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Fuzzy Power Control Algorithm for Wireless AD HOC Sensor Networks

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The realization of power gain control is an important goal of wireless ad hoc sensor network networking. The traditional wireless ad hoc sensor network power control method adopts an adaptive parameter fusion method, which has poor control adaptability, poor beat separation between control links and a poor load balancing effect. A wireless ad hoc sensor network power control scheme based on PID neural network control is proposed, and a PID deadbeat control algorithm for wireless ad hoc sensor network is designed. Combining a flux linkage controller and speed controller, an artificial intelligence PID fuzzy feedforward neural network is constructed to obtain a PID feedforward neural network model of a wireless ad hoc sensor network based on artificial intelligence. A Nash equilibrium game model of a wireless ad hoc sensor network node transmission power game is constructed by adopting a parameter fusion and adaptive parameter identification method, a power consumption output gain scheduling model of the wireless ad hoc sensor network is constructed, and the output power of the wireless ad hoc sensor network is controlled by combining a sensing information tracking identification method. Simulation results show that the algorithm has good convergence, and the transmit power of cluster head node has higher gain, which reduces the energy consumption of sensor nodes and improves the performance of wireless ad hoc sensor networks.

Keywords: Wireless Ad Hoc Sensor Networks, Fuzzy, Power, Control, Gain, Equalization, Load

1. INTRODUCTION

A Heterogeneous Wireless Sensor Network (HWSN) is composed of many different energy nodes, which are randomly assigned to target areas and are dedicated to sensing environmental events such as floods, fires and earthquakes. Nodes compress sensing information into data packets and send these packets using data compression aggregation to base stations. Most of the energy of nodes is consumed in data transmission (Mohan et al., 2013). However, it is difficult to replace batteries in these nodes after deployment to the environment, so the energy of the nodes is limited. A way to make heterogeneous nodes with limited energy survive longer has become one of the hot research topics of HWSN (Kimmett et al., 2015).

In order to realize the high efficiency and practicability of wireless ad hoc sensor networks, the best way is to carry out efficient wireless ad hoc sensor networks and scheduling control for the management of wireless ad hoc sensor networks (Zhao et al., 2018). Under the existing networking conditions of wireless ad hoc sensor networks, the software of wireless ad hoc sensor networks is upgraded to achieve the high utility rate of wireless ad hoc sensor networks. Based on this, the power control management of wireless ad hoc sensor networks can result in several benefits. First, because only the software of wireless ad hoc sensor networks is improved and upgraded, the material resources, human resources and financial resources required for system improvement are relatively small, which will greatly reduce the complexity of the system. Second, a software-based system upgrade is an important means to improve the efficiency of wireless ad hoc sensor networks under the existing technical conditions (Li et al., 2018; Alturas et al., 2020). It exists as an important means to improve the management of wireless ad hoc sensor networks, and also meets the needs of modern development. The important

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*Corresponding Author Email: yaoli_2019new@163.com purpose of wireless ad hoc sensor networks is to achieve transmission power gain and optimal scheduling of power grid nodes. Therefore, the research on the power gain algorithm of wireless ad hoc sensor networks plays a fundamental role in upgrading the entire wireless ad hoc sensor networks (Fan et al., 2018).

Traditionally, the wireless sensor network control method and PID neural network control method are mainly adopted for wireless ad hoc sensor network control. The calculation of network node power gain is realized by adjusting a control beat. Gu et al., 2012, proposed a GIS grid-connected wireless ad hoc sensor network power consumption and energy overhead control method based on power feedforward robust prediction deadbeat grid-connected control, which adopts voltage and current double closed loop control and combines this with a neural network control system. Linear prediction and grid-connected control of grid voltage have improved the power gain of distribution network nodes and achieved positive results. However, the adaptive error correction capability of the algorithm is poor, and the problems of sampling delay and dead time have not been effectively solved. Guo et al., 2018, proposes a nonlinear control design method for grid-connected transmission of power feed-forward control, which is improved to some extent compared with PID non-power compensation control of transmission. However, current distortion is prominent and control performance is limited when the voltage is overloaded. Ye et al., 2014, proposed a linear feedback linearization double-loop cascade wireless ad hoc sensor network power consumption and energy cost control design scheme, which has good performance for wireless ad hoc sensor network power consumption and energy cost drive system and non-linear control. However, it fails to solve the problem of how to improve voltage stability and prevent current distortion when the damping oscillation effect occurs when the voltage outer loop adopts PID compensation, resulting in beat generation, poor load balancing effect and inability to effectively realize the power gain of the transmitting node affecting the wireless ad hoc sensor network and scheduling performance.

In view of the above problems, this paper proposes a wireless ad hoc sensor network power control scheme based on PID neural network control, designs a deadbeat PID control strategy, solves the optimal transmission power of cluster head node based on Nash equilibrium solution in the control equation, and improves the transmission power gain. Through model and algorithm design, deadbeat control of wireless ad hoc sensor network is realized, and the improvement of the power gain algorithm is realized. Finally, a performance test is carried out by simulation experiment, and the effectiveness conclusion is drawn.

