International Journal of Smart Home
Vol. 9, No. 6 (2015), pp. 119-132
http://dx.doi.org/10.14257/ijsh.2015.9.6.14

The Research on Smart Home's Wireless Control Mechanism

Yang Zhongguo[1] and Cai Tianfang[2]

[1, 2]*College of Mechanical and Electrical Engineering, Zaozhuang institute, 277160, China*
13589610269@163com

Abstract

In order to improve smart home's wireless control measure and overall level of smart home, the current concerned problem is to design a wireless network protocol that is low-cost, easy to develop and oriented to the field of smart home. The paper puts forward the general framework of smart home's wireless control on smart home's wireless control protocol and specific applications, and designs hardware and network structure for this system. By combining with design and algorithm implementation of repeaters, the paper improves WSN routing protocol, which is based on applications of smart home, and geographical routing protocol, which is appropriate for this scene. Meanwhile, the paper applies double bounce greedy algorithm and routing void mark to improve the problem of routing void. In this way, it avoids from the generation of routing void to the greatest extent. Through the simulation experiment, it can draw a conclusion that comparing with GPSR protocol and GEAR protocol, the improved protocol has a great improvement on node energy consumption and effective avoidance of routing void. It makes network performance improve to a greater degree. Before deploying smart home's network nodes, it should pay more attention to deploy the number of nodes. In appropriate node deployment, better network performance of smart home can be obtained.

Keywords: *Smart home, wireless control, protocol improvement, models*

1. Introduction

With the constant development of computer network and modern communication technology, home intelligentization has already received increasingly popular [1, 2]. Smart home is a high-tech product brought by the information era. It is an inevitable requirement, when people pursue for high-quality living conditions. In the future, smart home will be the indispensable necessities of life and possess broader market prospect simultaneously. The development of smart home will drive the development of internet of things simultaneously. The development of smart home system will be an irresistible trend of our residential technological innovation and an inevitable choice of modern residential industry [3, 4]. By combining with current advanced network communication technology, bussing technique and computer technology, an irresistible trend of technical innovation in our residential field is to apply the technology of commercial intelligent buildings into civil architecture. At the same time, implementation of smart home system is also the necessary approach to drive the modernization of our residential industry.

Application of Wireless Sensor Network (WSN) in smart home is one of hotspots in WSN technology application research field. Design of smart home's WSN routing protocol is a critical problem. In smart home, because of limited sensor node energy, limited deployment regions and the limited number of nodes, the routing protocol of geographical location information is more appropriate for smart home's routing protocol as the demand for manual deployment, larger node density, more complicated home equipment. Therefore, studying and designing WSN routing protocol of geographical

ISSN: 1975-4094 IJSH
Copyright ⓒ 2015 SERSC

location information that is appropriate for smart home will have an important academic significance and practical value.

Smart home network includes low-speed control network and high-speed information network. Control network mainly realizes the automatic control and monitoring on the equipment, *etc.* On the other hand, information network mainly realizes the transmission of voice and video, *etc.* At present, smart home network gives priority to wired form. However, smart home network built by wireless sensor network technology can have good monitoring on home environment and convenient networking. It also can realize remote control. Therefore, the author studies its applications in smart home in accordance with these characteristics of Wireless Sensor Network, puts forward a recommendation on establishing smart home network based on wireless sensor network, as well as sets up this network model.

2. Wireless Sensor Network

Wireless Sensor Network [5-7] synthesizes the sensor technology, embedded computing, modern network and wireless communication technique, *etc.* multiple advanced technologies. It is self-organized distributed network system that is consisted of small and ubiquitous sensor nodes with wireless communication and computing power. Through real-time monitoring, perception, collection environment and information of monitoring objects assisted by various integrated micro-sensors, information processing of embedded system and self-organized wireless communication network, it can send perceptual information to the user terminal in the way of multi-hopping trucking scheme. In this way, users can master the condition of the monitoring area and respond. Comparing with traditional wireless network, wireless sensor network possesses some obvious characteristics. Structure of wireless sensor network is shown in Figure 1. In sensor network, the function of every node is the same. A lot of sensor nodes are arranged in the observation area. After each sensor node conduct preliminary data processing and information fusion on detected useful information, each sensor node transfers it to users. The process of data transfer is sent to the receiver in the way of refile through adjacent nodes. Then it is sent to the final user through wireless or Internet.

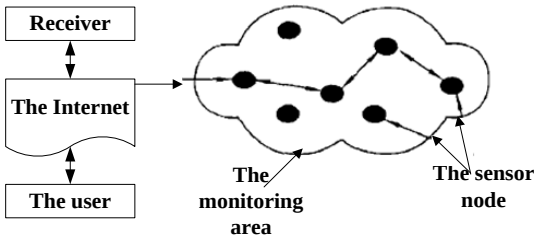

Figure 1. Sensing Process of Wireless Sensor

3. General Framework of Smart Home's Wireless Control System

For control of computers and various household appliances, users often adopt the ways of decentralized control and decentralized management. Its disadvantage is that various electric appliances can be networking, so users can't control uniformly. In such a situation, the paper puts forward a kind of imagine, which utilizes multi-interface to conducing united networking and centralized control on all household appliances. Meanwhile, the paper makes use of an intelligent control terminal to realize integral control [8-10]. Smart home's control terminal equipment can be integrated with the following parts [11]: common household appliances. Intelligent control terminal provides multiple connectors for household appliances and assigns an only ID automatically to equipment connection, so as to ensure plug and play and realize centralized control of

 Copyright ⓒ 2015 SERSC

equipment, such as, turn on/off of household appliances, function set of equipment and check on equipment status, *etc.* Security equipment: intelligent control terminal connects to family security monitoring equipment. Alarm signal can report back to users through control terminal. Users can check the state of family at any time through control terminal. Domestic medical equipment: control terminal is equipped with specialized and unified peripheral interface to connect with domestic medical equipment, can realize remote medical consultation and patient monitoring, *etc.* functions. Structure diagram of Internet of Things' smart home terminal is shown in Figure 2.

