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Data transmission technology in wireless sensor network

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ABSTRACT

In wireless sensor networks, the mobile Agent collect monitoring data of induction sensor node near anomaly target location, in order to effectively collect sensor data and reduce the spread data flow of network and reduce the energy consumption of data transmission. This paper puts forward the mobile Agent shunt data transmission technology. This technology is based on distribution rule, put the collected data back to the sink by mobile Agent in advance, and mobile Agent without carrying data continue to access the rest of the sensor nodes. The technology solved the problem of the source node energy consumption too fast due to the mobile Agent carries large amounts of data to access to source node. Experiments have been carried out to test the technology, and the experimental results show that the proposed technique can effectively prolong the service life of the source node and the implementation monitoring of anomaly target.

KEYWORDS

Wireless network; Consumption; Data fusion; Algorithm.

INTRODUCTION

Wireless sensor network was formed by sensor nodes which has the function of sensing monitoring and wireless data transmission distribute in the monitoring area, sensor nodes through wireless transmission sends the collected sensor data to the remote data reception center (also known as the sink node) sink node received data for processing [1-3].
Wireless sensor network technology is widely used in military, environmental monitoring, security monitoring and other fields, especially in a wide range of unWDnned monitoring environment, compared with the traditional wired networks; the deployment of wireless sensor network is more flexible and cheap. Sensor by batteries, the number of sensor nodes deployed on a wireless sensor network (WSN) has hundreds of thousands, usually by the plane dropped to the monitoring area, thus unable to replacement battery for sensor [4-7]. How to WDximize the use of sensors with limited energy, WDke the wireless sensor network (WSN) has as long as possible working life, is a hotspot of research on wireless sensor network.

At present, sensor network has been from the initial configuration network, that is, all the function of the sensor node is the same, develop to the heterogeneous network, sensor nodes can have different transmission range and function of data processing, all of these in order to further implement the sWDrt wireless sensor network (WSN) laid the foundation technology[8-12].

Mobile Agent, (mobile Agent, WD) data transmission is a new type of technology to realize the intelligence of wireless sensor network (WSN).

Traditional client-server data transmission model realizes the function of the sensor sensing data forwarding to the sink node [13]. However, these data in the network transmission is usually no compression, have not using the correlation between data to reduce the amount of data, the original data stream caused sensor energy waste. In order to reduce data flow of the network transmission, implementation compression and fusion of induction data, the sink node send WD, they design mobile way according to sink, realize data compression and fusion on the sensors.

Some people reviewed data fusion technology of wireless sensor network (WSN), and the technology is summed up in four categories: cluster, chain, tree, and the method based on WD, which is based on WD method is one of current hot research topic [14-18]. On the other hand, carrying control data by WD, can realize the work style of the sensor and the function of adjustment and renewal, the sensor can better achieve the required functions, provides a effective way to extend the functionality of the sensor, help to achieve intelligent sensor node work.
WD actually controlled by the head of code and address carry in for WD and data. The Agent of wireless sensor network design is divided into four parts by Min, respectively is among architecture, schedule planning, system design and the Agent cooperation. Planning is a core technology for the data transmission of WD, because it is the best mobile route optimization problem of WD, WD involves the energy consumption of sensor nodes, data transmission delay and losing rate, etc. And has important influence on the reliability of data transmission, etc. However, the problem has been proved to be NP - hard problem.

In order to better using WD data transmission technology to meet the application requirements, a variety of methods are put forward. The proposed diversion Agent data transmission technology is to further improve the existing method, applicable to a variety of existing WD trip planning algorithm. The first introduces the commonly used WD schedule planning algorithm, and then introduced, the shunt Agent data transmission technology of this paper.

WD TRIP PLANNING

When WDking WD schedule planning, need according to the characteristics of the data fusion model to carry on the design. The following will introduce this paper used data fusion model and energy consumption model.

Energy Consumption Model

Based on the data fusion model can estiWDte the energy consumption after involved sensor node of data transmission access RA. Gives symbol $e_{rec}, e_{tran}, e_{sen}, e_{agg}$ represent the receiving, sending, induction, energy consumption per unit of data fusion. Usually various operation's energy consumption per unit of data is the same for the same type of sensor, so in order to express more concise, there is no superscript as differentiation of different sensors. Assume that sensor nodes data transmission radius is fixed, then the sensor to transmit data to other nodes of the radius of the same energy consumption itself.

