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Jointed Energy Saving and Cluster Route in the Mobile Ad-HOC Network

Jinshan Huang[1]

[1]*Department of computer science, Yunyang Teachers'College,
Hubei Shiyan, 442000
E-mail: 18101316@qq.com*

Abstract

The LNCR-IDS for the mobile Ad-HOC network is put forward for the problem that the redundancy clusters are adverse to energy saving because leaf node independent clusters exist in the CHS and cluster partition in the traditional mobile Ad-Hoc network containing IDS. Firstly, make analysis on the traditional random cluster partition method and find that the method easily results in the problem of redundancy partition, put forward the new method which carries out cluster partition starting from the leaf node, try to solve the problem of redundancy of cluster partition, so as to lower the energy consumption; secondly, make analysis on the realization of algorithm, construct the algorithm of single node elimination and give the process of cluster partition via simple analysis example in allusion to the proposed method; finally, carry out simulation comparison with the existed algorithm via the experimental platform created, the proposed algorithm should be about 30% less than the comparing algorithm in the number of clusters, which is beneficial to the improvement of network service life.

***Keywords**: Mobile Ad-Hoc; Leaf node; Cluster lowering; Energy saving; Intrusion detection*

1. Introduction

With the development of science and technology and rapid change of computing information science, the mobile communication equipment such as mobile phone have been widely used, which brings revolution to the share of resource information. Mobile Ad-Hoc network is a multi-hop or temporary self-organized system formed by wireless transceiver, which conducts data transmission through the coordination between the mobile nodes within a certain scope. The network have the features of having no center, distributivity, multi-hop routing and others, which has been widely applied to the fields of military affairs, emergency rescue and others[1-2]. However, the MANET network is easier to be intruded by network attack because of the opening of MANET and uncertainty of network topology, therefore, the function of intrusion detection is required to be attached to the MANET network [3-4]. Based on the cluster partition and cluster node selection, there are wide researches about the method activating the function of intrusion detection, for example, the Literature [5] has put forward the distributed algorithm based on the connected dominating set nodes, a dominating set is a picture and the intrusion detection is executed at connected dominating set nodes. Because the connected dominating set generally forms at the node with high intensive degree, which causes the formation of more number of classified clusters than by selecting the CHs plan randomly, and the cluster superposition will occur when the community intensive degree is high, causing the over consumption of IDS operation; The Literature [6] has put forward the clustering scheme based on area, firstly, classify the MANET network as super clustering area, then

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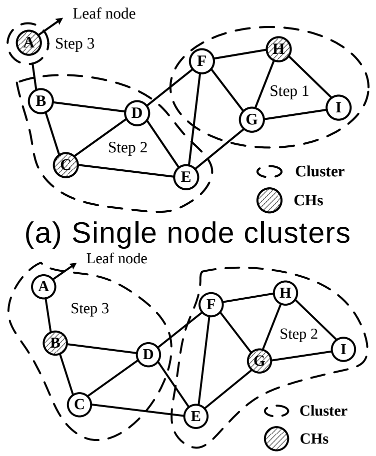
comprehensively consider clustering process connectivity and load equilibrium, so as to cause more efficient IDS. However, the CHs node selection of the algorithm has not considered the energy conditions of the node, the network life cycle is short; the Literature [7] has put forward agent distribution agreement, that is to classify the MANET network into several areas, then select one sub-set from each area randomly and operate intrusion detection agency at the node of the sub-set. But it will cause extra energy consumption and others because the increase of random area distribution.

With the gradual upsizing of MANET network, to prolong the network service life and lower network composition cost become more and more important [8-9]. Therefore, different from the above intrusion detection system of cluster partition method, the main research purpose of this article is to prolong the network service life and put forward the LNCR-IDS for the mobile Ad-Hoc network.

2. Efficient Cluster Creation

2.1. Problem Description

In order to lower the CHS number $\#h$, the strategy adopted here is to decrease the CHS which only contains single node (the cluster only contains CHS, without cluster member). As shown in Figure 1 (a), the majority of single node clusters are composed of leaf node (LN), which is caused by that the LN as the last node is selected as CHS during the classification of cluster.



