



AENSI Journals

Australian Journal of Basic and Applied Sciences

ISSN:1991-8178

Journal home page: www.ajbasweb.com



An Optimized Cluster Head Selection Approach using Analytical Hierarchy Process and Particle Swarm Optimization

¹M. Buvana M and ²Dr M. Suganthi

¹Assistant Professor, Department of Computer Science and Engineering, PSNA College of Engineering and Technology, Dindigul, India

²Professor, Department of Computer Science and Engineering, Thiagarajar College of Engineering, Madurai, India

ARTICLE INFO

Article history:

Received 10 October 2014

Received in revised form

22 November 2014

Accepted 28 November 2014

Available online 1 December 2014

Keywords:

Ad hoc network, clustering methods, particle swarm optimization, energy efficiency, quality of service.

ABSTRACT

In this paper we explain how the performance of cluster is improved in mobile ad hoc network environment by developing a clustering algorithm to elect the cluster head, to effectively utilize the power of the node participating in cluster formation, to minimize the wastage of bandwidth by reducing the control signals and to reduce the over-head in cluster maintenance. It may also strive to attain the objectives in this regard we introduce a novel optimized clustering algorithm which is used a mathematical model that gives a hierarchal method to select a cluster head from each cluster based on the calculation of weight. The Analytical Hierarchy Process is used to calculate the weight of each node and optimize the cluster using particle swarm optimization. Energy, coverage area, mobility, quality of service is taken as the main factor and each factor having some sub criteria. There are 7 sub criteria's are taken to find the weight for each node and apply the particle swarm optimization to select the optimized cluster head. The extensive simulations were performed to show that the proposed approach is an effective approach for clustering in MANET.

© 2014 AENSI Publisher All rights reserved.

To Cite This Article: M. Buvana and Dr.M.Suganthi., An Optimized Cluster Head Selection Approach using Analytical Hierarchy Process and Particle Swarm Optimization. *Aust. J. Basic & Appl. Sci.*, 8(18): 266-275, 2014

INTRODUCTION

Mobile ad hoc networks (MANETs) play a critical role in today's wireless ad hoc network research. A MANET is a self-organizing system of wireless nodes which can communicate with each other without pre-existing infrastructure. The self-organizing wireless networks system is composed of a collection of devices that communicate with each other over a wireless medium. Such a network can be formed spontaneously whenever devices are located within transmission range. Joining and leaving of nodes occurs dynamically, particularly when dealing with mobility in wireless networks. MANETs provide unforeseen applications in some new fields.

One such problem is how to create an organizational structure amongst these nodes. Since the fundamental advantage of MANETs is the ability to deploy them in an ad hoc manner, as it is not feasible to organize these nodes into groups. For this reason, a large amount of research work is focusing on ways of creating these organizational structures (or clusters) (Bandyopadhyaya, 2003; Dhurandher.S.K, et.al 2006). The clustering phenomenon, as we shall see, plays an important role not just in organization of the network but also can dramatically affect network performance. There are several key limitations in MANETs that clustering schemes must consider, such as limited energy, network lifetime, mobility and stability.

In this paper, we propose a Novel optimized cluster head selection based on Analytical Hierarchy Process and Particle Swarm Optimization. The main goal is to minimize the number of cluster, selection of cluster head with efficient energy consumption and maximizing the network lifetime. The rest of this paper is organized as follows. Section 2 consists of review of related works. Section 3 introduces definitions and models like system model, and the factors definitions which is used in AHP. Section 4 provides the proposed work with Particle swarm optimization is applied to optimize the cluster head election procedure. The simulation results have demonstrated its performance improvement in terms of packet delivery ratio and network lifetime is explained in section 5.

Related Work:

Current algorithms for the construction of clusters are contained in many routing protocols, as well as clustering heuristics, such as (i) lowest-ID heuristic (ii) node-weight heuristic.

Corresponding Author: M.Buvana, Assistant professor, Department of Computer Science and Engineering, PSNA CET, Dindigul, Tamilnadu, India.
E-mail: bhuvana_beula@yahoo.co.in.

Lowest-ID(Handy et.al 2002) is known as identifier based clustering. In this algorithm, each node is assigned a unique ID. Periodically, every node broadcasts the list of nodes so that it can be heard. Among the neighbors, the node with minimum ID is selected as a cluster head. The drawback of this heuristic is its bias towards nodes with smaller ID, which leads to battery drainage of certain nodes. Moreover, it does not attempt to balance the load uniformly across all the nodes.