2. BASIC DEFINITIONS

2.1 Problem Description and System Model for Wireless Ad Hoc Sensor Networks

Wireless ad hoc sensor networks are an important factor to ensure the stable development of people's lives, so in recent years, the construction of wireless ad hoc sensor networks has been placed in an important position in the development of the country (Guo et al., 2016; Jansar et al., 2020). In the whole development process of wireless ad hoc sensor networks, wireless ad hoc sensor networks are the key to the control and schedule of the energy consumption of wireless ad hoc sensor networks. Wireless ad hoc sensor networks mainly have the following two problems:

(1) The overall development of wireless ad hoc sensor networks is very good, but the development of local wireless ad hoc sensor networks is not ideal. The problem mainly lies in the imbalance between the management of urban wireless ad hoc sensor networks and non-urban wireless ad hoc sensor networks. In other words, urban wireless ad hoc sensor networks are well developed, however wireless ad hoc sensor networks in marginalized areas are not necessarily as well developed. It is impossible to realize better intelligent management of power consumption and energy expenditure of wireless ad hoc sensor networks, so the scheduling efficiency of wireless ad hoc sensor networks is low, which affects the scheduling effect of power consumption and energy expenditure of wireless ad hoc sensor networks in the whole marginalized area (Xiong et al., 2018).

(2) The waste rate of wireless ad hoc sensor network management is high. From real world data, it can be seen that in a large area, whether in the core urban areas or in marginalized areas, the system's wireless ad hoc sensor network power consumption and energy cost waste are serious problems.

Judging from the above two actual situations, there is a lot of room for improvement in the management system of wireless ad hoc sensor networks in marginalized areas (Dai et al., 2016). Based on this, an intelligent management of power consumption and energy expenditure of marginalized wireless ad hoc sensor networks is proposed to intelligently schedule and manage the power consumption and energy expenditure of wireless ad hoc sensor networks in marginalized areas so as to improve the overall efficiency of wireless ad hoc sensor networks (Ma et al., 2016). Therefore, it is of great significance to study the drop-by-drop wireless ad hoc sensor network model and realize balanced scheduling in developing wireless ad hoc sensor networks to improve the power consumption and energy overhead service performance of wireless ad hoc sensor networks (Zhou et al., 2018).

Firstly, this paper gives the wireless ad hoc sensor network model of a wireless ad hoc sensor network. Before designing the model, the definition and description of relevant symbols are given, as shown in Table 1.

It is assumed that the wireless ad hoc sensor network consists of a sink node SN and N cluster head nodes. Non-negative data sequence of urban wireless ad hoc sensor networks:

$$S = \{S_1, S_2, \ldots, S_L\} \tag{1}$$

The information of the power consumption and energy cost control node of the first wireless ad hoc sensor network is defined as:

$$\delta_{ik}(t) = G(V = k|U_i,\ \Theta(t)) \tag{2}$$

Table 1 Relevant symbols and definitions of wireless ad hoc sensor networks model.

Symbol	Meaning
CH	Cluster head node of wireless ad hoc sensor networks
SN	Convergence node
MN	Member node
C	Cluster head node set
C_1	Power consumption and energy overhead data of wireless ad hoc sensor networks are gathered in a time slice
C_2	Inactive cluster head node set
N	Number of node scheduling states
T_i	Number of Hierarchical Matching Fusion Slots
P	Network node transmit power
h	Cluster Head Node Power Gain
λ_i	Delay Response Corresponding to Nodes
γ_i	SINR value obtained by cluster head node at sink node end

The N cluster head nodes of the wireless ad hoc sensor network constitute a cluster head node set. Fuzzy differential equation method based on cloud theory is adopted to realize discrete processing of the network time vector. The wireless ad hoc sensor network power consumption and energy overhead scheduling data in the wireless ad hoc sensor network are divided into N time slots. Assuming that the duration of each time slot is T and each transmission scheduling set is satisfied, the wireless ad hoc sensor network power consumption and energy overhead data are sent to some nodes in set B within the same time slot without communication conflict, so that the wireless ad hoc sensor network power consumption and energy overhead scheduling data sent by the active cluster head node set in each time slot are represented by the aggregation node and are satisfied. The maximum independent set of wireless ad hoc sensor network nodes is constructed for wireless ad hoc sensor network power consumption and energy overhead networks. $S_i(i = 1, 2, \cdots, L)$ can send data to SN in each time slot. If the dominant node u adds the dominating node to the data aggregation tree, it can get the data that cannot be sent to SN. When $C = C_1 \cup C_2$, the number of active cluster head nodes changes, thus completing the model design and scheduling control of wireless ad hoc sensor networks (He et al., 2017; Aguilar et al., 2019).

2.2 PID Deadbeat Control Algorithm for Wireless Ad Hoc Sensor Networks

Based on the design of the wireless ad hoc sensor network model mentioned above, a PID deadbeat control algorithm is designed. For each marginalized wireless ad hoc sensor network power consumption and energy cost intelligent management node, the design and research of distributed cooperative scheduling are respectively carried out. When the marginalized wireless ad hoc sensor network power consumption and energy cost intelligent management node is applied in the high-efficiency time division multiple access protocol, a cyclic scheduling corresponds to the initialization process and several time frames of an intelligent management node for power consumption and energy expenditure of a marginalized wireless ad hoc sensor network, and intelligent control scheduling is carried out for the control time frames of each intelligent management node for power consumption and energy expenditure of the marginalized wireless ad hoc sensor network, thereby achieving a better overall effect.