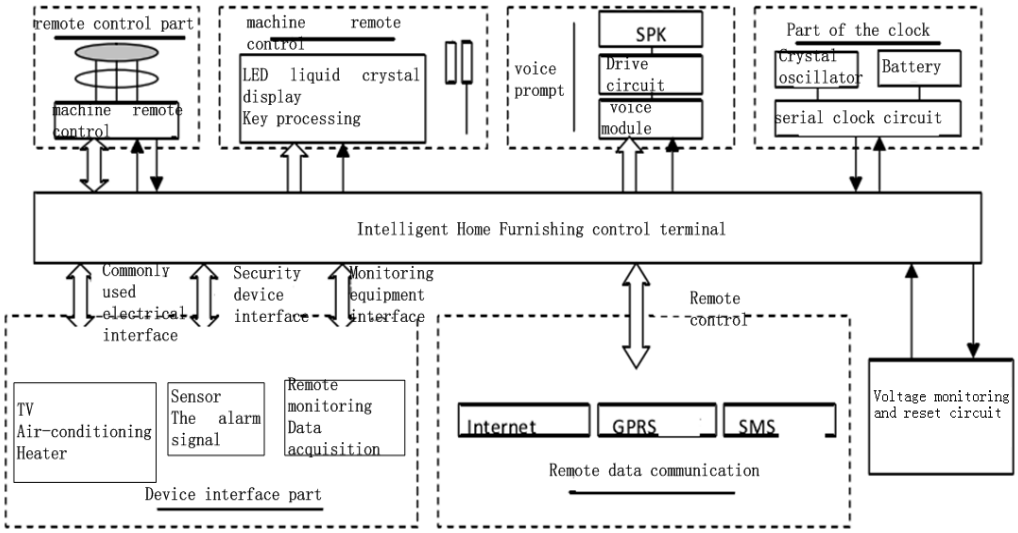

Figure 2. Structure Diagram of Internet of Things' Smart Home Terminal

Common household appliances, security equipment and domestic medical equipment is mutually connected through RS-485 bus and assigns an only access ID to every electrical equipment to realize equipment centralized control. Remote control: users can conduct remote control through Internet and GPRS network. Domestic various alarm signals can be sent to users in the form of short message and multimedia message through GPRS. In this way, users can know running status of domestic equipment in time and ensure their property safety. Man-machine interaction includes remote control, display, voice prompt and clock. Through harmonious man-machine interaction design, users can experience various conveniences brought by modern home intelligentization sufficiently.

4. Hardware Design

4.1. Network Structure and Hardware Structure Design

RS-485 bus interface designed in this paper is directly connected with serial port 0 of embedded processor and achieves communication through two pins of TXD and RXD, as well as level shifter. In the mode of parallel transmission, RS-485 transmission line should connect to final resistance. When adopting two kinds of different modes of connection, it can realize different functions. If adopting the connection method of four lines, it only can realize one-to-many data communication. A pin of the microcontroller connects to the output of RS-485. The change of intellectual electric apparatus' connection state can be determined by conducting a test on time hopping of this pin level. The function of signal processing circuit is to isolate output level of intellectual electric apparatus from electrical signals in bus. By using SN75176, serial interface in single-chip microcomputer can be transformed into RS-485 interface. In this way, it can realize serial

Copyright ⓒ 2015 SERSC

port communication between each connected household appliance and embedded development board. RS-485 network structure is shown in Figure 3.

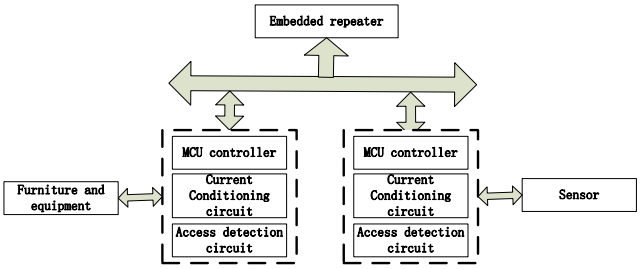

Figure 3. RS-485 Network Structure

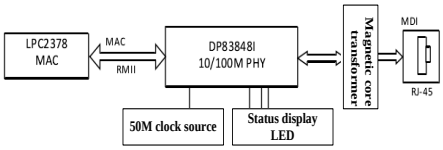

Figure 4. DP83848I's Hardware Structure

The system uses 10/100M Ethernet module of DMA in LPC2378 of ARM processor. It greatly improves the delivery and receiving rate of data package, increases timeliness of system delivery and receiving data and reduces workload of microprocessor. In ARM process, Ethernet module's RMI interface chip connects to Ethernet PHY chip (DP83848I). DP83848I's hardware structure is shown in Figure 4. MA delivery and reception data are responsible for information transmission of data buffer and data bus. Delivery of SMA Manager is to write data transmission, transmission state and descriptors in storage. Module can resend this data, handle an abnormal termination and control the delivery of data. The function of receiving manager is to take charge of detection information, filtering specific data frames and storing valid data. RMII is responsible for conducting real-time data transmission with DP83848I, as shown in Figure 5.