Weighted clustering algorithms (WCA) (Vieuet.al, 2006) depend on the weight of the nodes in the network. In these algorithms, the node with lower weight among the neighbors is selected as a cluster head. Although it can increase the stability of clusters, it cannot obtain the optimal number of cluster heads. Furthermore, calculation and storage of the weight are costly and the overhead induced by WCA is very high.

In (Natalia Vassileva et. al, 2008) describes, the main objective is towards maximizing the lifetime of wireless ad hoc networks through energy efficient routing. Moreover, the factors that influence the depletion of energy in ad hoc networks are revealed and the mechanisms for load balancing, which is considered as important criteria in MANETs, are proposed. But as in many researches, the proposed method for load balancing is the theoretical one and hence the correctness of the method is not guaranteed since there are no results of simulation.

(Li Q, Aslam J et.al, 2003; Nen, (2007), describes Online Power-aware Routing in Wireless Ad-hoc Networks. This paper discusses online power-aware routing in large wireless ad-hoc networks for applications where the message sequence is not known. The main purpose of this research is to optimize the lifetime of the network. Also it shows that online power-aware routing does not have a constant competitive ratio to the online optimal algorithm. Here an approximation algorithm called max-min $z P_{\min}$ that has a good empirical competitive ratio is proposed. To ensure scalability, a second online algorithm for power-aware routing is introduced. This hierarchical algorithm is called zone-based routing.

Gupta 2005 believes that the overhead of CH election may be highly reduced by using fuzzy logic. Mamdani Method is used as the fuzzy inference technique, as well as the COG (Center of Gravity) is adopted as defuzzifier approach. Three fuzzy variables such as energy, concentration and centrality are used to optimize CH selection in order to extend the network lifetime efficiently. The operation of this fuzzy CH election scheme is divided into rounds each consisting of a setup and steady state phase. During the setup phase, the base station (BS) collects the energy and location information from all sensor nodes and elects the CHs using fuzzy if-then rule according to the collected fuzzy variables and then the cluster is organized. In the steady state phase, the CHs collect the sensed data and perform data fusion functions to compress the data into a single signal, and then transmit the composite signal to the BS directly. Though this clustering mechanism prolongs the network lifetime, some demerits caused by the centralized algorithm exist even so. The BS has to collect information from all sensor nodes, which may be very complex and can generate more overhead. Furthermore, the centralized algorithm is only suitable for small or medium sized network.

Analytic hierarchy Process (AHP) (Yin, 2006), which is used to integrate cluster head selection method. To increase the lifetime there are three criteria are taken that are residual energy, mobility, and the distance. Head nodes are elected in every round based on the mobility and the energy of the nodes. Moreover it has some limitation and it cannot consider the QoS and it affects the throughput and access delay.

MWBC (Huang 2008) is a multi-weight based clustering algorithm for maximal-lifetime wireless sensor network design, which takes into consideration many factors such as the ideal degree, current energy, transmission power, link quality, and relatively position of the nodes. First of all, nodes obtain the parameters that can describe the situation of the local network through exchanging information each other. Then these parameters are dynamically calculated to be the weight, which the node holds to compete for CH, through the weighted average approach. Simulation results show that MEBC algorithm can obtain more reasonable cluster distribution and better load balancing features. However, the weight of each parameter is determined according to trial and error approach, which results in the lack of theoretical support and will impede the performance of the whole algorithm. Moreover, linear weighted calculation has its limitations, and it cannot really reflect the relationship between the various network parameters.

A Hybrid, Energy-Efficient Distributed Clustering Approach for Ad Hoc Sensor Networks (Younis 2004) is an iteration-based clustering protocol that occasionally selects cluster head on the basis of a hybrid of the node residual energy and a communication cost. It gets better the distribution of cluster heads and it may consume more amount of energy.

The PSO-C (PSO-clustering) (Kulkarni RV, et.al 2011), protocol depreciates since the PSO functions are executed in an entirely centralized way at the base station. The transmission of the sensor information to the sink at the beginning of every CH selection round gives some unnecessary delays and energy dissipates. Furthermore, at the beginning steps of each cluster head selection round, entire sensors in the network are necessary to send their location information and residual energy level to the sink. Such transmissions not only increases congestion in the network, but also lead to unnecessary energy drainage.

Analytical Hierarchy process and definitions:

A. Analytical Hierarchy Process (AHP):

Analytical Hierarchy Process (AHP) (Yin 2006) is a method for comparing a list of objectives or alternatives. AHP is a comprehensive, logical and structured framework. It allows improving the understanding of complex decisions by decomposing the problem in a hierarchical structure. The incorporation of all relevant decision criteria, and their pair wise comparison allows the decision maker to determine the trade-offs among objectives. This procedure recognizes and incorporates the knowledge and expertise of the participants. It makes use of their subjective judgments, which is a particularly important feature for decisions to be made on a poor information base.