Compared with the existing wired communication technology, wireless communication technology has the following advantages:

1. Mobility, without the limitation of communication cables, communication terminals can move freely or be arranged at will in the communication area.
2. Fast and flexible network, wireless techonology removes the necessity of the tedious work of digging cable trenches and laying cables during installation, reducing the overall construction amount.
3. Wide area coverage. Wireless communication can cover all areas that can be reached by wired communication, and data communication can also be realized in places where it is inconvenient to use the cable network.
4. Strong extension ability, wireless communication can be composed of a variety of topology structures, and it is very easy to extend the network by adding more nodes.

Considering DC reference voltage u_{dc} and DC side energy e_u, the average value of grid voltage and grid current calculated by a discrete Fourier transform is as follows:

$$E = \sum_{p=1}^{n} E_p = \frac{1}{l} \sum_{p=1}^{n} \sum_{k=1}^{l} \left[r_p(k) - y_p(k) \right]^2 \tag{3}$$

Where, E_p is the average value of the output voltage, $r_p(k)$ is the active loss of the distribution box of the wireless ad hoc sensor network, $y_p(k)$ is the grid frequency, and the obtained deadbeat control flux linkage control equation is:

$$W(n+1) = W(n) - \eta \frac{\partial E}{\partial W} + \partial \Delta W(n) \tag{4}$$

The above formula is a PID control equation based on the average model of the system. In the non-linear control

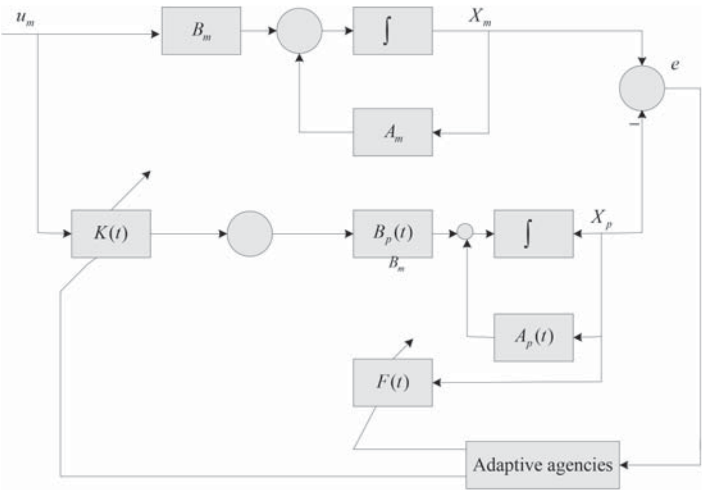

Figure 1 PID deadbeat control system model for wireless ad hoc sensor networks.

wireless ad hoc sensor network grid-connected converter, a damping attenuation characteristic appears, and the output voltage error term and inductance current error term have great autocorrelation characteristics. Therefore, the rotation speed controller is also used to suppress the inversion characteristic (Ye et al., 2015), thus improving the dynamic performance of the system. The rotational speed controller uses a zero-order retainer to design the transfer function, which is:

$$w'_{sjh}(n_0+1) = w'(n_0) - \eta'_{sjh}\frac{\partial J}{\partial w'_{sjh}} \tag{5}$$

In the above formula, $w'(n_0)$ is the sampling current at time t, sjh is the PID fuzzy control coefficient of system lag beat, and η' is the deadbeat control output at refresh time. To sum up, through the combination of the flux linkage controller and rotational speed controller, the artificial intelligence PID fuzzy feedforward neural network is constructed, and the PID feedforward neural network based on the artificial intelligence wireless ad hoc sensor network is obtained. The input and output model of the deadbeat grid-connected wireless ad hoc sensor network power consumption and energy overhead control is shown in Figure 1.

In the figure, the dot represents the PID neuron of the wireless ad hoc sensor network. The input vector given by the artificial intelligence feedforward neural network system is $r_1, r_2, \cdots, r_n$, which is used as the PID control current amplitude input. The input layer is of $2n$ neuron structure (Mekikis et al., 2018). The direct current output control of the wireless ad hoc sensor network is realized through power feedforward control. At this time, the neuron input is:

$$\begin{cases} net_{s1}(k) = r_s(k) \\ net_{s2}(k) = y_2(k) \end{cases} \tag{6}$$

The feed forward neuron adopts the voltage and current double closed loop control, and the measured power gain of wireless ad hoc sensor network is reduced to a low frequency signal through amplitude modulation, thus obtaining the state of the neuron as follows:

$$u_{si}(k) = net_{si}(k) \tag{7}$$

The output of neurons in the input layer is:

$$x_{si}(k) = \begin{cases} 1, & u_{si}(k) > 1 \\ u_{si}(k), & -1 \le u_{si}(k) \le 1 \\ -1, & u_{si}(k) < -1 \end{cases} \tag{8}$$

In the above formulas, 1 and -1 respectively represent the high and low electric frequencies of PID feedforward neural network in wireless ad hoc sensor networks, and in Formulas (6) and (7): $y_s(k)$ is the duty ratio of switch tube; $r_s(k)$ is the filter inductance of the system, which is expressed as the output control. In practical engineering applications, it is difficult to accurately obtain the filtered inductance. It is necessary to establish the serial number of the subnet and the serial number of the controlled variable $(s = 1, 2, \ldots n)$. In addition, i in the above formula is the serial number of the subnet input layer $(i = 1, 2)$. Thus, the PID deadbeat control for wireless ad hoc sensor networks is realized.

