Dynamic coverage optimization for wsn based on ant colony algorithm

Yang Tao[1] ,Sun Zeyu[1,2], Zhang Yong[3*]

[1] *Computer and Information Engineering, Luoyang Institute of Science and Technology, Luoyang 471023, China.*

[2] *Electrical and information Engineering, Xi'an JiaoTong University Xi'an 710061, China*

[3]*Mathematics and Computer, Chizhou University, Chizhou 247000, China*

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Abstract

In order to better meet the coverage requirements, is presented based on Ant Colony Algorithm for solving the covering problem in geometry, mapping algorithm between the node and the target, effectively cover the use of mobile nodes in the part area coverage model, including process is through the node energy consumption nodes moving strategy to identify the network coverage, coverage hole process to eliminate or not completely covered, so as to realize the multiple coverage. The experimental results show that, the algorithm can not only use the minimum node to complete the effective coverage area of local, and through mobile strategy and scheduling nodes to balance the energy consumption of all nodes, prolong the network life cycle.

Keywords: Wireless Sensor Network (WSN); Coverage Rate; Sensor Nodes; Ant Colony Algorithms; Relational Model

1 Introduction

Wireless sensor network characteristics are mainly concentrated in small volume, low energy consumption, have ability to calculate, and through the form self-organized wireless network system, information collection and information processing, information transmission in a body's comprehensive information system [1]. Today, wireless sensor network technology is applied more widely, mainly used in military, defines, health care, rescue, monitoring and traffic engineering domain. With the development of wireless communication technology, wireless sensor network (WSN) has become one of the main topics of many scholars at home and abroad research. Due to the wireless sensor network node energy limited and environment location complex reasons, such as how to effectively resist the node energy consumption is too rapidly been the research focus on one of the problems [2]. From the aspect of network topology to study, wireless sensor network is mainly manifested in the clustering structure. Clustering structure is the basic idea of the wireless sensor network node clustering, and each layer can be divided into several clusters, a cluster; Communications within the cluster, the cluster head nodes will be collected data information fusion, will complete the processing of the data to the node. In order to better complete the task, needs to solve two problems: first: how to reduce the overhead of node energy, choice of data information in the transport process, the optimal path to the node. Second: with the ant colony algorithm and path selection process, will inevitably bring each path pheromone imbalance phenomenon. How to better solve this phenomenon, must through the local and global pheromone update strategy to optimize; That is, in each node as the source node, which is formed by the radio message when a single local area, based on the current pheromone concentration calculation of each node is selected as the probability of the next-hop, namely energy more nodes become the next-hop routing probability is bigger. Therefore, in view of the above two problems, this article will TEEN algorithm and ant colony algorithm, through the ant colony algorithm traverse all the nodes of the global and local pheromone updating strategy by control is optimized, so as to effectively reduce the overhead of network node energy, the balance of the network node energy, prolong the network life cycle, improve the network quality of service.

2 Related works

M.G allagher et al. Studies in the literature [3] the question is: through to the program insert print statements or other ways to the program of pile, path oriented test, to program statements of pile driving test procedure, make the program to return to the current state of the various variables or numerical size, this method can be according to the different software to produce different kinds of measured data, but the loops and back problems will appear in the process of execution. In ref. [4] P.K.M ahanti and others in the software test automation on the application of ant colony algorithm, to find the abnormal problem using ant colony algorithm in software, this is the first time using the ant colony algorithm in software testing.N. Gupta and others in the literature [5] an iterative relaxation method is put forward, at the time of each repeat procedure, the execution of branch number has nothing to

