Power Allocation Method of Communication Network Based on Harmony Algorithm

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Abstract: Power allocation is an important research topic of communication research. In view of the shortcomings of the current power allocation methods in communication networks, such as poor fairness, communication interruption and low frequency, a new power allocation method based on harmony search algorithm is proposed in this paper. Firstly, the current research on power allocation in communication is advanced. The mathematical model of communication power allocation is established by line analysis. Then the mathematical model of communication power allocation is solved by harmony search algorithm. Finally, the simulation experiment of communication power allocation is carried out. The experimental results show that under the condition of high SNR, the harmony search algorithm can quickly find the communication power allocation scheme, improve the communication capacity, and greatly reduce the frequency of communication interruption.

1. Introduction

In the working process of communication system, there is a phenomenon that multiple users preempt a channel, so power allocation in communication network is very important, which directly affects the success rate of communication and the error rate of data transmission. Therefore, power allocation in communication network has become an important research topic.

Aiming at the problem of power allocation in communication networks, a lot of research institutions and scholars have conducted in-depth research, and put forward many effective algorithms to solve the problem of power allocation in communication networks. Generally, the problem of power allocation in communication network is transformed into a non-linear optimization problem, and then a corresponding mathematical model is established to solve the problem. The mathematical model has some constraints. Finally, a certain technology is used to solve the mathematical problem. The result is the best power of communication network. Distribution schemes, such as solving mathematical models by linear programming, are fast and easy to implement for simple communication systems. However, for high SNR communication networks, the efficiency of this method will be greatly reduced, and sometimes even the optimal solution can not be found. Power allocation scheme for telecommunication networks [2]. Later, with the deepening of the research on swarm intelligence technology, some scholars put forward the power allocation method of communication network based on swarm intelligence technology. They solve the power allocation problem of communication network by simulating the biological behavior of nature, such as genetic algorithm, etc. [3]. This kind of method has powerful searching ability, so we can find it. The success rate of power allocation problem to communication network is high. However, in practical application, genetic algorithm also has some limitations, such as parameter setting without unified theoretical guidance and setting by experience, which has certain blindness and sometimes has the shortcoming of slow convergence speed. Therefore, it is still the goal of people to find a better power allocation method for communication networks.

Aiming at the shortcomings of current communication power allocation methods, such as poor fairness and high frequency of communication interruption, a communication power allocation

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method based on harmony search algorithm is designed in this paper, and its performance is tested by simulation experiments.

2. Harmony Search Algorithm

Harmony search algorithm is an artificial intelligence technology that simulates musicians' tuning. For a problem, harmony is a possible solution. The harmony effect is determined by the objective function f(x). The steps of solving the harmony search algorithm are as follows:

Step1: Assume that there are the following conventions:N is the number of fundamental solutions of the initial harmony search algorithm,and the range of values is $[x_i^L, x_i^U]$; T is the maximum number of searches; HMS is harmony memory library scale and $HMCR$ is Probability of value; PAR is the harmony tuning probability,and bw is vocal cords and rhythms。

Step2: Generate HMS harmony sounds: $x^1, x^2, \cdots, x^{HMS}$,and save them to the harmony memory library, the details are as follows:

$$HM = \left[\begin{array}{cccc|c} x_1^1 & x_2^1 & \cdots & x_N^1 & f(x^1) \\ x_1^2 & x_1^2 & \cdots & x_N^2 & f(x^2) \\ \vdots & \vdots & \cdots & \vdots & \vdots \\ x_1^{HMS} & x_1^{HMS} & \cdots & x_N^{HMS} & f(x^{HMS}) \end{array}\right] \tag{1}$$

Step3: Learn from the harmony memory library to produce a new harmony, and fine-tune the tone to produce the corresponding tone as $xx_i^{'} = (xx_1^{'}, xx_2^{'}, \cdots, xx_N^{'})$ 。

Step4: Choose a value from the new harmony according to the probability $HMCR$ of harmony value. select a value from the solution range through $1-HMCR$ to produce a new harmony, as follows:

$$x_i^{'} = \begin{cases} x_i^{'} \in (x_i^1, x_i^2, \cdots, x_i^{HMS}), \ if \ \text{rand<HMCR}, \\ x_i^{'} \in X_i, \ \text{otherwise}; \qquad \text{i=1,2,}\cdots\text{,N} \end{cases} \tag{2}$$

Step5: If $x_i^{'}$ comes from HM , then it is need to adjust the tone slightly, that is:

$$xx_i^1 = \begin{cases} xx_i^{'} + rand * bw, & \text{if rand<PAR} \\ xx_i^{'}, & \text{otherwise} \end{cases} \tag{3}$$

in the formula (3), rand is a random number.

Step6: Evaluate the new solution $x_i^{'} = (x_1^{'}, x_2^{'}, \cdots, x_N^{'})$ If it is better than the worst solution in harmony memory, replace the worst solution, that is:

$$\begin{aligned} & f(x^{worst}) = \max_{j=1,2,\cdots,HMS} f(x^j) \\ & if \ f(x^{'}) < f(x^{worst}), \ \text{then} \ x^{worst} = x^{'} \end{aligned} \tag{4}$$

Step7: If the times of work exceeds $T_{\max}$, then the optimal solution of the problem is obtained according to $x_i^{'} = (x_1^{'}, x_2^{'}, \cdots, x_N^{'})$.

3. Power Allocation Method for Communication Network

3.1 Mathematical Model of Power Allocation in Communication Network

There are three kinds of nodes in a communication system: source node (S), relay node (R), target node (D). They can communicate with each other. The principle of communication is shown in Figure 1.

