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A routing algorithm with virtual optimal hop characteristics based on greedy forwarding

Xiaoqiang Jia[1]*, Chunping Ge[2]

[1]School of Mathematics and Information Science, Institute of Applied Mathematics, Weinan Normal University, Weinan 714099, Shaanxi, (CHINA)

[2]School of Physics and Electrical Engineering, Weinan Normal University, Weinan 714099, Shaanxi, (CHINA)

E-mail : 394892738@qq.com; 446992439@qq.com

ABSTRACT

In the modern wireless sensor networks, greedy forwarding is widely used in geographic routings. However, the “routing void problem” is always around. In order to solve the “routing void problem” in the modern wireless sensor networks, a routing algorithm based on greedy forwarding is proposed by introducing Virtual optimized hop nodes. In this algorithm, as long as the network topology allows, the greedy forwarding data packets (GF) for data packet transmission is used, which will make the routing path algorithm with very high robustness, as well as the final routing path has been generated as close as possible to the shortest path routing. If the greedy forwarding fails (when the routing void problem occurs), the virtual optimal hop method is used to find the next hop node, and to make the greedy forwarding recover work also. The algorithm is simulated in the Wireless network simulation platform based on Java. When routing void problem occurs, the performance of the algorithm is compared with “GEDIR2” and “GPSR”, experiments show that on the premise of the energy consumption, virtual optimal algorithm is superior to “GEDIR2” and “GPSR” on lifetime, data transmission efficiency and stability; avoid using flat graph algorithm and the flooding technology in many traditional protocol, and solve routing void problem routing inside the node topology.

KEYWORDS

Greedy forwarding;
GEDIR2 and GPSR;
Routing void;
Virtual optimized hop.

INTRODUCTION

In recent years, the military communications network construction has made great progress, but due to various reasons, there are deficiencies in some aspects. For example, there exists in interconnection and interworking, cooperation and coordination and the overall guarantee. In order to adapt to the needs of the future, vigorously promoting civil-military integration, flexibly establishing and perfecting the network safeguard mechanism and promoting communication support ability has important significance. And to improve the communication ability, first of all, accurate positioning and accurate data transmission are needed.

With the exponential explosion of the number of wireless terminal box[1]device increasing and performance growth, routing protocol based on location information become an important role in modern wireless sensor network routing protocol with its flexibility, robustness[2], and high scalability[3]. When the transmission range is limited, the multi-hop transmission is necessary from the source node to the sink node in routing path. But in the modern wireless network, the topological structure of the whole network is changed rapidly and randomly, so before arriving at the relay node, node of the choice becomes unpredictable. It is hard to determine an effective routing path. As a highly efficient, data packet transmission method of real-time strong, greedy forwarding[5] is widely used in routing protocol based on location information. But the "routing hole" problem is always inevitable. So, how to solve the "routing hole" problem in the topological structure of an internal node has become an important problem.

In geographic routing[4, 7], a method to solve the routing hole is GPSR[8] algorithm, which combines the right-hand rule and graphic technology to solve the routing hole problem. The right hand rule defines rule selection direction from the plane in the network topology when the routing void problem[15] occurs. However, this rule will result in routing loops. Sometimes because some critical path are deleted leading to some redundant hop. Another one of the most classical methods to solve the routing hole problem is the CEDIR[9] protocol. In fact, it is a variant of the GPSR protocol, as it is with greedy forwarding as a main mode of data packet transmission. However, there also exist some differences between them. In the GEDIR, the nearest adjacent nodes distance from the lodge node will be directly selected as the next hop, without considering the node itself holding data packet. In this route, each decision is made by the local information of nodes. Therefore, the structure of information can not be obtained throughout the network topology information to get the optimal result. In order to find out the relative optimal routing, a flooding technique is used, which also brings a lot of extra energy consumption. Most routing protocols based on location information are combined with greedy forwarding routing and plane routing technology. This technology is called greed - Surface - greedy routing protocol (GFG[5]). In GFG routing, greedy forwarding routing protocol is the main mode of transmission of the data packet; when greedy forwarding fails, that is to say the node cannot find a more closer node to the node than its neighbor nodes, and then the plane routing technology is used to save this failure. In any case, greedy forwarding routing can be applied. Plane routing technology in GFG routing is based on the right-hand rule. In order to ensure its correctness; it must be applied without crossing edges of the planar graph. For a planar graph by the plane composition, plane routing to each data packet gets through along the plane until it reaches a plane spanning subgraphs, which is made as GFG routing base graph. In geographic routing, they are often used as a base graph. For example, Bose et al used the GG[11]and Karp and Kung used RNG. However, GG and RNG[12] are relatively sparse, which make them in the presence of a geographic routing have long routing.

If the greedy forwarding fails (when the routing void problem[15] occurs), virtual optimal hop method can be used to find the next hop node, and to make the greedy forwarding restoration work. With the introduction of some "virtual optimal hop" nodes, a new routing algorithm based on greedy forwarding can be put forward, which can use the existing information in one hop range instead of topology information or flooding technique and flat graph algorithm, and many redundancy hop producing and efficiently solving the greedy forwarding producing the "routing hole" problem can be avoided. By theoretical analysis, which is better than GPSR and CEDIR2[10] methods on the performance, while the advantages of CF algorithm is retained. The algorithm is a routing algorithm based on geographical location information; geographic location information is used to the stateless and efficient in the topology structure in a hop.

