

Research of Improved Wireless Sensor Network Routing Protocol

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Abstract

Wireless sensor network is composed of a dense deployment of intelligent sensors in the monitoring area basis points in Ad Hoc network of application system. Based on improved grouping kind of energy efficient routing protocol is a kind of adaptive, distributed routing protocols. Basis points through the sensor and its deployment area to build mathematical model, deduce a given number of basis points improved grouping the computational expressions of the class. Numerical results obtained using the MATLAB software, and the calculation results are analyzed, it is concluded that with the increase of bp number x , the change of the improved grouping class k curve approach gently, as bp number x increases to a certain stage, the overall trend or bp number x increases, the improvement group class k increase, but in a local number x range basis points to increase the impact on the optimal cluster number k .

Keywords: wireless sensor network, routing protocol, the improvement group class, MATLAB

1. Introduction

As the chip technology, micro system technology, the rapid development of wireless network transmission technology, wireless sensor network technology more and more get people's attention, and obtained the rapid development and wide application. Wireless sensor network technology originated in the late 1990's the United States, is known as the "century most likely to change the world one of the top ten technology" [1-2]. MIT as a "ball is one of the three major high-tech industries of the future" good academic value and commercial prospects in this field attracted the world scientific research institutions to research and development.

Wireless sensor network (WSN) is a special kind of wireless self-organized network. It is composed of a dense deployment of smart sensors in the monitoring area basis points in Ad Hoc network of application system. The development of wireless sensor network (WSN) first originated in military applications. Rapid deployment, self-organization mechanism of sensor network, as well as low into the wood and high fault tolerance, wireless sensor networks in military applications has been rapid development. It for more military deployment, the enemy weapons and equipment strength, terrain and the enemy target evaluation and monitoring. Nowadays, wireless sensor network technology was used in civilian areas, such as environment monitoring, precision agriculture, remote medical treatment, industrial control, protection of cultural relics, coal mine production safety, traffic control and digital home security, *etc.* Because sensor basis points is limited hardware devices, computing power and storage capacity is very limited, especially in energy, almost all provided by the battery, and often cannot change once deployed sensor bp battery, tend to be one-time, need to be able to be used for several months or years. So how to make full use of the basis points of energy, improve energy efficiency of the system, and extend the life cycle of the whole system is the key issues in wireless sensor network can be used widely [3]. This has become the current a hotspot in the field of

wireless sensor network (WSN) research.

Research on low power wireless sensor network in the network protocol stack of all levels, including the physical layer, data link layer, network layer and application layer. Each layer can be according to its own characteristics and different function to design energy saving strategy. Such studies include: low power consumption chip sensor bp, low-power MAC layer communication protocol, low power consumption of the routing layer routing protocol, and with a low power consumption for the purpose of data fusion technology, *etc.* Among them, under the condition of existing hardware equipment, for low power consumption of the routing protocol research, to reduce the network energy consumption and prolong the network life cycle is very valuable

Wireless sensor networks by the protocol design of the main goal is to find the shortest path of data transmission, so as to reduce the consumption of energy source for basis points, to prolong the network life cycle; And traditional Ad Hoc network routing protocol design of the main goal is to provide high quality service in mobile condition. These differences led to the current Ad Hoc network routing protocol does not apply to wireless sensor network. The existing research on wireless sensor network routing protocol are mainly two-dimensional type routing protocol routing protocols and grouping type two kinds big. 2D type refers to all the points in the network's position is the same, no management basis points, the network structure is simple; Grouping type refers to, in the network basis points are divided into different levels, compared with the previous layer is the next layer of base points of management basis points, more complex network structure [4-5].

Flooding and Gossiping is two classical two-dimensional in sensor network routing protocol, they do not need any routing algorithm and topology maintenance. Flooding in every basis points received packets to the adjacent forward, until the packet arrival destination basis points or hop count value exceeds the predetermined worshipping. Flooding of improvement is every basis point don't inform packets to all of the adjacent, but a random selection of a neighboring as the next packet forwarding. Flooding and Gossiping is easy to produce the information explosion and information integration problem. HEED algorithm selection of group head base is first on the basis of the residual energy of basis points, randomly selected from the initial set of head basis points, and then to communications within the group of the discretion of the price competition to produce the final group head of bp.

