WRECS: an Improved Cluster Heads Selection Algorithm for WSNs

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***Abstract*—This article focused on the energy limit property of Wireless Sensor Network, and proposed a residual energy based algorithm WRECS, which is improved on classical routing algorithm LEACH. The algorithm took the normalized residual energy and the cumulative number of the normal nodes supported by the cluster heads as cluster-heads selection parameters. In order to balance the energy consumption of each cluster-head, the algorithm took both the different positions of the base station and the initial energy of the network into consideration, and weighted the two factors to balance the energy consumption between transmission and data fusion. Simulation results show that the algorithm can promote the lifetime of the uneven energy network and does not impair the effects of the LEACH algorithm.**

***Index Terms*—WSN, LEACH, routing algorithm, residual energy, WRECS**

I. Introduction

Wireless Sensor Network (WSN) is composed of a set of sensors with the Ad Hoc mode. WSNs combine the physical world with the logical world, and make the real world able to be sensed. WSNs have been widely used in environment monitoring, military, bio-medical and disaster rescue [1].

WSNs often use one or several sink nodes as the data aggregation nodes [5]. Sink node passes the fused data to the operator through LAN. Typically, sensors in such a network are equipped with sensing, data processing and radio transmission units while the power is highly limited [6]. Due to the limited energy, it is necessary to do some researches on improving the energy efficiency to prolong the network lifetime [8].

Data gathering is a common but critical operation in many applications of WSNs [3]. The traditional way to process the mass and redundancy data is data fusion which can reduce the communication load. Hierarchical (Clustering) mechanisms are extensively exploited to increase the network scalability and reducing data latency [10]. The first clustering protocol applied in the WSNs is LEACH [11], which is one of the best routing protocols.

LEACH was proposed by Heinzelman, Chandrakasan and Balakrishnan in 2000. It is renowned for its success in extending the lifetime of Wireless Sensor Networks [13]. Considering it is a classical routing protocol and it has been meliorated by numbers of researchers in recent years, this paper's proposal is also based on the framework of LEACH. In LEACH, few nodes are selected as cluster heads and other nodes use these cluster heads as routers to the sink. The cluster heads take the responsibility of data fusion and aggregation, and this will cost a lot of energy. To balance the energy dissipation of nodes, LEACH changes the cluster heads randomly over time. A node becomes a cluster head for the current round if the chosen random number is less than the threshold $T(n)$ in (1).

$$T(n)=\begin{cases}\dfrac{p}{1-p.(r \bmod \frac{1}{p})} & n\in G\\ 0 & otherwise\end{cases}$$
$$\begin{aligned}&\mathrm{G}=-1 \quad \text{if(cluster)}\\&\mathrm{G}=0 \quad if\,(r=1/p)\end{aligned} \tag{1}$$

Here, p is the ratio of clusters and total number of deployed nodes N. r is the current round and G is a number, and it forms a set of nodes that have not been cluster heads in the last $1/p$ rounds in one epoch. Here, p is 5% to make the network work at the maximum lifetime [14].

Although LEACH was the first algorithm proposed to improve the lifetime of the WSNs, it still has some shortcomings.

a) Residual energy of each node is not considered when the cluster heads are selected.

b) Using the random selection algorithm, the number of the cluster heads is not fixed. Different number of cluster heads means that the amount of normal nodes supported by the cluster is uneven, and this will lead to an uneven energy dissipation among cluster heads.

N-LEACH [15] was proposed by Tripathi, Singh and Verma in 2012 to rectify the defect of uneven energy dissipation among cluster heads in LEACH. N-LEACH

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sets G as an accumulation of supported nodes number. In LEACH, G is a boolean value which is set to *-1* if the node become a cluster head and returns to 0 at each *(1/p)*th round. But in N-LEACH, G is a real value which changes by round to round. N-LEACH uses (2) as the cluster selection threshold to balance the supported nodes among clusters.

$$T(n) = \begin{cases} \dfrac{p}{1 - p.(r \bmod \frac{1}{p})} & n \in G \\ 0 & otherwise \end{cases}$$
$$G = G + p \cdot m \quad if\,(Cluster)$$
$$G = G - 1 \quad if\,(r = 1/p). \tag{2}$$

Here, p is the desired percentage of cluster heads, m is the number of supported nodes by a cluster node and G is initialized by 0 and it will change if the node becomes a cluster head.

N-ELACH balances the uneven energy dissipation caused by the different number of normal nodes in every cluster in each round. If the optimum number of cluster is k, then the average number of nodes supported by a cluster head is N/k. The number of cluster heads may be greater or less than k in some rounds. If the number of the cluster heads is less than k, then the supported number of nodes is more than N/k and this cluster head will spent more energy than the cluster head that support an average number of nodes. On the contrary, the node will spent less energy.

