Short Communication
Volume 11:05, 2022

Telecommunications System & Management

ISSN: 2165-7920

Open Access

Effects of Inertia and Acceleration Coefficients on Particle Swarm Optimization Algorithm for Selection in the Swarm of Satellites

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Abstract

PSO is getting some serious attention in recent era in optimization problem. It reduces the computational efforts and memory load. It is the artificial intelligence which is inspired by the social movement of elements in a group, for example birds flock or fish school etc. Optimization techniques are stochastic, deterministic, random and probabilistic. Stochastic technique is used where the information about the search space is not exactly known. Inertia weight is a major parameter which ominously effects the union, manipulation and exploration trade of in PSO technique. This article deals with the effect of the inertia and acceleration coefficients on the selection of a satellite that obeys the PSO algorithm.

Keywords: Inactivity and increasing speed coefficients • PSO • Satellite

About the Study

One of the best optimization techniques is Particle Swarm Optimization (PSO) introduced in 1995 by Kennedy and Eberhart. They were inspired by the motion of particles in a group [1]. This is an optimization technique inspired by social behavior of bird flocking and fish schooling in search of food. It is based on swarm intelligence and rated high among other similar techniques [2]. The two most important aims of PSO are acceleration convergence speed and avoiding the local optima [3].

The PSO is easy in its implementation, it gives high computational production compared to other other heuristic algorithms and it is robust to control parameters these are the healthy features of PSO. It can be applied to nonlinear and large search problems and yields better outcomes with better efficiency. There are some major components of this algorithm which has the significant effect on the efficiency of the results.

In PSO particles in the search space update their movement according to its own experience and the movement of the neighboring particles.

Acceleration coefficient

During iteration the acceleration coefficient controls the movement or the distance in the particular iteration. Whereas, the inertia coefficients pedals the conjunctions conduct in PSO. In start it was considered as the fix value but later with the popularity of this technique and experimental research showed that its value can be in certain range. However, it is better to assign the inertia weights at the start of the algorithm with the lager values and gradually decrease it to get superior outcomes [4].

Inertia coefficient

The investigation and the misuse highlights of the PSO calculation is adjusted by the dormancy coefficients w [5]. The idleness weight lies in the middle of 0.4 to 0.9 and gives great outcome in this range. It is the capacity of nearby and worldwide best molecule in every emphasis [6]. It does not have the consistent esteem nor does it require the diminishing investment variation esteem. Versatile latency weight strategy was acquainted with control the populace assorted variety by modifying the idleness loads [7].

In the creators utilize the speed data to alter the latency coefficients [8]. He originally utilized the speed data rather than position data. Trials were led on various capacities to look at the outcomes. The reenactment has demonstrated that the latency loads can improve the execution of PSO.

Ongoing work in the change of PSO is coordinated towards the presentation of the dormancy weight techniques. Better estimation of inactivity loads yields In the better hunt of neighborhood and worldwide best of a molecule. In the creator proposed another method to improve the execution of PSO which is the adaptable exponential time changing idleness weight [9]. The results have demonstrated that the ideal latency weight is 0.4 and the ideal speeding up coefficients is 0.2 and 0.8 [10].

To study the effect of the inertia weights, the scenario is taken from [11] where Tahir et al. takes satellites as the particles and no of satellites form the swarm of particle. After setting the swarm size let $x_i(t)$ is the position of a satellite at any time instant t in the complete swarm i.e. $x_i \varepsilon X$. Each satellite has its own velocity position as well. Let the velocity of satellite is $v_i(t)$.

As the satellite is not alone it is moving in a swarm of many satellites so satellite will interact with each other obeying some rules. Let's now observe the motion of satellite in the swarm (Figure 1).