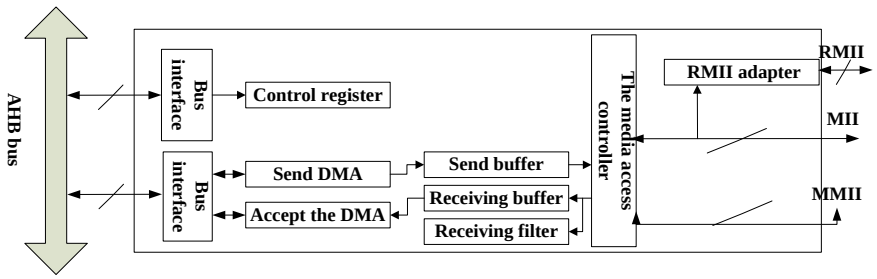

Figure 5. Data Transmission Diagram between RMII and DP83848I

The key of remote alarm control in GPRS of this paper involves in: ①adopting embedded system to realize the function of sending and receiving short message; ② conducting rational analysis and process by collecting abnormal signal through site acquisition terminal. When detecting abnormal information, such as, discovery of fire behavior, it should open self-extinguishing plant immediately; ③ sending camera's capture pattern information to wireless communication module through serial port. Then it sends to users, control system and serial communication module through GPRS. By using a relay, the operation of turning on/off domestic electrical equipment can be implemented. Control terminal of this equipment must be directly controlled by ARM

 Copyright ⓒ 2015 SERSC

controller's I/O pin. When connecting to ARM processor's SIM300 communication module, level switch should be conducted, while MAX232 is the commonest chip of level switch. Interface schematic diagram of MAX232 chip of level switch is shown in Figure 6.

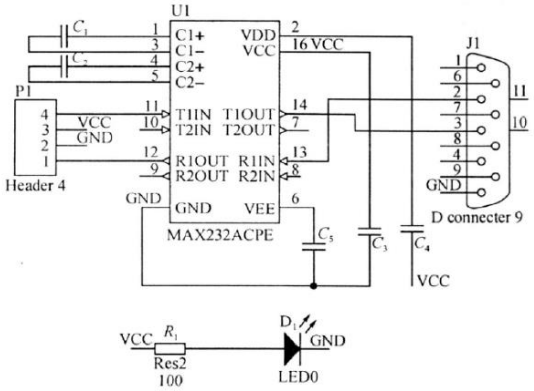

Figure 6. Interface Schematic Diagram of MAX232 Chip

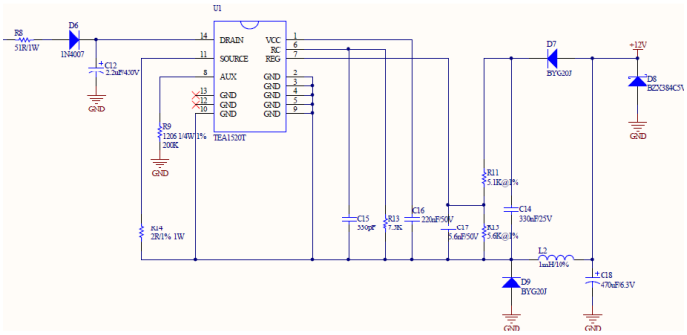

Figure 7. AC-DC Circuit Design

4.2. Design of Repeaters

Repeaters adopt TEA1520T chip, design simple-type switching power supply and mainly provides 5V/12V direct-current main for each chip. D6 is rectifier diode, and C2 is filter capacitor. They can rectify 220V AC Power into DC. L2 and C18 are the equipment of follow current and maintaining power for switching power supply. D8 is direct-current stabilizer. R13 and C15 are oscillation resistance and vibration capacitance, respectively, consisting of RC oscillating circuit for TEA1520T chip. R14 is over-current detection. Taking advantage of current foldback circuit can limit drain current to surpass the ultimate value. R9 is demagnetized resistance. R8 is partial pressure protective resistance to protect TeA1520 and improve interference resistance of circuit. C16 is power supply VCC filtering of TEA 1520 chip. Output feedback circuit, after output direct-current main goes through D7 and C14 filtering, as well as partial pressure of R11 and R15, it can obtain feedback voltage Ureg and add to Pin7 of TEA1520, as shown in Figure 7.

Because products require that output power should reach +16dBm, while radio frequency module CC1101 only has +1-dBm of the maximum power output, it requires for external PA circuit can reach this requirement. PA circuit adopts MOS pipe 2SK3078. Radio frequency receiving and transmission circuit path use high-frequency switch AS179 to isolate. Antenna adopts high-gain external antenna, as shown in Figure 8.

Copyright ⓒ 2015 SERSC

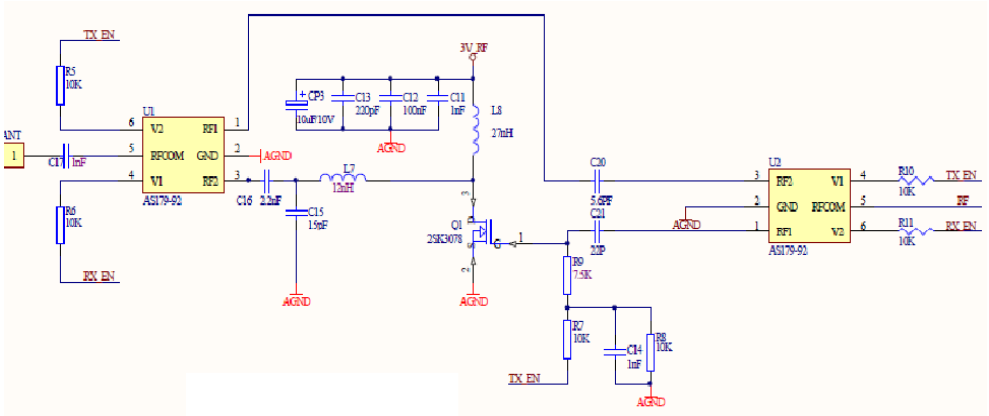

Figure 8. The PA Circuit Diagram of RF Receiving and Delivery

Logic design of relay route concerns whether signal processing can realize the optimization and is schematic figure 9 of algorithm. The core thought is that gateway equipment can select the routing automatically in line with signal strength of wireless lighting controller transferred by every trunking, when the equipment register and control.