N-LEACH adds $(k/N)\cdot m$ (where k/N is equal p) to G when a node becomes a cluster head. If a cluster head supports more than N/k nodes and losses more energy, then for the next few N/k-1 rounds it will lost the chance to be a cluster head unless $G \leq 0$. If a cluster head supports less than N/k nodes, it remains eligible to become a cluster head. Thus, the algorithm makes a cluster head only spend N/k energy in every N/k round.

Although N-LEACH largely improves the lifetime of the WSN, it still does not consider the residual energy of each node. Another problem is that if the node supports less than N/k nodes, at the *(1/p)*th round, the cluster will certainly become a cluster head. This will make the number of cluster heads extremely large at a certain round and this problem is periodic. Fig. 1 shows the periodic phenomenon of N-LEACH.

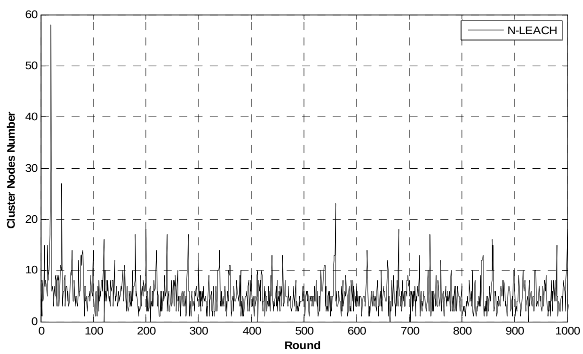

Figure 1. Number of cluster heads in N-LEACH

In this paper, a weighted residual energy based cluster heads selection algorithm (WRECS) was proposed to prolong the lifetime of the WSN. The algorithm used the residual energy of the sensor nodes to influence the selection of the cluster heads, and it guaranteed the nodes with more energy had a larger opportunity to become cluster heads. As a result, the lifetime was prolong.

The rest of this paper is organized as follows. In the second section, the network model and the main problem will be described. The third section is for the details of the WRECS, which includes the realization of the algorithm and the pseudo code. Then simulation results will be given in section four and a conclusion in section five.

II. Problem Outline

WSN is a data-centric network[12]. Sensor nodes monitor the environment, collect the data and transmit the data to the sink node. The sink node analyses the data and draws some conclusion about the activities in the area. Before the problem is stated, it is necessary to make a few assumptions about the network model and introduce the radio model.

A. Network Model

Assuming that a set of sensor nodes are distributed in a square area randomly, and it can be described with the graph theory. Let $G=(V,E,W)$ to present the network, where $V=\{v_0,v_1,\ldots, v_n\}$ is a set that represents the wireless sensor nodes, $E=\{e_i,e_j\}(i,j$ in $\{0,1,\ldots,n\})$ represents that there is a bidirectional line between v_i and v_j, and $W=\{w_0,w_1,\ldots,w_n\}$ implies a set of weights of the network for different condition. Each node has the following properties:

a) Wireless sensor nodes are randomly distributed in a $100*100m^2$ area.

b) Sink is distribute in the center of the area or out of the area, and it is settled.

c) All the communication among the nodes is single hop.

d) All nodes are position unware.

e) All nodes have the ability to compute and transmit or receive data, and the transmission power can be adaptive. The network model is shown in Fig. 2 for the radio hardware energy dissipation.

In order to achieve an acceptable signal-to-noise ratio (SNR) in transmitting an l bits message over a distance d, the energy expanded by the radio is given as (3) to (5).

$$E_{Tx}(l,d) = \begin{cases} l \cdot E_{elec} + l \cdot \varepsilon_{fs} d^2, & d < d_{corssover} \\ l \cdot E_{elec} + l \cdot \varepsilon_{mp} d^4, & d > d_{corssover} \end{cases} \tag{3}$$

$$E_{Rx}(l) = l \cdot E_{elec}, E_{DA}(l) = l \cdot E_{da} \tag{4}$$

$$d_{corssover} = \sqrt{\varepsilon_{fs} / \varepsilon_{mp}} \tag{5}$$

Where, E_{elec} is the energy dissipating per bit to run the transmitter or the receiver circuit, ε_{fs} is for free space

