Research Journal of Applied Sciences, Engineering and Technology 9(2): 79-83, 2015
DOI:10.19026/rjaset.9.1380
ISSN: 2040-7459; e-ISSN: 2040-7467

Submitted: July 18, 2014 Accepted: October 17, 2014 Published: January 15, 2015

Research Article

Invulnerable Cluster Head Election Model to Handle Selfishness in Wireless Sensor Network

[1]P. Thiruvannamalai Sivasankar and [2]M. Ramakrishnan
[1]Department of CSE, Sathyabama University,
[2]Velmmal College of Engineering, Chennai, India

Abstract: Wireless Sensor Networks have found a vital place in current rapid moving world. Clustering is one of the most efficient and traditional methods for routing in such sensor networks. This study aims to propose an efficient cluster head election model to handle selfishness in the wireless sensor network. Clustering plays a very important role to increase the lifetime of the wireless sensor networks. In clustering techniques, every group called a cluster is controlled by the cluster head. Each sensor transmits its collected information to the base station via the cluster head. The load to the cluster head is higher than its members because it requires performing tasks like data aggregation, control and reporting to base station. In this case, the sensor nodes may act selfishly to participate in the cluster head selection process. To avoid selfishness in the cluster head selection process, the proposed scheme uses rate analysis method. In the proposed scheme, the load of the cluster head is shared among its members. The rate analysis value is updated for each and every round. So, all the sensors can honestly participate in the election without selfishness. The proposed scheme is gauged by using the QoS metrics through simulation results obtained by Network Simulator.

Keywords: Clustering, Quality of Service (QoS), selfishness attack, Wireless Sensor Network (WSN)

INTRODUCTION

A Wireless Sensor Network (WSN) consists of two kinds of nodes. They are sensor node and base station. The sensor node is tiny in size and it has very limited amount of battery power for its operation. It is used to sense or monitor the environmental condition like pressure, temperature, humidity etc. The Base station is located far away from the sensor nodes and its energy is not restricted. The sensor nodes work cooperatively and collect monitored data and send it to the base station. The base station process the data collected from the sensor and provide information to the user.

The wireless sensor networks are getting more popular because of its use in the battle field for national security and many upcoming applications like remote monitoring, industrial automation and control. Nowadays the wireless sensor networks are used in many range of application such as environmental monitoring, forest fire detection system and in many other fields.

The sensor nodes typically consist of replenishing batteries. They have very limited amount of storage, computational capability and communication ability. As the WSN is widely used in the critical application, the energy conservation of the sensor node should be optimized. The lifetime is a very acute parameter in wireless sensor network. The clustering of the senor nodes increase the lifetime of the network by the cluster head collecting that cased data from all its members in the cluster and send it to the base station. The cluster head is responsible for the transmission of sensed information of the sensor in its cluster to the base station. So, the cluster head should be selected carefully based on some criteria.

Generally wireless sensor nodes are resource limited one. The resources of the WSN should be used in the efficient manner. The clustering is a very effective technique for the efficient use of resources. Raghuvanshi *et al*. (2010) Deals with the issue of choosing optimal number of clusters with the intension of reducing the energy consumption. The fuzzy C-means clustering scheme is proposed in Raghuvanshi *et al*. (2010) to decide an optimal number of clusters.

In this study, Private Cluster head election model is proposed (Buttyan and Holczer, 2009) to protect cluster head from various types of attacks. If the attackers destroy the cluster head in that case, entire cluster cannot operate until the problem is detected or a new cluster head is elected. As the cluster head is more vulnerable to attacks, the attackers find the cluster head by monitoring the election process or the traffic. The private cluster head election model skins the identity of cluster head from the attackers who can monitor the execution of cluster head election model.

Corresponding Author: P. Thiruvannamalai Sivasankar, Department of CSE, Sathyabama University, Chennai, India

The cluster head election is the process of selecting a leader node for the group of nodes. The cluster head should be able to communicate with all its members and store the information about its members as well. The analytical hierarchy process algorithm is used to select the cluster head for the wireless sensor networks in Hussain *et al*. (2013). The cluster head is selected based on three parameters: they are energy level of the sensor, link strength with other nodes and distance to the base station. Based on these three parameters, the weight is calculated and assigned to all sensor nodes. The sensor with highest weight value is elected as cluster head.

The cluster head election by using fuzzy logic is presented in Gupta *et al*. (2012). The accurate cluster head selection decreases the energy consumption for the communication with the sink and increases the lifetime of the network. The fuzzy logic descriptors in Gupta *et al*. (2012) include energy level, concentration and centrality. The energy indicates the remaining or available energy in each node. The concentration is the number of nodes present inside its communication range. The centrality is the case where the cluster head should be present in the center of all other nodes in the cluster. Based on these three fuzzy variables the cluster head is elected.