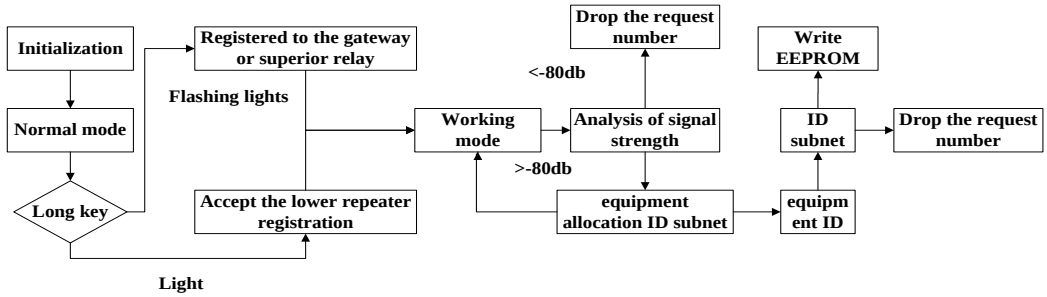

Figure 9. Logic Design and Registration's Flow Diagram of Relay Route

5. WSN Geographical Routing Protocol Improvement Based on Applications of Smart Home

5.1. Design Idea of Smart Home's WSN Routing Protocol

Smart home environment is stable. The scope of node deployment is limited. The scale of nodes is smaller, so network nodes require for manual deployment. Redundant information between nodes is less. There is no need for data fusion. Moreover, it's hard to adopt hierarchical routing protocol. The limited energy of nodes should avoid from utilizing flooding route. It should reduce the energy dissipation as much as possible. It's difficult to apply the data-centered routing protocol. Node position and network topology are basically fixed. Location information is comparatively easy to be obtained by subordinating degree function, so it's better to apply geographical routing protocol. For parts of nodes in smart home, geographical location information of most of nodes is relatively important. It is significant for data collection to obtain the geographical location information. For example, condition monitoring sensors of household appliances, if the condition of household appliances is abnormal or household appliances break down or electric safety problems is caused by power failure, it requires for first aid of control center. Thus, geographic position is the important information for locating smart home's problems.

After selecting appropriate smart home's routing protocol, it should take routing algorithm into consideration in line with the characteristics of routing protocol. Because

 Copyright ⓒ 2015 SERSC

single-hopping greedy algorithm of GEAR protocol has routing void, while this phenomenon has severe wasting of resources under the circumstance of larger void. In order to solve this problem, the paper applies the strategy of double bounce routing and marked routing void in the improved protocol, and selects routing through the smallest cost of double bounce routing. This is an improvement on local optimum of greedy algorithm and a mark on the nodes of routing void. In this way, it can avoid from routing void more effectively, so as to save more energy of nodes.

5.2. Improvement Project on Geographical Routing Protocol's Routing Void Problem

Case I: The next optimal node of nodes' minimum routing cost node is failure node, as shown in Figure 10. Assumed that transmit energy cost of node data in unit distance is invariable, data grouping is from node A to node S. According to single hop greedy routing algorithm, the next minimum cost node of node A is node B. However, because B's minimum cost node C is failure node, B will get into routing void, so it selects suboptimal node E. If node A adopts two bounce routing algorithm, the neighbor list of node A have the status information concerning B and C. It can know that C has already been failure in advance. Moreover, it can judge B is routing void node, so it will select node E as the next one, so as to save more energy.

Case II: The node's next minimum cost node is routing void node, as shown in Figure 11. Node A sends data grouping to Node S. If it adopts single hop greedy algorithm, the next node of minimum cost is B, while node B doesn't have closer node than its targeted node. Therefore, node B is routing void node. Ultimately, node B still sends grouping to node E. On the other hand, if it uses double bounce greedy routing algorithm, node A will get node D through node E directly and arrives in the targeted node S.

Case III: The next node of node's next minimum cost node is routing void node, as shown in Figure 12. Aiming at routing void problem of double bounce, there are two kinds of conditions: IGEAR protocol applies double bounce greedy routing mechanism, and adds routing void node mark place (represented by hole parameter) to list information of the neighbor node simultaneously. According to the following analysis, there are two conditions: it knows that node C is routing void, and it doesn't know that node C is routing node. When it knows node C is routing node, its hole parameter is set as 1. Before data transmission, it should judge whether double bounce is routing void node or not. If it is judged as routing void node, it can select another path to transmit data continuously, so as to avoid from this routing void path. If it doesn't know that node C is routing void, grouping will be transferred to C through node B. In the process of looking for the next double bounce routing, node C finds that it is routing void node. Node hole parameter is set as 1 and sends help message to inform all neighbor nodes. Meanwhile, it selects the subminimum node of routing cost in double bounce nodes to transfer grouping continuously.