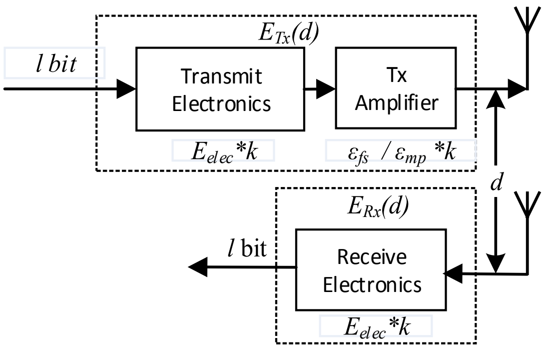

Figure 2. Network model block diagram

channel model and ε_{mp} is for multi-path fading channel model. The model to use depends on the distance while the crossover bound is $d_{corssover}$. d is the distance between the sender and the receiver and E_{DA} is the energy dissipated per bit for data fusion [16]

B. Problem Statement

Transmitting data is an important task for wireless sensor network. Once a sensor runs out of energy, it is considered that the network is dead because some areas cannot be monitored. Therefore, designing an energy efficient routing algorithm is significant for large scale sensor networks. As discussed in last section, LEACH and N-LEACH are energy-efficient and cluster-based routing protocols. But both protocols do not consider the residual energy of the nodes while N-LEACH appears a periodic cluster head too much phenomenon.

The energy dissipation of a cluster node can be described as (6).

$$E_{CH} = E_{Tx}(l, d_{toch}) + (E_{DA}(l) + \mathrm{m}E_{Rx}(l)) + E_{Tx}(l, d_{tosink}) \quad (6)$$

Here, $E_{Tx}(l,d_{toch})$ is the energy used to broadcast the node as a cluster head. E_{Rx} is the energy used to receive the data from normal nodes and E_{DA} is the energy used for data fusion. $E_{Tx}(l,d_{tosink})$ is the energy used to send the data to sink node and m is the number of nodes the cluster node supports.

In this work, the residual energy and the position of sink node are considered while the distance between the cluster head and sink node can also lead to unbalance energy consumption. Another element is the number of normal nodes that one cluster node supports. The two factors are weighted for the cluster selection, so the algorithm is called WRECS. The details of the algorithm will be described in next section.

III. WRECS Details

WRECS is a LEACH-like clustering scheme, where all the nodes are partitioned into several clusters with one cluster head in each cluster. The cluster heads gather the data and transmit it to the sink node.

The core idea of WRECS is combining the residual energy with the supported number of normal nodes based on LEACH, weighted them to adapt different sink positions or network frameworks. This helps the network select a proper cluster and makes the energy dissipation more balance.

A. WRECS Algorithm

Considering two different situations, one is that the sink node is in the center of the network and the other is that the sink node is outside the network area. The primary energy dissipation in (6) is different.

If the sink is in the center of a small network, the energy consumed for transmitting data from normal nodes to cluster heads will nearly the same as energy consumed for transmitting data from cluster heads to sink. As the sink is in the middle of the area, $E_{Tx}(l,d_{toch})$ and $E_{Tx}(l,d_{tosink})$ are approximately same. The main discrepancy of energy dissipation is focused on the data fusion as (7).

$$E_{CH}(i) - E_{CH}(j) \approx (E_{DA}(l) + E_{Rx}(l)) \cdot (m_i - m_j) \quad (7)$$

Here, $E_{CH}(i)$ is the energy dissipation of cluster node i , and m_i is the number of normal nodes supported by the cluster node i.

In this situation, the basic way to balance the energy consumption is to use the supported number of normal nodes based on N-LEACH while it still needs a way to restrain the large cluster number. So the weighed coefficient should make the threshold apt to N-LEACH.

If the sink is far away from network, $E_{TX}(l,d_{tosink})$ of each cluster head will be extremely different. The energy consumed in data fusion and data receiving is uneven but it is far less than the uneven consumption caused by the distance. In this situation, the main discrepancy of energy dissipation is focused on the distance to the sink, which can be reflected on the residual energy of the cluster heads.

Furthermore, it is unrealistic to make initial energy of all sensor nodes the same and in some situations, the energy of a sensor node is almost random when it joins into the network. It is important to consider the residual energy of sensor nodes when cluster heads are selected.

Here, we use (8) to estimate the residual energy of the sensor nodes.

$$P_n(t) = \min\left\{ \frac{E_n(t)}{E_{total}(t)} k, \quad 1 \right\} \quad (8)$$

$E_n(t)$ is the residual energy of the node at time t. $E_{total}(t)$ is the total energy of all sensor nodes. k is the optimal number of cluster heads and it can make $P_n(t)$ select an optimal number of cluster heads, which is the same as (1).