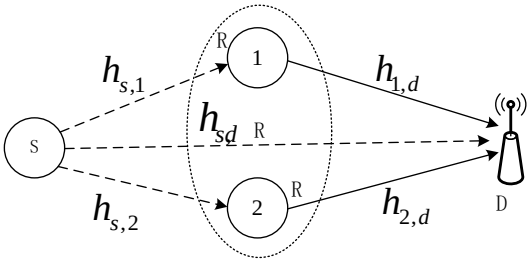

Fig.1 Working principle of ship communication network

Suppose y denotes the received signal and there is a certain noise n in the signal, then the received signals of node R and node D at each stage are:

$$Y_i = h_{s,i}\sqrt{P}X + n_i \quad (i = 1, 2, d) \tag{5}$$

In formula (5), $h_{s,i}$ is the channel between S and node i .

In the second stage, the received signal of node D is:

$$R = \sum_{i=1}^{2} \alpha_i \sqrt{P_i} h_{i,d} Y_i + n \tag{6}$$

In formula (6), α_i is the control coefficient.

The formula for calculating the SNR of node D is as follows:

$$\bar{\gamma} = \tilde{P}_s d_{s,d}^{-\alpha} + \sum_{i=1}^{m} \frac{\tilde{P}_s d_{1,i}^{-\alpha} \tilde{P}_{i,2} d_{i,2}^{-\alpha}}{\tilde{P}_s d_{1,i}^{-\alpha} + \tilde{P}_{i,2} d_{i,2}^{-\alpha} + 1} \tag{7}$$

P_1 and P_R is the maximum transmission power of node S and node R. The current powers of R and S is $P_{i,2}$, P_s respectively. The relationship between them is as follows:

$$\begin{cases} P_s + \sum_{k=1}^{k=m} P_{k,2} = P_{total} \\ P_s \le P_1, P_{k,2} \le P_R \end{cases} \tag{8}$$

In formula (8),P_{total} is Total power.

The mathematical model of power allocation for high SNR communication networks is as follows:

$$\begin{aligned} &\max \quad \bar{\gamma} \\ &s.t. \\ &\begin{cases} P_s + \sum P_{i,2} \le P_{total} \\ P_s > 0, P_{i,2} \ge 0 \\ P_s \le P_1, P_{i,2} \le P_R \end{cases} \end{aligned} \tag{9}$$

3.2 Working steps of power allocation method in communication network

(1) Designing the objective function of power allocation in communication networks.

(2) Initialize harmony memory library according to the mathematical model of power allocation in communication network.

(3) According to the objective function of power allocation in communication network, the individual of harmony memory library is evaluated.

(4) To update the solution of harmony memory database and generate a New Harmony memory database.

(5) Evaluate the New Harmony memory solution and replace the latest solution.

(6) The number of iterations increases to determine whether the number of iterations exceeds $T_{\max}$, and if not, return to step (4) to continue.

(7) According to the optimal solution of harmony memory database, the optimal power allocation scheme of communication network is obtained.

4. Experimental results and analysis

In order to verify the performance of the proposed power allocation method in communication network, the proposed algorithm and the power allocation mechanism based on genetic algorithm are compared by using MATLAB 2014 as the simulation platform. Under different SNR conditions, the channel capacity and outage probability of the two power allocation methods are shown in Fig. 2 and Fig. 3, respectively.

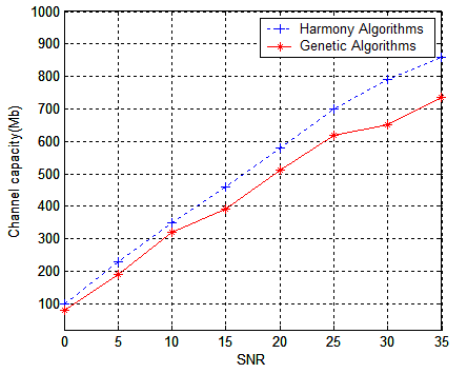

Fig. 2 channel capacity of ship communication system

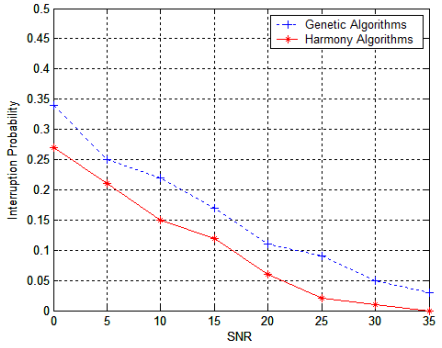

Fig.3 communication interruption probability of ship's communication system

From Fig.2 and Fig.3, it can be seen that the power allocation results of the communication network in this method are better, the channel capacity of the communication system is improved, and the outage probability is reduced. Under the condition of high signal-to-noise ratio, the communication results are ideal.

5. Conclusions

In order to obtain a more ideal power allocation scheme for communication network and improve the quality of wireless communication, a power allocation method for communication network based on harmony search algorithm is proposed. Firstly, the mathematical model of power allocation in relay communication system is established, and the power allocation problem in relay communication system is transformed into a non-linear optimization problem. Then the harmonic search algorithm is used to solve the problem, and corresponding improvements are made to overcome the shortcomings of the harmonic search algorithm. Finally, the simulation experiment is used to test its feasibility. Yes. The simulation results show that compared with other power allocation methods, the proposed method achieves a better power allocation scheme for communication network, improves the channel capacity of the system, reduces the probability of communication interruption, and greatly improves the system performance.

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