**** Corresponding author's*** e-mail: jsjsdoc@163.com

do with the test program path length, only associated with input variables, can effectively avoid in the process of the test program of circulation and back problems. Jin Cherng Lin and others in the literature [6-7] research is based on the path coverage test, using the basic principle of genetic algorithm, using the generalized hamming distance to improve traditional fitness function of genetic algorithm, and by running the result proved the effectiveness of the proposed method. Willam Visser et al. Studies in the literature [8] is applied in the JAVA programming language based on path coverage testing technology. Jones b. F [9] and others in the literature research method of generating test data in branch coverage method was used to verify a classic case of triangle type of program, the results show that the number of test data using the algorithm generated than random method to generate the test data of a lot less, to reduce the redundant data.R. gutierrez irgis Moheb [10] in the field of data flow testing is also used in genetic algorithm; ArunBiradar, Satanik Panda, Dr. Velur Rajappa [11] software testing data in the literature research is based on graph theory of genetic algorithm, the first step is to construct a directed graph, the directed graph including all the nodes in the tested program, the second step is to construct the initial population, the population based on the directed graph of nodes, find the parent node, then the parent node, crossover and mutation operators to generate new child node, make the child nodes have the characteristics of the optimal. Peter and Susan Khor Grogono in their studies the literature [12] is the automatically generated based on the path coverage test data by using genetic algorithm; Moataz A.A hmed and Irman Hermadi is proposed in the literature [13] a new type of software test data generation model, the model is based on some operations of genetic algorithm, using the new software can generate coverage specified path of test data, have high path coverage; Carlos m. errands and others in the literature [14] binary ant algorithm are studied, and the successful application in the dynamic optimization problem they proposed algorithm. Praveen Ranjan Srivastava and others in the literature [15] proposed the use of intelligent automatic test data generation water droplets (IWD), the generated test data can help reduce the workload. Maria Claudia F.P.E killing and others in the literature introduced two kinds of selection and evaluation based on genetic programming procedure of the test data. In wireless sensor network clustering structure energy conservation is an important goal in the design of wireless sensor network (WSN), the routing algorithm for wireless sensor networks have great effect on the energy consumption, so to improve the validity of the routing algorithm to reduce energy consumption of the network is very necessary, LEACH protocol based on clustering is the first, it through a balanced network energy consumption and prolong the network life cycle of a target, but LEACH agreement also have many shortcomings, for the lack of it, many improvements are put forward. LEACH (Low Energy Active Clustering Hierarchy) association - proposed by MIT Heinzelman first put forward by WSN clustering hierarchy routing protocols, occupies an important position in the WSN routing protocols, then based on clustering routing protocols, such as a TEEN PEGASIS mostly by LEACH development such as the basic idea of LEACH agreement is to select cluster head nodes by randomly cycle to the entire network of energy load is evenly distributed to each sensor node, so as to reduce the network energy consumption. The purpose of improving network had life cycle. As shown in figure1:

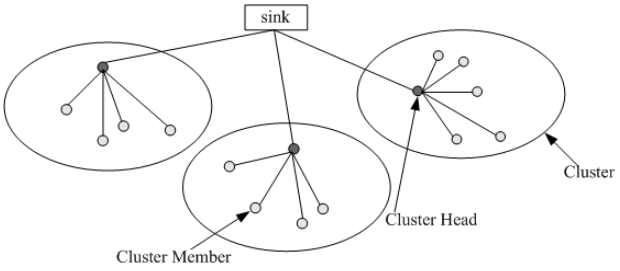

FIGURE 1LEACH Clustering Structure

3 TEEN Agreements

TEEN(Threshold Sensitive Energy Efficient Sensor Network Protocol) Routing protocols use similar LEACH clustering algorithm, just use different strategies in data transmission phase, is the concrete practice of TEEN agreement set in hard Soft two worshiping value, in order to reduce the number of sending data, at the time of each cluster head selection will be two threshold broadcast out; When monitoring data for the first time in more than one set of hard threshold, the node set the data for the new hard threshold and sends in the following time slot period. After that, only by monitoring data of more than hard threshold and the change range of monitoring data is greater than the soft threshold, the node will send the latest monitoring data, and setting it to new hard threshold. By adjusting the size of the two values of worshiping, can be a reasonable balance between accuracy and system energy consumption. Using this method, you can monitor some emergencies and hot spots, less than the active network; data transfer capacity significantly save energy consumption and is suitable for the type of network application. The simulation results show that TEEN is more effective than LEACH. But TEEN two drawbacks: first, if a node of the testing data is always short of hard worshiping values, the node will not transmit any data, also can't know whether this node failure, so the method is not suitable for periodic sampling network; second, the data once conform to the requirements of the threshold, the node immediately transmitted, easy to cause interference, if using TDMA, and will cause delay in data.