(a) Single node clusters

(b) No single node clusters

Figure 1. Two kinds of Cluster Partition Method

In Figure 1 (a), $A, B, \cdots, I$ are network nodes, of which A is leaf node, the broken circle stands for same-kind cluster, the part with hatching line stands for the selected CHS node. During the cluster partition in Figure 1 (a), the order is executed as per step 1-3, thus, the result caused by cluster partition is that with the pre-conditon of guaranteeing the completeness of the former 2 clusters, the leaf node A is isolated and separately classified as one kind of cluster. For this, considering to carry out cluster partition from the leaf node, as shown in Figure 1 (b), after CHS node selection and adjustment, the type 3 cluster in Figure 1 (a) is downgraded to the type 2 cluster in Figure 1 (b), the single node cluster of leaf node A is cancelled. For the algorithm designed in Figure 1 (b), it will be described in the section 2.2.

2.2. Single Node Cluster Removing Algorithm

According to the analysis of the foregoing section 2.1, the single node cluster removing algorithm is mainly composed of 2 steps: the period of information exchange between nodes and the period of formation of cluster partition.

(1) Period of information exchange. Every node will exchange the self-information with neighboring node, including the node ID, status, node expectation dump energy and number of neighbor nodes. The node has three states: unspecified, CHs and cluster member. When the node has the function of CHs, the function of IDS will be activated. The information exchange period algorithm pseudo-code is as shown in Figure 1.

In the pseudo-code of algorithm 1, e is the expectation dump energy, n is the number of neighboring node, e_prev is the previous expectation dump energy, e_cur is the current expected residual energy, p is the cluster partition recycle set up in advance, avg_r is the average energy consuming rate, w is the weighting factor. In the process of information exchange, firstly, every node will broadcast the Hello data packet, and report to the neighboring node of the existence, the data packet contains the node ID, state and other information. Then, every node will calculate the expected residual energy through the call of Calexpresenergy(). Finally, every node will broadcast the SEND_INFO data packe, which contains the node ID, expectation dump energy and the number of neighboring nodes.

```
Algorithm 1: information exchange peri(
InfoExchange () :
1state = "unspecified" ;
2. broadcast (Haluo, ID, state)
3. calculate the expected residual energy Calexpenergy ()
4. Broadcast (send _ info, ID, , n) ; Calexpenergy()
1.r = (  _ pre -   _ flag) / p;
2.param _ r = (param _ r × (i - 1) + r) / i;
3.r = w × r + (1 - w)  × param _ r;
4.ifstate = "unspecified"then5.     =  _ flag;
6.   else ifstate = "CHs"then
7.          =  _ flag - r × p;
8.         r _ head = r;
9.   else {state = "cluster member"}
10.      if r _ head = 0then
11.            =  _ flag - (r + r _ ids) × p;
12.      else
13.            =  _ flag - r _  pre × p;
14.      end if
15.end if
```

The function Calex-pres-energy() is mainly used for the calculation of expected residual energy, firstly, the energy consuming rate r uses the recent energy consuming rate and average energy consuming rate to calculate, the corresponding formular (2) and pseudo-code line 1-3. Then, if the node state is "unspecified", because there is no the information of energy consuming rate, the expectation dump energy and the current dump energy are the same (pseudo-code 4-5). If the node state is "CHs" or "Cluster Member", the expectation dump energy is pseudo-code line 6-14, and the corresponding formula (1). In the algorithm 1, r_head is correspondance with the r_i^H in the $\hat{E}_i = E_i - \left(r_i + r_i^{IDS}\right)t$. (2) Period of cluster partition. In the period, every node is defined as CHs node or cluster member node according to the foregoing information exchange process. The period of formation of cluster partition is executed periodically, in this period, the role of CHs is replaced into the node peak with the highest expectation dump energy. The period of formation of cluster partition is shown as algorithm 2.

Algorithm 2 gives the period of formation of cluster partition, some nodes declare themselves to be CHs based on the information exchange with the neighboring nodes. After the completion of the InfoExchange () operation in the first period, every node will call the Cluster() function, whose main function is to confirm whether the smallest degree node has the chance to become CHs by comparing the "unspecified" state node with the neighboring node degree and ID information, and then call the Headselection(). If many "unspecified" state nodes have the same degree, which with the biggest ID will be selected as the CHs. In the period of Cluster(), the leaf node is preferentially transfered to the smallest degree. The foregoing algorithm is not only the period in which the leaf node can activate the formation of cluster partition, at the same time, the nodes in the node density area can also activate the period of formation of cluster partition, the algorithm has good parallelism.

