Multicast routing algorithm based on cloud computing strategy in wireless sensor networks

Zeyu Sun[1, 2*], Shouying Li[3]

[1]*Department of Computer and Information Engineering, Luoyang Institute of Technology, Luoyang, Henan, 471023*

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

[3]*Department of Mathematics and Physics, Luoyang Institute of Technology, Luoyang, Henan, 471023*

Received 1 June 2014, www.tsi.lv

Abstract

In the paper, the existing wireless sensor network routing protocol classification and comparative studies, then A targeted selection of typical clustering routing protocol Low Energy Adaptive Clustering Hierarchy (LEACH) protocol for the study, points Insufficient analysis of LEACH, and on this basis to select the optimal number of cluster head LEACH protocol, Selected on the basis of cluster head node, communication between clusters, cluster head node in a distributed fashion to improve "change After the agreement into improving the selection criteria LEACH cluster head, so that the cluster head node distributed more evenly, avoiding Free a single node excessive energy consumption. Finally, the improved LEACH protocol is added by way of randomly selected based on the energy value of closed Residual nodes on MATLAB simulation platform, the simulation results show that adding the residual section Point effectively extending the network life time improves the efficiency of the network.

Keywords: wireless sensor network, routing protocol, network lifetime, sensor nodes

1 Introduction

Wireless sensor network consists of sensors, sensing the object and the observer three basic elements. Wireless sensor networks are between devices, communication between the sensor and the observer. Most or all nodes in wireless sensor network nodes can move their position, which makes the relationship between nodes varies with the mobile node continue to occur. Between nodes in Ad Hoc mode to communicate, each node can act as a router, and each node has a dynamic search, the ability to connect and positioning of recovery. Information collected by observers can actively query or collection of wireless sensor networks can also be passively receiving information transmitted in wireless sensor networks. Information collected by observers for analysis processing, and then take the appropriate measures to reach a certain goal [1]. Wireless sensor networks are self-organizing network, the automatic generation of network topologies. Topology control means to meet the region overlying Under conditions of coverage and network connectivity by selecting the node transmit power control and network key nodes, delete unnecessary links to generate an efficient network topology to improve the efficiency of the whole network, to extend the life of the network cycle [2]. Good network topology can improve efficiency of the link and routing protocol for the upper data fusion, target location, time synchronization basis for many applications, the network load balancing beneficial to extend the lifetime of the entire network [3]. Time synchronization is directly related to the application of wireless sensor network protocols running and running on it. Network Each node has its own local clock, the nodes within a particular time if the system are synchronized, with the passage of time, there will be some deviation of the clock nodes, the system needs to sleep if many nodes will likely predetermined there may not be time to wake up. Wireless sensor network storage and computing capacity of a single node are weak, the decision of the traditional network protocol is not suitable for wireless sensor networks, the agreement must be to design suitable for wireless sensor networks based on its own characteristics. In wireless sensor networks, routing protocols need to consider not only the energy consumption of a single node, but also need to consider the energy consumption of the entire network.

Wireless sensor networks are self-organizing network (Ad-Hoc), but with self-organizing networks are essentially different [4]. Self-organizing network is composed of hundreds of thousands of nodes in a dynamic wireless multi-hop communication is formed in the form of peer to peer wireless network, which is characteristic for the purpose of data transmission, the node can continue to provide energy, more stable operation of the entire network, the data computing and computing capacity is weak, less the amount of information stored in the data; wireless sensor networks and ad hoc network structures are generally similar, except with the characteristics of self-organization of the network, the main difference is: wireless sensor networks based on data- processing centre,