3.1 FORMATION OF THE CLUSTER

Program is running, each sensor node in the interval [0, 1] randomly select a data, if the selected data is less than the threshold T (n), the node will be around to circulate the news of himself as a cluster head nodes, and soft threshold and hard threshold, and the other does not become a cluster head nodes according to their own which depends on the strength of the received radio

signal into clusters, and the related hair to send information. T (n) calculation formula is:

$$T(n)=\begin{cases}\dfrac{p}{1-p[r \bmod(1/p)]} & \text{n} \in \text{G} \\ 0 & \text{n} \notin \text{G}\end{cases} \quad (1)$$

P is percent of all nodes in cluster heads, *r* is the cycle of round number, *G* is the latest in round 1 / *p* is not in the cluster head nodes.

3.2 DATA TRANSMISSION

When the nodes selected value more than hard threshold, the node will be the value stored in the internal variables in the taboo table, and in accordance with the TDMA time slot cluster, sends the data to the data fusion in the cluster heads, the results will be transmitted to the base station. If the current monitoring data is greater than the hard threshold and the number difference between the TABOO TABLE and soft threshold is greater than or equal to, data transfer node will once again. And, after data transmission for a period of time, TEEN will return to the next round of cluster head selection and clusters. Clustering routing protocol mainly has the following three advantages, one: most of the time within the cluster nodes can close communication module, with the cluster head is responsible for the data of long distance routing forwarding function. It can not only ensure nodes within range of the data communication, and can largely save the network energy can cluster head nodes in the cluster fusion data then forwards the data, thus reducing the data traffic, and achieve the purpose of save the network energy; Three: clustering topology structure not only facilitate the management, for the application of the distributed algorithm, but also a series of changes to the system to make rapid response, the network has good scalability, which is suitable for large-scale network.

4 Ant colony algorithms and the fusion process

4.1 THE BASIC ANT COLONY ALGORITHM

Ant colony algorithm, ant colony optimization is to observe the real world behaviour for the exchange of information and inspiration, to imitate. Real ants in the absence of visual can be found from food source to the nest of the shortest path; at the same time, they can adapt to the change of environment, when there is obstruction had the shortest path, can find a new shortest path. Ants between individuals through a substance called pheromones to pass information. Ants in the process of movement, not only can it passes along the path with the material, but also can perceive the existence of the material, and can distinguish the strength, and is moving towards the direction of the high strength, to determine their own direction. So, ant colony collective behaviour is composed of a large number of ants will show a information positive feedback phenomenon, in order to realize the mutual exchange of information between ants. A path through the more ants, ant chooses the path behind the greater the probability. Ant is through the information exchange between individuals to carry on the optimal choice of the path, thus achieve the goal of searching for food.

4.2 THE CHARACTERISTICS OF THE WEIGHTS IN ANT COLONY ALGORITHM

At present, how to speed up the convergence and reduce the stagnation in the research of ant colony algorithm is a balance between one of the difficulties. Because it is not only to ensure the algorithm search space as large as possible, to find the optimal solution of the solution space; And to make full use of the internal group is the most effective information, ensure that the emphasis of the algorithm as much as possible position in those with higher fitness of individuals in space, thus ensuring to significantly probability to find the optimal solution. We can according to different ant requested quality solution, the use of dynamic weighting method to give weight to the ant, and then according to the weight of the ants on the different characteristics of ants by timely adapt to update pheromone. Therefore, we should judge the ant colony is gathered in the search space to one or a few dissolved to distribution. We can through the calculation of the average of the iterative solution of all the characteristics of the subset classification error rate and the iterative solution of the minimum feature subset classification error rate to determine the number of difference between degrees of polymerization of ant colony. From it, we can infer, polymerization of ant colony number smaller than the relative dispersion of ant colony, therefore, we can put the number difference between the two as a measure of whether ant colony convergence, the structure characteristics of the ant colony solution for:

$$E_{avg}=\frac{1}{n}\sum_{k=1}^{na}E_k \quad (2)$$

E is for the current iteration of the ant structure classification error rate of the solution of the feature subset, when updating the pheromone of *E* is less than the E_{avg} ants gives a relatively large weight, the less you give weight, the greater the for more than or equal to *E*, E_{avg} ants which gives a relatively small fixed weights. So the ant *k* in the current iteration of the selected feature on the release of pheromones as follows:

$$\Delta\tau(f_i)=\begin{cases}Q\lambda_k / E_{avg} \\ 0,\end{cases} \quad (3)$$

Under the weight of λ_k type is obtained:

$$\lambda_k=\begin{cases}(E_{avg}-E_k)/(E_{avg}-E_{\min}) \\ 0 \qquad E_k \geq E_{avg}\end{cases} \quad (4)$$

Can see E_k the closer the $E_{\min}$, weight lambda approximates to (1). Calculate according to the formula (2) the structure characteristics of the each iteration the ant E_{avg}, then according to the individual ant's tectonic characteristics of the difference between *E* and E_{avg} to phero-

mones change accordingly. This can not only avoid local convergence too fast, improve the global search ability of ant colony, increase the diversity of the solution space, and will not reduce the search speed of ant colony, to ensure the efficiency of ant colony search. When path pheromone to increase or decrease the amount of under the feeling number difference of the ants, the ants will feel less than the amount of information on the path of change, choose the path choose this path also depends on the probability of size ants routing before experience formed by the subconscious mind; When the path of increase or decrease the amount of pheromone in ant feel above number difference, ants will be influenced by the conscious mind, all the ants according to the path information dictates the size of the routing probability. In the ant colony algorithm, the ant in structure, the principle of choosing the next node application and pheromone update rules of ant colony can search to the optimal solution plays a decisive role.

4.3 INSPIRED BY THE FUNCTION AND STRUCTURE

The ant in the process of search target, always the first to select the most can satisfy the evaluation function. He initial, because all nodes of pheromone intensity is the same; so, we need to employ heuristic function of ant's direction. In the basic ant colony algorithm, the heuristic function is defined as the reciprocal of the distance between the two cities, but this does not apply when search for characteristics of the node. Because the Filter feature selection methods, characteristics and categories of mutual information between can better reflect the characteristics of the importance of each characteristic nodes inspiration function has to be defined as the characteristic and category of mutual information, as shown below:

$$\eta_{fi} = I\left(f_i{:}C\right) \tag{5}$$

f_i Said conditions characteristics, C class features.

Initially, the multiple ants randomly placed on the characteristics of a node, and starting from the starting point according to ants state transition rules to choose the next characteristics. After ants construct the solution of all the characteristics has of the solution of $k \in [1,n]$ training classification respectively, according to the state characteristics of ant colony classification error rate to evaluate the advantages and disadvantages. A single ant selects features according to the formula (6) and (7):

$$s = \begin{cases} \arg\max\{\tau(u)^{\alpha} * \eta(u)^{\beta}\}, & if\ (q < q_0),\ u \in allowed_k \\ p(s), \text{ otherwise}, & s \in allowed_k \end{cases} \tag{6}$$

$$p(s) = \frac{[\tau(s)]^{\alpha} * [\eta(s)]^{\beta}}{\sum_{u \in allowed_k} [\tau(u)]^{\alpha} * [\eta(u)]^{\beta}} \tag{7}$$

Among them: alpha, beta, said the relative importance of the pheromone and the heuristic information; $allowed_k$ refers to the current ant k search all optional feature set; k s ant the currently selected features; u said with features of adjacency; Ant k come in $allowed = \{0,1,2,\cdots n-1\}$ said the next step allows you to select all of the nodes, the list of $tabu_k$ record of the current node, through the ants when all n nodes are written to the table $tabu_k$, ant k to complete a cycle, the route is a solution of the problem by. q_0 is evenly distributed in the interval [0, 1] is a random variable, is used to determine the rules of ants pheromone and heuristic information of the product of the biggest features and ants choice has the biggest transition probability of relative importance, in order to ensure the ant of utilizing the information in the past at the same time, also have the ability to develop new search space, prevent ants only get too fast convergence to the local optimal solution.