In this algorithm, as long as the network topology allows, it will use the greedy forwarding data packets (CF) for data packet transmission, and will make the routing path algorithm with very high robustness, as well as the final routing path generation as close as possible to the shortest path routing. When the routing void problem[15] occursÿvirtual optimal hop method can be used to find the next hop node to overcome it.

THE PROPOSED ALGORITHM

When to use greedy forwarding as a data packet forwarding strategy, there is a challenge to face. If only the neighbor's node location information is used as routing forwarding credentials, an inherent shortcomings is round. Data packet sometimes has to violate greed strategy in some topology structure, move to geometric distance to the node is farther than the current node. For a simple example to describe the situation, as is shown in Numbering of Figure 1., the distance is equal from all points of the dashed arcs to the node D. In Numbering of Figure 1., the node A on the equivalence of arc is more close to the target node G than its two neighbor's nodes (the node B and C). Even though there are two paths A - B - E - G and A - C - F - G to node G, but A can't select greedy forwarding with the data packet to A node or B node. Because the node A is local optimum, in all its neighbor nodes, no nodes is closer than the node G.

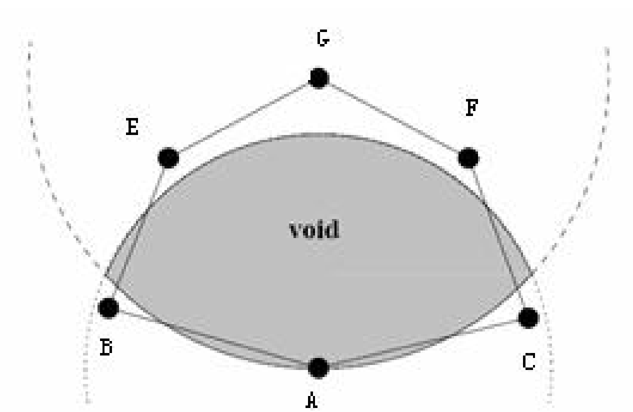

Figure 1 : Routing void sketch

Greedy forwarding

Greedy forwarding strategy was first put forward in order to divide Internet data into packet and optimize them, B. Karp introduce this thought pioneering to wireless sensor network. In the routing algorithm based on the geographic location information, each data packet has its location information from the source node to the host node. So, on the basis of it, of the current node holding a group data can easily make a locally optimal choice to choose their next-hop. In particular, if a node know its location information of neighbors nodes within a hop scope, then the local optimum choice will be selected for the next hop of the current node. Data packet will be forwarded to neighbor node of the host node position in the field until finally the data packet is distributed to the host node.

Greedy forwarding one of the biggest advantages is that it only uses the information of neighbor nodes to handle routing and search for the next hop node. This is a kind of algorithm of statelessness, which has nothing to do with the density of nodes in wireless sensor network and the total number of host nodes in the network. As the density of nodes deployed in wireless sensor network (WSN) space increases, received by greedy forwarding path is more and more close to the shortest path between source node and the host node. As the density of nodes increasing in wireless sensor network, path received by greedy forwarding is more and more close to the shortest path between source node and the host node

Routing void

Evident in Numbering of Figure 1., the circle makes the connection line between the node A and node G as the radius, without any neighbor nodes. From the vision of node A, the shaded area of no any node is called routing void area.

Numbering of Figure 2. compares the routing path of the GPSR algorithm and VOH/GEDIR2 algorithm. The dotted line routing path is realized by the GPSR method, the solid line routing path is realized by the VOH method or the GEDIR2. Node S is the source node and D is the lodge node, the node X is the active node current, others are ordinary nodes. By the introduction the node X in the face of the routing hole[7] problem, nodes A and B are in the transmission range of X and C node in the common. Therefore, based on the technology of planar graph (RNG/GG) routing path obtained from the classical method is (S-X-A-B-C-E-F-J-D), which is due to the critical path (X-C) that was removed in GG or RNG. So in this scene, two redundant hops are increased. With the increase of density of nodes in the network, redundant hop of the GPSR may be more and more. For example, if some nodes locate the common region between A and B, so in order to avoid routing loops, using the right-hand rule of the planar graph technology will removed path (A-B), so there will be added two redundant hops. In wireless sensor networks, each additional hop means that the network has more energy consumption and shorter life. However, the stateless of GPSR is needed. In this scenario, the current node X is not required to maintain routes information to all nodes in the network. That is to say, in the location information table in the local node, X only need to save its neighbor nodes (S, A, B, C) routing information. Moreover, which make any routing decision is not dependent on the information of other nodes, and can make a judgment on the local information in real time.