* ***Corresponding author*** e-mail: lylgszy@163.com

the node is not limited energy supplement, the network has the ability to monitor and control, data processing ability [5,6]. First, the wireless sensor networks in the work process often subject to external factors and the impact on the environment , usually in high-density portion opposed to the node to complete coverage of the target area, tracking and positioning, due to the presence of high - density deployment of nodes , making between nodes frequent phenomenon when transferring the data redundancy, thereby causing disruption and congestion of the network, how to deploy sensor nodes cover the target area of concern and to avoid the occurrence of network redundancy in wireless sensor networks is an important issue. Secondly, the sensor nodes in wireless sensor networks is perceived by the local self- organization in the form of data, the collected data is calculated after processing to the base station, base station forwards the data to the user after the integration. Data acquisition and processing of information in the calculation process involves mechanisms for wireless sensor network coverage, targeting mechanisms, data fusion mechanisms and connectivity mechanisms for wireless sensor networks [7] to achieve this important part of the process is covered by the mechanism. Again, from the perception of the physical world, the wireless sensor networks to handle data collection accuracy and stability and the effective coverage of the target area under certain conditions depends on systematic and complete coverage mechanism [8]. The importance of covering another mechanism also depends on physical performance , is the energy networks of sensor nodes, wireless sensor networks by optimizing coverage, for a reasonable allocation of network resources, improve network quality of service, to suppress the node energy consumption and prolong the network lifetime have played a crucial importance.

2 System architectures

Sensor nodes are usually scattered in a random form of the coverage area, wherein the sensor comprises a combination of nodes in the cluster, the cluster head node, base station or other communication devices, the Internet, from other user groups. Each sensor node After collecting data, through a preliminary analysis and data fusion to pass information to the cluster head node, cluster head node will collect information again computing integration, network link to hop along the way to pass to the base station in data transmission can be collected and processed more sensor nodes, the data reaches the base station or satellite channel in a wired manner calculated developed manner to the user shown in Figure 1.

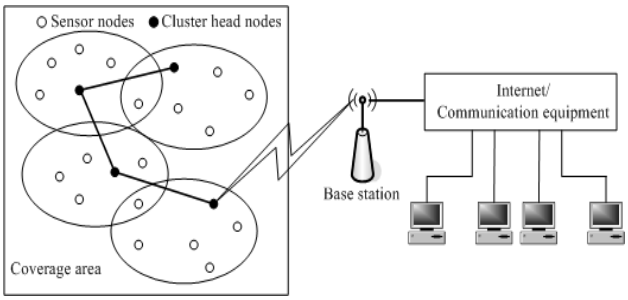


FIGURE1 Wireless Sensor Network Architecture

After randomly distributed in the coverage area of the sensor node cluster, let the sensor node becomes higher energy cluster head node, the sensor nodes collect the relevant data covering the area between the sensor nodes through the self-organization, multichip constitute a communication network system, sensor nodes can collect data cluster head node hop along the network link transmission; through multiple hops after being sent to the base station node, the base station node with a strong computing power, storage capacity, communication ability and control capabilities, and at the same time limiting its energy from outside the base station node can also collected data reprocessing, data processed through a wired network or other communication device applications forwarded to the terminal. For the user, it can make various requests to the wireless sensor network services, such as requiring that access a variety of commands and control information, etc., in order to obtain information and control information related queries.

The sensor nodes of different composition and different practical application, in general, the sensor node by the sensor module, the processor module, a communication module and a power control module is a combination of four parts. The main function of the sensor module is within the coverage area of data collection and data conversion; processor module is mainly responsible for the calculation of the collected data, storage and processing of data transmitted over the other node information; communication module is the main function of the sensor node or a cluster head node for a wireless communication, exchange data and control information; energy control module is mainly responsible for providing energy to the sensor nodes, micro-battery cell is required to, the structure diagram shown in Figure 2.

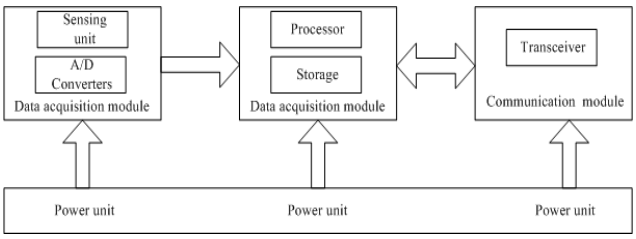


FIGURE 2 Diagram of the structure of the sensor nodes

With the in-depth study of the rapid development of wireless sensor networks as well as staff proposed protocol stack for wireless sensor network nodes. The main