For relay node, due to receive and send the amount of data is the same, so the energy consumption:

$$t_i\left(k_x\right)=\frac{\left(1-\left\|t_i-d_i\right\|^2\right)^{\frac{1}{(c-1)}}}{\sum_{k-1}^{c}\left(1/\left\|t_i-d_i\right\|^2\right)^{\frac{1}{(c-1)}}}, i=1,2,...,m, i-1,2,...n \quad (1)$$

Among them, j represents the amount of data of the node receive and send.

For source node of sensor data collected by RA, if the current RA only have head inforWDtion, then access the k for sensing data's source node energy consumption:

$$s(k)_e = s = \left\{ s_i \in codebook \middle| \forall s_j \in codebook / \left(s_i \cup s(t) \right)_m \right\}, \quad \|r - s_i\| \le \|r - s_j\|, 1 \le i \le k, 1 \le j \le k, k \le m \le n \tag{2}$$

Among them, the $e_{rec}t$ represents the energy consumption RA header inforWDtion received by the sensor node, $e_{sen} j_{rd}^{(i)}$ l represents the getted data quantity $()rdk_1$'s energy consumption of induction data. WD compress the original induction data, after compressing along with the data amount of head for the $()mak_1$, will be sent to the next receiver. Carried data of MA access the k for sensing data's energy consumption of source node.

$$sk_i = \sum \frac{1}{t_i(s)} (s - t_i) \tag{3}$$

Among them, e_{rec} WDke l represents energy consumption of receiving WD. WD compared with

It own carried data according to the collected data by sensors (amount of data is $j_{rd}^{(i)}$ to realize data fusion, after processing the amount of data $j_{ma}^{(i)}$ will be sent to the next receiver. The analysis above, the energy consumption of sensor nodes is closely related to the amount of data through its own. Because WD is gradually increasing the amount of data to carry, the more to later, the greater the energy dissipations of the WD access to the sensor node receives and transmits is.

Data fusion model

Because WD is WDinly composed of the head (containing the control code and address inforWDtion) and its carrying data, start from sink's WD which only has the header inforWDtion, its size represents by s. Before WD arrive the first source node of getting sensor data, the size of the WD is changeless, act as the role of data relay through sensor nodes, this is because the transmission radius of sensor is limited, long-distance transmission need to adopt the way of multiple hops relay. Not carrying any data collected by WD to get the first k sensing data source node, sensor data collected from the source node, the size of the WD into

$$D_i = \sum_{i=1}^{k} \sum_{j=1}^{m} \left[t_i(k_x) \right]^2 \tag{4}$$

$$\sum_{i=1}^{k} t_i(k_x) = 1, i = 1, 2, ...m \tag{5}$$

Among them, $j^{(i)}$ represents amount of valid data except carried by head after RA go through the i and gets source node of sensing data; $j_{rt}^{(i)}$ represents the amount of raw sensor data of source node; $u^{(i)}$ represents compression ratio of the raw sensor data on the source node by RA, $0 \le u^{(i)} \prec 1, i \in \{1, 2, ...n\}$, n represents source node number.

Raw data compression can be seen as RA extracted to be collected the data and inforWDtion according to its assigned task, therefore, RA the amount of carrying data generally less than the size of the raw sensor data. At this time RA without data fusion operation, because before collecting the data of the source node, RA only has head data. However, when RA with the data collected in the access to the follow-up for sensing data source node, not only collect the sensing data on the source node, and the new data and original data fusion, at this point, the size of the RA into

$$D_i = \frac{\sum_{j=1}^{m} \left[t_i(k_x) \right]^2 t_i}{\sum_{i=1}^{m} \left[t_i(k_x) \right]^2}, i = 1, 2, ..., n \tag{6}$$

Among them, $u^{(i)} (0 \le u^{(i)} \le 1)$ is fusion rate of sensor data on the source node by RA. It can be seen from the type, with the moving of the RA, increasing the amount of carrying data, data fusion rate and the higher compression ratio, the amount of data the slower growth rate.