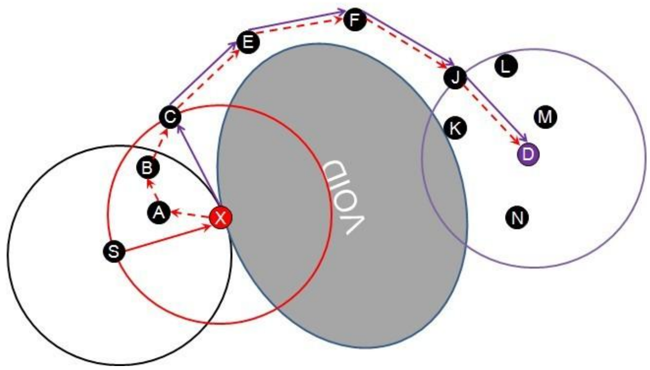

Figure 2 : A scene in the example given on wireless network routing

Using GEDIR2[10] algorithm, the routing paths (S-X-A-B-C-E-F-J-D) may be obtained, which is the same with the VOH algorithm in the scene of the positive results. In this scenario, the cost of VOH and GEDIR2 algorithm seems to be consistent. However, GEDIR2 algorithm is also accompanied by the occurrence of another typical events. In order to obtain the routing path, there is a lot of extra energy loss. Which is as shown in Numbering of Figure 1., X is the active node current and faces the routing hole problem. According to GEDIR2 greedy forwarding rules, X node will choose nearest neighbor node as next hop transmission object distance from lodge node D, that is to say, the node C will directly be selected by X as the next hop node of greed. However, out of the question, in the neighbor nodes of C, without any nodes are more close to the lodge node D than the X node, the data packet will be back to the node X, so the routing void problem occurs. At this time, based on flooding technology, X sends a "Path finder data packet" to all neighbor nodes (S, P, R, A, B, C) rather than the node D. Then, the two hop node information of X nodes can be obtained, such as the node of E information. At this time, X node can design a routing path of two hop range (X-C-E). Then, the data packets are sent from node C to node E. In fact, one potential problem may still affect a good routing decision. Hypothesized that R is nearer to D than E, C is the active node current. Then, data packets are transmitted to the R instead of E in the next transmission. Therefore, in this case, the GEDIR2 will introduce an additional overhead. But the routing path whose achievement is very efficient. Geographic location information of neighbor nodes within the scope of two hops also gives it enough information to make the pilot guidance for future routing decisions.

Therefore, in order to avoid many defects of two kinds of traditional algorithm, as far as possible to maintain their advantages, a virtual optimal hop algorithm is proposed in this paper (VOH) in order to achieve in a structure to obtain a stateless, efficient routing.

RESEARCH METHOD

When greedy forwarding fails, also means that the routing void problem happened. As is shown in Numbering of Figure 3., the algorithm is into the VOH process.

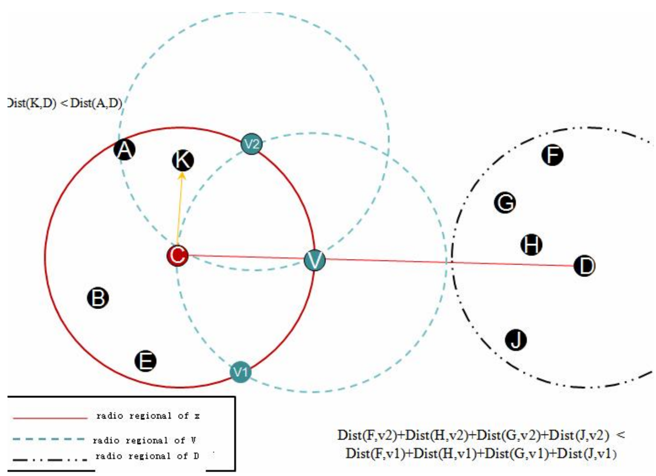

Figure 3 : An application example of virtual optimal hop

Taking an example, the algorithm is described in detail.

As is shown in Numbering of Figure 4., C is the active node current, and face the hole problem, this is no other node close to the lodge node compared its neighbor nodes and C node itself. At this point, draw a straight line between C and D, as a set of optimal hop. If there is optimal hop[5, 6], it must be in this line. Then, the optimal hop is generated in a straight line and a circle of broadcast area for C at the intersection, as is shown in the formula (1),

