8 - 29 Application of Modern Intelligent Optimization Method in Parameter Setting of PI Regulator of Accelerator Power Suppies Components

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In the accelerator control system, many components use PI regulators for feedback control of the closed-loop system. In the process of parameter setting of PI regulators, empirical methods are often required and a lot of time is spent on parameter setting. This paper proposes a serial algorithm for generating multiple dimensional variables, which covld greatly improve the speed of parameter setting, reduce the time of manual parameter setting, and provide a fast and feasible method for parameter setting of equipment in accelerators that requires manual intervention solution.

Although the general parallel parameter tuning algorithm is more convenient to model in computer software, it is difficult to apply the algorithm in practice because it requires multiple sets of physical equipment to run the algorithm in parallel. The algorithm in this paper overcomes this difficulty. By adopting the characteristics of multi-dimensional variable coding and serial optimization, it can use only one set of field equipment environment to achieve the optimization effect of parallel algorithms.

The algorithm in this paper takes a single device optimization as an application scenario, and designs a serial random heuristic algorithm. The algorithm takes Tabu search (TS) as the main body and introduces the sampling operator of simulated annealing (SA) idea. While ensuring the search speed, the importance of the initial feasible solution in the main algorithm of the tabu search is greatly reduced, so that it has the ability of global optimization.

The performance of the hybrid algorithm in this paper was verified by using the standard TSP benchmark problem with a node size of 30. 100 experiments were carried out on simple TS (greedy strategy), simple SA and the hybrid algorithm designed in this paper by TSP method. The algorithm performance indicators are as follows:

STS means Simple Tabu Search algorithm, SSA means Simple Simulated Annealing algorithm, THA means the hybrid algorithm in this paper, and GOS means Global Optimal Solution.

It can be seen from the Table 1 that although the optimal rate of TS is not high, its algorithm takes a short time. As a global optimization method, SA has a high rate of optimal rate and a small average relative error, but its running time is slower than that of TS.

Table 1 Quantitative comparison of performance indexes of three algorithms.

Quantitative indicators	Simple TS	Simple SA	The hybrid algorithm
Excellent Rate [a]	10%	59%	53%
Average time/s	1.15106	13.2149	4.3730
Average relative error/	11.1020	1.0152	3.6760

Comparing the hybrid algorithm with the SA algorithm, under the condition of starting from a single initial solution, only 33.09% of the time of the SA algorithm is used to achieve the optimal rate of about 90% of the SA algorithm; compared with the original TS algorithm, the optimal rate has increased by 500%, and the performance is excellent.

Through the right side color line of Fig. 1, we use this algorithm in the field to tune the parameters of the PI regulator of the accelerator power supply components, which also shows that the algorithm can be applied in the field device.

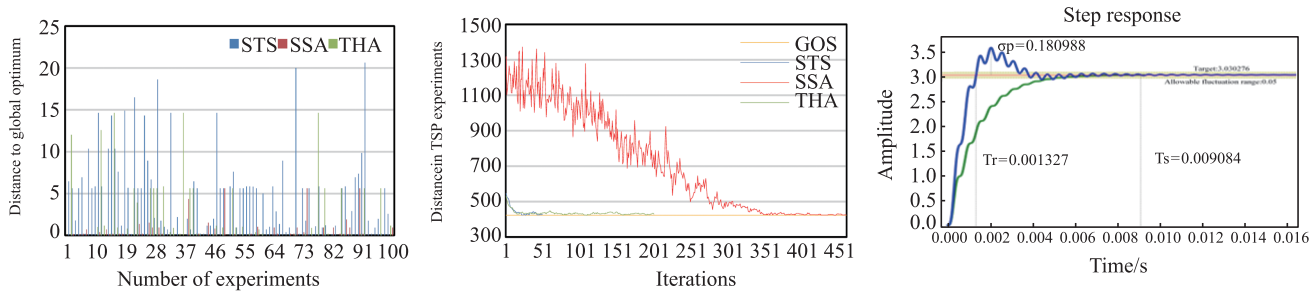

Fig. 1 (color online) The left figure (color histogram) is compares the distance between the 100 experimental results of the three algorithms and the global optimal solution (0 scale in the figure horizontal line). And the middle figure (color line) Compare the iterative curves of the three algorithms when the global optimal solution is obtained in each experiment.The right figure (color line) is the Step Response Image of Accelerator Power Components. The green line represents the original step response of the power component, and the blue line represents the step response of the component adjusted by PI adjustment after using the algorithm in the text to optimize.

References

[1] Kenneth V. Price, Rainer M. Storn, Jouni A. Lampinen, Differential Evolution: A Practical Approach to Global Optimization[M], (2005).

[2] F. Yang, W. M. Qiao, W. Zhang, Astronomy and Astrophysics, 3110(2011)1094.

8 - 30 Radiation Safety Report of IMP in 2022

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The radiation safety license of IMP includes the using of the class I, II and III radiation facilities, and the class III, IV and V radiation sources, which were reissued on June 23rd 2022.

The main radiation devices at IMP include the class I radiation facility Lanzhou Heavy Ion Research Facility HIRFL, China accelerator facility for super heavy element CAFe, and several class III radiation facilities.

There are 38 radioactive sources in category V and above category V, including 7 category III sources, 4 category IV sources and 27 category V sources, all of which have fulfilled the environmental protection supervision procedures.

In 2022 HIRFL runs for 7 944 h in total. There are 19 kinds of beams provided for various scientific experiments completed that covers the total operation beam time of 6 095 h, and the highest energy of the ion beam provided was $^{78}Kr^{26+}$ with the energy of 460 MeV at CSR throughout the year.

Environment radiation level was measured with TLDs which were placed on the campus of the institute around HIRFL, 15 sites of radiation level show no difference with environment background level of Gansu province[1]. Furthermore, environmental neutron and gamma dose was monitored by 3 environment radiation monitoring stations continuously, and no abnormal data had been found in 2022. Environmental radiation dose of neutron and gamma ray had been measured with portable dose meter twice per year, and the measured results show no difference to the background, which can be seen in Table 1.

The external dose received by workers mainly due to the residual radiation after the accelerator was shut down. Maximum surface dose rate had been measured in 2022 is 4 mSv/h at the end of the target at 130 SFC hall. To reduce the external dose of workers, adequate cooling time, and reducing the operating time is essential.

662 persons accepted individual dose monitoring in 2022, and the results are shown in Table 2. The annual collective effective dose was 105.92 mSv. 662 persons are less than 1 mSv. The highest individual dose was about 0.57 mSv, which did not exceed the dose limit (20 mSv) of national standard. Table 2 shows the measured results in 2022 of IMP.

Total α, β radioactivity in soil, water, plant samples from environment around HIRFL and soil, plant samples from Radioactive Waste Storeroom (RWS) are measured with BH1216 low background α, β Measuring Instrument and the results are shown in Table 3, in comparison with the background level of China[2].