2.3 Introduction to Wireless Self-Grouping Sensor Networks

2.3.1 Characteristics of Wireless Self-Grouping Sensor Networks

A wireless self-grouping sensor network integrates sensors, embedded computing, distributed information processing, wireless communication and other technologies, and can cooperate with other networks to detect, perceive and collect information of various objects in real time, and process their data (Malekshan et al., 2017). It is a kind of distributed wireless communication network formed by a large number of cheap and dense intelligent wireless sensor nodes without fixed infrastructure. All nodes in the network are of equal status and assume host and routing functions. Each sensor node has the function of receiving and sending messages (Szott et al., 2018). Due to the limitation of the transmission range, when two nodes cannot communicate directly, they can be forwarded through an intermediate node.

A wireless self-grouping sensor network has the following characteristics:

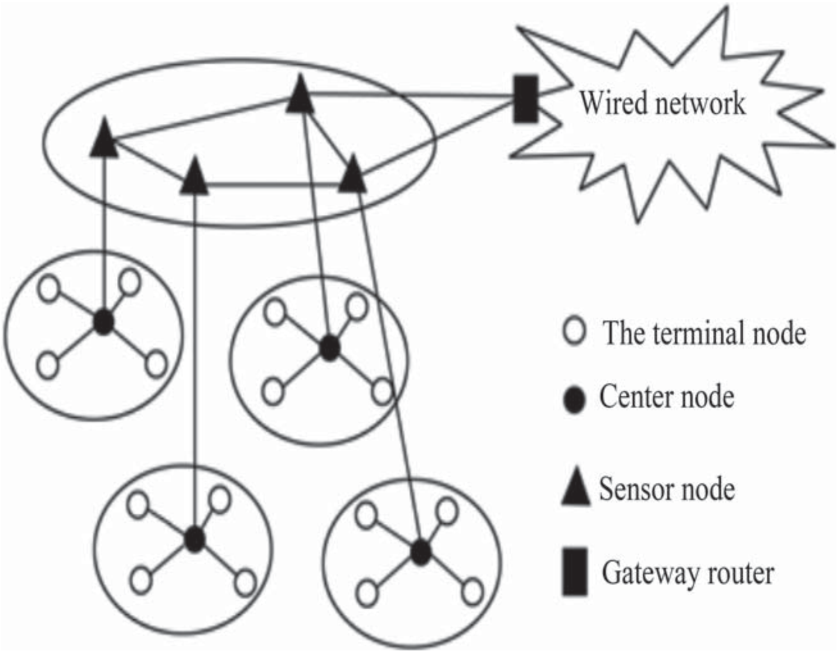

Figure 2 Wireless self-grouping sensor network structure diagram.

(1) Large scale deployment, reflected in two primary aspects: sensor nodes that are distributed over a large geographical area; and an intensive deployment of sensor nodes. The large-scale nature of a wireless self-group sensor network can make the signals obtained from different spatial perspectives have a higher signal-to-noise ratio, which can improve the accuracy of monitoring, increase the monitoring area, and reduce blind areas.

(2) Self-organization. The location of sensor nodes is not usually predetermined, for example, a large number of sensor nodes can be spread by aircraft, or by random placement in dangerous areas (Yang et al., 2018). Therefore, sensor nodes are required to have a self-organizing ability, which can be configured and managed automatically, and a multi-hop wireless network system can be formed automatically through topology mechanism and network protocol, and the self-organization of the network is required to be able to adapt to the dynamic changes of network topology structure.

(3) Dynamic topology. The topology of the network changes for the following reasons: 1) Failure of sensor nodes caused by environmental factors or power depletion; 2) The addition of new nodes (Hannan et al., 2018); 3) The change of environmental conditions that may cause the change of wireless communication link bandwidth; 4) The three elements of the sensor network, sensor, sensing object and observer, may have moved.

(4) Reliability. Sensor networks are particularly well suited for deployment in harsh environments or areas unreachable by humans. Sensor nodes may work in the open air, be exposed to the sun or wind or rain, or even be damaged by unrelated people or animals. Sensor nodes are often randomly deployed. All these require sensor nodes to be very strong, not easily damaged, and adaptable to a variety of harsh environmental conditions.

(5) Application of a relevant network. A wireless ad hoc sensor network is mainly used to perceive the objective world and obtain relevant information. This determines that different wireless sensor nodes should be used for different information, and different application backgrounds have different requirements on wireless sensor ad hoc network, and its hardware platform, software system and network protocol can be quite different.

(6) Data-centric. A wireless ad hoc sensor network (WSN) is a kind of task network. When users use an ad hoc sensor network to query events, they will directly inform the network of the events they care about, instead of focusing on a sensor node.

The structure of a wireless self-grouping sensor network is shown in Figure 2.

2.3.2 Generation of a Wireless Self-Grouping Sensor Network

The specific steps of the generation process of a wireless self-grouping sensor network are as follows:

(1) Sensor nodes are randomly scattered, using manual, mechanical, air drop or other methods. See Figure 3 for details.

(2) After being scattered, the sensor nodes enter the wake up state of starting self-check, and each sensor node will send out signals to monitor and record the working conditions of the surrounding nodes. The wake up and mutual detection process diagram is shown in Figure 4.