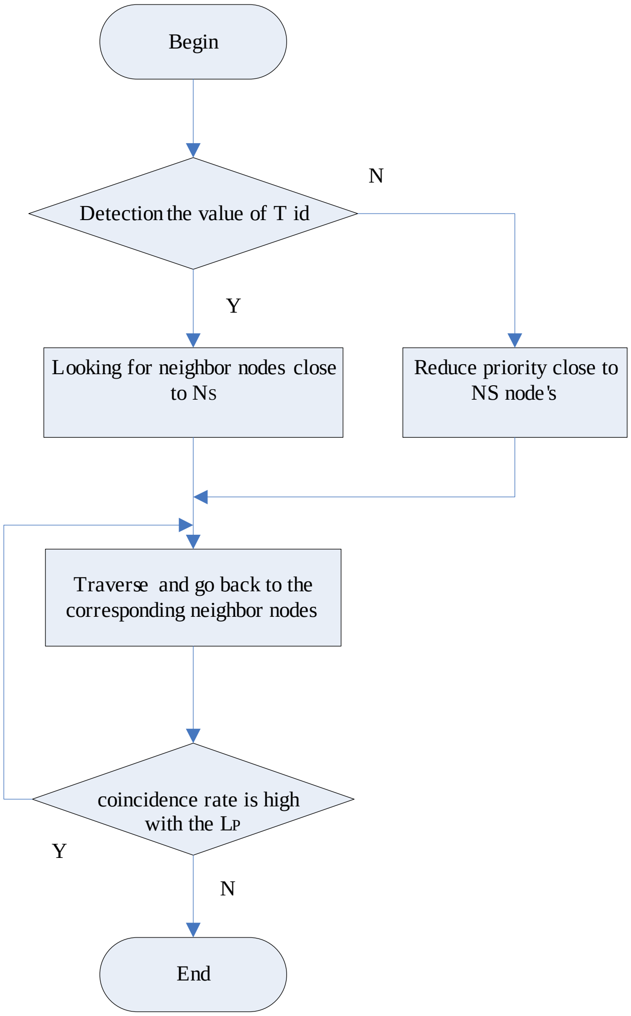

Figure 4 : Data packet backtracking

Where $C(x_c, y_c)$ is for the current node, $D(x_d, y_d)$ as the node.

$$\left\{\begin{array}{l}(x_v - x_c)(x_d - x_c) = (y_v - y_c)/(y_d - y_c) \\ (x_v - x_c)^2 + (y_v - y_c)^2 = r^2\end{array}\right\} \rightarrow v(x_{v,} y_v) \quad (1)$$

$$\left\{\begin{array}{l}(x_{1,2} - x_c)^2 (y_{1,2} - y_c)^2 = r^2 \\ (x_{1,2} - x_v)^2 + (y_{1,2} - y_v)^2 = r^2\end{array}\right\} \rightarrow \left\{\begin{array}{l}v_1 = (x_1, y_1) \\ v_2 = (x_2, y_2)\end{array}\right\} \quad (2)$$

$$\left\{\begin{array}{l}(x_p - x_2) + (y_p - y_2) < r^2 \\ (x_p - x_c)^2 + (y_p - y_c)^2 < r^2\end{array}\right\} \rightarrow p(x_{p,} y_p) \quad (3)$$

Location information based on C and V, using the formula (2) can be calculated by the two node position. The position of V_1 and V_2 is calculated; from the V_1 and V_2 the new virtual optimal hop is selected. Then, Euclidean distance of the neighbor node of V_1, V_2 to node D such as F, G, H and J nodes can be calculated.

In this case, because the V_2 is the shorter distance[16], it was chosen as the new optimal hop. Next, the neighbor nodes are found within the sharing region to V_2 and C, as is shown in equation (3).

In this case, two neighbor nodes can be obtained (A and K). Finally, Euclidean distance the V_2 and between A and K nodes is calculated, the smaller distance of neighbor nodes is considered the next hop to be the active node C. So far, the problem in this case the routing void is solved by VOH algorithm, and finally found the next hop when the routing void problem occurs.

The location coordinates of nodes.

Using greedy forwarding data packet transmission has to confirm location information of lodge node in the scene, in this article, acquiesce in the routing process in a flat topology. Because of modern wireless network topology is the dynamic variation of the moment, so the coordinate information in the data packet will dynamically update with each hop. As for the introduction of node ids, in routing algorithm based on geographical location information, index a corresponding node can through an ID.

Ld : The plane coordinates set of neighbor nodes within a hop scope of Lodge node.

Virtual optimal hop algorithm need to use location information of a hop scope of the node for the new virtual optimal hop choice and apply the information in this list to orientation routing decisions. If directly make the shortest path between the current node and nodes as the half-way line, in node density larger side, hole routing problems is relatively small, so before make routing decisions, which leads to density oriented ahead of time. Due to the node location information is dynamically changed, therefore, its neighbor's nodes information are also changed. Make it more after each hop line, the node list is updated.

Ns and Ps: identification and location information of data grouped into node.

When data packet transmission get to the current node, if unable to find the next hop node usually there are two solutions, one is discarding the data packet. Another is to jump back to the previous relay routing nodes. But, in the dynamic topology, perhaps after a hop of data packet transmission, the source node location have ran out of the current node of wireless communication area, in this case cannot simply discard or jump back to the previous node. Data packet backtracking algorithm is as Numbering of Figure 3.

Lp: passes through the set of the relay node ID from source node to the current.

Lp records the traversed relay routing nodes. And can help us to do some optimization on the routing decisions. In Lp, for example, many ids of the repetitive relay routing node are recored, which means that there are a lot of redundant relay routing in routing decisions. If the next time traverse to the repeated routing with a certain number of relay routing, let their routing weight down to a minimum. Give priority to the choice of the other nodes so as to avoid too much redundant relay routing.

The incoming flag(1/0) of data grouped.

When incoming flag is 1, the data packet is a greedy forwarding to the current node. When the flag is zero, it is believed that the incoming node occurs routing hole problems, then introduced virtual optimal hop algorithm transmit data packet to the current node.