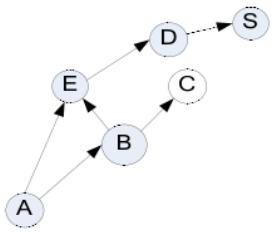

Figure 10. Double Bounce Greedy Outing

Copyright ⓒ 2015 SERSC

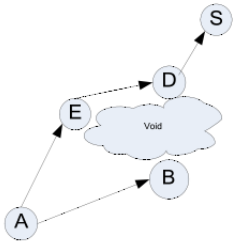

Figure 11. Advanced Discovery of Double Bounce Greedy Routing Void

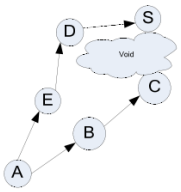

Figure 12. Avoidance from Void through Routing Void Label Method

Assumed that nodes are uniform distribution in certain rectangular region of smart home environment, there are only 8 single hop nodes and 16 double bounce nodes around the center nodes. If it needs to judge whether center nodes are the routing void node, it should take energy cost surrounding 24 nodes into consideration. In this way, it can reduce the probability of making nodes become the routing void node greatly.

The node function is defined as:

$$n(N) = \{N_{j,i}() \, dist \, (N, N_{j,i}) Z < R, \, j = 1,2, i < n\} \quad (1)$$

R is the radius of the scope of information collect. Nj, i is the number of j hop's distance of node N to neighbor nodes of i. Under the situation of applying double bounce greedy routing and node void label to improve strategy, within the node communication range, there is no minimum node that is closer to targeted node than this one in node sets of single hop and double bounce. In such a situation, nodes can become the routing void node. Improvement strategy can avoid from failure nodes and routing void problem more effectively than single hop greedy routing program.

5.3. IGEAR Protocol Network Model

IGEAR protocol network model includes network scene, node composition, node communication and deployment strategy, and specific situations are as follows:

① Network scene: multiple sensor nodes are deployed in smart home environment, are responsible for monitoring, alarming and corresponding intelligent processing function of various functions in family environment. For example, it can turn off family electric lights and implement power failure on fault household appliances automatically, when no people stay at home. When some events happen, event information collection nodes will transfer data information to control terminal through routing.

② Node composition: except for control terminal, all nodes including sensing module, data processing module, communication module, power module and positioning system module have the same primary energy and status. Nodes have the same information sending power.

③ Node communication and deployment: every node can collect the information at random in the range whose radius is R. Nodes adopt full duplex link. Within the

 Copyright ⓒ 2015 SERSC

communication distance, arbitrary two nodes can communicate mutually. Nodes are deployed in smart home environment manually, and assumed that all nodes are stationary.

④ Double bounce routing and node void label method: every node obtains its location information by using location algorithm, such as GPS location and trilateral location algorithm, *etc*. It sends its location and rest energy to its neighbor nodes periodically at some interval. Every node updates corresponding information in time, records the information of single hop's neighbor nodes and double bounce's neighbor nodes within the communication range, and marks routing void nodes in routing process simultaneously.

IGEAR protocol inquires the realization process of two stages in information spreading: 1) aggregation nodes send inquiry command to the nearest nodes in monitoring area; 2) the sequence of inquiry command is sent to all nodes in monitoring area and resends inquiry getting data information to Sink node along the above-mentioned inverse path.

① Send inquiry information to the nearest nodes in monitoring area. Beginning with Sink node, it is spreading process of inquiry information. It establishes routing in the form of double bounce greedy algorithm. The node selects the node with the minimum cost in double bounce as the double bounce routing, and selects the minimum integrated cost node between this node and double bounce node as middle transmit node, so as to complete data transmission. In routing process, the discovered routing void node is labeled by whole parameter and informs its neighbor nodes to change the void node routing information. The calculation of routing cost is as shown in formula (2).

$$c(A, D) = a \times d(A, D) + (1 - a) \times e(A) \quad (2)$$

The node still obtains information of neighbor nodes in the way of hello information and stores it in Neighbor List. The list includes the following information: location information between neighbor nodes of single hop and double bounce, energy information and routing void information. The routing void information is represented by hole parameter. The node needs to broadcast its information and single hop neighbor nodes' information to the node's single hop neighbor nodes, respectively, by making use of two information exchange. Every node records the information of neighbor nodes within the range of double bounce. Based on A, node sets of single hop and double bounce are represented by S (A)-1 and S (A)-2, respectively. When selecting greedy routing, it can conduct routing optimization in line with the information of double bounce neighbor nodes and reduce the occurrence probability of routing void.

Assumed that the current node is A, targeted node is D, and the front single hop node of A is P. The specific realization process is as follows:

1) Look for the existence of targeted node D in set S (A)-1, send the grouping to D, and complete data transmission. Otherwise, continue the following operation.

2) Select targeted D as the minimum node of routing cost in set S (A)-2, and assume as the node J.

a) Judge whether J is void node, namely, whether hole parameter is 1. If it is void node, select subminimum node of routing cost in targeted node to judge whether it is routing node. If there is no discovery of non-void node through the entire double bounce nodes, node A is void node.

b) If J is not routing void node, it can find node M from single hop to J in set S (A)-1. Node M needs to meet the requirement of minimum c (A, M) +c (M, J). Send data grouping to node M, and send it to node J through M. Continue to cycle in this way until it sends to the targeted node D. In this process, modify the routing cost of node M and node J in line with formula (3), inform its neighbor nodes in the way of hello information by using the modified energy information and node status information. The purpose of modifying node touring cost is to maintain the judgment of link quality. If there is no appropriate single hop node M, select the subminimum node of routing cost from node D in set S (A)-1. Repeat Step 2) until it finds out proper M. If there is no satisfied M through

Copyright ⓒ 2015 SERSC

all nodes in set S (A)-2, it indicates that node A is routing void node. The front node P of node A selects proper node in neighbor nodes. For example, B is regarded as double bounce node. Modify routing cost of node A is shown in formula (3). Here h (B, D) is the routing cost from node A's neighbor node B to the targeted node. c(A,B) is the single hop routing cost of node A's next path B.

$$h(A, D) = h(B, D) + c(A, B) \quad (3)$$

3) After node A is confirmed as the routing void node, change its hole parameter into 1. After the completion of modification, node A sends hello information to all neighbor nodes. The information includes location information, routing cost information and void node information. After neighbor nodes receive the hello information, update the routing information of this node. When selecting path for next routing, first of all, it should judge whether the node is routing void node. If it is void node, select suboptimal node to repeat the above-mentioned process. Conduct data transmission, according to the following process, namely it can avoid from the generation of routing void greatly.