Algorithm 2: period of formation of cluster part

For each input packet()
1: *Reading* HC , C , X_d , Y_d *and* **P** *from the packet.*
2: **If** HC = 0
  Then *drop the packet*
 Else HC = HC-1 *and perform step* 3
 End if
3: **If** $C = 0$
  Then *perform step* 4
 Else $C = C - 1$ *and skip to step* 5
 End if
4: *Using* (X_d , Y_d) *and* (X_c , Y_c) *to calculate* **P** .
 If $\boldsymbol{P} = (0,0,0,0)$
  Then *send the packet to* NI
 Else *perform step* 5
 End if
5: *Routing calculating.*
 If $\boldsymbol{Y}_{(N,S,W,E)} = \boldsymbol{F} \bullet \boldsymbol{P} \bullet \bar{O} \neq (0,0,0,0)$ /* P^1 port */
  Then *send the packet to any port which value is* 1
 Else if $\boldsymbol{Y}_{(N,S,W,E)} = \boldsymbol{F} \bullet \bar{\boldsymbol{P}} \bullet \bar{O} \neq (0,0,0,0)$ /* P^2 port */
  Then *send the packet to any port which value is* 1
 Else *send the packet to source port* /* P^3 port*/
End if

3. Simulation Experiment and Analysis

In the simulation, the use of NS-2 simulator is actually the discrete-time generator in allusion to network. The size of network simulation area is $1000m \times 1000m$, the transmission scope of each node is $200m$, the random generation network is as Figure 2, the newtork is the random topological structure diagram with the condition of 70 network nodes.

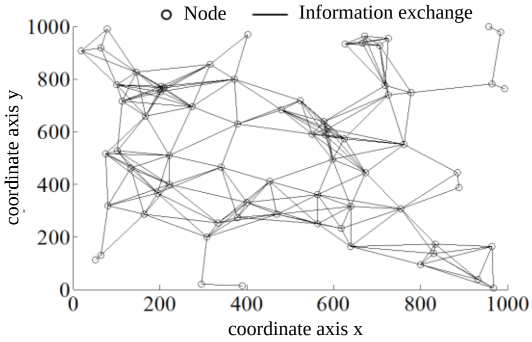


Figure 2. Topological Graph of Random Network

The node energy consumption is determined by the operating mode: sleep mode and idle mode. Because there is no data sending and receiving in sleep mode, the node energy consumption is small. The energy consumption of IDS execution mainly includes: detection of intrusion energy consuming rate, detection of single node energy consumption and the number of cluster members, then the calculation formula of energy consumption of IDS execution is:

$$IDS = DCR + \left(MCR \times \#cluster\ member \right) \quad (6)$$

All the simulation result is the average value obtained by 100 times of operation in different network topological structure. For the proposed algorithm and the algorithm available in the document: Literature [5] algorithm and Literature [6] algorithm, of which, Literature [5] is the distributed algorithm based on the connected dominating set node, one dominating set is one picture, the function of intrusion detection is executed at the connected dominating set node. Literature [6] is the clustering scheme based on area, firstly, classify the MANET network into super clustering area, then comprehensively consider the connectivity and load equilibrium in the process of clustering, so as to result in effective IDS. The simulation comparison indicator selects the average lifetime of networks (ALN) and the average number of network clusters (ANNC). The simulation comparison results is shown as Figure 3-5 and in chart 1.

Figure 3 gives the conditions of network lifetime with the change of number of nodes. Simulation parameter setting: initial energy 30kJ, $DCR = 2.0$, cluster partition reconstitution cycle is 1000s. The Figure 3 is the simulation comparison result with random network node distribution, it can be seen from Figure 3 that, with the change of total number of network nodes, the network lifetime of the three algorithms basically keeps unchanged, which shows that the simulation algorithm is not sensitive to the indicator of total number of network nodes, but the average network lifetime with the algorithm in this article is obviously better then that with the Literature [5] algorithm and Literature [6] algorithm under the same condition. The Literature [6] algorithm has not taken the network lifetime into consideration, it is the worst in simulation indicator, the following experiment will mainly compare the function performance in ALN indicator with the algorithm in this article and the Literature [5] algorithm.

Figure 4 gives that algorithm of this article and the Literature [5] algorithm change with the change of number of network nodes, and gives the network lifetime change conditions. Simulation parameter setting: initial energy 30kJ, $DCR = 2.0$, cluster partition reconstitution cycle is 1000s. It can be seen that the service life with the two algorithms are lowering with the increase of leaf nodes number, but in comparison, the decreasing speed of the algorithm in this article is slower than that of the Literature [5] algorithm. This function improvement varies from 0→14 with the variation of number of leaf nodes, the function improvement percentage presents monotone increasing from 0→26.5%, which shows that the algorithm of this article is much more effective in the treatment of leaf nodes than the doument [5] algorithm, and meanwhile, shows that the leaf node has significant influence on network lifetime.