4.4 THE FUSION PROCESS

First: TEED algorithm clustering method in the network to carry on the clustering, the quantity of the permissible maximum diameter for r, between the cluster head node to the gathering node path by ant colony algorithm to search, but as a result of using more jump way to cluster heads can lead to convergence point data transmission between adjacent nodes energy consumption is bigger, so should be used when calculating the weighted structure determine optimal solution, in order to reduce number of members in the cluster, and reduce the load in clusters; Secondly, introduce the residual energy of cluster nodes of ant colony algorithm, so that you can avoid excessive use of a cluster head in the process of searching routing program is running[16]. Third: a set of "artificial ant's agent by adopting the method of distributed parallel test, search from each cluster head node to the gathering node routing; Fourth: artificial ant's pheromone information and make full use of the path search conditions, establish the optimal routing in the form of local search. Fifth: "artificial ants" work together, through the update has a holiday point of routing table, guide the subsequent search of artificial ants, ensure that eventually find an optimal routing of data gathering.

5 Algorithm implementation and update policy

5.1 LOCAL UPDATIONG MECHANISM

Ants from node *i* to node *j*, the path (*i*, *j*) (7) to update the pheromone according to the formula:

$$\tau_{ij}\left(t+1\right) = \left(1-\xi\right)\tau_{ij}\left(t\right) + \xi\Delta\tau_{ij}\left(t\right) \tag{8}$$

$\xi \in (0,1)$ And $\Delta\tau_{ij} = \Delta\tau(0)$ is the initial value of information. This not only can effectively avoid falling into local optimum, and reduce the probability of repeated selection has chosen path, effectively avoid the occurring of ants converge to the same path, and then improve the global search ability of ant colony algorithm. Ants search focuses in the current cycle so far to find the shortest path field area, global update rule is in after all the ants have completed their path execution, update the pheromone formula is:

$$\tau_{ij}\left(t+1\right) = \left(1-\xi\bullet\tau_{ij}\left(t\right)\right)\bullet\tau_{ij}\left(t\right) + \xi\bullet\tau_{ij}\left(t\right)\Delta\tau_{ij}\left(t\right) \tag{9}$$

$$\Delta\tau_{ij}^{k}=\begin{cases}\dfrac{Q}{L_{\min}} & \text{边}(i,j)\in L_{\min}\\ -\dfrac{Q}{L_{\max}} & \text{边}(i,j)\in L_{\max}\\ 0 & \text{otherwise}\end{cases} \tag{10}$$

ξ is a pheromone volatilization coefficient, such as ξ must change occurs, you can limit the path pheromone concentration of unlimited increase, reduce the probability of trapped in local optimum, so as to increase the convergence rate of ant colony. On behalf of the ants are the shortest and the longest path to walk away. In the early stages of the algorithm, if for the ants walked the path has certain probability to obtain the information updates, can improve the ant chooses the path of the corresponding probability. Pheromone by accumulating certain path to achieve a certain number reduces the optimal path with the worst path boundary, information gap between in order to ensure the ant search behaviour concentrated near the optimal path.