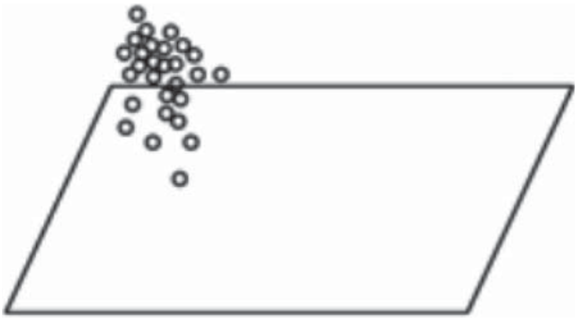

Figure 3 Placing the sensor.

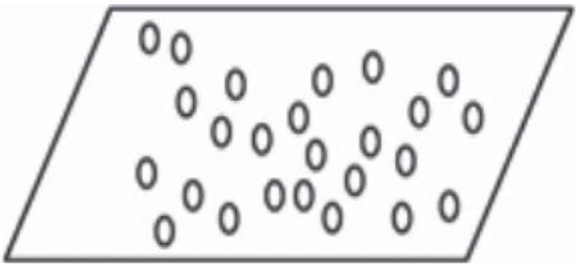

Figure 4 Wake up and mutual detection process diagram.

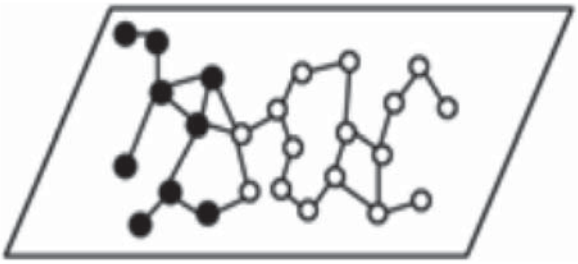

Figure 5 Automatically connect to a network diagram.

(3) These sensor nodes will use certain networking algorithms according to the situation of the surrounding nodes monitored, thus forming a network combined with certain laws. The automatically connected network diagram is shown in Figure 5.

(4) Sensor nodes that make up the network choose the appropriate path for data communication according to a certain routing algorithm. Routing for communication is shown in Figure 6.

3. NASH EQUILIBRIUM AND REALIZATION OF A POWER GAIN ALGORITHM IN WIRELESS AD HOC SENSOR NETWORKS

Based on the model construction and deadbeat control design based on the PID algorithm, a Nash equilibrium game model of wireless ad hoc sensor network node transmission power game is constructed to realize that all cluster head nodes in the wireless ad hoc sensor network have the best transmission power.

For $CH_i(i \in C_1)$, by lag one beat control, the state of integral element is obtained as follows:

$$u'_{s2}(k) = u'_{s2}(k-1) + net'_{s2}(k) \tag{9}$$

According to the maximum theorem, for a given γ_{th}, the predicted value of the grid-connected inductance is tested, and the state of the differential element is obtained as follows:

$$u'_{s3}(k) = net'_{s3}(k) - net'_{s3}(k-1) \tag{10}$$

A low complexity algorithm based on the Nash equilibrium solution is used to solve the optimal transmission power of the cluster head node. The output of each neuron in the hidden layer of the power consumption and energy overhead control system of the wireless ad hoc sensor network based on artificial intelligence feedforward PID neural network is obtained as follows:

$$x'_{sj}(k) = \begin{cases} 1, & u'_{sj}(k) > 1 \\ u'_{sj}(k), & -1 \le u'_{sj}(k) \le 1 \\ -1, & u'_{sj}(k) < -1 \end{cases} \tag{11}$$

Through the Nash equilibrium game of wireless ad hoc sensor network node transmission power game, dynamic attribute weight prediction current control technology is adopted to compensate delay, deadbeat control and sinusoidal pulse width modulation are realized, and the dynamic attribute weight adjustment characteristic equation is as follows:

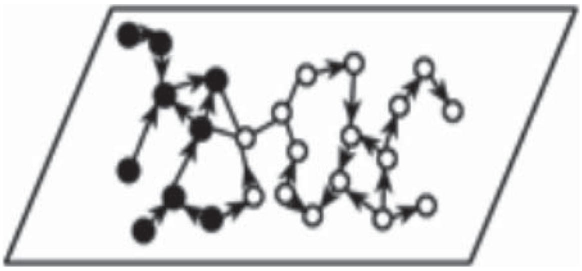

Figure 6 Routing for communication process diagram.