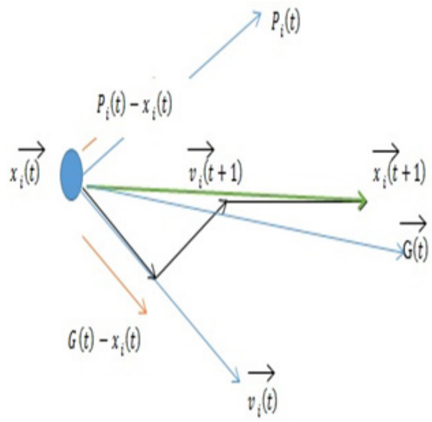

Figure 1. Velocity and position vectors.

Each satellite has its own best experience which is known as the individual best. It is appeared by $P_i(t)$. Notwithstanding the individual best the molecule has best understanding among the entire swarm called the worldwide best position or worldwide best involvement. It is appeared by $G_i(t)$, $X_i(t+1)$ here is the new refreshed position and is the refreshed speed of a satellite. This satellite development can be written as scientific

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Received: 22-Nov-2019, Manuscript No. JTSM-21-001-PreQc-22;**Editor Assigned:** 29-Nov-2022, PreQc No. JTSM-21-001-PreQc-22; **Reviewed:** 29-Dec-2022, Qc No. JTSM-21-001-PreQc-22; **Revised:** 28-Jan-2021, Manuscript No. JTSM-21-001-PreQc-22; **Published:** 08-Mar-2022, DOI: 10.37421/Jtsm.2022.11.313

conditions.

$$x_i(t+1) = x_i(t) + v_i(t+1)\text{.........}(1)$$

$$v_i(\text{t}+1) = \omega v_i(\text{t}) + \text{c}_1[p_i(\text{t})] + \text{c}_2[G(\text{t})]\text{.......}(2)$$

The velocity and position updation can be written in its ith and jth components.

The equation for updating the velocity of satellite is as follows

$$v_{ij}(\text{t}+1) = \omega v_{ij}(\text{t}) + \text{r}_1 c_1[p_{ij}(\text{t}) - x_{ij}(\text{t})] + \text{r}_2\text{c}_2[\text{G}_{ij}(\text{t}) - x_{ij}(\text{t})]\text{.......}(3)$$

The updated equation of position can be stated as follows.

$$x_{ij}(\text{t}+1) = x_{ij}(\text{t}) + v_{ij}(\text{t}+1)\text{.......}(4)$$

These equations are basically the simple rules behind the PSO and must be followed by each satellite in the swarm. There are three components of the PSO's equations.

$\omega v_i(\text{t})$ is called inertia component.

$\text{r}_1\, c_1[p_{ij}(\text{t}) - x_{ij}(\text{t})]$ is called cognitive component.

$r_2 c_2[G_{ij}(t) - x_{ij}(t)]$ is called social component.

Where $\omega v_{ij}\ (t)$ I the inertia terms c1 and c2 are the acceleration coefficients and r is the random number between 0 to 1.

Results and Discussion

Programming steps in matlab

- Problem definition
- Parameters of PSO
- Initialization
- Iteration main loop of PSO
- Results

Parameter setting

Parameters are set according to Table 1 it is observed that the inertia weight has a great impact on PSO results. When population size N is 20 acceleration coefficients are taken as 0.7 and inertia weight is 1, the service time decrease continuously and takes constant values after 13th iteration as shown in Figures 2-6. That may create a doubt that all the satellites that are supposed to be handed over to other satellites have same service time. Multiple results are obtained while changing the inertia weights and acceleration coefficients and the population size some of the results are shown here. As the value of w is increased the graph becomes more complex and long streams of constant values are repeated. But as w is decreased he service time appears to be more decent and small intervals of same values ae obtained.