It is proofed in (9) to (11).

$$E_{total} = \sum_{n=1}^{N} E_n(t) \quad (9)$$

$$E[\#CH] = \sum_{n=1}^{N} P_n(t) \cdot 1 = k \quad (10)$$

$$
\begin{aligned}
E[\# CH] &= \sum_{n=1}^{N} P(n) \cdot 1 \\
&= (N - k \cdot (r \bmod \frac{N}{k})) \cdot \frac{k}{N - k \cdot (r \bmod \frac{N}{k})} \\
&= k
\end{aligned} \tag{11}
$$

According to (8) to (11), the WRECS can be described as (12).

$$
\begin{aligned}
T'(n) &= \begin{cases} w \cdot P_n(r) + (1-w) \cdot T(n) & \mathrm{n} \in G \\ 0 & others \end{cases} \\
G &= G + p \cdot m \quad \text{if}(cluster) \\
G &= G - 1 \quad if \quad r = 1/p
\end{aligned} \tag{12}
$$

Here, G is the same like N-LEACH and w is the weighting coefficient which is fit for the network framework and should be broadcasted by the sink at each round.

B. The Main Steps of WRECS

Step 1. According to the position of the sink and the energy state of the sensor nodes, the operator sets the weighting coefficient.

Step 2. The sink node broadcasts the coefficient, the total energy of whole network and synchronization message to all nodes for each round. At the first time, the total energy can be an estimate value.

Step 3. All sensor nodes receive the messages and change the coefficient, then they use WRECS protocol to decide whether to be a cluster node or not. If one node becomes a cluster head, it should broadcast a cluster-form-message with its ID to other nodes to form a cluster.

Step 4. If the nodes are not cluster head, they receive the cluster-form-message, then they choose a cluster head with a high signal strength to send a join-in-message with its ID, and wait for the cluster head's acknowledgement.

Step 5. The cluster heads receive the join-in-message and accept the request, then they post the acknowledge-message to the normal nodes. Here, a cluster is formed.

Step 6. The normal nodes monitor the environment and get the data, then they use TDMA method to transmit the data to the clusters, also the data contains the residual energy of the nodes.

Step 7. The cluster heads receive the data form the normal nodes and compute it for data fusion. Then the cluster heads summate the residual energy of all the nodes in this cluster, and transmit the sum of the residual energy and data to the sink node.

Step 8. The sink node receives the data and residual energy of the sensor nodes from the cluster heads. Then, it should calculate the total residual energy of the whole network and repeat *step 2*.

C. Pseudo Code for WRECS

```
Initial Network( )
{
    while( t = 0)
    do
```


```
Initial Network( )
{
    while( t = 0)
    do
```


```
      Initial E(n);    // E(n) is the initial energy of
                       //  a sensor node n
      G(n) = 0;        // G(n) is used to identify if
                       // the node can be a cluster head
       Round = 0;
       Etotal  =  rand*NodeNum;  // Etotal is the
                       // total Energy of whole network
    end while
}
SinkBoradcastNewRound( )
{
  whlie( receive data)
    do
// Get the data form all cluster heads
       ReceiveDatafromCluster();
// Pick up the residual energy form the data
      ResidualEnergy = GetTheResidualEnergy() ;
//  Calculate the total energy of the network
     TotalEnergy = Sum(ResidtalEnergy);
 end while
   // Synchronize the node's Time
   TimeSynchronization();
   // New Round
   BroadCasts(TotalEnergy);
   BroadCast(NewRoundMessage & Weight);

}

ClusterHeadElection( )
{

  //Receive the new round message, the total
 //energy of the network and weight coefficient
       ReceiveMessage();
   // According (12) to check if the node will
   //declare itself as a cluster head
       ElectCluster();
   if (cluster head)
     BroadCast(ClusterFormMessage);
     Receive(JoinInMessage);
     Send(AckonwledgeMessage);
    // then the cluster will know the number of
    // nodes in this cluster
     m = GetTheNodesNumber();
     G(ClusterID)= G(ClusterID)+ (k/NodeNum)*m
     // k is the optimal number of cluster nodes
   end if
    if(Round = NodeNum / k)
      G(ClusterID) = G(ClusterID) – 1;
      Round = 0;
   end if

}

DataTransmission( )
{
```

```
    while( node(n) transmitting data)
      do
       if(Cluster)
         DataFusion();
      //Get the total residual energy of the cluster
        CalcuateTotalResidualEnergy();
        SendData(sensor data &cluster's residual
                    energy);
       else
         SendData(sensor data &node(n)'s residual
                    energy);
       end if
     end while
}
```

IV. Simulation and Results

The algorithm is simulated in MATLAB to set up a comparative analysis for LEACH, N-LEACH and WRECS proposed in this paper. For the experiment, the simulation parameters are listed in Table I. The simulation consists of four parts for different sink positions and different initial energy. Each part is simulated for 50 times with different deployments of sensor nodes.