components are divided into: a physical layer, data link layer, network layer, transport layer and application layer. Time synchronization and positioning sub- position of the layer in the protocol stack is rather special, its working principle is dependent on the data transmission channel for collaboration positioning and time synchronization consultation, while also providing a variety of information support for network protocols. As to form the basis of the MAC protocol, geographic routing protocols, etc. These protocols are needed in high-precision positioning and time synchronization on. In addition, the protocol stack also includes three management platforms, namely: energy management platform, mobile management platform and task management platform. The main role of energy management platform is to complete the overall management of the entire network of energy through energy wireless sensor network node scheduling conversion ; mobile management platform, the main role is to move the process when the node forwarding and receiving data in a wireless sensor network, and forwards and processing the received data. Task management platform main role is to coordinate multi- task allocation process, completed between the wireless sensor network nodes work together through a variety of collection and configure the interface to configure and monitor the appropriate mechanisms port also supports multi-task and resource sharing. The main function of the protocol stack layers are: The main function is to handle the physical layer and the data transmission error rate monitor data, to provide transparent data transport stream, while providing a simple radio signal modulation information and technology; data link layer is responsible for the services provided on the basis of the physical layer, communication between entities to establish a data link connection , transfer to a "frame " for the data packet units, and using error control and flow control methods, so that there is an error in the physical line to become error-free data link, monitoring the completion of the frame , media access and error control; main function is the network layer to create logical data transmission link by routing the packet through the communication sub-algorithm to select the most appropriate path to implement congestion control , and , networking and other functions; main function is to transport layer packet processing errors, restructuring packet ordering, data flow control and to ensure the quality of communication services; main function of the application layer is composed of a series of application software to complete monitoring of multi-tasking and control.

3 LEACH protocol and optimization strategies

3.1 LEACH protocol

LEACH protocol by MIT's Heinzelman, who proposed the first WSN clustering hierarchical routing protocol, occupies an important position in the WSN routing protocol, and subsequently clustering based routing protocols such as TEEN, PEGASIS etc. Most developed by LEACH come the basic idea is to select the protocol LEACH cluster head node randomly cycle through to the energy of the whole network load evenly distributed to each sensor node, which can reduce the energy consumption of the network to improve network lifecycle purpose of this chapter will focus on description and analysis of LEACH shown in Figure 3.

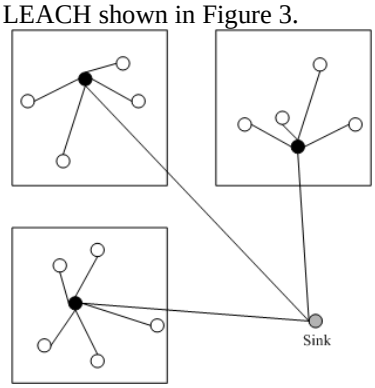


FIGURE 3 Schematic of LEACH

LEACH protocol LEACH-shaped card is put forward on the basis of a centralized routing protocol, which effectively solve the uncertain number of clusters and cluster head node selection optimization problems compared to the LEACH protocol and effectively increase the amount of data received by the base station prolong the survival time of the node. Firstly, the energy of the agreement as a condition of the current node cluster head selection At this point all the nodes are no longer equal probability as a cluster head, but with the current energy is proportional to the current energy more elected as cluster head node probabilities have large number of i-node probability at time t as cluster head for Pi (t), which is calculated as follows equation:

$$p_i(t) = \min\left\{\frac{E_i(t)}{E_{total}(t)}k, l\right\}, \tag{1}$$

where k is the number of cluster heads in each round, $E_i(t)$ is the energy of the current node i, $E_{total}(t)$, N are N nodes and the energy of the current, so $E_{total}(t) = \sum_{j=1}^{n} E_j(t)$.