② The sequence of inquiry information is transmitted to all nodes in monitoring area. Meanwhile, inquiry acquisition data information is resent to Sink node along the above-mentioned reverse path. After inquiry information reaches the monitoring area, it also can be transmitted through recursion geography (when node density is larger). Or the flooding way (when the node is small) in the area will spread inquiry information to all nodes in the targeted area.

6. Simulation Experiment on Smart Home's Wireless Control

The paper adopts the compiler integrated by LAR Embedded Workbench, PNETI (Optimized Performance Engineering Tool), MATLAB (Matrix Laboratory) and Open Source Software, NS2 (Network Simulation 2) network simulation software. By using GPSR protocol, the paper conducts the simulation on IGEAR protocol by adopting ways of modification and supplement for its protocol codes. GPSR protocol realizes greedy algorithm and combination of void surrounding transmission, and modifies and adds codes, so as to realize simulation process of IGEAR protocol, mainly including modification of hello information and increase of neighbor list's parameters. Modification process of protocol is as follows:

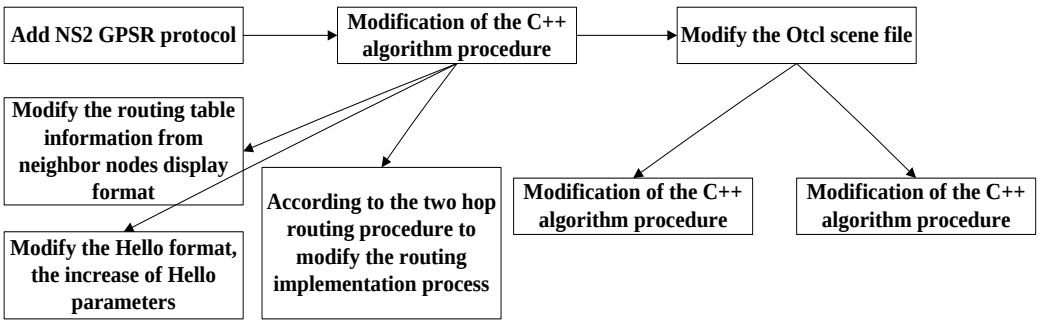

Figure 13. Protocol Modification Frameworks

Process all of them comprehensively and simulation results can be obtained, as shown in Figure 14 and 15. The deployment of network nodes is random. Deployment area is fixed as 20m*20m, while the number of deployment nodes should be adjusted in line with experimental design. By using setdest, node information can be generated at random.

 Copyright ⓒ 2015 SERSC

```
Administrator@feng /home/jin/ns-allinone-2.29/ns-2.29/gpsr
$ ns wireless1-gpsr.tcl
GPSR configuration file
num_nodes is set 50
warning: Please use -channel as shown in tcl/ex/wireless-mitf.tcl
GPSR configuration file
INITIALIZE THE LIST xListHead
Loading connection pattern...
Loading scenario file...
Load complete...
Starting Simulation...
channel.cc:sendUp - Calc highestAntennaZ_ and distCST_
highestAntennaZ_ = 1.5,  distCST_ = 13.2
SORTING LISTS ...DONE!
NS EXITING...

Administrator@feng /home/jin/ns-allinone-2.29/ns-2.29/gpsr
$
```