2. Related Works

The predecessor of the Ad Hoc network is put forward by the packet radio network in the United States, is a kind of don't have cable infrastructure to support the self-organization of mobile network. In the network basis points are by mobile host has a radio transceiver, basis points through multiple hops between the data in the form of interaction. Wireless sensor network from the organization form and constitute a way belongs to the Ad Hoc network, belong to one of the wireless distributed network.

Ad Hoc network is the biggest characteristic of all points of equal status, no absolute main points in a network, without human intervention and existing auxiliary infrastructure communication, can through the distributed algorithm to coordinate each other's behavior, very suitable for use in the environment of military and disaster relief, in addition to wireless sensor networks have self-organization, Ad Hoc network infrastructure support, but also has many other distinctive features:

1) Limited power energy

Basis of wireless sensor network almost entirely by the battery power supply, energy is very limited, and wireless sensor networks are often deployed in dangerous area or desolate place, usually in a state of unattended. So for sensor basis points for battery

replacement is difficult to complete. Basis points of energy limited is one of the biggest constraint in the design of wireless sensor networks, and wireless sensor network can be widely used one of the biggest challenges you face.

2) Limited communication ability

Communication coverage of wireless sensor network is only a few tens of to hundreds of meters, and because the landscape such as mountains, buildings, obstacles and the influence of the natural environment such as wind and rain thunder and lightning, the communication between the sensor bp may be intermittent, or work basis points for a long time from the network. How to solve this problem is also one of the challenges faced by wireless sensor network.

3) Limited Computing and storage capacity

The deployment of wireless sensor network needs a large number of sensors, so the sensor basis points have to be very cheap price, otherwise we are not widely used. Cheap sensors basis points of the processor and memory of the computing power and storage capacity must be limited. How to use the limited computing power and storage capacity to handle large amounts of sensory information is one of a hotspot in the research of the wireless sensor network.

4) Network dynamic change fast

Due to the constant change of the deployment environment, so wireless sensor network (WSN) will be followed by the corresponding change. Network often has a point to join or failure, brought about changes in the topology. How to make the network adaptive network structure changes, the sense of mission is not affected in a wireless sensor network research and need to solve a problem.

5) The wide deployment of basis points is big enough

A huge number of basis points in wireless sensor network (WSN) tend to be scattered over vast geographical areas. Due to the change of geographical environment, making the network maintenance is very difficult, even is not to maintain, so you need to wireless sensor network has good anti-destroying ability and fault tolerance.

Wireless sensor network system usually includes wireless sensor basis points, and management basis points. A large number of sensor basis points by artificial deployment or aircraft seeding deployed in monitoring area within or near, through the organization of the network. In the form of collaboration for perception and gathering information of interest [6-10]. Sensor basis points by the sensor module, the processor module, wireless communication module and power supply module four parts. Sensor module is responsible for the perception and gathering data in monitoring area; Data from the processor module is responsible for the storage and processing itself and other basis points from the data; Wireless communication module is responsible for basis points for wireless communication, exchange control and other sensor information and sending and receiving data; Power supply module is responsible for providing energy supply, sensor, which usually use micro cells. According to the needs of different applications, the structure of the bp can also include positioning systems, mobile systems, *etc.*

In the early of the wireless sensor network protocol stack consists of the physical layer, data link layer, network layer, transport layer and application layer. The physical layer is responsible for providing a simple, robust data sending, receiving and modulation technique; The use of the data link layer is responsible for arrangement of wireless channel, reduce told that caused by the conflict between basis points; The network layer is responsible for routing and data fusion; If the application layer, transport layer is responsible for the coordination maintain data flow; Relies on the sense of mission, can use different application layer software in the application layer. Protocol stack also

includes energy management, mobile management and task management three platforms, respectively to energy management of sensor basis points, to monitor the movement of the sensor base and the function of monitor the task scheduling.