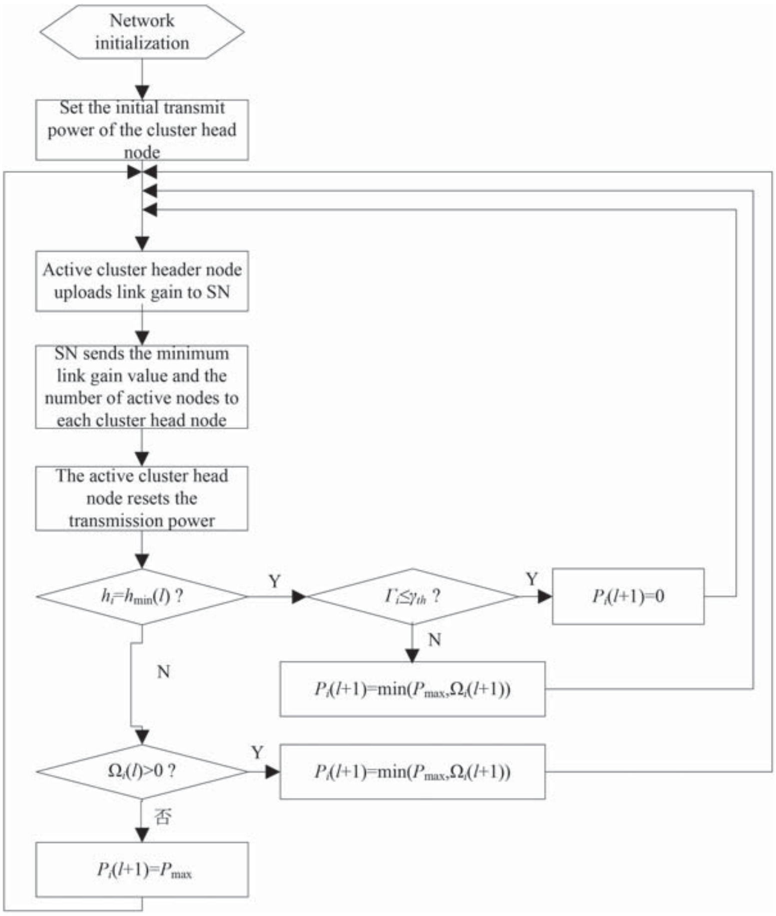

Figure 7 Algorithm implementation flow.

$$w_{sjh}(n_0+1) = w_{sij}(n_0) - \eta_{sij}\frac{\partial J}{\partial w_{sij}} \tag{12}$$

The weight adjustment learning step in the above formula must have dynamic attributes to compensate the system error delay so as to effectively suppress the effect and obtain the optimal transmission power strategy for all cluster head nodes in the wireless ad hoc sensor network. The power gain is:

$$E(p) = \left[\underbrace{0, 0, \ldots, 0}_{i-1}, \frac{\gamma_{th}\sigma^2}{h_i\left[G-(n-k-1)\gamma_{th}\right]}, \ldots, \frac{\gamma_{th}\sigma^2}{h_i\left[G-(n-k-1)\gamma_{th}\right]}\right]^T \tag{13}$$

It can be seen from the above that there is no other Nash equilibrium in the Nash equilibrium external game. Therefore, the Nash equilibrium is the only Nash equilibrium in the above game that can maximize the power gain of wireless ad hoc sensor networks. To sum up, the implementation process of the improved algorithm is shown in Figure 7.

(1) If the cluster head node is detected nearby, when the node is in the waiting active state, the node state becomes node member, cluster node and its attribute value, etc. If no cluster head node member is detected nearby, the node abandons the "qualification waiting state" activity. If there is no cluster head node or member node nearby, it detects whether the random function value meets the activity requirements, whether it meets the active state, and whether it meets the initial state.

When the node is in the contest cluster-head state, if the node of contest cluster-head is detected in the

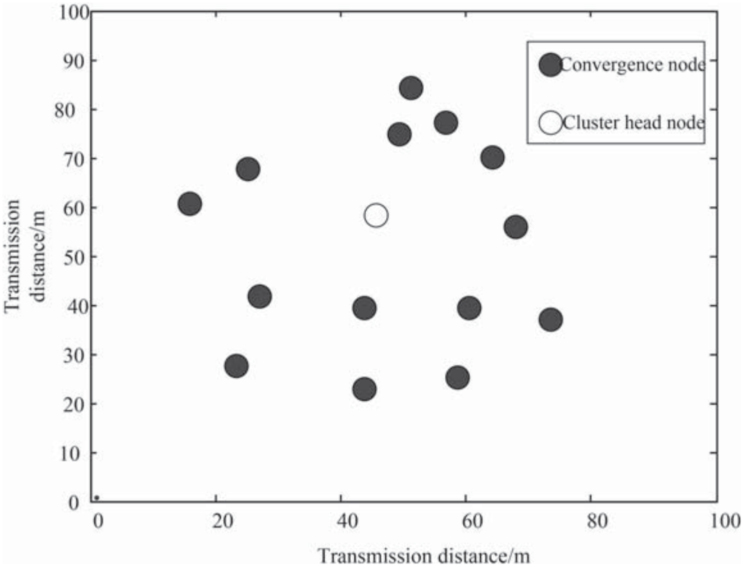

Figure 8 Hierarchical network node distribution diagram of wireless ad hoc sensor network.

neighbor's neighbor, it will return to the original waiting state. If there is no contest cluster-head node in the neighbor's neighbor node, the contest cluster-head will be successful.

When the node is in the waiting for disqualification state, if there is a cluster head nearby, join the cluster and become a member node. If there are no cluster heads nearby and only member nodes, become a guest node.

If a cluster head node is detected nearby, the node in the guest node state will join the cluster and become a member node. Nodes that are on member nodes remain in their original state.

The node at the cluster head node will remain in its original state.

(2) In case of network outage, node failure for a short period, etc.

If the guest node and the member node lose contact with the original cluster head, they will return to the waiting state and re-execute the networking clustering algorithm.

If the cluster-head node finds that its jurisdiction conflicts with that of other cluster-head nodes, or if it finds that member nodes or cluster-head nodes of other clusters appear nearby, it will return to the waiting state and re-execute the clustering algorithm.

As this algorithm is designed for peer nodes, it is suitable for distributed systems, as each node generally only needs to know the communication radius of other nodes. When choosing a cluster to communicate, we need to know the state of the node in the communication radius, without knowing the topology of the whole network.