IMPLEMENTATION OF VIRTUAL OPTIMAL ALGORITHM

When a data packet is forwarded to the new routing relay node, flag value of D will be tested by the node, if it is found that D is consistent with the coordinate information of the current node, then the data packet arrives at the lodge node can be determined, data packet forwarding is completed successfully. If not, the next step, check whether the greedy forwarding data packets can be used. In its neighbor list by computation the Euclidean distance value of D can be drawn. If the greedy forwarding fails, then calculate the position information of the first virtual best hop, and then with the location information obtained (potential virtual optimal hop) location information of two intersection points, which calculates the position information for the 2 intersection point to Ld distance value, chooses the smaller as the new virtual optimal nodes. Next, in the cross area to find new optimum virtual hop from the nearest node as the next hop node. Finally, the T flag value is set to 0 in the data packet and forwarded to the next hop node. If it is a greedy forwarding to the T flag, the value is set to 1.

When to use virtual optimal hop or greedy forwarding are unable to find the next hop node, in order to make packet arrive at the next node, the data packet goes back to the last successful transmission packet node to find the possible successful next hop relay node[13] has to be let.

Data packet back is as shown in Numbering of Figure 4., identity values of T will be determined at the beginning, learned from the previous section, when the value is “1”, which means data packet is from greedy forwarding to the current node; when the value is “0”, which means data packet is sent by virtual optimal hop to the current node. If T value is 1, make the current node lie in its neighbor list and look for neighbor nodes close to Ns directly; If the value is 0, node back priority is made descend close to Ns in the neighborhood of the current node list. Then, traverse the entire deployment neighbor list, choose the highest priority of neighbor nodes and go back grouping, in addition, the reference value of Lp is judged

If backtracking point is consistent with the marked point, the coincidence rate is very high. so, the backtracking node will be given up and chosen a next neighbor node as backtracking node. Because the entire network topology is dynamic[13, 14], not only does which control the backtracking by a node ID, but also introduce the concept of Ps, and combined with the calculation of neighbor nodes near the Ps position to reduce the selection range of neighbor nodes. Algorithm process is as shown in Numbering of Figure 5.

THE SIMULATION ENVIRONMENT RESULTS AND DISCUSSION

Parameters of simulation environment include platform and simulation parameters. In the simulation, each object simulation platform is based on Java programming.

Simulation parameters

As shown in TABLE 1., the simulation parameters are described in detail in the TABLE 2.

Assume the initial energy of the node is constant(20J). When a node makes the data packet

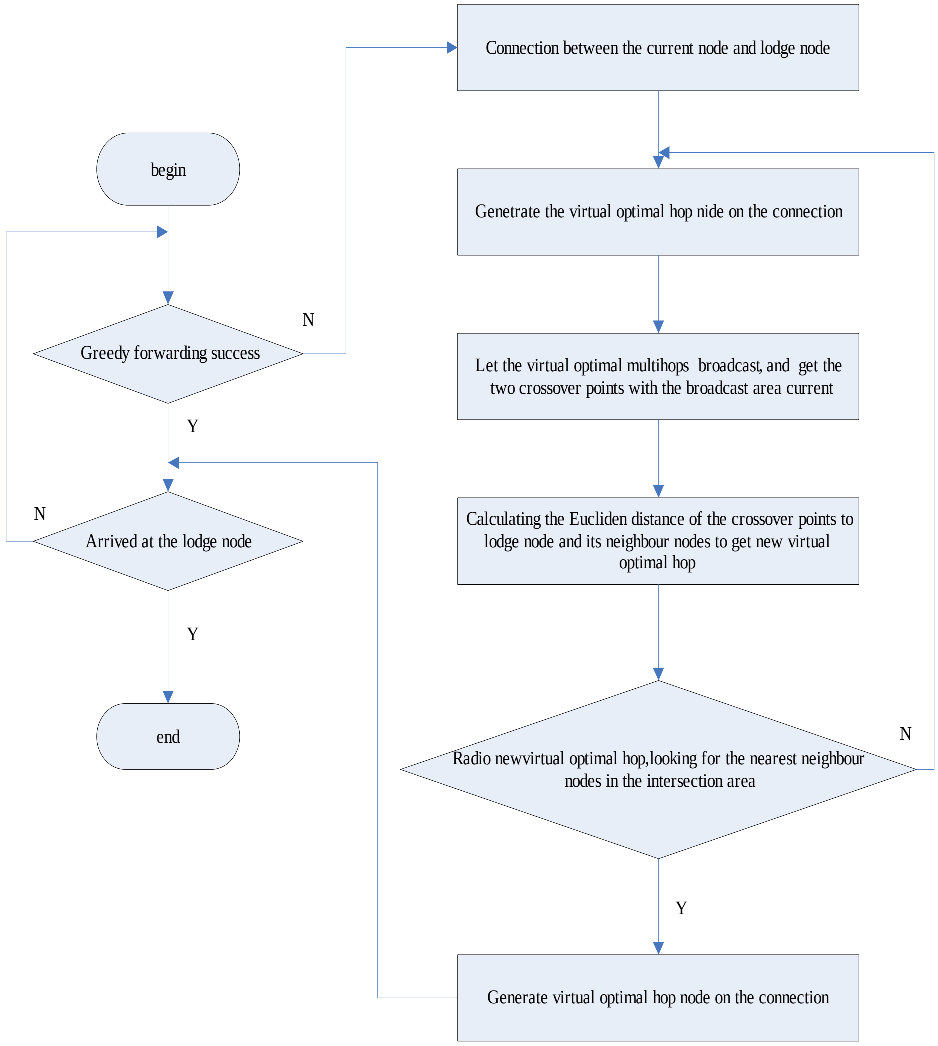

Figure 5 : VOH routing algorithm flow chart

TABLE 1: The virtual optimal hop data packet

Data packet variable	The specific function
D	Identification and location coordinates of lodge node
Ld	Lodge node neighbor node set in one hop range.
Ns	The incoming node ID of data packets.
Ps	The incoming node geographical position information of data packet
Lp	passing through the relay node identification set from the source nodes to the current nodes
T	The introduction flag of data packets. （1/0）