Routing protocols in wireless sensor network and application, so people in different application designed for the routing protocol. The routing protocol of wireless sensor network according to the different Angle can be divided into different categories as shown in Figure 1. According to the division routing dynamic way, which can be divided into active routing protocols and two types of passive routing protocols; According to the topological structure of network and bp, depending on the position of the routing protocols can be divided into plane and hierarchical clustering routing protocol, the different methods of hierarchical clustering routing protocol based on group and can be divided into intensive grouping protocol and distributed group.

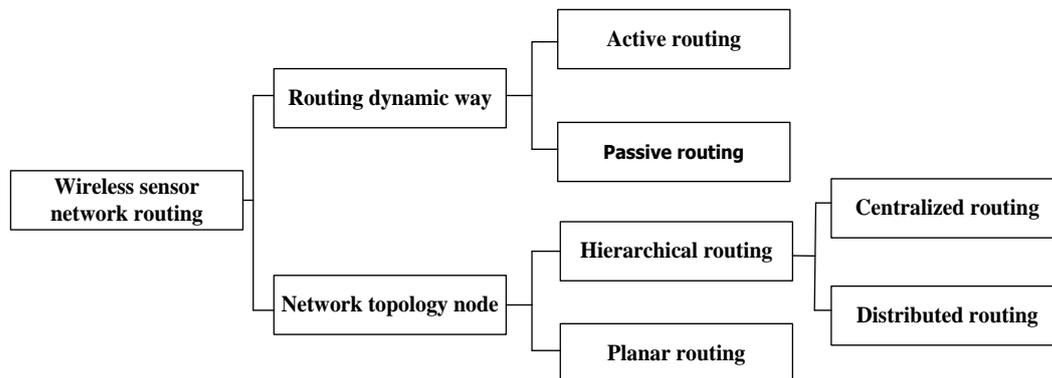


Figure 1. The Category Mop of Wireless Sensor Networks

Two dimensional type of routing protocol features are: all points of equal status, the network structure is simple, easy to maintain, and good robustness. But because there is no management basis points in the network, so resources optimization and the ability to work is bad, bad extensibility. Typical wireless sensor network routing protocol in the topology structure, communication, mobility and extensibility *etc.* There are many similarities and differences, in order to facilitate these routing protocols are intuitive comparison, in this paper, the content included in Table 1

Table 1. Typical Wireless Sensor Network Routing Protocol Table

Routing protocol	topology	Sexual energy consumption	mobility	scalability	Data compatibility
Flooding	plane	Bad	bad	bad	no
GossiPing	plane	Bad	bad	bad	no
SPIN	plane	Good	general	general	no
DD	plane	Good	general	general	no
LEACH	grouping	Better	bad	good	yes
LEACH-C	grouping	Better	bad	good	yes
HEED	grouping	Better	bad	better	yes

3. Based on the Improved Grouping Classes of Routing Protocol Design

Wireless sensor network (WSN) is a special kind of wireless self-organized network. It is composed of a dense deployment of smart sensors in the monitoring area basis points in Ad Hoc network of application system. Because sensor basis points is limited hardware equipment, almost all the energy provided by the battery, so how to make full use of bp energy, prolong the network life cycle is about the key issues in wireless sensor network can be used widely. Efficient routing protocol to cut the average energy consumption and

prolong the life cycle of the whole network. Packet type network with high energy efficiency, good expansibility. The existing research on the grouping of wireless sensor network routing centered on how to select group head, how to classify the group, how to reduce traffic data fusion to consider design, in consideration of energy consumption, the emphasis of the algorithm are different.

Wireless sensor network routing protocol is designed based on different application scenarios, not a universal. This paper puts forward the design scheme is designed for the leakage of harmful gases, and other such sudden application and design. The characteristics of this type of application is a small deployment and basis points is not easy to artificially for installation, backbone networks composed of the gateway may be powered by basic facilities. In order to meet the characteristics of this type of application to the requirements of wireless sensor networks, routing protocol USES the distributed packet routing scheme. Due to the class based on improved grouping the design of wireless sensor network routing protocol is based on such as the harmful gas leak, sudden application, so more than the deployment of wireless sensor basis points with the method of seeding, before on routing protocols, this paper first some assumptions on the model [11].