TABLE I.
SIMULATION PARAMETERS

Area	100*100 [m^2]
Sensor nodes number	100
Data package length	4000 [*bit*]
Control package length	100 [*bit*]
ε_{fs}	10 [$pJ/bit/m^2$]
ε_{mp}	0.0013 [$pJ/bit/m^4$]
E_{elec}	50 [nJ/bit]
$d_{crossover}$	87 [m]
E_{DA}	5 [$nJ/bit/signal$]

Scene I. The sink node is in the center of the network (position is (50, 50)) and the initial energy is same. Fig. 3 to Fig.6 show the number of alive nodes and the number of cluster heads in each round with two different weighting coefficients. The statistical results are shown in Table II, and the improved percentage is compared with N-LEACH.

TABLE II.
STATISTICAL RESULTS OF SCENE I (*W*= 0.7)

Algorithm	Lifetime		Improved
LEACH	First dead	795	-20.5%
	Half dead	1015	0.6%
	All dead	1160	11%
N-LEACH	First dead	958	0%
	Half dead	1008	
	All dead	1032	
RECS	First dead	931	-2.8%
	Half dead	1047	2.8%
	All dead	1092	5.8%

Results in Fig.3 to Fig.6 show that the WRECS can prolong the lifetime of the network and restrain the peculiarity of large number of cluster heads occurred in N-LEACH. In this network framework, the *w* should be close to zero if the largest number of cluster heads is acceptable.

Scene II. The sink node is in the center of the network (position is (50, 50)) and the initial energy is set randomly. Fig. 7 to Fig.10 show the number of alive nodes and the number of cluster heads in each round with two different weighting coefficients.

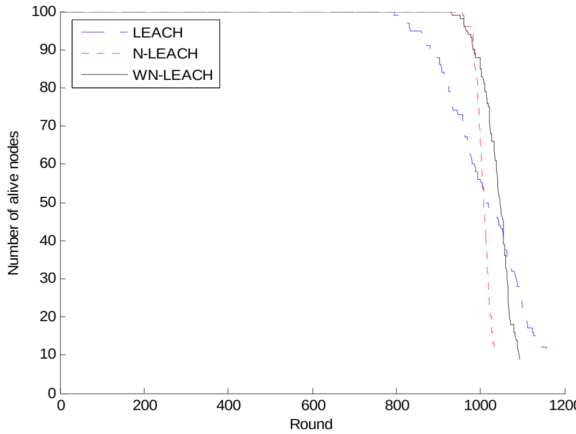

Figure 3. Number of alive nodes in scene I (w=0.7)

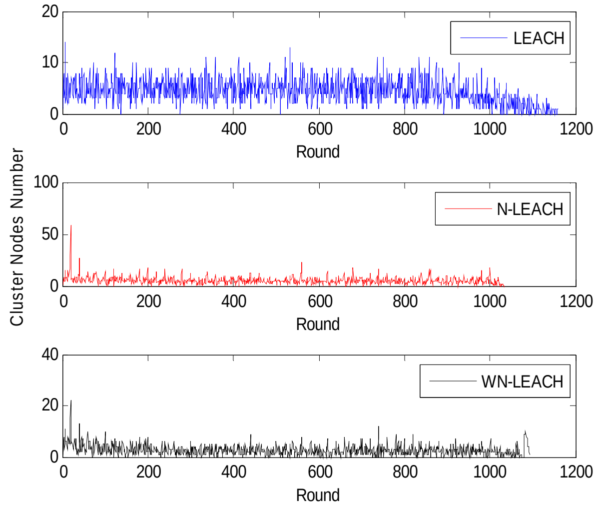

Figure 4. Number of cluster heads in scene I (w=0.7)

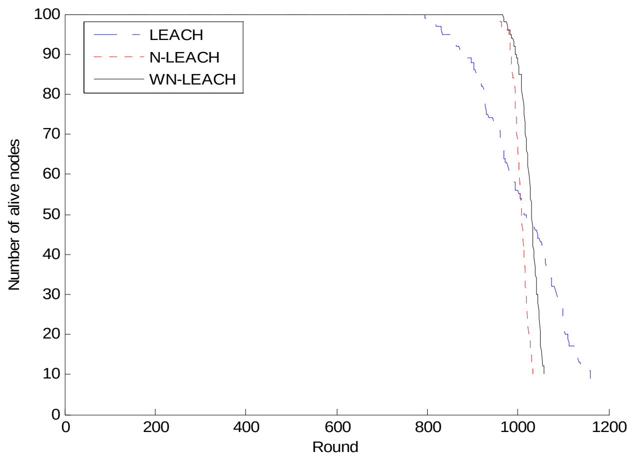

Figure 5. Number of alive nodes in scene I (w=0.4)