The cluster head is elected based on its location in Mishra *et al*. (2013). The spatially distributed sensor nodes are grouped into optimal number of clusters. Then the cluster head should be elected for each and every cluster. Cluster members can communicate with the cluster head directly within one single hop. The cluster head should be closer to the base station to transmit the aggregated data to the base station.

MATERIALS AND METHODS

The wireless sensor network is the resource limited network. So, many times the sensor node acts selfishly in the network. In clustering scheme, the cluster head plays an important role because of its responsibility to collect that sensed information from its members and transmit the collected information to the base station as mentioned in Fig. 1. A node in the sensor network may not participate in the election because of its selfishness. Sometimes the node acts selfishly after elected as a cluster head. To overcome these problems, a new cluster head election model is proposed. In this model, we propose a solution to balance the resource consumption of cluster head among its members to avoid the cluster head from acting selfish.

In the proposed scheme, the rate analysis value is used to encourage the nodes to honestly participate in the election. For each and every round, the rate analysis value should be updated. The rate analysis value is calculated based on the esteem value.

The esteem value (ES_v) includes the expected number of time slots that a node wants to stay alive (nTi) in a cluster and energy level (Ei) of a node. The Esteem value is calculated using the Eq. (1):

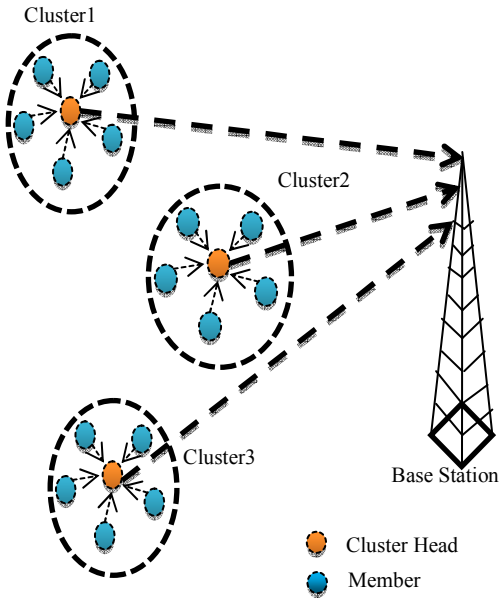

Fig. 1: Clustering in wireless sensor network

$$ES_{Vi} = {}^{E_i}/_{nT_i} \quad (1)$$

The number of packets for each node is based on its esteem value. This is indicated by per centum of sampling value (PC (SVi)):

$$PC(SV_i) = \frac{ES_{Vi}}{\sum_{i=1}^{N} ES_{Vi}} \quad (2)$$

The rate of analysis value is used to motivate the node to participate in the election. The following function is used to calculate the rate analysis value:

$$C_i = \begin{cases} \infty \; if \; (E_i < E_{dgi}) \\ \frac{PC(SV_i)}{ES_{Vi}} \; otherwise \end{cases} \quad (3)$$

The notations in Eq. (1), (2) and (3) are given below:

nT_i = No. of time slots that a node wants to stay alive
E_i = Energy level of the node i
$PC(SV_i)$ = Per centum sampling value
E_{dgi} = Minimal energy to be cluster head
N = Number of packets
C_i = Rate analysis value
ES_{Vi} = Esteem value

If the rate analysis value of node i is infinity when energy level of that node is lesser than the energy required to data gathering activity. This indicates that the energy level is too low to become a cluster head.

Figure 2 explains the flow of the selection of cluster head in the proposed cluster head election model. The esteem value is found out for each sensor