Each one goal is the formation of K clusters. LEACH specific process is as follows: For any node N, node N generates a random number in the range between 0 and 1, if this number is less than a given threshold value $T(n)$, the cluster head node N becomes node, while the node N broadcasts itself as a cluster head information. Threshold $T(n)$ of the expression shown in equation:

$$T(n) = \begin{cases} \dfrac{p}{1 - p\left[r \bmod (1/p)\right]}, \\ 0 \end{cases} \tag{2}$$

where, P is the desired cluster head node is the percentage of all, that the percentage of the total number of nodes in the cluster head after every round, its value is generally

from 4% to 5%, for different applications, p values different. r is the number of rounds of the current loop. When $r = 0$, $T(n) = p$, the probability of each cluster head node becomes the same, all for p. The larger the value of r, the value of $T(n)$ is greater, so as not to become too cluster head node, the greater the probability of cluster head. When $r = 1 / p - 1$, $T(n) = 1$, then this will become a cluster head node. When $r = 1 / p$ and $r = 0$ when $T(n)$ of the same value, $r = 1 / p + 1$ and $r = 1$ when $T(n)$ the value of the same after $1 / p$ wheels, and all nodes restart a new round of circulation.

3.2 OPTIMIZATION STRATEGIES

In practical applications, it is often encountered in multi-criteria or objectives, design and decision-making problems, "such as securities investment issues, investors in order to get higher returns, you need to select the best stocks to invest in, in general, an outstanding shares have the following characteristics: good performance, low price-earnings ratio, growth higher, but usually these goals are in conflict, such as the current domestic steel industry generally better performance of listed companies, earnings are relatively low, but the steel industry is not sunrise industry, the company's growth is not high; while some small and medium sized companies although growth is high, but the performance is poor, the high price-earnings ratio, and thus to be able to choose a good stock, you need to make investment decisions among these goals a balanced approach that more than a numerical target in a given region of the optimization problem is known as multi-objective optimization.

In order to solve multi-objective optimization problem, we need to create a general mathematical model, we must at first determine its decision variables, the general case, the decision variables n dimensional Euclidean space as a point E_n, namely:

$$x = (x_1, x_2, x_3 \cdots x_n) \in E^n. \tag{3}$$

Then is the objective function, in general it can be assumed with P objective functions and decision variables are all about function, namely:

$$f(x) = \left[f_1(x), f_2(x), \cdots f_p(x) \right]^T. \tag{4}$$

Finally, its constraints, from a mathematical point of view, there are two constraints: inequality constraints and equality constraints, constraints can be defined as the m inequality constraints and k equality constraints:

$$\begin{cases} g_i(x) \le 0 \quad i=1,2,3 \cdots m \\ h_j(x) = 0 \quad j=1,2,3 \cdots k \end{cases}. \tag{5}$$

If all are the minimization of the objective function value, the multi-objective optimization problem can be described as the following mathematical model:

$$\begin{cases} min\ f(x) = \left[f_1(x), f_2(x), ..., f_p(x) \right]^T \\ x_i^{\alpha} \le x_i \le x_i^{\beta} \end{cases}, \tag{6}$$

where, x is the decision variable, $f(x)$ is the objective function, X represents the decision vector formed by the decision space x, $g_i(x)$ and $h_i(x)$ constraints x feasible decision variables to determine the range, min represents Vector Minimization, namely vector target $f(x) = \left[f_1(x), f_2(x), ..., f_p(x) \right]^T$ in certain constraints as far as possible the various sub-objective function minimization. It can be seen when the $p = 1$, the mathematical model for a single objective optimization problem mathematical model.

Multi-objective optimization problem is that people in the production or frequently encountered problems in life, in most cases, due to multi-objective optimization problem in all its goals are in conflict, a sub-target improvement may cause the performance of other sub-goals reduced, in order to make optimal multiple targets simultaneously is impossible, and thus in solving multi-objective optimization problem for each sub-goal can only be coordinated and compromise treatment, so that each sub-objective functions are optimal as possible multi-objective optimization problem with a single objective optimization problem is essentially different, in order to properly solve multi-objective optimization problem the optimal solution, we must first multi-objective optimization of the basic concepts of a systematic exposition.

Definition 1: N Viola Space:

$$\begin{cases} x = (x_1, x_2, x_3, ..., x_n)^T \\ y = (y_1, y_2, y_3, ..., y_n)^T \\ x = y \quad Iff \ x_i = y_i \quad \forall i=1,2,3,...,n \\ x > y \quad Iff \ x_i > y_i \quad \forall i=1,2,3,...,n \end{cases}. \tag{7}$$

Definition 2: Let $X \subseteq R^m$ be a multi-objective optimization model constraint set, $f(x) \in R^p$ is a vector objective function, $x^n \in X$ and x^n the X all the other points are superior, called x^n is the multi-objective minimization model optimal solution.