1) Basis points randomly, relatively homogeneous are deployed in the G*G perception of the area.

2) Basis points deployed after the completion of the static state, no longer move.

3) Sensor base type is the same, the same initial state energy.

4) Gateway point always is located in the center of the sensing area.

According to the characteristics of this kind of specific application and the deficiency of the existing routing protocol was proposed based on improved packet routing protocol of a class. Routing protocols were considered in the design scheme of this type of application of the actual environment and the basis of sensor deployment and its remaining energy, can initialize the sensor network effectively, the entire network basis points on average energy consumption, extend the life cycle of the whole network. En maor reference points of the residual energy and degree of basis points dn the two measures. In the process of data collection and transmission, we plan to use TDMA communication mode, to ensure that the gateway and set points can be respectively in each time slot to send and receive different signals and not confused. Group head base election and the division of process contains group head basis points of generation, the division of four steps, data transmission and data fusion are as follows:

1) In the first place, bp random, relatively homogeneous are deployed in the G*G perception of the area, each point has a synchronous timer and a timeout timer. Basis points after the completion of the deployment, remain stationary state, no longer move. Gateway base is located in the center of the sensing area. We prescribed every hour for a rounds, each rounds on a group of division and data acquisition, the interval parameters can be set for the user.

2) Reference to AOW algorithm to select group head, basis points between each other mutual information, obtain degree of bp dn, and combined with its remaining energy en to calculate weight In. Because $In = 0.4d_n + 0.6e_n$ basis points of the residual energy of parameters is more important than degree of basis points this parameter, so the $c_2 > c_1$, $c_2 = 0.6$, $c_1 = 0.4$. Similarly, the value of experience, adjust according to the different application scenarios. Every basis point place to play with this basis ID in a cyclical messages inform the adjacent base points, points knowing all jump up to the adjacent base points of In values.

3) The adjacent base points after receive the inform, record all jump adjacent In values. By comparing with the adjacent base points In value, has the largest value is selected as the basis of group In head.

4) Group head of bp told a notification to its adjacent. The adjacent base points you may receive more than one notice, it sends a reply back to signal the strongest basis points,

to join the group. We each group contains basis points number of cap for x/y, x represents the number of basis points, y represents the improvement group classes. Group head basis points according to the order to include these points in your group, and for those who are not included in the basis of response in unicast way, making it possible to take part in other groups. Basis points after I received the refused to information, if it received the other group head of bp's announcement, it announced by sending a response to try to join the group; If have not received any other group of head of bp's announcement or rejected again, the composition of the basis points in this group will not be involved. When the timeout timer arrived, to enter a dormant state.

5) Until all the group set up is completed, in order to prevent data transmission sends the conflict within the group, group head of basis points to the basis of allocation TDMA time slot in the group.

6) members basis points to collect data, and to save locally, as well as in its TDMA time slot to deliver group head of bp. Group head basis points after the data fusion, sent to the gateway.

7) gateway basis points will receive data via satellite or cable link sent to the remote control terminal. Grouping and data acquisition and transmission, the end of the activity until the next data collection period, the next rounds repeat from step 2.

4. Model Establishment and Simulation Calculation

4.1. Model Establishment and Derivation

In wireless sensor network based on grouping, sensory area is divided into multiple child area. Each child area by a group of head and multiple members basis points [12-13]. Due to the group head of basis points to send to the data collection basis points from its members, so too many members will add restructuring head base points of overhead, is not conducive to extend the life cycle of the whole network. Again, too few members of the basis points, or short of good coverage, makes some areas perception blind area; Either needs to be divided into more groups, can also add restructuring head on the basis of energy consumption, is unfavorable to extend the life cycle of the whole network. As much as possible in order to save energy and prolong the network life cycle, according to a reasonable number of clusters is required to divide the area constitute a group.