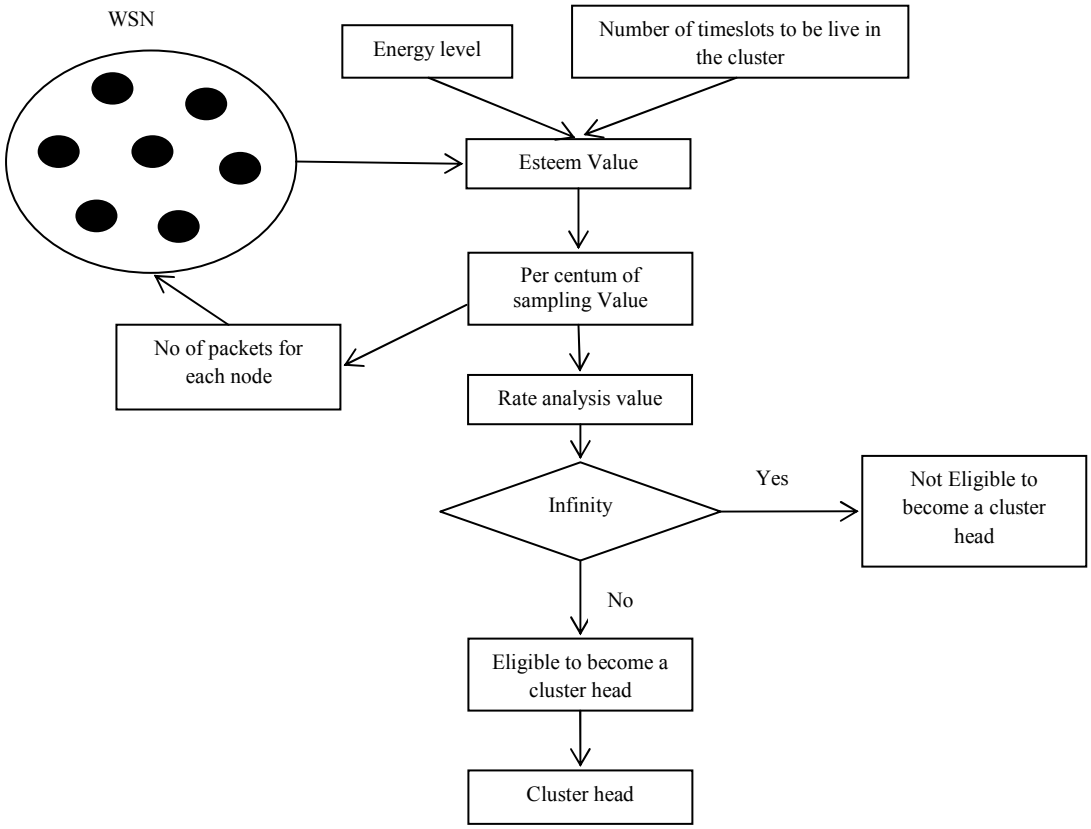

Fig. 2: Flow diagram of the proposed cluster head election method

node by giving the energy level and the number of time slots that a node a node wants to live in the cluster, as the input. The mean of the esteem value is called as the per centum sampling value. The per centum sampling value is used to decide the number of packets for each node. Based on the esteem and per centum sampling value, the rate analysis value for each node is calculated. The node which is having the lowest rate analysis value is participating in the election. The leader node is selected based on the number of vote get from other nodes in the cluster. The load of the cluster head is shared among the nodes in the cluster based on its rate analysis value.

Thus the proposed cluster head election model provides the optimal cluster head selection and encourage the node to behave honestly by sharing the task load among its members.

RESULTS AND DISCUSSION

The NS2 Simulator is mainly used in the research field of networks and communication. The NS2 is a discrete event time driven simulator which is used to evaluate the performance of the network. Two languages such as C++, OTCL (Object Oriented Tool Command Language) are used in NS2. The C++ acts as back end and OTCL is used as front end. The X-graph is used to plot the graph. The parameters used in the simulation are tabulated in Table 1.

Table 1: Simulation parameters used for the proposed method

Parameter	Value
Channel type	Wireless channel
Radio propagation model	Two ray ground
Network interface type	Wireless Phy
MAC Type	IEEE 802.11
Interface queue type	PriQueue
Antenna model	Omni Antenna
Routing protocol	AODV

The packet delivery ratio, packet loss ratio, overhead and energy consumption are the parameters used in the simulation to evaluate the proposed method.

Packet delivery ratio: The Packet delivery ratio is the ratio of the data packets delivered to the destination successfully.

The Packet delivery ratio is one of the important parameter to evaluate the quality of the network. The formula used to find the Packet delivery ratio is as follows:

$$PDR = (\text{No. of packets delivered})/\text{Time} \quad (4)$$

Figure 3 gives the graph for Packet delivery ratio. The graph shows that, the proposed scheme In Vulnerable Cluster Head Election (IVCHE) method provides high performance than the existing scheme

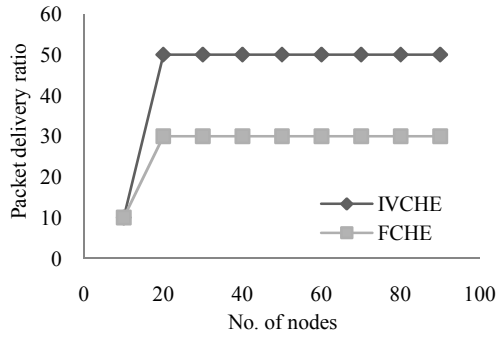

Fig. 3: Packet delivery ratio of the proposed scheme In Vulnerable Cluster Head Election (IVCHE) method compared with fuzzy based cluster head election method