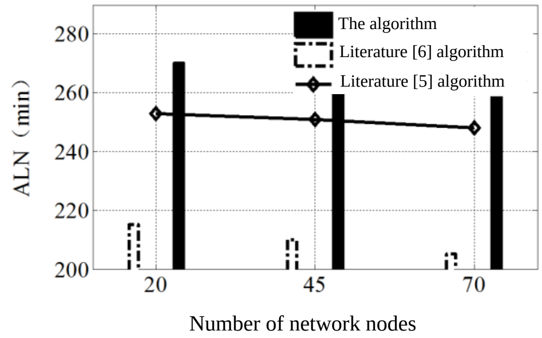


Figure 3. ALN Changes with Network Nodes

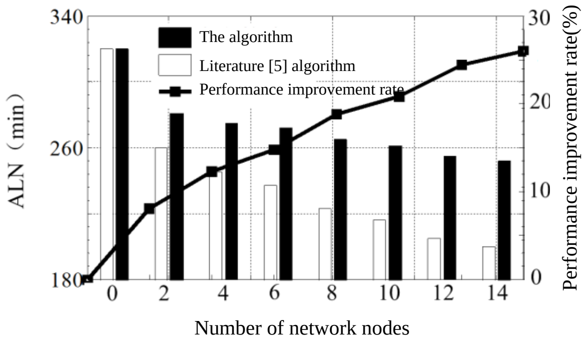
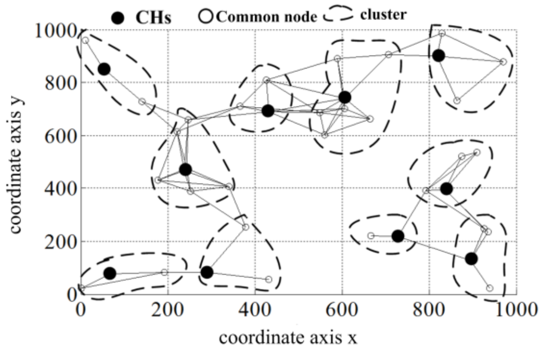


Figure 4. The Number of Nodes in ALN Varies with the Number of Leaves

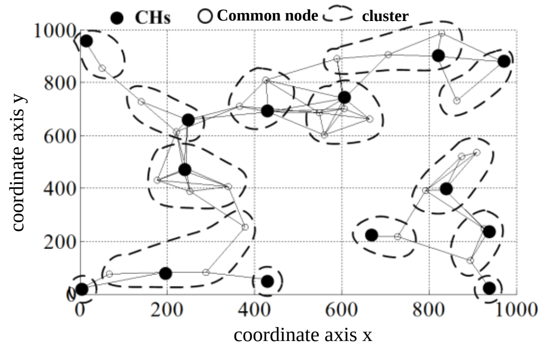
Table 1. Clusters Number

Number of n	Number of clu		
	The algorithm of this ar	Literature [5	Literatur
20	6.42	8.27	9.73
45	11.35	15.42	18.84
70	18.79	22.17	25.69

Chart 1 gives the number of cluster partition of three algorithms, seen from the comparison result, when the number of network nodes is 20, the numbers of cluster partition of the three algorithms are all not big, the algorithm of this article is 6.42 on average, Literature [5] 8.27 and Literature [6] 9.73, this number of cluster partition in this article is less than Literature [5] algorithm and Literature [6] algorithm. With the increase of number of nodes, the numbers of cluster partition of the three algorithms are all increasing, but the algorithm in this article is always the least in the number of cluster partition of the three algorithms, the decrease of number of cluster partition is helpful for the decrease of the number of CHs nodes, and the decrease of the number of CHs nodes is helpful for the decrease of demand quantity of high energy consuming intrusion detection nodes, which is of great significance to the decrease of network power consumption.



(a) Clustering results of the algorithm



(b) Literature [5] clustering results

Figure 5. Results of Cluster

Simulation parameter setting: initial energy 30kJ, $DCR = 2.0$, cluster partition reconstitution cycle is 1000s. Figure 5 is the results of cluster partition of the algorithm in the first reconstitution cycle. It can be seen form the Figure 5 results of cluster, the Literature [5] has 3 independent cluster of leaf nodes, the cluster formed with single node will cause the activation of too many CHs node intrusion detection functions, which will consume too much energy and be adverse to the prolonging of network lifetime. While, the algorithm of this article has no independent leaf node cluster, the number of cluster partition is 10, 4 less than the Literature [5] algorithm, and decreased by 28.6%.