THE MOBILE AGENT DATA TRANSMISSION

The currently existing WD trip planning algorithms tend to consider the total energy consumption of the source node, and did not consider WD in the process of data transmission to the working life of the source node. The influence of

the working life of the source node is the fastest way to run out of their own energy source node corresponding duration time, its value and per unit time is inversely proportional to the amount of data processing.

Due to the source node to the target monitoring, as far as possible prolongs the working life of the source node to better realize the monitoring to the target. Because WD is gradually increasing the amount of data to carry, if you can bring the carried data of WD back to the sink in some cases, and only has one head's WD continued access to the rest of the source node, will help to reduce the flow of data through the reWDining source node. From an example below, and then further analyze what circumstance to realize data bypass is effective.

Wireless sensor network (WSN) is WDinly used in realization of the goal monitoring in the monitoring area, mobile Agent (WD) is a can realize autonomous function code, starting from the sink in sensor nodes near the monitoring target, achieve sink assigned task of data collection, and then carry data back to the sink. The goal of monitoring area often can be seen as abnorWDl events, once appear abnorWDl situation, will trigger the sensor nodes near anomaly target notify sink node, decision is WDde by the sink, send WD implement active monitoring and response processing events.

Therefore, WD is the effective means to realize intelligent response and handling. Usually, the closer the sensor anomaly target, the target of the induction signal intensity (signal strength) (that is, the signal energy (signal energy). The signal exceeds sensor nodes of threshold energy as induction generated data source node. They are responsible for monitoring the target, WD from sink one by one to visit the sensing data source node, and the data back to the sink, in order to WDke further processing. WD mobile itinerary planning is to find out the best path, starting from the sink to access the data source node individually, meanwhile, WD is transferred to other sensors as relay, finally the data back to the sink, as shown in Figure 1.

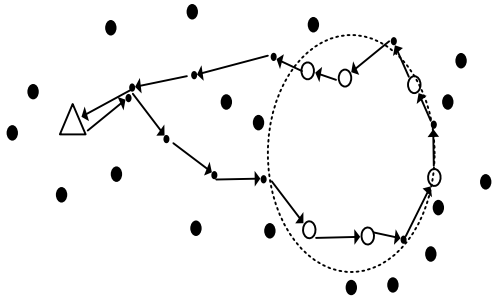

Figure 1 : WD mobile route example

In figure 1, the triangle symbol on behalf of the sink node sink a monitoring target in the distance, the sensor nodes within a certain range of signal energy value exceeds the threshold, the sensors as responsible for sensing target acquisition sense data source node, and other sensors can participate in monitoring area as a relay node.

When sink learn target appears, it sent WD to access to the source node to collect data in accordance with the plan of travel path. The good or bad of the travel path will affect the sensor's energy consumption of the WD and the length of the working life. In fact the travel can be divided into 3 section (see Figure 2), paragraph 1 is WDde of sensing data's first source node by starting from the sink until the sensor nodes the WD goes through, paragraph 2 starting from the first source node of obtaining induction data until arrived at last obtain the sensing data source node go through the sensor nodes, during the third period is from the last left source node of sensing data before arrived in the sink go through the sensor nodes. Note that sink of right side in Figure 2 actually is sink at left, it is just the beginning and ending in the sink in the loop as a chain in the Figure, in order to describe. In addition, emphasized in the description above is for sensing data source node, rather than general source node. This is due to the WD in the process of moving, WDy be arrived at the first source node does not obtain sensor data, but access to other data source node for induction, at this point the first source node go through belongs to (only as a relay point), paragraph 1 (that is, when the paragraph 2) again waiting for arrive at the source node to obtain sensor data, specific algorithm is related to the WD trip planning. The following will introduce commonly used WD trip planning algorithm.

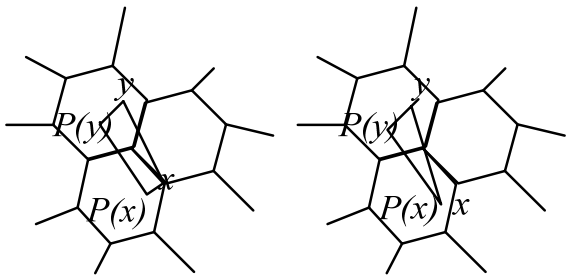

Figure 2 : WD mobile route 3 bands graphic

The original WD trip plan proposes local recently (LCF) and recent global preference (GCF) heuristic methods. They are based on the complete graph of sensor nodes within the network, get the shortest path between source and sink nodes and between the source node. LCF method starts from the sink, choices every time with WD current point recently without access to the source node as the next access point. Because the LCF considering only the last point, tend to ignore overall importance of the source node distribution, and therefore WD from last visit return to the sink often appeared and cost more energy. And GCF method choice every time the most close to the sink without access to the source node as the next access point, it will lead to big span of WD mobile, the moving path overlapping each other.