5.2 PARAMETERS

Parameter has a great influence on the network search. Reasonable parameter Settings can not only improve the search speed of convergence of the network system, to enhance the global search ability, can also effectively inhibit algorithm appear premature stagnation phenomenon. Alpha is heuristic factor; it reflects the ants accumulated in the process of sports information in guiding the relative important degree in the process of ant colony search. When alpha value is too large, positive feedback can lead to local optimum path to enhance, algorithm premature convergence phenomenon appear probability is increased. Conversely, when the alpha value through the hour, it will not only result in slow convergence speed, will also increase in the probability of local optimal solution. Beta is expected to stimulating factor; it reflects the heuristic pheromone in ant colony search process of the relative important degree. When β is too large that lead to accelerate the convergence speed of the system, and overall search ability of the system at the same time, the increase in the probability of local optimal solution. Conversely, when the beta value through the hours, will cause the system becomes very slow convergence speed, it is difficult to find out the optimal solution. Therefore, in order to avoid other factors lead to too much error, based on the calculation, the use of α=2, β=3 and node number same number of ants, random distribution is shown in figure 2:

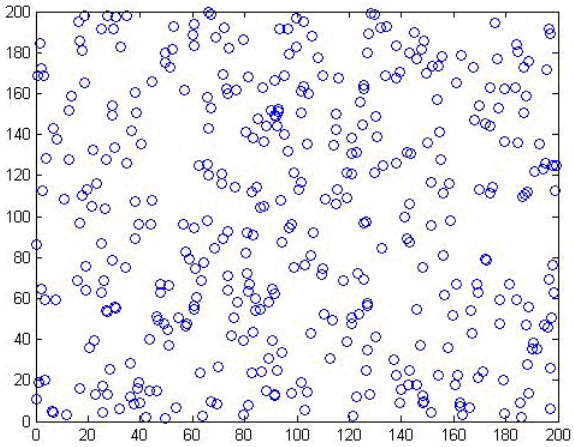

FIGURE 2 Random distribution of network nodes

5.3 ALGORITHM STEPS

In this algorithm, we can set the number of feature subset *m* according to the data set, to avoid repeated search for some feature subset. Provisions of any ant select *m* a feature to complete a search process, among them, the *m* for search cycles, each cycle can search out contains m features of approximate optimal feature subset, then *m* value at a certain ratio increased.

Step1: initialization parameters: make time *t* = 0, cycle number of $N_c=0$, $\eta_{ik}=d_{ik}$ Settings; $\tau_{ij}=0$. $\Delta\tau_{ij}=0$, and there he put the starting point $tabu_k$, given the value of the α,β,ρ and $(i,j)\in R$.

Step2: when the termination conditions *while* not satisfy conditions algorithm, using *for* loop to *m* ant is placed on the initial node.

Step3: ant individual calculated according to the probability of state transition equation (6) select node *j* and forward, $j\in(C-tabu_k)$ at this time.

Step4: $tabu_k$ pointer changes and node *j* into $tabu_k$, let the pointer to node *j*.

Step5: lookup to see if there is not traverse the nodes, if $k<m$, $k++$ after the jump to step 3.

Step6: calculation *m* ants path length *L*, record the current optimal solution $L_{\min}$, and the loop to get the optimal path for the first time L_k.

Step7: when ants after traverse all the nodes on the pheromone trails according to formula (8) (9) (10) to update.

Step8: when $L_{\min}\le L_k$, updated τ_{ik} and $\Delta\tau_{ik}$, and replace the optimal route $tabu_k$. If the cycle number is greater than or equal to the cycle number, largest output end of the cycle and the optimal path length L_k.Otherwise empty $tabu_k$, and jump to Step2.

6 Performance evaluation

In simulated using MATLAB6.5 simulation experiment to evaluate network performance better, every time the simulation results are the average of 100 times, in order to ensure the ant number equals the number of nodes, the specific simulation parameter list as shown in table 1:

TABLE 1：The simulation parameter list

parameter	value	parameter	value
Network size	200*200 m2	$E_{R\text{-}elec}$	50nJ/b
Number of nodes	300	E_{min}	0.02J
R_s	25m	The packet header	25B
$E_{T\text{-}elec}$	50nJ/b	Initial energy	2J
ε_{fs}	10(pJ/b)/m2	Broadcast packet	25B
ε_{amp}	100pJ/b/m2	each round	100ms
Q	150	β	3
α	2	τ_0	0.1
ξ	0.1		