By definition, multi-objective optimization problem is to make the optimal solution x-vector objective function $f(x)$ for each sub-goal is to achieve the most advantages of the solution, obviously, in most cases; the optimal multi-objective optimization problem solution does not exist.

Definition 3: Pareto optimal solution: Let $X \subseteq R^m$ be a multi-objective optimization model constraint set, $f(x) \in R^p$ is the vector of the objective function. If $\xi \in X$, ξ and there is no more than the superiority of x, then ξ is a minimal model of multi-objective Pareto optimal solution, or non-inferior solution.

Definition 4: No inferior set with the front end: Let $X \subseteq R^m$ be a multi-objective optimization model

constraint set, $f(x) \in R^p$ is a vector objective function. $\lambda \in X$ Is a minimal model of multi- objective Pareto optimal solution set, then λ is called non-inferior set of *X*, $Y = f(\lambda)$ is called Pareto optimal front.

Seen from the above definition:

a) Multi- objective optimization problem with a single objective optimization problem is essentially different, in general, multi-objective optimization problem Pareto "optimal solution is a collection of the Mu most cases, similar to the single-objective optimization problem in a multi-objective optimal solution optimization problem does not exist, there is only Pareto optimal "multi-objective optimization problem is just a Pareto optimal solution acceptable" not bad "solution, and usually most multi-objective optimization problem with multiple Pareto optimal solution.

b) If a multi-objective optimization problem optimal solution exists, then the optimal solution must be Pareto optimal solution, and the Pareto optimal solution is also the optimal solution by only composed of these, do not contain other solutions, so can be so say, Pareto optimal solution is a multi-objective optimization problem reasonable solution set.

c) For practical application, must be based on the level of understanding of the problem and the decision-makers of personal preference, from a multi-objective optimization problem Pareto optimal solution set of one or more selected solution as a multi-objective optimization problem of optimal solution, so seeking more objective optimization problem the first step is to find all its Pareto optimal.

3.3 ROUTE OPTIMIZATION

Weight coefficient variation method is used to solve multi-objective optimization problem of the earliest methods. The basic idea is: For a multi- objective optimization problem, if for each of its sub-objective function $f_i(x)$ given different weights w_i, where the size of w_i represents the corresponding sub-goals $f_i(x)$ in a multi-objective optimization problem in an important degree, the individual sub-goals weighted linear function can be expressed as:

$$\begin{cases} f(x) = w_1 f_1(x) + w_2 f_2(x) + \cdots w_p f_p(x) = \sum_{i=1}^{p} w_i f_i(x) \\ w_i = \dfrac{random_i}{random_1 + random_2 + \cdots random_p} \end{cases} . \quad (8)$$

As to the fitness function $\sum_{i=1}^{p} w_i f_i(x)$ roulette wheel selection can be determined by hybridization and mutation of the individual involved and so on. Thus, this method can provide a lot of random points to a valid interface search direction; this algorithm is used to Flow-shop scheduling problems, and achieved good results.

Here we have normalized the objective function, when the first *t*. Let $(x_1, x_2, x_3 \cdots x_p)$ generation populations, $h_i(t) = max\{|f_i(x_1)|, |f_i(x_2)|, |f_i(x_3)|, .., |f_i(x_p)|\}$ then $f_i(x)$ can be normalized to the new objective function:

$$g_i(x) = \frac{f_i(x)}{h_i(t)} . \quad (9)$$

The new fitness function can be redefined as:

$$G(x) = \sum_{i=1}^{m} w_i g_i(x) . \quad (10)$$

Adapted according to the size of the angle $g(x)$ with the roulette wheel selection operator $p_0(t)$ is selected from the initial population of parent and points N for hybridization, parents set point set is P:

$$\begin{cases} x_k^i = r \cdot x^i + (1-r) \cdot x^{i+1} \\ x_k^{i+1} = (1-r) \cdot x^i + r \cdot x^{i+1} \end{cases} . \quad (11)$$

Where *r* is a random number between [0,1], $[x^i, x^{i+1}] \in P$, $[x_k^i, x_k^{i+1}] \in p(t)$, $p(t)$ is set after hybridization offspring.