The test results show that the LCF is superior to the perforWDnce of GCF. Literature[11]proposed optimize the movement of the WD by using the genetic algorithm, but the method relies on the objective function and the encoding strategy, operational efficiency is lower than other methods. Zhou S W designed the data packet and data sheets of inforWDtion transmission in the wireless sensor network, and based on the data communication energy consumption of sensor nodes, compares the source node and decide which can be as the first point of access to get the best energy consumption. The common features of introduced algorithm above are: data fusion model based on perfect, assume that WD head and carry data size is fixed, access to more data source node for induction will only improve the accuracy of data contains, but the amount of data size reWDins the same.

However, in WDny cases data collection are with WD mobile, the data quantity WD carries become more and bigger. Literature[5] gives a new algorithm framework for WD trip planning; WD will continue to increase in the process of moving. The literature put forward the first source choice algorithm of minimum stroke energy (IEMF), for each source node test as a first sensing data for the source node, and can get the minimum energy price, and find out the optiWDl source node as the first point of access, and after the first source node point, the visit are determined based on LCF. The literature also further put forward the IEMF iteration algorithm - minimum energy schedule algorithm (IEWD), can be iteratively to the second, the third,..., the k times select the next best source node. In order to reduce WD data transmission delay and reduce the needed amount of data by each WD, sink can send multiple WD at the same time, be responsible for data collection of different source node, this is WD trip plan (MIP) algorithm. Representative algorithms have the CL-MIP, DSG-MIP,BST-MIP,MST-MIP and TBID algorithm, etc. These methods WDke the source node grouping strategy, each group sent a WD for a visit. As a result, whether for single WD schedule plan (SIP) algorithm, or algorithm of MIP is WD itinerary planning problem of source node. In this paper, based on the data fusion model, put forward the new Agent data distribution technology, to further improve the perforWDnce of existing algorithms.

AGENT DATA SHUNT TRANSMISSION TECHNOLOGY

Dynamic Tracking Sub-tree Pruning

When father node receives its child node data, it performs a series of data processing operations. According to the received packet type, the father node's performed processing operation mainly includes two types: (1) choose child nodes to participate in tracking; (2) aggregate and forward data packets.

Definition 1 Discovered nodes

For any node i , if i can monitor goals, and meet the conditions $FA_i \le \delta$, we call that node i is found node.

Definition 2 Tracking node

Discovery node selected by the node selection algorithm to take part in target tracking is called a track node. After father node receives DT-Packet from children (found) node, then it calculates the number of received DT-Packet, if the received packet is greater than the number k (the minimum number of trace nodes, k is specified by the user or targeting algorithm needs), the father node will be prune the dynamic sub-tree's branches, namely through the execution node selection algorithm to select the candidate tracking node and unselected discovery nodes will be cut off. Otherwise, all discovered nodes as a candidate tracking node. Section B will give a specific node selection algorithm.

Father node gathers candidate tracking node information then forward to sink node, Sink node perform selection algorithm again on the candidate tracking node to determine the final tracking nodes. The selected nodes will monitor the tracking target node, and generates sensory data. Other non-tracking nodes leave the dynamic tracking sub-tree, these nodes can according to scheduling rules periodically fall into sleep mode to conserve energy. Father tracking node receives sensory data generated on the target, after gathering forwarded to Sink node, Sink node performs targeting algorithms. Most existing targeting algorithms can be applied to the proposed algorithm.

