

A Searching Algorithm for Antenna Phase Center



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Abstract

This paper introduces search algorithm as the new method for phase center error analysis. Particle Swarm Optimization (PSO) is taken as an instance for searching phase center. At last, the advantages of the new method compared with the classical method are present.

Introduction

Spacial location is essential for navigation satellite. The invented coordinate of satellite signal relates to that of the antenna on the satellite. To ensure the accuracy of navigation satellite, the coordinate is determined by antenna phase center.

The definition of antenna phase center is given according to the National Spacecraft Standard. It is a point as the sphere center of antenna radiation, the surface of far field radiated sphere in service range has the minimum RMS(Root Mean Square) on phase fluctuation of the radiated electric field in antenna co-polarization.(Test Method of Navigation Satellite Antenna Phase center Q/QJA229-2014)

In this paper, a searching algorithm is adopted to solute the antenna phase center and the advantages are also studied.

Searching Algorithm

PSO is the new intelligent optimization method after genetic algorithm. Similarly, it is also a random research method imitated the inheritance and evolution of creatures.

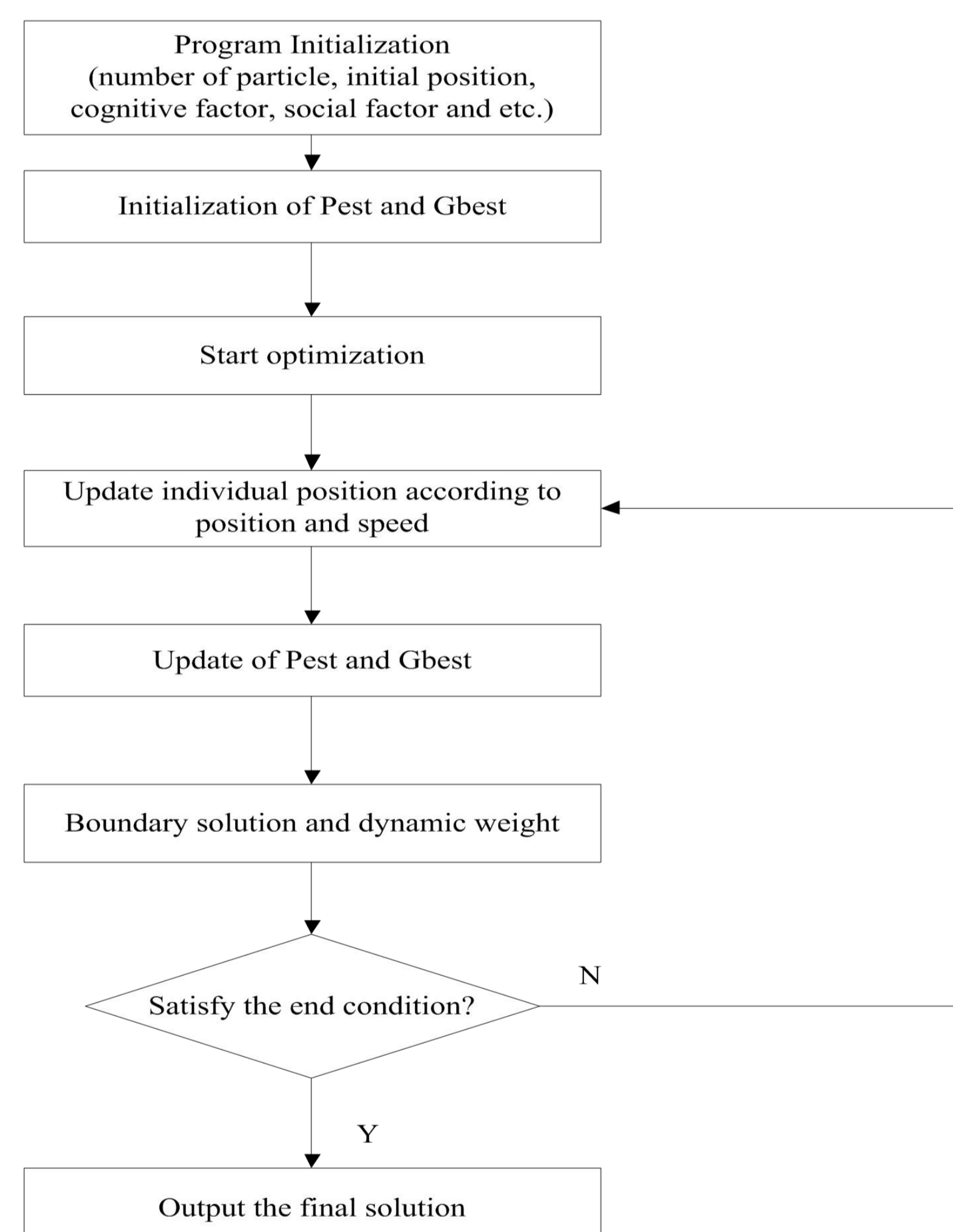


Fig. 1. Diagram of searching algorithm

Comparison

It can be seen in Figure 2 that after 100 times of iteration, the complete convergence realized. And the final solution of searching algorithm is well consistent with classical method which is described in Table I.