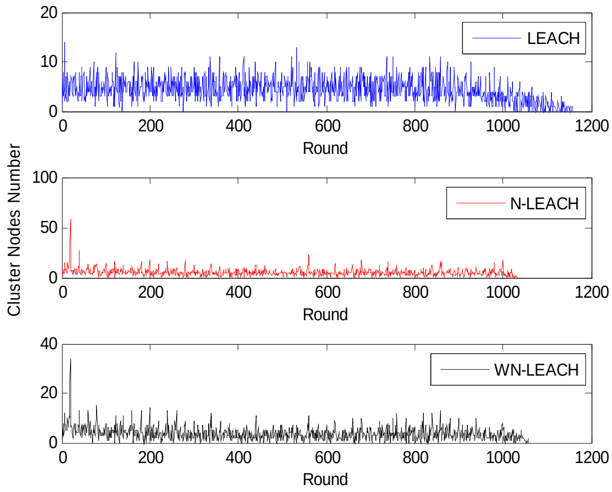

Figure 6. Number of cluster heads in scene I (w=0.4)

Results in Fig.7 to Fig.10 show that when the initial energy of each sensor nodes is different, the WRECS performed better than the LEACH and N-LEACH algorithm. The algorithm can extend the lifetime of the network and balance the energy dissipation. The parameter *w* should be close to 1 if the initial energy is highly uneven.

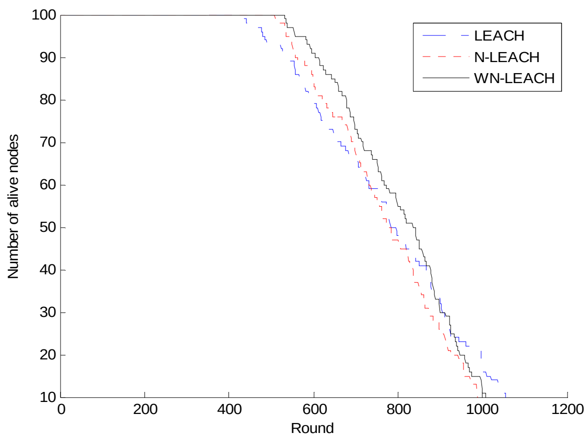

Figure 7. Number of alive nodes in scene II (w=0.7)

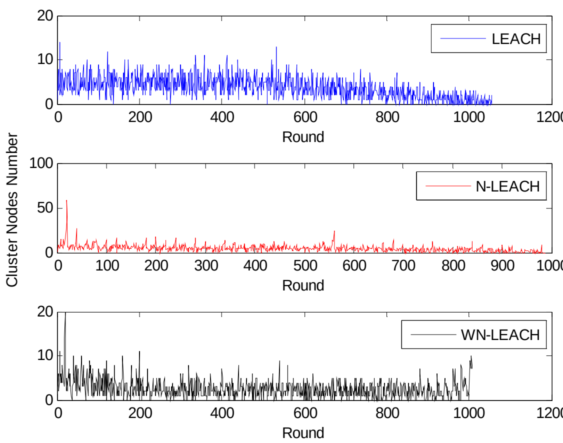

Figure 8. Number of cluster heads in scene II (w=0.7)

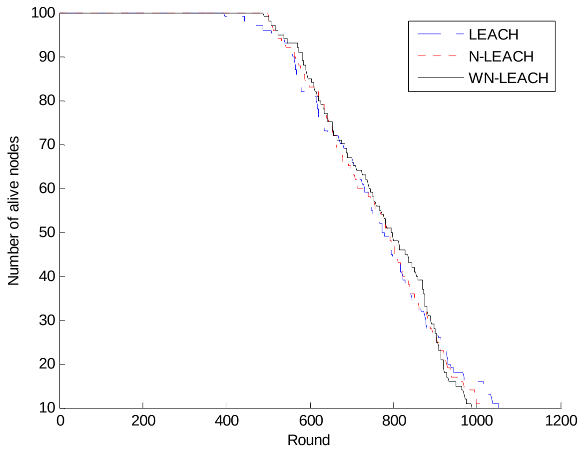

Figure 9. Number of alive nodes in scene II (w=0.4)