transmission, which consumes about 0.4 joules of energy. When a node receives a data packet, which consumes about 0.2 joules of energy. Simultaneously, the node moving speed value is defined as 30-60 m/round

TABLE 2 : Simulation parameters

The simulation network area	1340*1340 m^2
The broadcast radius of nodes	250 m
The number of nodes	100
The routing void number	1
The routing void area	π*30,000 m^2
primary energy	20J
The transmission power	0.2J
The speed of the mobile node	30-60 m/hop

(from source node to the sink node a complete, successful data packet transmission). Each time 10% nodes are randomly selected and made it moving. Velocity value of node is a randomly value between 30 m/hop and 60 m /hop, and the direction of movement is random. 8 specific direction position numbers are defined as shown in TABLE 3. P(x, y) represents the position information of nodes in the simulation scene, which is the plane coordinates (x, y). S is the speed of mobile node value.

The simulation platform

Using the Eclipse classic 3.5.2 and JDK1.6 as simulation platform, on the basis of it, My Eclipse Enterprise workbench is made an IDE tool.

The simulation results

TABLE 3 : Mobile parameters configuration

direction	location
east	$P(x+s, y)$
northeast	$P(x+\frac{\sqrt{2}}{2}s, y+\frac{\sqrt{2}}{2}s)$
north	$P(x, y+s)$
northwest	$P(x-\frac{\sqrt{2}}{2}s, y-\frac{\sqrt{2}}{2}s)$
west	$P(x-s, y)$
southwest	$P(x-\frac{\sqrt{2}}{2}s, y-\frac{\sqrt{2}}{2}s)$
south	$P(x, y-s)$
southeast	$P(x+\frac{\sqrt{2}}{2}s, y-\frac{\sqrt{2}}{2}s)$

TABLE 4 : The average death round number of GPSR,GEDIR2, and VOH

	GPSR	GEDIR2	VOH
death round number（200 nodes）	1245.2	625.3	2771.0
death round number（110 nodes）	1096.1	614.9	2098.7

When the number of nodes in the network is less than 30, the network is the state of death. When the network of death, the final round of three kinds of algorithms and survival nodes will be measured and recorded(death round of GPSR, GEDIR2 and VOH in Numbering of Figure10.). Did 10 times experiments in the same simulation scenarios, and then get the 10 groups data packets. To improve the reliability of experimental data obtained, which is made by grouping the average results of the 10 values. The effects of each algorithm were showed. Scene simulation of different parameters of the experiment found that adding the physical routing holes in the 1340*1340 scene, probability of occurrence of the routing void problem is far beyond other scenes. So the scene itself can illustrate the problem. And set in the simulation, only when a routing hole problem occurs, node data packet forwarding and receiving will consume energy.

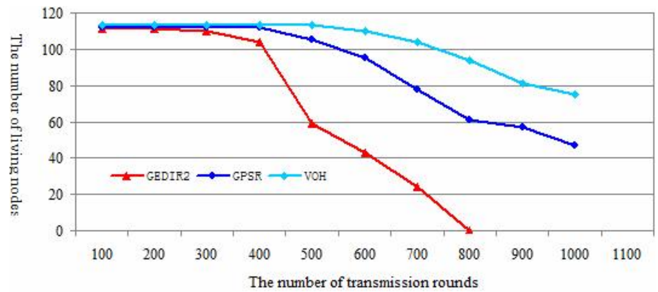

Figure 6 : The life cycle assessment (110 nodes)

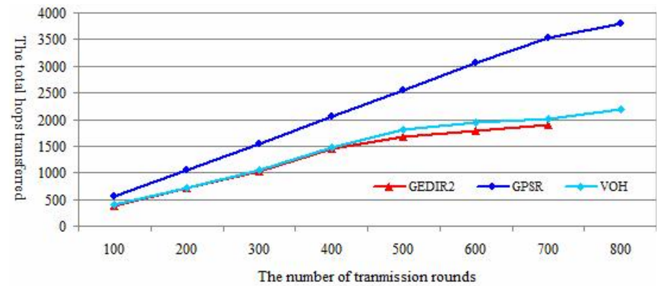

Figure 7 : Transfer efficiency assessment (110nodes)

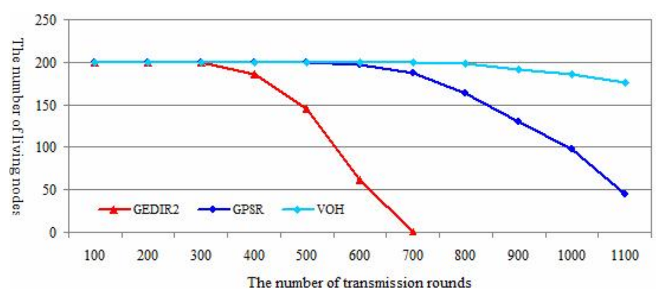

Figure 8 : The life cycle assessment (200 nodes)