Figure 14. Simulation Implementation

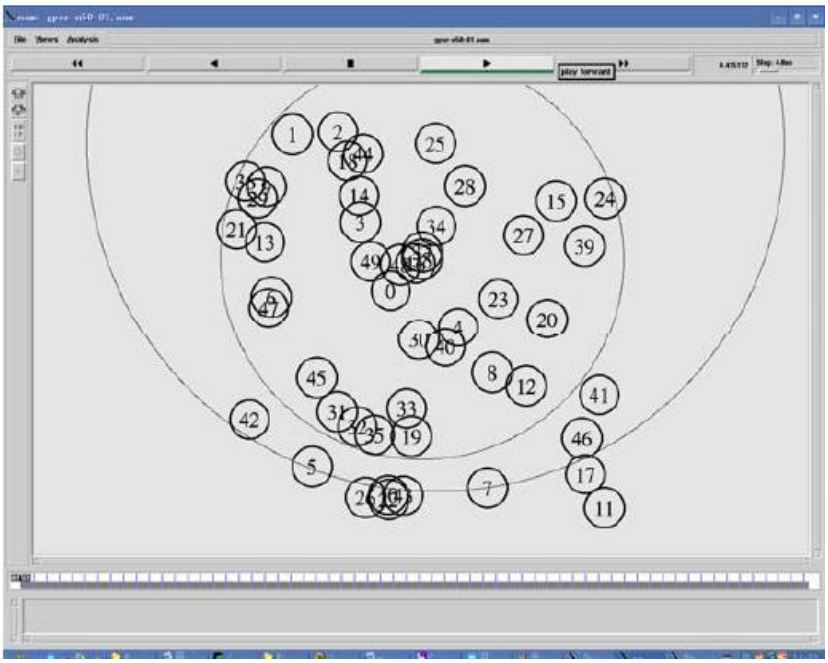

Figure 15. Displaying Results of Simulation Process

The description of simulation environment: simulation scene is 20m*20m rectangular region. The number of nodes is 20, 30, 40, 50, 55, 60, 65, 70, 80, 100, 120 and 150, respectively. The node of no. 0 is Sink node, the rest of them are general nodes. Simulation period is 1000 seconds. The communication range of nodes is 30 units. The scale of grouping is 32 bytes. The size of inquiry information is 32 bytes. The default initial energy of nodes is 1J. Sending and delivering a data package consume 0.2818w. Value of proportional parameter is 0.8(Parameter setting is only in line with experimental requirement and is independent of the actual value). With the increase of nodes, energy consumption of two protocols' average nodes presents the overall growth trend with the increase of nodes. IGEAR protocol is obviously superior to GPSR protocol, when the number of nodes is the same. In this experiment, comparing with GPSR, IGEAR improved protocol can save 0.032J energy for every node in a simulation period. It is good for lengthening the lifetime of network.

Copyright ⓒ 2015 SERSC

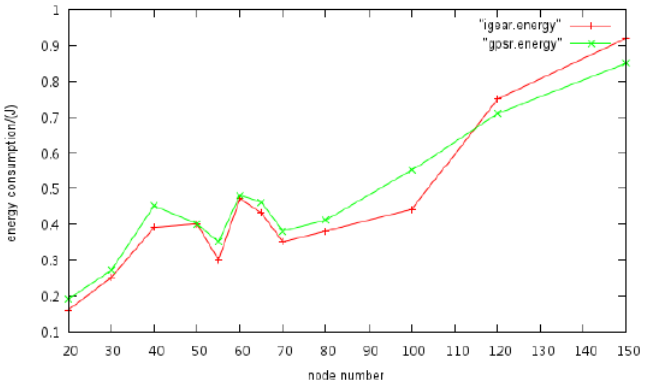

Figure 16. The Relationship between Average Node Energy Consumption and the Number of Nodes

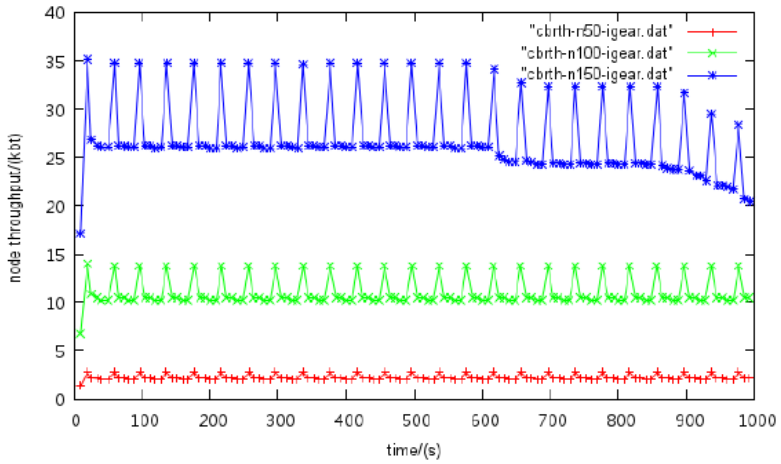

Figure 17. When Network Deploys Different Nodes, It Presents the Situation Change for Node Handling Capacity

In the same deployment region, when the number of network nodes is 50, 100 and 150, respectively, the relationship between handling capacity and time for a certain random node is shown in Figure 17. In simulation region, when the number of node is 50, the handling capacity of this node is about 2-3kbps. When the number of node is 100, the handling capacity of this node is about 10-14kps. When the number of node is 150, the handling capacity of this node is 26-35kbps. By comparing the handling capacity between 100 nodes and 50 nodes, the former increases 4 times of handling capacity. By comparing the handling capacity between 150 nodes and 100 nodes, the former increases 1.6 times of handling capacity. The increase of nodes' handling capacity will result in the drastic improvement of nodes' energy consumption. It proves that this improved protocol is more appropriate for small-scale network.

As shown in Figure 18, with the increase of node quantity, nodes' energy consumption also increases greatly. By comparing 100 nodes and 50 nodes, within a simulation period, nodes' energy consumption of the former is 2.17 times of the latter. Network failure is defined by 90% of node failure. Through this experimental simulation, it can observe that when deploying 50 nodes within the 20m*20m area, lifetime of network is 4990s. When deploying 100 nodes, lifetime of network is 3250s. When deploying 150 nodes, lifetime of network is 2450s. By comparing 100 nodes and 50 nodes, the former's lifetime of network is 0.65 times of the latter. In general, nodes' energy consumption consumes stably and capacity usage ratio is higher, lifetime of network will be longer. In small-scale

 Copyright ⓒ 2015 SERSC

network, performance of improved protocol will be more excellent, and survival time of network will be longer.