Assume x points randomly deployed in the area of $G \times G$, the gateway is located in the center of the area, division y a group to achieve energy efficient. Each rounds of group head, the energy consumption for E_{ch} members bp energy for E_M because the gateway basis points at the center of sensory area, group head of the data on the basis points by a jump transmitted to the gateway, so the energy loss in the power amplifier using free space model ε_{fs} calculation, at this point, the energy consumption and communication is directly proportional to the square of the distance. One bit of data set points of each transmission consumes energy as E_b , the basis points each time send energy consumption is E_T , each receiving energy consumption for E_R . Has the following formula:

$$E_T = l \cdot E_b + l \cdot \varepsilon_{fs} d_{toCH}^2 \quad (1)$$

$$E_R = l \cdot E_b \quad (2)$$

Divided the group head of bp's election and group process to eight main steps, the following will use the expression to the eight steps of energy expression.

1) The head of the group basis to accept the application: $l \cdot E_b + l \cdot \varepsilon_{fs} d_{toCH}^2 \quad (3)$

2) The group head of bp unicast application to join the group: $l \cdot E_b \quad (4)$

3) Group head basis points broadcast announcement statement as:

$$l \cdot E_b + l \cdot \varepsilon_{fs} d_{toCH}^2 \quad (5)$$

4) Group head points to accept data: $(x/y - 1) l \cdot E_b$ (6)

5) The group head of bp accept this notice:
 $l \cdot E_b + l \cdot \varepsilon_{fs} d_{toCH}^2$ (7)

6) The group head of basis points to send data: $l \cdot E_b$ (8)

7) Groups of data fusion head basis points: $(x/y - 1) l \cdot E_A$ (9)

8) Group will head basis points data sent to the gateway:
 $l \cdot E_b + l \cdot \varepsilon_{fs} d_{toBS}^2$ (10)

Cluster head nodes and members of the node energy consumption calculation formula:

$$E_{CH} = l \cdot E_b + l \cdot \varepsilon_{fs} d_{toBS}^2 + (x/y - 1) l \cdot E_b + l \cdot E_b + (x/y - 1) l \cdot E_A + l \cdot \varepsilon_{fs} d_{toBS}^2 \quad (11)$$

$$E_M = l \cdot E_b + l \cdot E_b + l \cdot \varepsilon_{fs} d_{toCH}^2 + l \cdot \varepsilon_{fs} d_{toCH}^2 \quad (12)$$

Each of the rounds, the amount of energy consumption for E_{round}

$$E_{round} = (4x - y) l \cdot E_b + (2x - y) l \cdot \varepsilon_{fs} d_{toBS}^2 + (x/y - 1) l \cdot E_b + (x - y) l \cdot E_A + y l \cdot \varepsilon_{fs} d_{toBS}^2 \quad (13)$$

Members of the node and the average distance between cluster head nodes

$$\begin{aligned} d_{toCH} &= \iint \sqrt{x^2 + y^2} \cdot \rho_1(x, y) d_x d_y \\ &= \int_0^{2\pi} \int_0^{2\pi} r^2 \frac{x}{G^2} d_r d_\theta \\ &= \frac{2\pi x}{G^2} \cdot \frac{1}{3} r^3 \Big|_0^{\sqrt{\frac{G^2}{y\pi}}} \\ &= \frac{2}{3} \cdot \frac{Gx}{\sqrt{\pi y^3}} \end{aligned} \quad (14)$$

The average distance between cluster head nodes and gateway nodes

$$\begin{aligned} d_{toBS} &= \iint \sqrt{x^2 + y^2} \cdot \rho_2(x, y) d_x d_y \\ &= \int_0^{2\pi} \int_0^{2\pi} r^2 \frac{x}{G^2} d_r d_\theta \\ &= \frac{2\pi y}{G^2} \cdot \frac{1}{3} r^3 \Big|_0^{\sqrt{\frac{G^2}{\pi}}} \\ &= \frac{2}{3} \cdot \frac{Gy}{\sqrt{\pi}} \end{aligned} \quad (15)$$