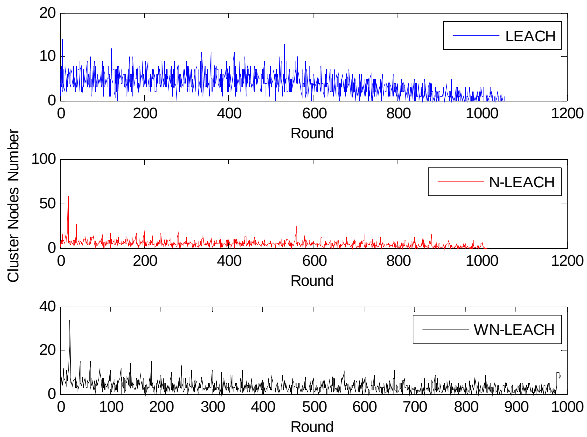

Figure 10. Number of cluster heads in scene II (w=0.4)

Scene III. The sink node is far away from the network (position is (50, 200)) and the initial energy is random. Fig. 11 to Fig.13 show the number of alive nodes, the number of cluster heads and the total energy of the network in each round. The statistical results are shown in Table III and the improved percentage is compared with LEACH.

TABLE III.
STATISTICAL RESULTS OF SCENE III (W= 0.7)

Algoritm	Lifetime		Improved
LEACH	First dead	330	0 %
	Half dead	589	
	All dead	853	
N-LEACH	First dead	244	-26.1 %
	Half dead	569	-3.4 %
	All dead	796	-6.7 %
RECS	First dead	355	7.6 %
	Half dead	659	11.9 %
	All dead	817	-4.2 %

Results in Fig.11 to Fig.13 show that when the initial energy of each sensor nodes is different, the WRECS algorithm performes better than LEACH and N-LEACH. The lifetime of the network is prolonged. In this situation, *w* should close to 1 if the initial energy is highly uneven.

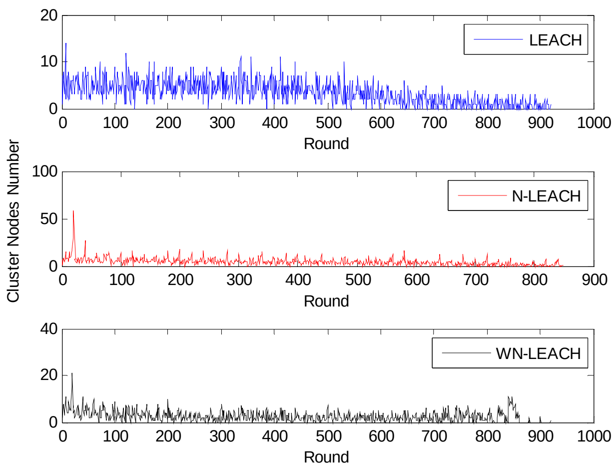

Figure 11. Number of cluster heads in scene III

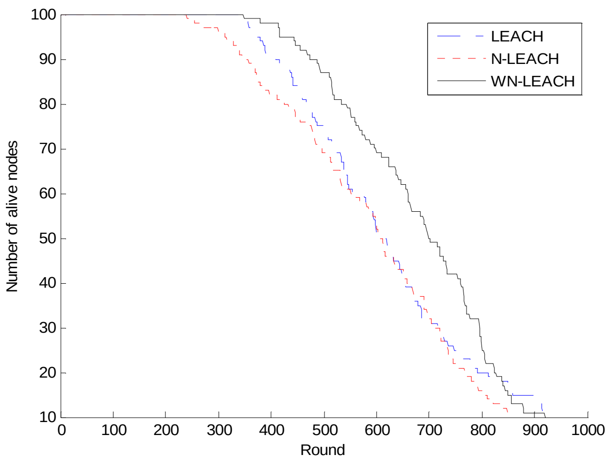

Figure 12. Number of alive nodes in scene III

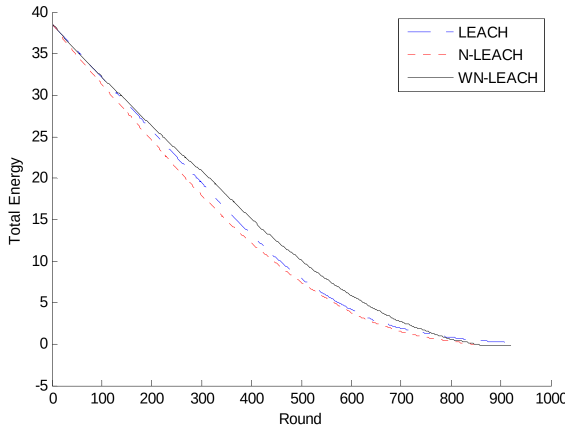

Figure 13. The energy dissipation in scene III

V. Conclusion and Further Work

In this paper, a new algorithm WRECS is proposed to improve the lifetime of WSNs. This algorithm takes the residual energy, the position of sink and the number of nodes that supported by the cluster heads into account and weights the factors to suit different network amework. The simulation of the algorithm in two ifferent scenes shows that WRECS performs better in indom initial energy situation. At the same time, this gorithm does not impair the performance in scene of aditional network framework like LEACH.