4. SIMULATION EXPERIMENT

In the simulation test, the layered network topology is used to build the wireless ad hoc sensor network model. A single sink node and 10 cluster head nodes are used. The cluster head nodes are randomly deployed and the root data nodes are randomly distributed in the user coverage area of the wireless ad hoc sensor network in terms of power consumption and energy expenditure. Here, assume a square area of 500m × 500m, the node transmission radius and interference radius are both 25m, and the network degree is fixed at 15. The maximum transmission distance of cluster head nodes is 50m, the link gain function is determined by the formula $h_i = v \times d_i^{-n}$, the number of cluster head nodes is 10, the maximum transmission energy is 1000KW, and the maximum processing gain is 100. The hierarchical network node distribution diagram of the wireless ad hoc sensor network is obtained as shown in Figure 8.

Using this algorithm, the power gain performance of four nodes in the transmission channel in the network and the power consumption and energy overhead scheduling control performance of the wireless ad hoc sensor network are tested. The Nash equilibrium of the transmission energy of each cluster head node transmits data to SN, i.e. $p = [0.1, 0.1, \cdots, 0.1]$ KW, with the maximum transmission power. The simulation results of the maximum transmission power of the wireless ad hoc sensor network with and without Nash equilibrium control are shown in Figure 9.

It can be seen from the figure that the traditional scheme with superior frame power gain of the whole wireless ad hoc sensor network can effectively improve the scheduling performance of the wireless ad hoc sensor network power consumption and energy overhead distribution network, and improve the energy ratio.The simulation results of the transmission power of each node under different iterations are shown in Figure 10. The number of active cluster head nodes decreases with the increase of threshold. When $\gamma_{th} \leq 10$ dB is used, all cluster head nodes can send data to SN, which proves that the method can effectively improve the power consumption and energy consumption of wireless ad hoc sensor networks and the transmission power of each cluster head node in the distribution network, thus maximizing the power gain of wireless ad hoc sensor networks.

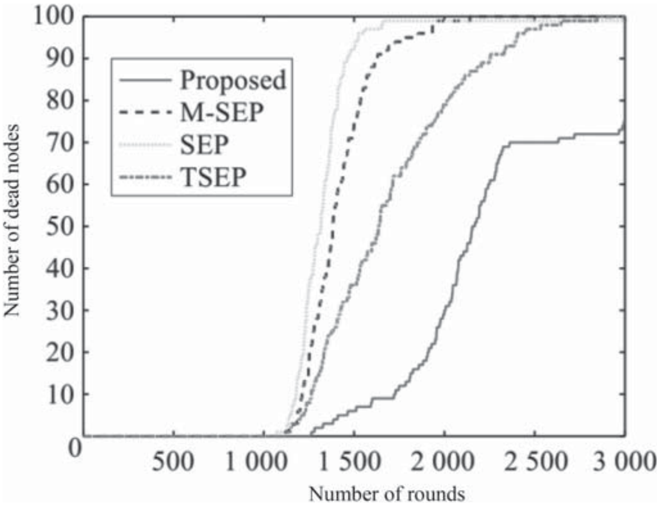

Figure 9 Simulation results of overall power gain for wireless ad hoc sensor networks.

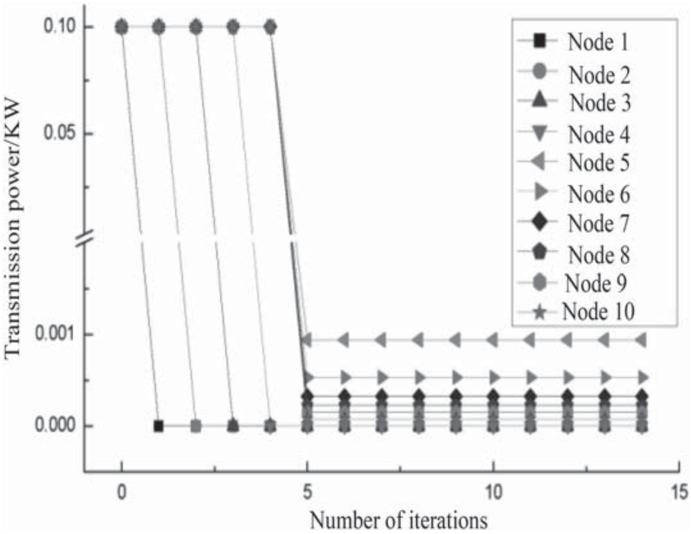

Figure 10 Transmission power of each cluster head node in wireless ad hoc sensor network.

Two performance indicators of the wireless sensor network (SOCA), the LEACH algorithm and the DHAC algorithm were compared by the simulation. If 100 sensor nodes are randomly distributed in an area of 100 * 100m, the coordinate point of the sink is (70,70), and the initial energy of all nodes is 0.5 J, Eelec = 50 pJ/bit, fs = 10 pJ/(bit·m-2), mp = 0.001 3 pJ/(bit·m-4). Both the information sent by each node to the head of the cluster and the information first sent by the cluster to the sink can be 4,000 bits, and the energy consumption of information fusion EDA = 5 nJ/bit. The relationship between total energy consumed by the network of these algorithms and working time is shown in Figure 11 and Figure 12.

The working time is measured by the number of rounds, and the cluster head fuses the information in the cluster and sends it to sink. This process is defined as one round. The initial energy of the network is 50 joules.