Let $x = (x_1, x_2, x_3 \cdots x_n)$ be a parent population of the body $p(t)$, $j = 1,2,3,...,n$, x_j is $x \in p(t)$, page j coordinate; $a_j < x_j < b_j$, a_i and b_i, respectively, of the search points in the space coordinate *j* The lower and upper bounds; $x_j^k \in p(t)$ is the first coordinate *j*, $p(t)$ is the first step Offspring collection; *r* is between [0,1] random number between; *T* is the maximum genetic algebra; t for the current genetic algebra; $r(0,1)$ said that produce 0 or 1 random number. There are:

$$\begin{cases} x_j^k = x_j + (b_j - a_j) \cdot r \cdot \left(1 - \dfrac{t}{T}\right) & if\ r(0,1) = 0 \\ x_j^k = x_j - (b_j - a_j) \cdot r \cdot \left(1 - \dfrac{t}{T}\right) & if\ r(0,1) = 1 \end{cases} . \quad (12)$$

Non-uniform mutation is to participate in the weight variation did a random disturbance; this disturbance in the early evolution of a relatively large range, but with the evolution of generation increases, changes in disturbance gradually decreases.

What is part by a description of the problem shows that the mesh size small enough to cover the entire area can be approximated as point coverage, but also to guarantee coverage performance. It proved that when the sensor node communication radius of R_c is greater than or equal to twice the detection radius R_s, the algorithm constructs a cover set is able to guarantee the network connectivity; contrary cannot be guaranteed. To this end, for $R_c < 2R_s$, this paper designed a low time complexity algorithm to maintain network connectivity, as shown in Figure 4:

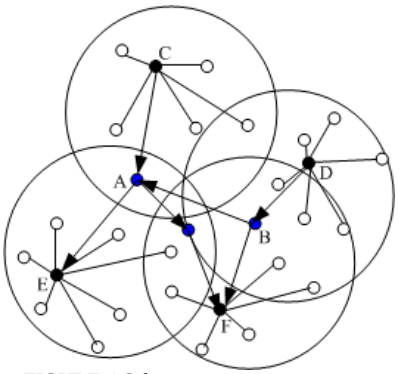


FIGURE 4 Schematic route optimization

Network to obtain the minimum working set of nodes, the central node can take advantage of the depth-first search (depth first search, DFS) or breadth-first search (breadth-first search, BFS) to determine the working node connectivity. If the work can not constitute a connected network nodes, then we put the work could form the set of nodes connected region called the work connected subset of nodes. Therefore, the work of each subset of nodes connected nodes is able to keep working connectivity. Then find work any two connected subset of nodes nearest two working nodes *A* and *B*, shown in Figure 4. A wake it working node communication distance range and the nearest node from the Node *B*. For example the node *C* is awakened, if the Node *B* is still in the communication range of the node *C*, the node *C* will wake it up and away from the communication range of the node *B* nearest node until the node *A* and *B* can constitute a communicating. , The network connectivity of a further judgment. If there is not a set of nodes connected work, we then calculated above, until the entire network to maintain communications.

4 Evaluation systems

In order to evaluate the feature of the algorithm, this paper MATLAB 6.5 is adopted as a simulation platform in this paper, the sensor nodes are randomly deployed in different network areas, the parameters are included in Table 1.

TABLE1 Simulation parameters

parameter	value	parameter	value
dimension 1	100*100m^2	ε_{amp}	20(pJ/b)/m^2
dimension 2	200*200m^2	$E_{R\text{-}elec}$	30nJ/b
dimension 3	400*400m^2	E_{min}	0.05J
Number	80-350	Header	20B
R_s	5m	Initial energy	5J
$E_{T\text{-}elec}$	20nJ/b	broadcast	20B
ε_{fs}	10$(pJ/b)/m^2$	each round	100ms

The wireless communication models for Sensor node transmitting data and receiving data are respectively the following:

$$E_{Tr}(k,d) = E_{T-elec}k + E_{amp}(k,d) = \begin{cases} E_{T-elec}k + \varepsilon_{fs}d^2k & d < d_0 \\ E_{T-elec}k + \varepsilon_{amp}d^4k & d \geq d_0 \end{cases} . \quad (13)$$

In the above formula, $E_{T\text{-}elec}$ and $E_{R\text{-}elec}$ denote the energy consumption of wireless transmitting module and wireless receiving module; ε_{fs} and ε_{amp} stand for the energy consumption parameters of spatial model and multiple attenuation models; d_0 is a constant.