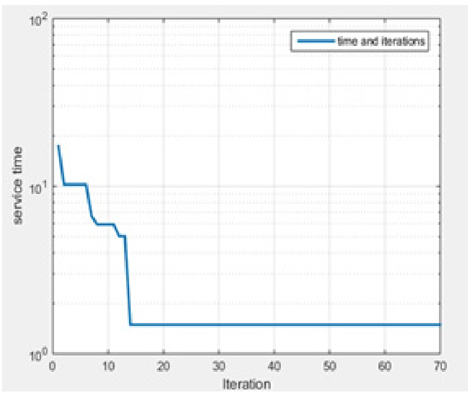

Figure 2. Service time and iterations N=20, C1 and C2=0.7, w=1

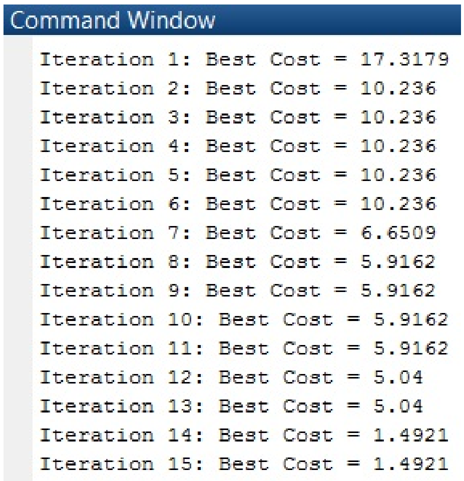

Figure 3. Service time on each iteration Best cost=best service time.

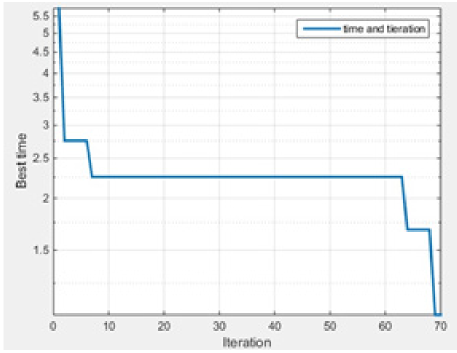

Figure 4. Best time and iteration N=40 C1 and C2=0.7, w=0.8
Note: (——) time and iteration

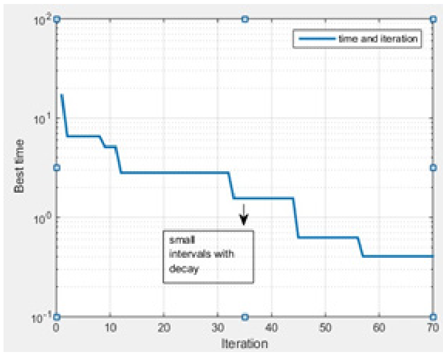

Figure 5. Best time and iteration N=40 C1&C2=0.6, w=0.5.
Note: (——) time and iteration

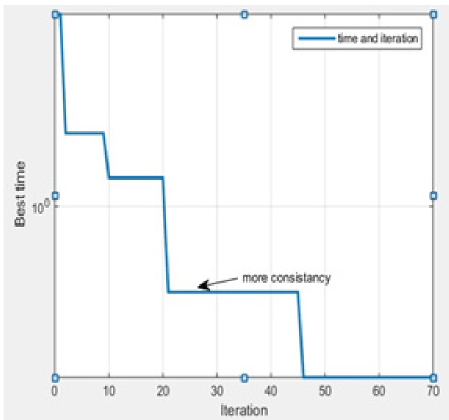

Figure 6. Best time and iteration N=20 C1 and C2=0.7, w=0.5.
Note: (——) time and iteration

Table 1. Parameter table

Parameter	Values
Population size	20,40
No of decision variables	4
Lower bound and upper bound of decision variable	-10 to + 10
Personal Acceleration coefficient c1	0.1 to 1
Social Acceleration Coefficient c2	0.1 to 1
W= inertia coefficient	0.4 to0.9
No of iterations	70

Conclusions

Simulation results have shown that the inertia weight and acceleration coefficient has a significance effect on PSO performance. We also conclude that from the value range of inertia weights (0.4 to 0.9), PSO has a greater efficiency on inertia weight of 0.5.

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How to cite this article: Rehman, Tahir and Faizullah Khan " Effects of Inertia and Acceleration Coefficients on PSO Algorithm for Selection in the Swarm of Satellites ." *J Telecommun Syst Manage* 11 (2022): 313