B. Definitions:

In order to achieve efficient cluster head selection, we take the energy, coverage Area, Mobility, QoS as the main criteria. The sub-criteria are composed of battery power, transmission range between a node and its neighbors, link quality, speed, throughput, memory size, and delay. On the basis of the all-inclusive analysis and the estimate index of the CH selection, the hierarchy structure is constructed as in Fig. 1. In this case, we propose to use the AHP approach to evaluate the weight and particle swarm optimization as the CH selection scheme. Each node computes the following factor.

In initial step each node broadcast a message to all vicinity nodes. This message contains the information such as battery power, transmission range, speed, link quality, and so on. It takes 't' seconds to transmit the message to the vicinity nodes. Each node receives the information and it will be stored in the memory. When the initial steps are over, every node in the network will calculate power, transmission range, speed, and so on. In this way, the node can obtain all factors it wants. Then the nodes start to compute the following criteria.

1 Battery power (BP):

In MANET every nodes which wants to act as a cluster head .All the nodes have same transmit power and each node selects a threshold energy(E_{th}) and each node must maintain the value in their routing. Cluster head consumes more energy compared to the other nodes. In addition we choose high power nodes as cluster head because such node lose its energy. Result is prolonging the life of cluster head and it increases the stability of cluster. The following equation (1) shows how the residual energy is calculated.

The node then calculates the residual energy E_R using the following parameters:

Σ – Initial energy taken by the node, e_{tx} – Energy consumed in transmitting packets, e_{rx} – Energy consumed in receiving packets, γ – Energy consumption in idle state.

$$E_R = \Sigma - (e_{tx} + e_{rx} + \gamma) \quad (1)$$

2 Transmission Range (TRtx):

Distance and the transmission power are generated randomly for the nodes. Average distance and mean transmission power are calculated. Max distance of the nodes generated is taken as the radius for coverage area in transmission range. Average transmission range is computed with distance of the nodes.

$$TR_{tx} = \sqrt{\frac{P_t G_t G_r}{P_{R_{min}}}} (C/4\pi c)^2 \quad (2)$$

This transmission range is taken as the parameter to decide the cluster head. If a node has this value with all other nodes, that node will be selected as the cluster head.

3 Link Quality (LQ):

In MANET has a fading channel while transmitting a packet data lose may occur because of the fading. Retransmission is needed for the lost packet and the extra energy dissipation for the transmitter. So that Link Quality is evaluated to obtain the energy efficiency. Link Quality value is evaluated by using the following formula:

$$LQ = \frac{RT_n - RT_{min}}{RT_{max} - RT_{min}} \quad (3)$$

Where, RT_n is total retransmission between the adjacent node and the node within the cluster. RT_{min} , RT_{max} represents the minimum retransmission number and maximum retransmission number between the node and their adjacent node respectively.

4 Speed (SP):

Speed can be measured by how long the node has spent their time next to the node. Lower speed means that the node neighbour has spent a more time in its transmission range; it will give more stable situation.

$$SP = \sum_{j=1}^n \frac{S_L - S_F}{T_L - T_F} \tag{4}$$

Where, S_L is the signal strength of the last packet, S_F is the signal strength of the first packet, T_L, T_F is the time of the last packet and the first packet respectively.

5 **Throughput (T):**

Cluster head should have high throughput. That means it gives better connectivity with minimum packet loss between nodes in the network.

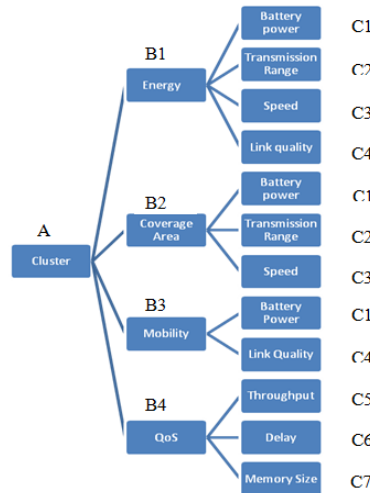


Fig. 1: Cluster head selection hierarchy structure.

6 **Delay (D):**

Delay means period between the data packet creation and the time when the last bit reach our destination.

7 **Memory size (MS):**

Memory size represents the capacity. Each cluster head should more capacity .More capacity deals with large number of requests and response between MANET nodes in the cluster network. Table 1 show the values of three nodes which is obtained by the criteria.