Experiment I: The first case is, with the same respective parameters, execute 50 times and get the mean value, then execute for 400 to compare with the LEACH and LEACH-C [9] protocol the quantitative relationship between number of remaining nodes and the number of turns, as shown in Figure 5:

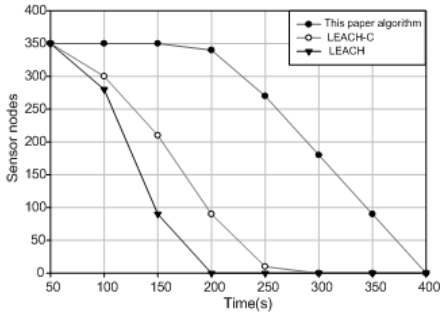


FIGURE 5 Remaining nodes and the round number

As can be seen from Figure 5, with increasing of time, the number of remaining nodes of proposed algorithm is higher than the LEACH protocol, and then the conclusion that with the increasing of time, the energy consumption of the proposed algorithm is lower than that of LEACH protocol, and the network lifetime is extended, also the network resources are optimized.

In order to achieve the scale of network coverage, and thus better evaluate the performance of the model in different sizes, which mainly reflect the minimum number of nodes needs to by deploy in different network coverage, each simulation experiment executed 50 times at average. Curve of node coverage changes is shown in Figure 6:

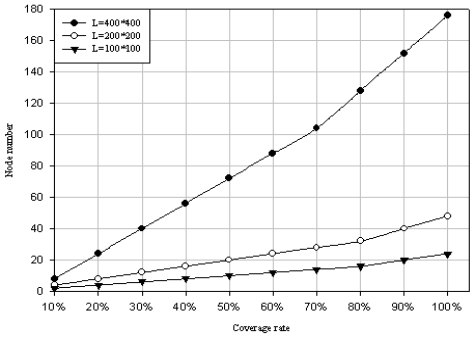


FIGURE 6 Coverage rate for different coverage area

Figure 6 shows the graph of the number of sensor nodes needed to deploy to achieve different node coverage under different network dimensions. The figure shows that, with the expansion of the network, to meet the demand for network coverage, the number of nodes required to be deployed will increase, and the higher the coverage of the network, the number of nodes need to be deployed increases can be obtained from Figure 6 more fast, so that the concern target node can achieve complete coverage.

This algorithm were compared with LEACH protocol, the situation at the same time and the same events occurred mainly as compared to another situation is to choose a random deployment area 400*m*×400*m* sensor nodes placed within 400*m*, compare LEACH protocol in the network operation the number of surviving nodes.

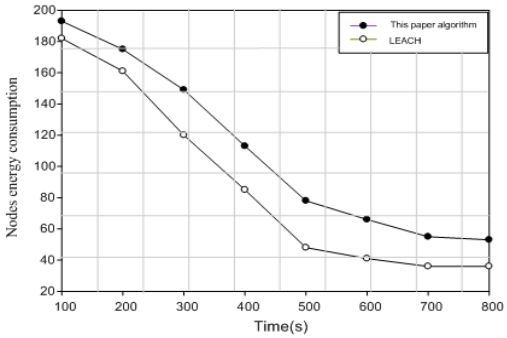


FIGURE 7 NETWORK energy consumption

Figure7 reflects the same number of rounds as having energy consumed by this algorithm is less than LEACH protocol, network energy consumption with time and showing a stable homogeneous state, compared with LEACH protocol is more energy saving, thereby prolonging the network lifetime cycle.