As can be seen from Figure 11, the energy consumption of the network using the LEACH algorithm is the fastest, followed by DHAC, and the energy consumption of SOCA is the slowest, mainly because SOCA's clustering method and cluster-head selection mechanism are more reasonable than the other two algorithms, which saves energy consumption, and the gap becomes more and more obvious with the increase of time. When the network starts to work, the node density is relatively high, so the average distance from the sink is relatively close. When there are more nodes at the head of the cluster, there is less energy consumption. With the increase of time, more and more nodes die, and the average distance between nodes and the sink increases. When the number of nodes at the cluster head decreases, the energy consumption loss caused by the unreasonable selection of cluster head will increase, accelerating the death of nodes.

It can be seen from Figure 12 that in the same time, the number of surviving nodes in the network is the largest by using SOCA algorithm, that is, the life of each node is prolonged. This is because SOCA algorithm can reasonably arrange the order for each cluster node to take turns as the cluster head through theoretical deduction, so that the energy consumption of each node is balanced, thus prolonging the life cycle of the network.

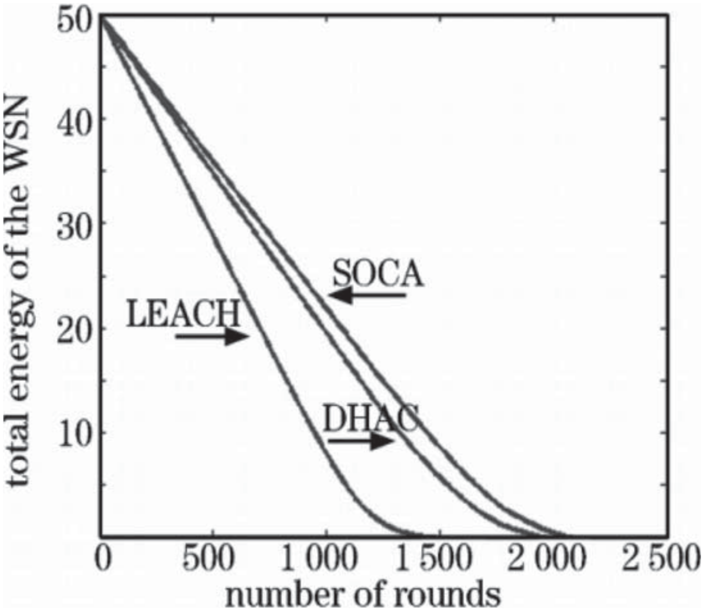

Figure 11 Total energy of the WSN versus number of rounds.

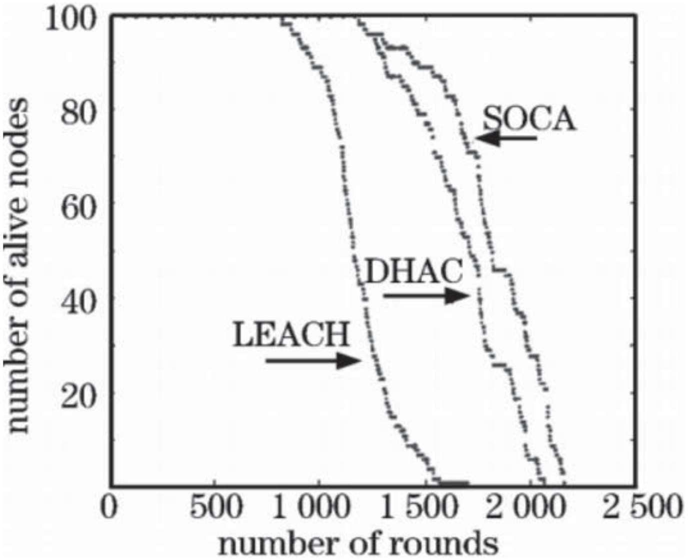

Figure 12 Number of alive nodes versus number of rounds.

5. CONCLUSIONS

In this paper, a wireless ad hoc sensor network power control scheme based on PID neural network control is proposed, and a PID deadbeat control algorithm for wireless ad hoc sensor network is designed. Combining a flux linkage controller and speed controller, an artificial intelligence PID fuzzy feedforward neural network is constructed to obtain a PID feedforward neural network model of a wireless ad hoc sensor network based on artificial intelligence. A Nash equilibrium game model of a wireless ad hoc sensor network node transmission power game is constructed by adopting a parameter fusion and adaptive parameter identification method, a power consumption output gain scheduling model of the wireless ad hoc sensor network is constructed, and the output power of the wireless ad hoc sensor network is controlled by combining a sensing information tracking identification method. Simulation results show that the algorithm has good convergence, and the transmit power of cluster head node has higher gain, which reduces the energy consumption of sensor nodes and improves the performance of wireless ad hoc sensor networks. This method has good application value in the power control of wireless ad hoc sensor networks.

According to the theoretical deduction, under the premise of saving energy, the conditions that need to be met for the merging of clusters are obtained. Under the condition that the number of nodes in the cluster does not exceed the upper bound, all clusters that meet the requirements are merged twice. This clustering method avoids the two situations of too few and too many nodes in the cluster. In order to balance the energy consumption of each node, the nodes in the cluster take turns to be the head of the cluster according to the order of priority, from high to low. Simulation results show that this algorithm can effectively save energy consumption and prolong the network life cycle.

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