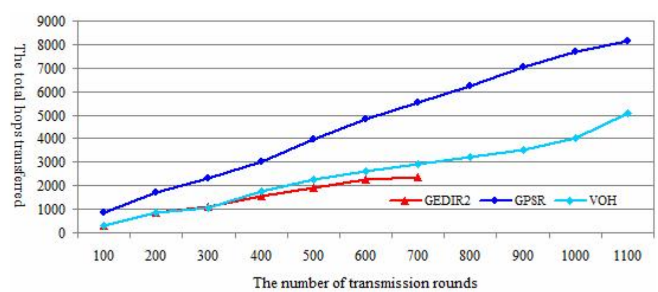

Figure 9 : Transfer efficiency assessment (200 nodes)

Likewise, Numbering of Figure 6. shows a similar result to Numbering of Figure 8.; the difference is the node density added in the experiment scene. In the same simulation environment the simulation experiment is also done 10 times, and then the average value of the living nodes of the three different stages in the algorithms has been made.

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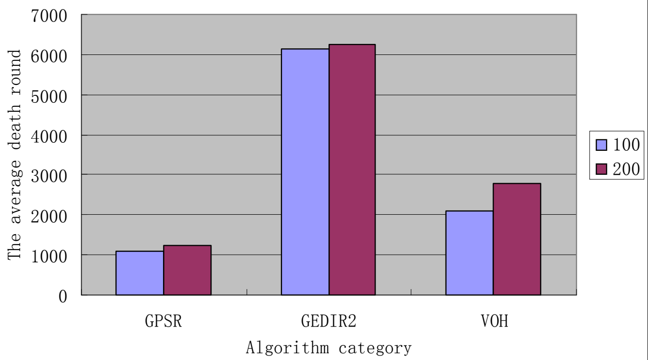

Figure 10 : Each average death round of GPSR,GEDIR2 and VOH

Numbering of Figure 7. and Numbering of Figure 9. illustrates the hop count routing path generated by the three algorithms and their changing trend with the increasing data packet forwarding round numbers. Three algorithms are evaluated in the same experiment scenes. After 100 rounds of data packet transmission, a hop count can be recorded each time. And also average value of 10 simulation results are obtained as the final experimental evaluation values. About the experimental results, some must feel very confused. That is, GEDIR2 can always use less hops to complete data packets in the same round than GPSR and Virtual optimal hop algorithm, but the life cycle is much shorter than the other two algorithms. It seems to be a paradox; in fact, there is no logical conflict between the two. First of all, the hop number calculation is recorded by detecting node of relay routing list stored by a successful transmission message object. However, to achieve an efficient transmission of the data packet routing path, GEDIR2 need to consume more extra energy than the other two algorithms, therefore its life cycle is shorter.

VOH is compared with GPSR and GEDIR2 on simulation results

In order to get better assess life cycle and data grouping efficiency, simulation with 110 nodes are completed. Numbering of Figure 6. and Numbering of Figure 7. describe in 100 nodes distributed randomly scenario, a performance comparison of 3 methods. Similarly, Numbering of Figure 8. and Numbering of Figure 9. describe performance comparison in the 200 node scene.

Numbering of Figure 7. and Numbering of Figure 9. give the development track of each kind of life cycle. As is shown in Numbering of Figure 7., in the simulation scene of 110 nodes, GEDIR2 was depleted in the 614.9 round. After the 370 round, which has a significantly reduce. The curve to GPSR algorithm is smoother than GEDIR2, and continuous 1096.1 rounds. When the routing void problem occurs at very high frequency, life cycle is long. Compared with the previous two methods, VOH always adheres to the 2099 round before being exhausted.

Numbering of Figure 7 and Numbering of figure 9 shows the trajectory of life cycle of each kind of method, when routing void problem is high frequency, VOH has a longer life cycle than GPSR and GEDIR2.

When node density increase in the experiment scene, VOH algorithm have a longer life cycle than the other two methods. Numbering of figure 6 and Numbering of figure 8 described hop trend of routing path in three algorithm. VOH has more efficient than GEDIR2 and GPSR on reducing the overhead to routing path. Numbering of figure 7 and Numbering of figure 9 has been proved the energy of consumption in VOH is more closer to GEDIR2, and has higher data packet transmission efficiency

In Numbering of Figure 7 and Numbering of figure 9, before 800 round, VOH method has almost no death node on transmitting data grouping, with the increase of the node density, overall performance of VOH is more stable than GPSR and GEDIR2.

The defect of the experiment

Because did not think of the MAC layer and physical layer, the simulation was conducted in an ideal environment. That is to say, in a wireless network without signal collisions and channel interference at MAC layer, but merely to study the routing layer, suppose all the underlying environment is the same. Three algorithms (GPSR, GEDIR2 and VOH) in dynamic simulation scene, in all possible circumstances, use greedy forwarding algorithm to transmit data packets. Among which, virtual optimal algorithm is proved in very scene of the routing hole problem happening frequent, which have a longer life cycle than the GPSR and GEDIR2. To reduce the routing overhead, VOH and GEDIR2 have higher efficiency than GPSR for routing path when the node density increases, the overall performance of the VOH is more stable than the GPSR and GEDIR2.