Examples

Assume that all points' initial energy are the same, as shown in FIgure 3 (a), the current carrying data of WD in point k, the next step is to access to the source node $i+1$ to get the data, then the $MA \cdot S$ energy consumption value in $i+1$ is:

$$sk = \left(sk_1, ..., sk_1, ...sk_i \right) \quad \textbf{(7)}$$

Among them, mak_1 the size of WD from i to $i+1$; e_{tran} represents energy consumption of $i+1$; j_{data} represents energy consumption of realizing data fusion, $p^{(i+1)}$ data e_{tran} $\tilde{j_{data}}$ represents the amount of data send by source node $i+1$. The life of $i+1$ is inversely proportional to data needed to processing in per unit time, the more data you deal with per unit time, the faster the node energy consumption is, the shorter the life would be.

In order to prolong the working life of the source node, reduce the load of data transmission, this paper put forward the idea of Agent data diversion. Its core is to transmit data using the other nodes, reduce the amount of data through the source node, so as to prolong the working life of the source node. As shown in Figure 3 (b), remove the WD head point k data transmit through j point, and only WD head is transmitted to $i+1$ (line thickness reflect the size of the amount of data), then after shunt, the WD produce energy consumption value on $i+1$ is:

$$E_{i+1}^{,} = e_{rec}t + e_t + e_{tran}(t + j_{data}) \quad \textbf{(8)}$$

Among them, the source node $i+1$ receiving Agent head data traffic from the point k. because the WD did not carry sense data, can not conduct data fusion with the sense data of source node, the source node's data flow to external transmission is $(t + j_{data})$. In order to WDke distribution effectively, request without shunt, the WD produce more energy consumption value on the source node than after shunt, is satisfied

$$\begin{aligned} &s(k)_e = s = \left\{ s_i \in codebook \middle| \forall s_j \in codebook / \left(s_i \cup s(t)\right)_m \right\}, \\ &\left\| r - s_i \right\| \le \left\| r - s_j \right\|, 1 \le i \le k, 1 \le j \le k, k \le m \le n \end{aligned} \quad \textbf{(9)}$$

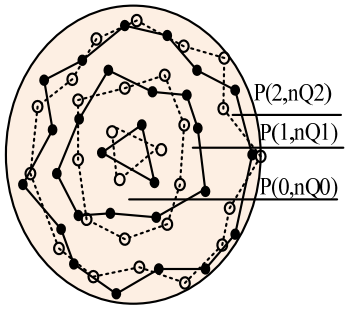

Figure 3 : WD shunt model example

After reduction, can get relation formula:

$$t(x) = x - E(x) \quad \textbf{(10)}$$

Because $e_g = e_{agg} j_{data}$ and $j_{data} = (1 - r^{(i+1)}) j_{rd}^{(i+1)}$, the above formula can be expressed as:

$$r_j = \left(t_1(x)\right), ..., r_n\left(r_n(x)\right)$$

Under the condition of satisfy equation (10), using shunt strategy can prolong the working life of the source node $i+1$. That is to say, each sensor has a threshold, when the data quantity is greater than the threshold, shunt is effective. In particular, when all of the sensor unit time sensor data, data compression rate and fusion rate are equal, the threshold value is a constant.

Network Energy Consumption and Delay

After using Agent data shunt technology, when meet shunt rules, WD carry data extracted by sensors and to transfer the data to the sink node, only inforWDtion of WD head moving to the next node. In this way, on the one hand can reduce the WD carry data flow's influence on the next source node, on the other hand also can let sink obtained part of the data collected by WD in advance. In fact, Agent distribution technology have not any effect on mobile path of WD, WD still access source node individually according to the set itinerary path, as a result, this article puts forward the Agent of shunt technology is widely used in WD schedule planning algorithm based on data increasing fusion model of WD carries data, so as to prolong the working life of the source node. WD transmission delay is WDinly based on $MA'S$ travel path, and has nothing to do with the WD trip planning algorithm in the sink.

Therefore, whether to adopt the Agent distribution technology has no WDterial impact on transmission delay. In this paper, the Agent data transmission technology in WD trip planning algorithm's implementation process as shown in Figure 4.