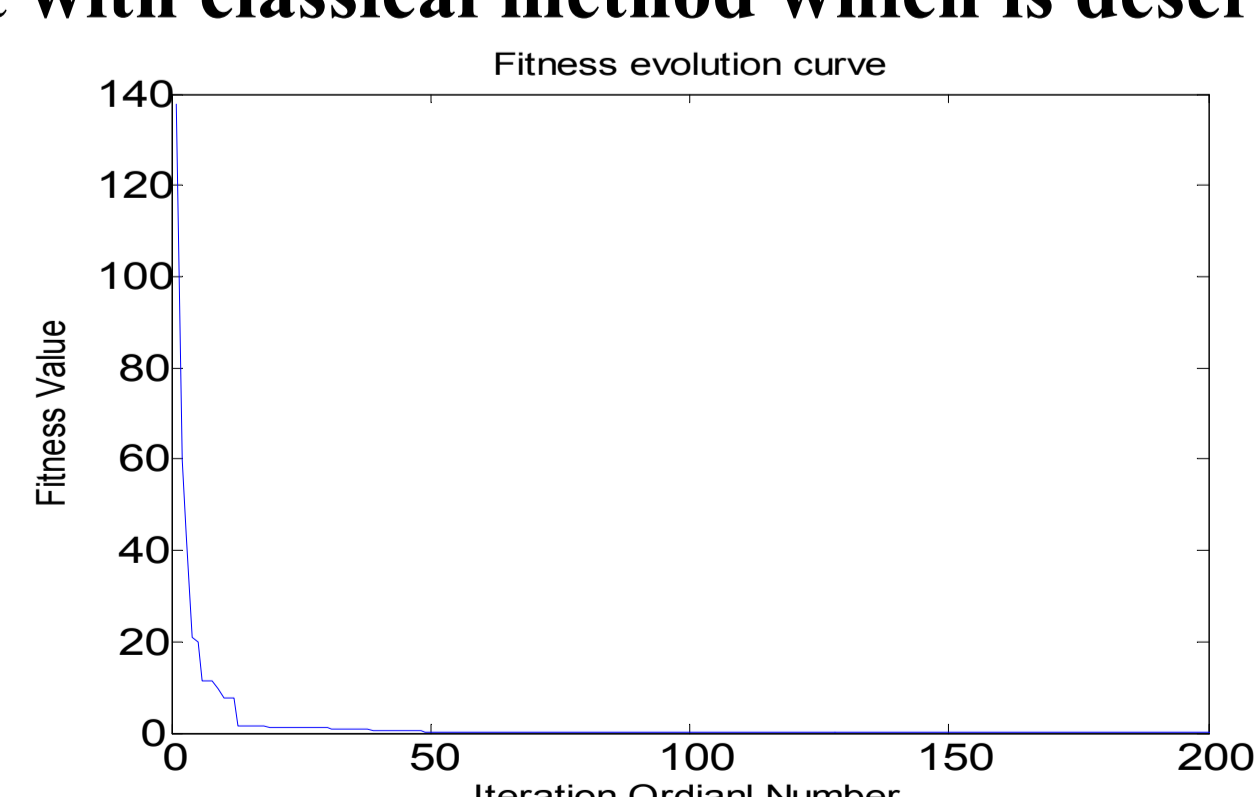


Fig. 2. Convergence of algorithm

TABLE I. Final Result of Phase Center Error

| Item | Classical method | Searching algorithm |
|----------------|------------------|---------------------|
| X | 0.2648mm | 0.2647mm |
| Y axis | -0.0302mm | -0.0301mm |
| Z axis | -193.6483mm | -193.6482mm |
| RMS | 0.5229 deg | 0.5229 deg |
| Computing time | 1s | 20s |

Extend application of PSO

PSO allows arbitrary shape as the searching range of the phase center. While the service range of navigate satellite is nearly circular, which is the