The sensor nodes to send and receive data wireless communication model are:

$$E_{Tr}(k,d) = E_{T-elec}k + E_{amp}(k,d) = \begin{cases} E_{T-elec}k + \varepsilon_{fs}d^2k & d < d_0 \\ E_{T-elec}k + \varepsilon_{amp}d^4k & d \geq d_0 \end{cases} \quad (11)$$

$$E_{Rx}(k) = E_{R-elec}k \quad (12)$$

On the type of $E_{T\text{-}elec}$ and $E_{R\text{-}elec}$ said the energy consumption of the wireless sending and receiving module; ε_{fs} and ε_{amp} respectively free space model and the multipath attenuation model for energy consumption amplifier parameters;d_0 is constant. Experiment from two different circumstances of different algorithms performance effect to evaluate its performance, the first is that when the same sensor nodes are 150, LEACH protocol and TEEN with the algorithm in this paper, at the same time and same events compared low, as shown in figure 3:

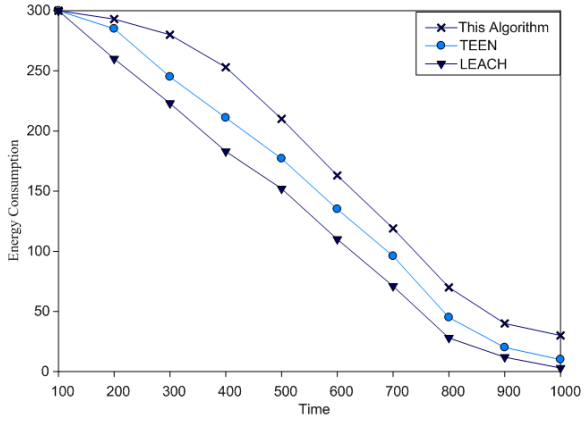

FIGURE 3：Network energy consumption curve

Can be seen from the figure 3, at the same time, the algorithm of network energy consumption is less than LEACH agreement and TEEN, and the extension of network energy consumption over time and gradually stabilized, which means its energy consumption is more uniform, and LEACH agreement TEEN is relatively fast because the network energy consumption, network instability may lead to later in the runtime.

The second is to consider the relationship between total network data and time experiment contrast, LEACH agreement with TEEN choice of cluster heads in the cycle of 50 s, cluster heads occupies 5% in all nodes and time is set to 900 s, as shown in figure 4:

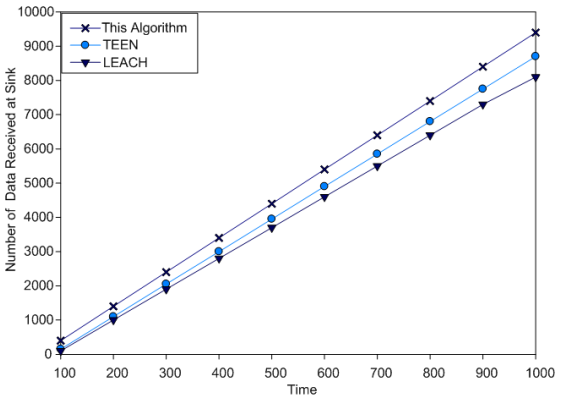

FIGURE 4：The total network to send data graph

Figure 4 reflects the different algorithms of the relationship between the total networks to send data with time change. According to the curve in the graph relationship: at the same time, this algorithm not only send the amount of data is greater than the LEACH protocol and TEEN, and in the same under the network energy consumption, the algorithm running time than LEACH protocol and TEEN algorithm is much shorter. In addition, compared with LEACH agreement and TEEN, the algorithm of network energy consumption growth are relatively stable over time, the energy consumption is relatively uniform.