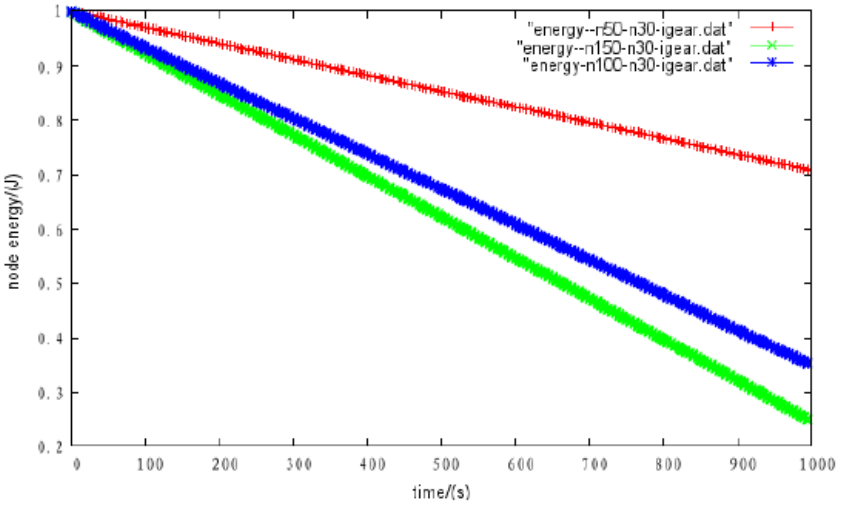

Figure 18. the Relationship between Nodes' Rest Energy and Time

Compared with GPST protocol, improved protocol IGEAT has larger improvement on nodes' average energy consumption. Though IGEAR improved protocol avoids from the routing void and saves energy by increasing nodes' routing void mark, the utilization of improved strategies including double bounce greedy routing and routing void mark increases the number of neighbor nodes and nodes' void mark and improves the routing information updating, so as to bring excessive energy consumptions. When the deployment nodes in network are appropriate, nodes' handling capacity maintains a balance for a long time. However, when network nodes are more, network energy will be exhausted quickly, because of oversized nodes' handling capacity. Compared with other protocols, improved protocol IGEAR is more suitable for the small-scale network, such as smart home environment. This protocol is not suitable for large-scale network. When network node density is increased, communication traffic between nodes will increase rapidly. Thus, communication energy consumption of nodes will enhance. The advantage that network avoids from invalid nodes and routing void in advance will be weakened by energy consumption quickly.

7. Conclusions

Smart home is called as intelligent residence. Generally speaking, it means that regards the residence as the platform, makes use of computer technology, network technology and automatic control technology and combines with various subsystems relating to home life organically to make home life become more comfortable, safer and more effective through integrated management. The development of intelligent housing system is an irresistible trend of our residence's technological innovation and is an inevitable choice of residential industry's modernization. By combining with current advanced network communication technology, bussing technique and computer technology, an irresistible trend of technical innovation in our residential field is to apply commercial intelligent building technology to civil architecture. Implementation of intelligent housing system is also an inevitable method to promote the modernization of our residential industry. The paper adopts the structure that regards control system as the center and Wireless Sensor Network as the peripheral communication network to build the entire intelligent housing system. After constructing the entire network, based on analyzing detailed design of network structure and repeaters, the paper puts forward the research on designing scheme

Copyright ⓒ 2015 SERSC

of wireless geographical routing's improved mechanism based on smart home applications, and comes up with network improved model of IGEAR protocol. Through simulation experiment, it can know that improved protocol is more appropriate for smart home network by comparing with existing other protocols. Network performance in every aspect still can improve greatly. Meanwhile, according to simulation results, the insufficiency of this protocol can be proposed.

Acknowledgements

The authors would express their appreciation for the financial support of Shandong Natural Science Foundation, grant NO. ZR2011EL016. The authors also would express their thanks for Shandong Science and Technology Development Project on Safety in Production, grant NO. LAJK2013-183.

References

[1] Y. Chun, "Application of ZigBee Technology in Smart Home", Intelligent Building and City Information, no. 1, **(2009)**, pp. 76-77.
[2] C. Liding and D. Defei, "Construction and Realization of Video Doorphone System in Intelligent Buildings", Automation and instrument, no. 6, **(2011)**, pp. 36-39.
[3] L. Jin, "Wireless Data Collection Network Based on ZigBee Technology", Observation and Control Technology, vol. 21, no. 8, **(2007)**, pp. 63-65.
[4] S. Cheng and S. Tiecheng, "Development of Wireless Sensor Network Nodes Based on ZigBee Protocol", Cutting Edge of Technology, no. 1, **(2006)**, pp. 9-14.
[5] D. Yali, "The Research on ANT Technology Based on Reducing Energy Consumption in Wireless Sensor Network", Computer Science, vol. 35, no. 4, **(2008)**, pp. 178 179,206.
[6] L. Da, "The Research and Implementation on WLAN Channel Plan and Control Technology", Changsha: National University of Defense Technology, **(2011)**, pp. 16 18.
[7] H. Haoran and L. Zongbo, "Design and Development Methods of Wireless Sensor Nodes", Computer Programming Technique and Maintenance, no. 14, **(2012)**, pp. 109-111.
[8] A. Guo, M. Haiwu and W. Yanyang, "Application of Wireless Sensor Network in Smart Home", Science and Technology in Western China, no. 03, **(2009)**.
[9] H. Peng, "the Research on Wireless Sensor Network Protocol NC-GEAR Based on Netowrk Coding", **(2011)**.
[10] Z. Hengyang, L. Yingying and L. Yunhui, "Research Progress of Wireless Sensor Network Routing Protocol Based on Geographic Position", Computer Application, vol. 25, no. 1, pp. 5.
[11] L. Yanjun, W. Zhi and S. Youxian, "Real-Time Routing Design of Sensor Network Based on Double Bounce Neighbor Information", Journal of Software, no. 07, **(2009)**, pp. 119-121.

Authors

Yang Zhongguo, male, lecturer at College of Mechanical and Electrical Engineering, Zaozhuang institute, Dean of Mechanical and Electrical Engineering majors section, main research areas are mechanical and electrical automation, wireless sensor network *etc*.
1980/10/26, Tel: 13589610269, E-mail: 13589610269@163.com

Cai Tianfang, female, lecturer at College of Mechanical and Electrical Engineering, Zaozhuang institute, Dean of Control engineering majors section, main research areas are mechanical and electrical automation, wireless sensor network *etc.*

 Copyright ⓒ 2015 SERSC