shape of earth. Hence circular range is employed in phase center calculation, as shown in Figure 3.

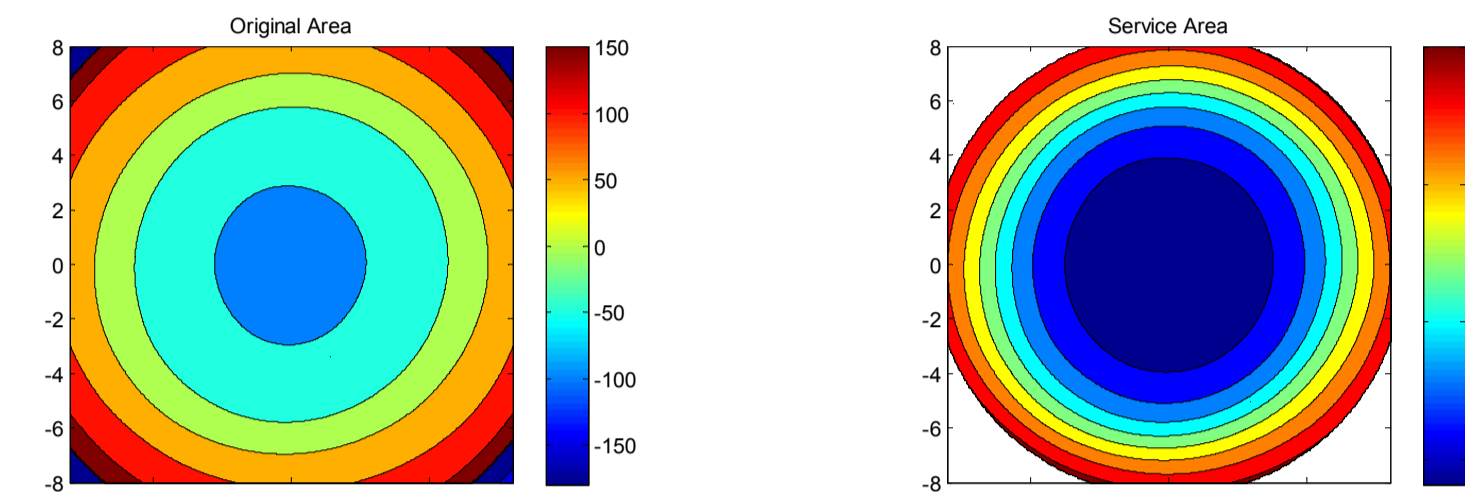


Fig. 3. Comparison of coverage

The comparison of different ranges of coverage is shown in Table II.

TABLE II. Comparison of different ranges

| Item | Rectangular range | Circular range |
|--------|-------------------|----------------|
| | 0.2648mm | 0.3744mm |
| Y axis | -0.0302mm | -0.0458mm |
| Z axis | -193.6483mm | -184.9247mm |
| RMS | 0.5229 deg | 0.3270 deg |

Figure 4 gives the convergence of algorithm in circular range.