(14) and (15) into (13), and the derivative of E_{round}

$$\begin{aligned} (E_{round})' &= -l \cdot E_b + \left[(2x - y) l \cdot \varepsilon_{fs} d_1^2 \right] - l \cdot E_A + (x/y - 1) l \cdot E_b + (y \cdot \varepsilon_{fs} d_2^2)' \\ &\approx -3 \cdot \frac{8}{9} \cdot l \cdot \varepsilon_{fs} \frac{G^2 x^3}{\pi y^4} + 2 \cdot \frac{4}{9} \cdot l \cdot \varepsilon_{fs} \frac{G^2 x^2}{\pi y^3} + 3 \cdot \frac{4}{9} \cdot l \cdot \varepsilon_{fs} \frac{G^2 x^2}{\pi} \end{aligned} \quad (16)$$

Because $l \cdot E_A$ and $l \cdot E_b$ all very small negligible, (16) is equal to zero [14-15]

$$(E_{round})' = -3 \cdot \frac{8}{9} \cdot l \cdot \varepsilon_{fs} \frac{G^2 x^3}{\pi y^4} + 2 \cdot \frac{4}{9} \cdot l \cdot \varepsilon_{fs} \frac{G^2 x^2}{\pi y^3} + 3 \cdot \frac{4}{9} \cdot l \cdot \varepsilon_{fs} \frac{G^2 x^2}{\pi} = 0$$

$$3y^6 + 2x^2y - 6x^3 = 0 \tag{17}$$

4.2 Simulation and the Result Analysis

Use of MATLAB to solution, in order to better the changing rule of the observed y values, x 50, 70, 90, ..., 990, to take down the whole y value, the results obtained are shown in Table 2. Figure 2 shows the relationship between x and y, where x represents the number of basis points x, y axis represents the number the number of the corresponding optimization grouping and bp y.

Table 2. Number of Basis Points and Improvement Group Categories Corresponding to the Table

x	50	70	90	110	130	150	170	190	210	230
y	6	10	11	12	13	14	15	16	17	17
x	250	270	290	310	330	350	370	390	410	430
y	18	18	19	19	20	20	21	22	22	23
x	450	470	490	510	530	550	570	590	610	630
y	23	24	24	25	25	26	26	27	27	28
x	650	670	690	710	730	750	770	790	810	830
y	28	28	29	29	30	30	31	31	31	32
x	850	870	890	910	930	950	970	990		
y	32	33	33	33	34	34	34	35		

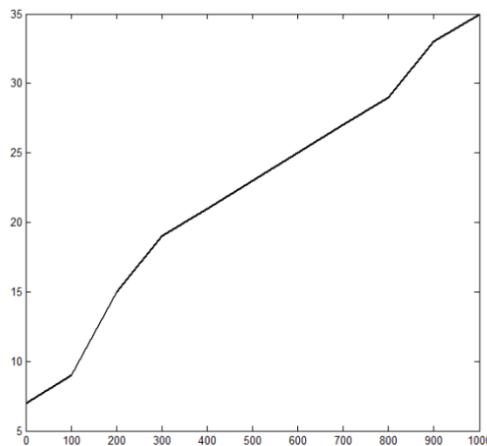


Figure 2. The Number of Basis Points Number and Improved Grouping Diagrams

Can be seen from Table 2 and Figure 2, the number of basis points x increase at the same time, the improvement group class y increase gradually, under some adjacent values of x, y value appeared 2 to 3 times repetition, shows that the overall trend is still with the increase of number of basis points x, improved grouping class y also increases. In a local range of rise in x y little impact.

5. Conclusion

Based on improved grouping kind of energy efficient routing protocol is a kind of

adaptive, distributed routing protocols. It weighted clustering algorithm using adaptive on-demand dynamic group elected head of basis points, the set of head rotation between different points, and therefore has the characteristics of self-organizing, efficient. The entire election process considering the residual energy and the base points adjacent number the two measures. Basis points in this paper based on the sensor and its deployment area to build mathematical model, deduce a given number of basis points improved grouping the computational expressions of the class. Numerical results obtained using the MATLAB software, and the calculation results are analyzed, it is concluded that with the increase of bp number x , improve group class y curve approach gently, as bp number x increases to a certain stage, the overall trend or bp number x increases, the improvement group class y increase, but in a local number x increases the range of bp to the influence of the number of optimization grouping y .

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