The signal collision and interference always exist in real environment. So, in the future work and study, In order to make the communication between nodes and the probability of channel occupancy and distribution[14], adding matching optimization strategy of physical layer and MAC layer is necessary.

CONCLUSIONS

A new algorithm with virtual optimal hop characteristics routing has been proposed. The algorithm is a routing algorithm based on geographical location information. Geographic location information is used to achieve stateless, and efficient in a hop topology structure. In this algorithm, as long as the network topology allows, the greedy forwarding data packets (GF) for data packet transmission is used, which will make the routing path algorithm with very high robustness, as well as the final routing path has been generated as close as possible to the shortest path routing. If the greedy forwarding fails (when the routing void problem occurs), the virtual optimal hop method is used to find the next hop node, and to make the greedy forwarding recover work also, it does not need to use to lead to redundancy plans optimization algorithms (such as RNG and GG), as well as some flooding class forwarding technology. When routing void problem is high frequency, VOH has a longer life cycle than GPSR and GEDIR2.; and has more efficient than GEDIR2 and GPSR on reducing the overhead to routing path. With the increase of the node density, overall performance of VOH is more stable than GPSR and GEDIR2.

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REFERENCES

[1] Yu-Tso Lin, Yo-Sheng Lin, Shey-Shi Lu; A Low-Power 2.4-GHz Receiver Front-End For Wireless Sensor Networks, Microwave and optical technology letters, **51(12)**, 3021-3024, **(2009)**.

[2] Hui-Ching Hsieh, Jenq-Shiou LeuWei-Kuan Shih; A fault-tolerant scheme for an autonomous local wireless sensor network, omputer Standards and Interfaces, **32(4)**, 215-221, **(2010)**.

[3] Zhenyu Zhang, W.K.Chan, T.H.Tse, Heng Lu, Lijun Mei; Resource prioritization of code optimization techniques for program synthesis of wireless sensor network applications, The Journal of Systems and Software, **82(9)**, 1376-1387, **(2009)**.

[4] Subramanian, Shakkottai; Geographic Routing With Limited Information in Sensor Networks, IEEE Transactions on Information Theory, **56(9)**, 4506-4519, **(2010)**.

[5] Fraser Cadger, Kevin Curran, A.Jose Santos, Sandra Moffett; Mobility and delay in greedy geographic routing, International journal of satellite communications policy and management, **1(3)**, 106-119, **(2012)**.

[6] S.De; On hop count and euclidean distance in greedy forwarding in wireless ad hoc networks, EEE communications letters, **9(11)**, 1000-1002, **(2005)**.

[7] G.Xing, C.Lu, R.Pless, Q.Huang; Impact of sensing coverage on greedy geographic routing algorithms, IEEE Transactions on Parallel and Distributed Systems, **l17(4)**, 48-360, **(2006)**.

[8] B.Karp, H.T.Kung; GPSR: Greedy Perimeter Stateless Routing for Wireless Networks, Proc. ACM MobiCom, 243-254, Aug. **(2000)**.

[9] Brad Nelson Karp; Geographic Routing for Wireless Networks, "Proc. Doctoral dissertation in Harvard University, October, **(2000)**.

[10] Ivan Stojmenovice, Xu lin; Loop-free hybrid single-path/flooding routing algorithms with Guaranteed delivery for wireless networks. IEEE Transactions on Parallel and Distributed Systems, **12(10)**, 1023-1032 **(2001)**.

[11] K.Gabriel, R.Sokal, A New Statistical Approach to Geographic Variation Analysis, Systematic Zoology, **18**, 259-278 **(1969)**.

[12] G.Toussaint; The Relative Neighborhood Graph of Finite Planar Set, Pattern Recognition, **4(12)**, 261-268 **(1980)**.

[13] Sojeong Ann, Hyung Seok Kim; Relay association method for optimal path in IEEE 802.16j mobile multi-hop relay networks, European transactions on telecommunications, **21(7)**, 624-631 **(2010)**.

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[14] Huang, C.-H.Scott, Sun, Min-Te, Liang, Qilian, Wan, Peng-Jun, Jia, Xiaohua; Interference-Aware, Fully-Distributed Virtual Backbone Construction and its Application in Multi-Hop Wireless Networks, IEEE Transactions on Communications,.**56(12)**, 3550-3560 **(2010)**.

[15] Tian Le Xie, Dong-liang Ren, Biao Zhang Lei, Cheng Shi-duan; Routing Void Problem of Greedy Forwarding Strategy in Wireless Sensor Networks. Journal of Electronics&InformationTechnology, **29(12)**, 2996-2999 **(2007)**.

[16] Li Mu-dong*, Xiong Wei, Guo Long; Intelligent algorithm for locating nodes in wireless sensor network based on processing strategy of optimal hopping distances, Journal of Computer Applications, **32(7)**, 1836-1839 **(2012)**.