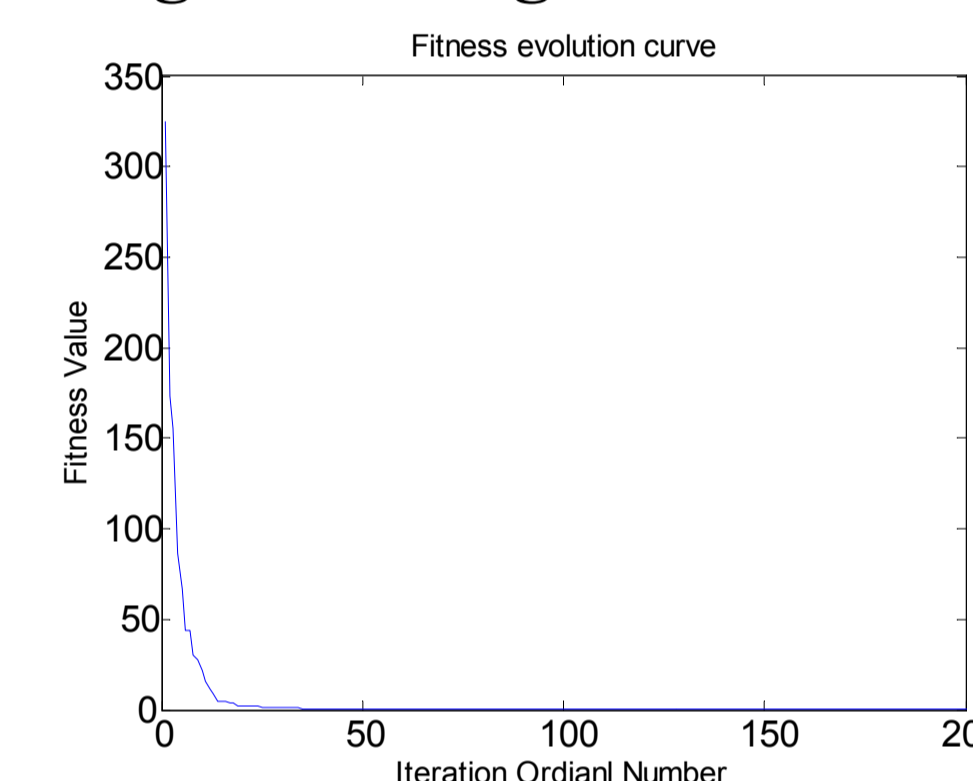


Fig.4. Convergence of algorithm in circular range

Meanwhile PSO allows changing the end condition. For instance, PP (Peak to Peak) is employed instead of RMS as the optimum target. The comparison is shown in Table III.

TABLE III. Result of different optimum target

| Item | RMS searching | PP searching |
|--------|---------------|--------------|
| X axis | 0.3744mm | 0.1503mm |
| Y axis | -0.0458mm | 0.0923mm |
| Z axis | -184.9247mm | -192.4775mm |
| RMS | 0.3270 deg | 0.4311 deg |
| PP | 2.1546deg | 1.5277deg |

PSO has many advantages on searching antenna phase center. Firstly, its convenience on arbitrary shape allows changing the calculation range. Secondly, PSO allows variety optimum targets. Last but not the least, PSO can also apply on searching the phase center of multi-beam antenna under different operation condition.

Conclusion

This paper takes PSO as instance to introduce searching algorithm and its application on phase center. According to the comparison of PSO and classical method, searching method has higher accuracy, flexible calculation condition and wide utilization.

Acknowledgement

The authors wish to acknowledge and express appreciation for the many helpful discussions with engineers and colleagues of Institute of Space Radio Technology of Xi' an Zhaobing, Li Wenlong, Li Xiangxiang, Chang Jinjiang, Zhang Jianguo, Deng Jiangtao, Cuilei, Liuchangwei and etc.

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