4. Conclusion

This article mainly puts forward the feasible solution for the single cluster partition of leaf nodes, puts forward the new method of carrying out CHs node selection by starting from the leaf node and sufficiently considering the residual energy of nodes, which efficiently lowers the redundancy of algorithm cluster partition, lowers the demand quantity of intrusion detection nodes and lowers the network power consumption by a large margin and the simulation result shows that the proposed algorithm is feasible and effective. The experimental verification part of this article is mainly based on the lab simulation, next, it will be considered that to construct simulation platform in actual environment and carry out algorithm verification.

References

[1] W. Gu, Z. Lv and M. Hao, "Change detection method for remote sensing images based on an improved Markov random field", Multimedia Tools and Applications, **(2016)**.

[2] Z. Lu, C. Esteve, J. Chirivella and P. Gagliardo, "A Game Based Assistive Tool for Rehabilitation of Dysphonic Patients, 3rd International Workshop on Virtual and Augmented Assistive Technology (VAAT) at IEEE Virtual Reality 2015 (VR2015), Arles, France, IEEE, **(2015)**.

[3] Z. Chen, W. Huang and Z. Lv, "Uncorrelated Discriminant Sparse Preserving Projection Based Face Recognition Method", Multimedia Tools and Applications, **(2016)**.

[4] Z. Lv, A. Halawani, S. Feng, H. Li and S. U. Rehman, "Multimodal Hand and Foot Gesture Interaction for Handheld Devices, ACM Transactions on Multimedia Computing, Communications, and Applications (TOMM), vol. 11, no. 1s, article 10, **(2014)**, p .19.

[5] K. Leng, W. Shi, J. Chen and Z. Lv, "Designing of a I-shaped less-than-truckload cross-dock: A simulation experiments study", International Journal of Bifurcation and Chaos. **(2015)**.

[6] J. Hu and Z. Gao, "Distinction immune genes of hepatitis-induced heptatocellular carcinoma", Bioinformatics, **(2012)**, vol. 28, no. 24, pp. 3191-3194.

[7] J. Hu, Z. Gao and W. Pan, "Multiangle Social Network Recommendation Algorithms and Similarity Network Evaluation", Journal of Applied Mathematics, **(2013)**.

[8] J. Hu and Z. Gao, "Modules identification in gene positive networks of hepatocellular carcinoma using Pearson agglomerative method and Pearson cohesion coupling modularity", Journal of Applied Mathematics, **(2012)**.

[9] X. Zhang, "Spike-based indirect training of a spiking neural network-controlled virtual insect", 2013 IEEE 52nd Annual Conference on Decision and Control (CDC), IEEE, **(2013)**.

[10] K. Wang, "Towards Scalable Distributed Workload Manager with Monitoring-Based Weakly Consistent Resource Stealing", **(2015)**.

[11] Z. Lv, T. Yin, Y. Han, Y. Chen and G. Chen, "WebVR-web virtual reality engine based on P2P network", Journal of Networks, vol. 6, no. 7, **(2011)**, pp. 990-998.

[12] J. Yang, B. Chen, J. Zhou and Z. Lv, "A portable biomedical device for respiratory monitoring with a stable power source", Sensors, **(2015)**.

[13] S. Dang, J. Ju, D. Matthews, X. Feng and C. Zuo, "Efficient solar power heating system based on lenticular condensation", Information Science, Electronics and Electrical Engineering (ISEEE), 2014 International Conference, **(2014)**.

[14] X. Zhang, Y. Han, D. Hao and Z. Lv, "ARPPS：Augmented Reality Pipeline Prospect System", 22th International Conference on Neural Information Processing (ICONIP **2015**), Istanbul, Turkey.

[15] K. Wang, "Overcoming Hadoop Scaling Limitations through Distributed Task Execution".

[16] S. Zhang, Z. Xinwen and X. Ou, "After we knew it: empirical study and modeling of cost-effectiveness of exploiting prevalent known vulnerabilities across iaas cloud", Proceedings of the 9th ACM symposium on Information, computer and communications security, ACM, **(2014)**.

Authors

Jinshan Huang, he graduated from Hubei Normal University in computer science and technology, Bachelor degree in science. Mainly engaged in computer application and maintenance teaching and network security research. He is a lecturer in Computer Science Department of Yunyang Teachers' College.