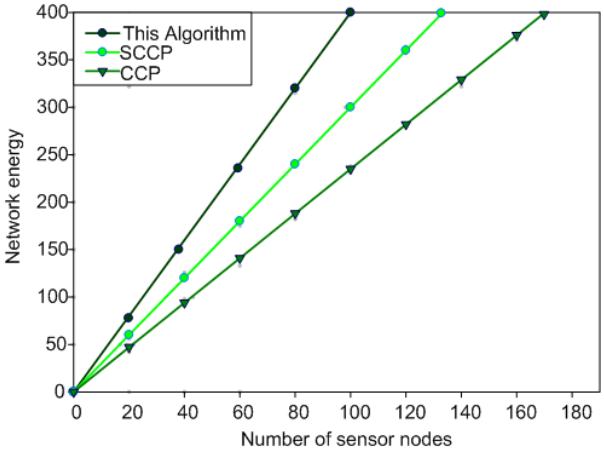

FIGURE 5: Sensor node number and the network energy diagram

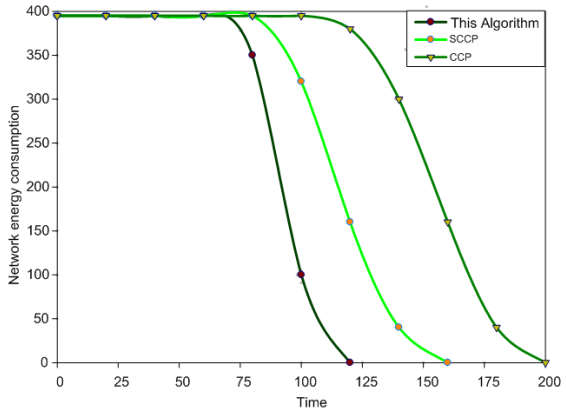

FIGURE 6：Graph network node energy and time round number

Figure 5 and figure 6 reflects the EPDM algorithm with CCP and SCCP algorithm under the condition of meet the network coverage, network energy and number of nodes and network node residual energy contrast change over time. Can see from the picture, under the premise of the same number of nodes, EPDM algorithm research network energy by increasing speed than in CCP and SCCP these two kinds of algorithms .For a certain energy, EPDM algorithm used by the node number is far less than other two algorithms. Figure 6 mainly reflects the total residual energy of nodes in the process of system operation in constant over time. Compared with other two algorithms, the algorithm in network coverage requirements at the same time, consume less energy. After the network running the same length of time, using the algorithm of network will than using SCCP algorithm of network energy saving 9% on average, than the CCP algorithm of network energy saving 17% on average, this is because when calculating the network coverage of the proposed algorithm computational overhead is small, the cause of the node energy consumption less.

7 Conclusions

In this paper, the ant colony algorithm and the integration of wireless sensor network routing jump properties more ideas applied to complex network environment, not only increased the network information transmission of packets sent, also reduced the energy consumption of scattered nodes, balance the network energy consumption and prolong the survival time of network, the network performance is more superior than in the past. By comparison with the simulation experiment shows that although the algorithm in the aspect of network energy consumption and sending data are better than that of LEACH agreement TEEN; Can prolong the network life cycle, but the algorithm still exist deficiencies. Because of the ant colony algorithm search time is longer, can easily lead to fall into local optimal solution, thus causes local redundancy phenomenon, make the data sent too slow.
In the future, our research will focus on, how to implement the ant colony algorithm in global optimization of multiple hops routing research; improve the technical requirements of complex network data transmission.

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Authors

< Yang Tao >

Yang Tao was born in 1982 in Luoyang City, Henan Province. In 2009, graduated from Lanzhou University, Master of Science, he is the Luoyang Institute of Computer and Information Engineering lecturer; the main research interests are distributed computing, and network information security.

< Sun Zeyu >

Sun Zeyu was born in 1977 in changchun city, jilin province, in 2010 graduated from lanzhou university, Master of Science; xi 'an jiaotong university study for a doctorate at present. He is a lecturer in luoyang institute of technology of computer and information engineering, is also a member of China computer society. The main research interest is in wireless sensor networks, parallel computing and Internet of things.

< Zhang Yong>

Zhang Yong was born in 1980 in XingXiang City, Henan Province. In 2008, graduated from Lanzhou University, Master of Science, he is Mathematics and Computer, Chizhou University lecturer; the main research interests are distributed computing, and nonlinear functional analysis.