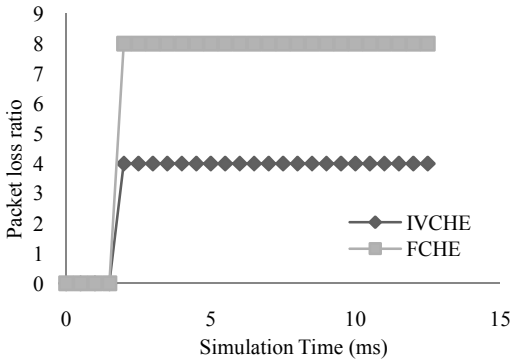

Fig. 4: Packet dropped rate of the proposed scheme compared with fuzzy based cluster head election method

Fuzzy logic based Cluster Head Election method (FCHE). Higher the Packet delivery ratio indicates that the high performance of the network.

Packet loss ratio: Packet Loss ratio is directly opposite to the Packet Received Rate. The ratio of Number of packets dropped per unit time is called as packet Dropped Rate. The Packet Dropped Rate is calculated by using the formula:

$$PLR = (\text{Number of packets dropped})/\text{Time} \quad (5)$$

The Packet loss ratio is used to evaluate the quality of the network provided by the routing scheme. Figure 4 shows the graph for Packet loss ratio of the proposed scheme. Lower the Packet loss ratio indicates that the high performance of the network.

Energy consumption: The energy consumption of a node decides the life time of the node. The residual energy is calculated by using the following formula:

$$\text{Residual Energy} = E_T-(n*P_T) \quad (6)$$

where,
E_T = Total Energy

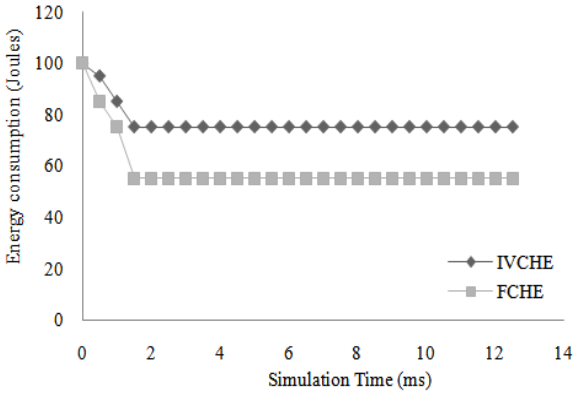

Fig. 5: Energy consumption of the node while using proposed scheme compared with the fuzzy based cluster head election method

n = Number of Transmission
P_T = Transmission Power

Figure 5 shows that the proposed scheme consumes less energy because of its efficient cluster head. It indicates that the proposed scheme provides the higher battery lifetime.

CONCLUSION

Wireless sensor nodes have very limited amount of battery power and it used to sense some critical information like environmental conditions, presence of enemies in the military field, etc., so the sensor nodes are not ready to voluntarily accept heavy communication load. Sometimes, they may act selfishly because of their limited amount of resources. While selecting cluster head in the clustering technique, some nodes do not participate due to its selfishness. This study proposed a novel cluster head election model to avoid selfishness to participate in the cluster head election. This scheme uses a rate analysis value to embolden the sensor nodes to participate in the election. The rate analysis value is estimated based in the energy of a node and its link quality with the base station. The rate analysis value is used to decide whether the sensor is having capability to transmit the required amount of data. It has been proven that, the proposed scheme provides a solution to balance the resource consumption of cluster head among its members to avoid the cluster head to become selfishly. Our techniques can be easily utilized in defense section for communication purpose because it only does not cover energy but it also covers security.

REFERENCES

Buttyan, L. and T. Holczer, 2009. Private cluster head election in wireless sensor networks. Proceeding of the IEEE 6th International Conference on Mobile Adhoc and Sensor Systems (MASS'09), pp: 1048-1053.

Gupta, I., D. Riordan and S. Sampalli, 2012. Cluster-head election using fuzzy logic for wireless sensor networks. Proceeding of the 3rd Annual Communication Networks and Service Research Conference, pp: 255-260.

Hussain, K., A.H. Abdullah, K.M. Awan, F. Ahsan and A. Hussain, 2013. Cluster head election schemes for WSN and MANET: A survey. World Appl. Sci. J., 23(5): 611-620.

Mishra, N.K., V. Jain and S. Sahu, 2013. Survey on recent clustering algorithms in wireless sensor networks. Int. J. Scientific Res. Publ., 3(4).

Raghuvanshi, A.S., S. Tiwari, R. Tripathi and N. Kishor, 2010. Optimal number of clusters in wireless sensor networks: An FCM approach. Proceeding of International Conference on Computer and Communication Technology (ICCCT, 2010), pp: 817-823.