5 Conclusions

Based on in-depth study of the LEACH protocol, for its shortcomings , the improved method , the purpose is to balance node energy consumption and prolong the network life cycle, for the improvement of LEACH protocol is mainly reflected in: select optimal number of clusters heads, helps to reduce energy consumption and improve overall network performance through improved residual energy more evenly distributed throughout the network, thus avoiding the low energy due as a cluster head node and the phenomenon of excessive energy consumption, better balance energy consumption of the nodes, extending the network life cycle [10]. Adopt multi-hop communication between clusters, the distance between the base station to avoid a free remote cluster head node due to a single hop communication distance and excessive consumption of energy. so evenly distributed in the cluster head node sensor networks, avoiding irrational energy consumption and the impact of network life cycle research work of this paper is not perfect , needs to be improved further exploration , the next step requires in-depth research in the following areas:

1) LEACH algorithm of this paper is based on a single-layer network topology structure, in future studies; we should adopt the improved algorithm, which was applied to a multi-level network topology.

2) The cluster nodes to the cluster head node using single hop communication, this will cause the cluster node energy depletion and end points quickly stop working, resulting in lower system life, may consider the use of a time-based within a cluster single-hop and multi-hop component hybrid routing methods.

Acknowledgements

Science of Technology Research of Foundation Project of Henan Province Education Department under Grant Nos.2014B520099; Natural Science and Technology Research of Foundation Project of Henan Province Department of Science under Grant Nos. 142102210471.
The Key Science- Education Project of the Henan province 'Twelfth Five-Year-Plan' under Grant No. 2011-JKGHAB-0051.

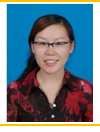
References

[1] Zhu R 2011 Intelligent Rate Control for Supporting Real-time Traffic in WLAN Mesh Networks *Journal of Network and Computer Applications* **34**(5) 1449-58
[2] Wang Y, Jiao Y, Zhang F 2003 Uniform and orthogonal genetic algorithm for multi-objective optimization *Journal of Systems Engineering* **18**(6) 481-6 *(in Chinese)*
[3] Jinhua Z, Zhongzhi S, Yong X 2004 A Fast Multi-Objective Genetic Algorithm Based on Clustering, Journal of Computer Research and Development **41**(7) 1081-7
[4] Wang Y, Jiao Y, Zhang F 2003 Uniform and orthogonal genetic algorithm for multi-objective optimization *Journal of Systems Engineering* **18**(6) 481-6 *(in Chinese)*
[5] Sun Z, Li Z 2013 Wireless Sensor Network Path Optimization Based on Hybrid Algorithm *Telkomnika* **11**(9) 5352-8
[6] Fang W, Liu F, Yang F 2010 *IEEE Transactions on Consumer Electronics* 2010 **56**(4) 2185-92
[7] Sun Z, Yu Y 2013 Coverage Control Algorithm Based on Ant Colony Algorithm in Wireless Sensor Networks *International Journal of Applied Mathematics and Statistics* **50**(20) 467-75
[8] Xiao Y, Chen H, Wu K, Sun B, Zhang Y, Sun X, Liu C 2010 *IEEE Transactions on Computers* **59**(4) 507-21
[9] Handy M J, Haase M, Timmermann D 2009 LEACH-C: Low Energy Adaptive Clustering Hierarchy with Deterministic Cluster-head Selection 4th *IEEE International Conference on Mobile and Wireless Communication Network* 9 368-72
[10] Liang L, Xi Z, Huang M 2013 *IEEE Sensors Journal* **14**(3) 3625-36

Authors

Zeyu Sun, born in 1977, Changchun, Jilin, China

Current position, grades: Lecturer in Luoyang institute of technology of computer and information engineering. Member of China computer society.
University studies: Master of Science at Lanzhou university in 2010. PhD at Xi'an Jiaotong university.
Scientific interest: Wireless sensor networks, parallel computing and Internet.



Shouying Li, born in 1979, Xinxiang, Henan, China

Current position, grades: Lecturer in Luoyang institute of science and technology of mathematics and physics, China.
University studies: Naster of logistics engineering Southwest Jiaotong University in 2009.
Scientific interest: optimization algorithm, logistics system optimization.