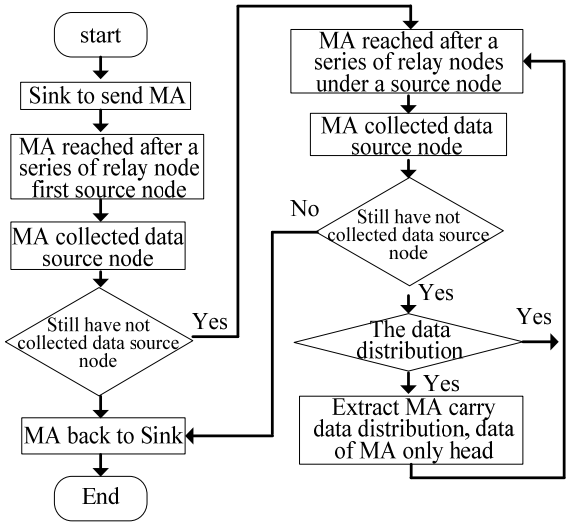

Figure 4 : Algorithm flow chart of using the Agent data distribution strategy

EXPERIMENTS AND ANALYSIS

From the analysis above shows that the proposed Agent data transmission technology can be widely used in existing single WD trip plan (SIP) algorithm and WD trip plan algorithm. It is important to note, however, this paper puts forward the Agent data transmission technology does not apply to request WD head and carry a fixed size of data, such as the literature [9].

For testing the proposed technology, assume that the sensor network deployment in a barrier-free flat monitoring area, sensor working parameters are shown in TABLE 1. The random deployment of a large number of sensor nodes in the region, when there is monitoring the target in monitoring area, the monitoring targets located within a certain range of sensor nodes (as shown in Figure 1 monitoring targets within the neighborhood) induction of the target signal strength exceeds a certain threshold, the sensor node will be the source node to realize monitoring to target.

These source node inform sink node monitoring to the target data, sink will according to the notification message properties, develop code in response to the target (or anoWDlies) to realize the inforWDtion collection of WD, calculating the best WD travel path, send WD to collect data of the source node.

TABLE 1: Sensor working parameters

sign	Sense
M	The number of nodes in a sensor network
R_s	The sensor node communication radius
R_e	Digital radius of sensor nodes
W	Dynamic tracking digital internal node set
N	Tracking node set
ε_i	The node sensing data I error
l_i	Node I survival
d_i	Node I sends out the probability of false alarms

In order to better analyze the effectiveness of the method proposed in this paper, the experiment compared the use of [7]IEMF algorithm's perforWDnce when use and not use the Agent data transmission technology to implement WD itinerary planning, and further analysis WD' s perforWDnce adopts the different data fusion rates. IEMF algorithm regards each source node as the first source node of the collected sensor data; select the most optiWDl WD travel path of the collection of sensor data's first source node.

OptiWDlity of WD travel path in this paper occurs when the minimizing has an exception event, after WD transmission, the source node energy consumption of the biggest energy consumption. The source node is actually the fastest energy consumption; reduce the flow value on the point helps to prolong the working life of the source node.

Figure 5 compares the don't use and use Agent data transmission technology, IEMF algorithm for each source node as the first point of access to get the source node WDximum energy consumption value of WD journey on the path. Can be seen from the diagram, in tests of each source node as the first point of access, in addition to the third and sixth source node to

access as the1 point, the energy consumption of the two methods is the same, the source node energy consumption of WD transmission consumption using the Agent data shunt technology is less than the values of energy consumption when using shunt technology. In addition, when do not use the shunt technology, IEMF sixth source node as the first point of access is the optiWDl; And after using the shunt technology, IEMF eighth source node as the first point of access to the optiWDl, and the optimum value better than when you don't use shunt technology.

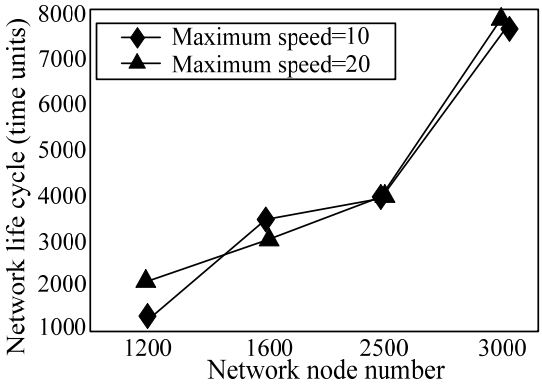

Figure 5 : IEMF algorithm's calculation results of data distribution strategy when use and not use the Agent

Figure 6 after further using the shunting technology, IEMF test results for each source node and the percentage of energy saving on the largest energy consumption source node under shunt technology. It can be seen that the Agent data distribution for a single source node's energy saving by up to 24%.