All of the works are focused on the cluster selection. here are much space to improve the performance of data ansmission. In this work, the weighting coefficient is ist fuzzy values obtained from the experiments. It truly in be determined in a certain network model by an tificial intelligence algorithm. In further research, we ill do more research on this field and try to find a way confirm the coefficient intelligently.

Acknowledgment

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References

[1] R. V. Kulkarni, A. Förster and G.K. Venayagamoorthy, "Computational Intelligence in Wireless Sensor Networks: A Survey," *Communications Surveys & Tutorials, IEEE*, vol. 13, pp. 68-96, April 2011.

[2] D. L. Kovacs, L. Wuyungerile, N. Fukuta; T. Watanabe, "Mixed Observability Markov Decision Processes for Overall Network Performance Optimization in Wireless Sensor Networks," *The International Conference of Advanced Information Networking and Applications, IEEE*, pp. 289 – 298, March 2012

[3] A. Nieto, J. Lopez, "Traffic Classifier for Heterogeneous and Cooperative Routing Through Wireless Sensor Networks," *The International Conference of Advanced Information Networking and Applications Workshops*, pp. 607-612, March 2012.

[4] J. N. Al-Karaki and A. E. Kamal "Routing Techniques in Wireless Sensor Networks: a Survey," *Wireless Communications, IEEE*, vol. 11, pp. 6-28, Dec 2004.

[5] .M. Haneef, W. Zhou and Z. Deng, "MG-LEACH: Multi Group Based LEACH an Energy Efficient Routing Algorithm for Wireless Sensor Network," *International Advanced Communication Technology Conference*. pp. 179-183, Feb. 2012.

[6] Y. Mao, C. Li and J. Wu, "EECS: An Energy Efficient Clustering Scheme in Wireless Sensor Networks, Performance," *Computing, and Communications Conference*, pp. 535-540, April 2005.

[7] H. D. S. Araújo, W. L. T. Castro and R. H. Filho,"WSN Routing: An Geocast Approach for Reducing Consumption Energy," *Wireless Communications and Networking Conference*, pp. 1-6, April 2010.

[8] E. Hajian, K. Jamshidi and A. Bohlooli, "Increasing WSN Lifetime by Using Learning Automata for Optimal Route Selection," *Information Networking and Automation*, vol. 1 pp. 215-218, Oct. 2010.

[9] R.A. Roseline and P. Sumathi, "Local clustering and threshold sensitive routing algorithm for Wireless Sensor Networks," The International Conference of *Devices, Circuits and Systems*, pp. 365-369, March 2012.

[10] C. Song, M. Guizani and H. Sharif, "Adaptive Clustering in Wireless Sensor Networks by Mining Sensor Energy Data," *Computer Communications*, vol. 30, pp. 2968-2975, Oct. 2007.

[11] W.R. Heinzelman, A. Chandrakasan and H. Balakrishnan, "Energy-efficient Communication Protocol for Wireless Microsensor Networks," *In the Proceedings of the 33rd Annual Hawaii International Conference on System Sciences*, pp. 3005-3014, Jan. 2000.

[12] X. F. Yan, X. H. Gu, L. Li and J. Y. Song, "A Hierarchical Clustering Algorithm Based on Energy and Distance Balancing For WSN," *The International Conference of Intelligent Computation Technology and Automation*, pp. 463-466, Jan. 2012.

[13] A.A. Abbasia and M. Younisb, "A Survey on Clustering Algorithms for Wireless Sensor Networks," *Computer Communications*, vol. 30, pp. 2826-2841, Oct. 2007.

[14] W.R. Heinzelman, A. Chandrakasan and H. Balakrishnan, "An Application-specific Protocol Architecture for Wireless Microsensor Networks," *Wireless Communications*, vol. 1, pp. 660-670, Oct. 2002.

[15] R.K. Tripathi, Y.N. Singh and N.K. Verma, "N-LEACH, a Balanced Cost Cluster-Heads Selection Algorithm for Wireless Sensor Network," *National Communications Conference*, pp. 1-5, Feb. 2012.

[16] D. Kumar, T.C. Aseri and R.B. Patel, "EEHC: Energy Efficient Heterogeneous Clustered Scheme for Wireless Sensor Networks," *Computer Communications*, vol. 32, pp. 662-667, March 2009.

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