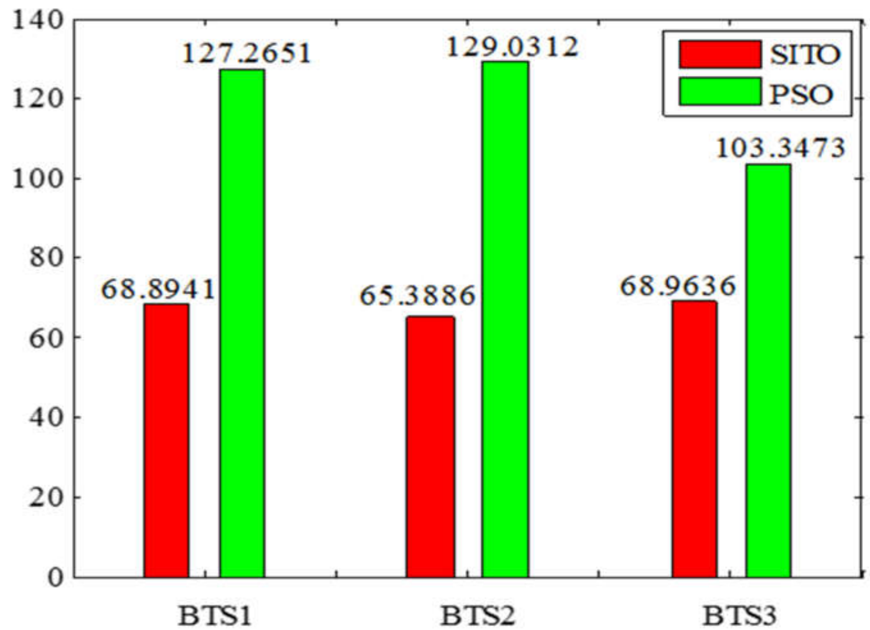

Figure 10: Attenuation Comparison for all Three BS Locations Searched by SITO and PSO

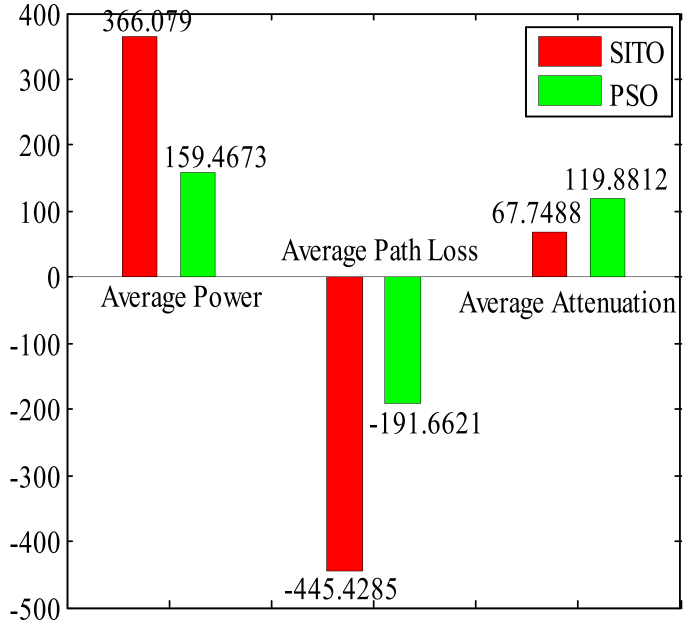

Figure 11: Comparison of Average Power, Average Path Loss, and Average Attenuation of all Three BS Locations Searched by SITO and PSO

From figures 8 to 11 and table 1 it is very clear that the power received from all the BS locations searched by SITO are greater than the power received from BS location searched by PSO. Also the signal which travels from location searched by SITO suffers lesser path loss and attenuation than the location searched by PSO. So SITO outperforms PSO in every respect.

VII. CONCLUSION

In this work a relatively new member of swarm intelligence family that is named as "Social Impact Theory based Optimization algorithm" is explained in detail. A very detailed literature review is presented in this study. All accessible previous work on Base Station optimization algorithms is tried to be reviewed. Most of the work in the literature is carried out in recent years and researchers mainly concentrated on continuous optimization problems. Previous work has presented that SITO has a very promising potential for modeling and solving complex optimization problems. In this thesis work social impact theory based optimization (SITO) is applied to determine the optimal location of BTS. The proposed work has ability to achieve optimal solution of coverage problem with desired number of BTS in cellular networks. This approach cultivates an innovative idea employing the SITO with enhanced fidelity. The results show that the SITO approach is effective and robust for efficient coverage problem of BTS location and is considered to give almost the optimal solution in wireless communication network.

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