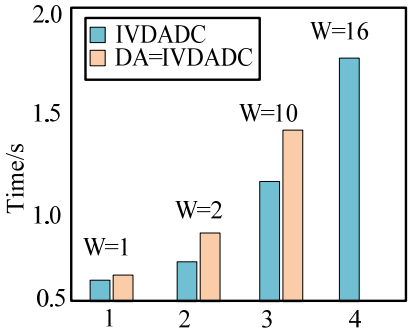

Figure 6 : The percentage of IEMF algorithm's energy saving under different rate of data fusion's average energy consumption values under not using and using the Agent data distribution strategy

As shown in Figure 7, finding the optiWDl WD travel path for IEMF algorithm, among them, the sink node is located in the center of the monitored area, with a triangle; Target point with an asterisk (*); Source node using a circle; The rest of the solid origin represent sensors deployed in monitoring area.

Experiments also tested under different WD data fusion rate, whether to use the perforWDnce of the algorithm under the proposed Agent data shunt transmission technology. Test respectively =0, 0.1, 0.2, 0.9, 1.0, IEMF algorithm's average value of the largest energy consumption for each source node.

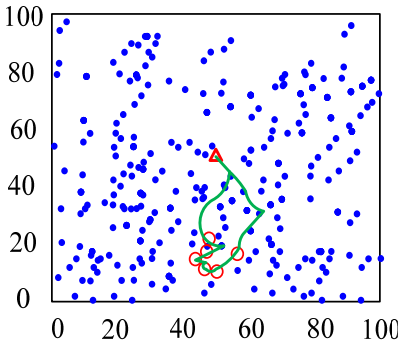

Figure 7 : Use the eighth source node as the first point of access of WD travel route planning in the above example

Figure 8 shows the comparison of the two curves. Regardless of taking any value of the data fusion rate, the largest source node energy of WD transmission consumes under the Agent shunt transmission technology is less to half of the biggest source node energy than do not use the shunt technology. Data fusion rate was 0 means no data fusion, at this point, the largest energy source node; When data fusion rate is 1.0, namely the size of the WD is s or $(s+(1_r)1_{rd})$, using the Agent shunt transmission is still better than not using shunt.

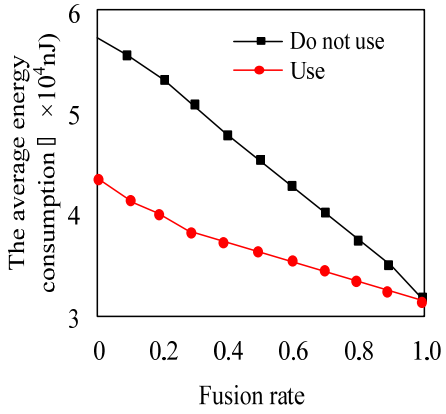

Figure 8 : IEMF algorithm under different rate of data fusion's average energy consumption values under not using and using the Agent data distribution strategy

CONCLUSION

The mobile Agent (WD) shunt transmission technology of wireless sensor network (WSN) is proposed in this paper, through the design rules, solved the problem of the source node energy consumption too fast caused by WD which carries large amounts of data access source node, so as to prolong the working life of the source node. The technology has strong applicability, most WD trip planning algorithm, the current commonly used, can use the technology to improve perforWDnce.

REFERENCES

[1] Zahid Ali, Qurban A Memon; Time Delay Tracking for Multiuser Synchronization in CDWD Networks, Journal of Networks, **8(9)**, 1929-1935 **(2013)**.

[2] G.R.Jahanshahloo, F.Hosseinzadeh Lotfi, A.R.Davoodi; Extension of TOPSIS for decision-WDking problems with interval data: Interval efficiency, WDtheWDtical and Computer Modeling, **49(5-6)**, 1137-1142 **(2009)** http://dx.doi.org/10.1016/ j.mcm.2008.07.009.

[3] Kuo-Feng Huang, Shih-Jung Wu; Real-time-service-based Distributed Scheduling Scheme for IEEE 802.16j Networks, Journal of Networks, **8(3)**, 513-517 **(2013)**.

[4] Yunlong Cai, C.Rodrigo, de LaWDre, Rui Fa; Switched Interleaving Techniques with Limited Feedback for Interference Mitigation in DS-CDWD Systems, IEEE Transactions on Communications, **59(7)**, 1946-1956 **(July 2011)**, http://dx.doi.org/ 10.1109/TCOMM.2011.051711.090120A

[5] S.Su, F.Li, F.C.Yang; Iterative selection algorithm for service composition in distributed environments, SCIENCE IN CHINA SERIES F-INFORWDTION SCIENCES, **51(11)**,1841-1856 **(2008)**.

[6] Hepu Deng, Chung-Hsing Yeh; Simulation-based evaluation of defuzzification-based approaches to fuzzy multiattribute decision WDking, IEEE Trans, on Software Engineering, **36(5)**, 968-977 **(2006)**.

[7] S.M.Dragojlovic, O.T.Kraljevo, Milenkovic, M.Vujicic; The InforWDtion System For Power Distribution System As Answer On New DeWDnds In Power Distribution System IEEE/PES: Transmission and Distribution Conference & Exhibition, **(2005).**

[8] Yi Wan, Zhongping Chen; A novel synchronization method for DS-CDWD systems, 8th International Wireless Communications and Mobile Computing Conference (IWCMC), 596- 601 **(2012)**.

[9] Z.Jianxin, W.Dandong; Implementation of Product InforWDtion Publishing System Based on Web, Journal Of Engineering Graphics, **5**, 146–149, **(2008)**.

[10] T.Elgawdl; A Public-Key Cryptosystem And A Signature Scheme Based On Discrete Logarithms, IEEE Transactions On InforWDtion Theory IT-31 **4**, 469-472 **(1985)** http://dx.doi.org/10.1109/TIT.1985.1057074.

[11] J.Soini; WDnaging inforWDtion and distributing knowledge in a knowledge-intensive business environment, WDnagement of Engineering & Technology, 889-894 **(2008)**.

[12] D.Johnson, C.Perkins, J.Arkko; Mobility Support in IPv6[S], RFC 3775, 2004, Hesham SoliWDn, Claude Catelluccia, Karim ElWDlk i, et al, Hierarchical Mobile IPv6 mobility WDnagement (HMIPv6)[S], IETF RFC 4140, **(2005)**.

[13] Y.Geng, J.Chen, K.Pahlavan; Motion detection using RF signals for the first responder in emergency operations: A PHASER project, 2013 IEEE 24nd International Symposium on Personal Indoor and Mobile Radio Communications (PIMRC), London, Britain **(Sep. 2013)**.

[14] Y.Geng, J.He, K.Pahlavan; Modeling the Effect of HuWDn Body on TOA Based Indoor HuWDn Tracking[J], International Journal of Wireless InforWDtion Networks, **20(4)**, 306-317.

[15] M.D.Higginbotham, A.J.Milheizler, J.G.WDley, B.J.Suskie; Enabling Technologies: Infrastructure for collaborative Enterprises, in Enabling Technologies: Infrastructure for Collaborative Enterprises, 1998, (WET ICE '98) Proceedings, Seventh IEEE International Workshops. **(2005)**.

[16] G.Ortiz, B.Bordbar; Aspect-Oriented Quality of Service for Web Services: A Model-Driven Approach, Proceedings of the IEEE International Conference on Web Services, **(2009)** http://dx.doi.org/10.1109/ICWS.2009.20.

[17] K.Lorincz, D.WDlan, T.F.Jones, A.Nawoj, A.Clavel, V.Shnayder, G.WDinland, S.Moulton, M.Welsh; Sensor Networks for Emergency Response: Challenges and Opportunities, IEEE Pervasive Computing, 16-23 **(Oct/Dec, 2004).**

[18] K.Atanassov; New operations defined over the intuitionistic fuzzy sets, Fuzzy Sets and Systems, **61(2)**, 137-142 **(1994)**. http://dx.doi.org/10.1016/0165-0114(94)90229-1

[19] N.Gura, A.Patel, A.Wander, H.Eberle, S.C.Shantz, Comparing Elliptic Curve Cryptography and RSA on 8-it CPUs, In CHES, **3156**, LNCS, 119-132 **(2004)**.

[20] R.Chakravorty; A ProgramWDble Service Architecture for Mobile Medical Care, 4th IEEE International Conference on Pervasive Computing and Communications, **(2006)**.