Table: 1: Example values of three nodes based on the parameters.

Node	BP	TR _{rx} (pos/time)	LQ	SP (in mins.)	T[in scale of 1000]	D	MS[In scale of 10]
1	60%=0.6	6	2	5	10	32.46	3
2	80%=0.8	4	1	7	5	18.4	4
3	25%=0.25	1	1	12	7	33.75	10

C. **Determining the Grade of Criteria Importance (Weight) using AHP:**

Grade of importance is determined from the investigation and from the variables. The judgment matrix is constructed based on AHP is shown as follows.

$$A - B = \begin{bmatrix} 0.2797 \\ 0.1911 \\ 0.1670 \\ 0.3227 \end{bmatrix} \tag{5}$$

$$B1 - C = \begin{bmatrix} 0.2169 \\ 0.5382 \\ 0.1381 \\ 0.1060 \end{bmatrix} \tag{6}$$

$$B2 - C = \begin{bmatrix} 0.2743 \\ 0.5505 \\ 0.1692 \end{bmatrix} \tag{7}$$

$$B3 - C = \begin{bmatrix} 0.3749 \\ 0.6251 \end{bmatrix} \tag{8}$$

$$B4 - D = \begin{bmatrix} 0.3163 \\ 0.2155 \\ 0.4568 \end{bmatrix} \quad (9)$$

When AHP is used, it is significant for performing the test in order to ensure the weight. From the above equations (6) (7) (8) (9) the weight is evaluated.

$\omega_1 = (0.2169, 0.5382, 0.1381, 0.1060)$ Similarly we can calculate the weight of other criteria such as $\omega_2, \omega_3, \omega_4$ from the table 2.

Table 1: Weight calculation based on the criteria.

Criteria	A			
	B1	B2	B3	B4
C1	0.2796	0.1913	0.16691	0.3229
C2	0.2169	0.27428	0.3749	-
C3	0.5382	0.5505	-	-
C4	0.1381	0.16917	-	-
C5	0.1060	-	0.6251	-
C6	-	-	-	0.3163
C7	-	-	-	0.2155
	-	-	-	0.4568

Cluster head Selection using PSO:

Kennedy et.al 1997, proposed a discrete binary version of PSO for binary problems. In the binary PSO, the particle's personal best and global best is updated as in real valued version. The velocity of each particle is therefore updated using the equation:

$$\begin{cases} v_{i,j}(t+1) = \eta \left(v_{i,j}(t) + c_1 r_1 (p_{best,j}(t) - x_{i,j}(t)) \right. \\ \left. + c_2 r_2 (g_{best,j}(t) - x_{i,j}(t)) \right) \\ x_{i,j}(t+1) = x_{i,j}(t) + v_{i,j}(t+1) \end{cases} \quad (10)$$

where $v_{i,j}$ is the particle velocity, $x_{i,j}$ is the particle position, t is the number of iterations, c_1 , and c_2 are two positive constants, referred to as the cognitive and social acceleration factors respectively, r_1 and r_2 are random numbers within the range $[0,1]$, and w is the inertia weight. The particle's best position (p_{best}) is denoted as $p_{ibest,j}$, the best position among all particles in the swarm is denoted as $g_{ibest,j}$. After the velocity updates, a piece-wise linear function as follows is used to force the velocity values so that they are within the V_{min} and V_{max} .

Node Evaluation:

After constructing the hierarchy tree structure shown in fig 1 evaluating the values of each node is obtained by the criteria that was defined in structure. Based on the values defined in section III and the grade of importance shown in table 1. overall evaluation of the node is obtained.

Cluster head election procedure:

Cluster head selection is the significant process for any clustering algorithm because it determines how the overall energy dissipated in the network. All nodes in the mobile network share the same responsibility and act as a cluster head. The proposed protocol operates in rounds where each round begins with a setup phase at which each cluster is formed. At the starting phases, all the nodes share their energy level as per the energy model in section III to its neighbor node. To ensure that Nodes of higher index are selected for cluster heads. All the selected CHs now send advertisement messages in the network declaring their presence as cluster heads. Each node now measures the distance from all the cluster heads. The node joins the CH with minimum distance and sends a message to the nearest cluster head.

During second phase, particle swarm optimization is used to improve the performance of the cluster head election procedure. The aim is to minimize the number of clusters while the load in the network is balanced among the clusters at the same time minimizes the energy wastes in a cluster based network. Consider the area $M \times M$ with n number of nodes. Cluster member nodes energy consumption can be expressed as

$$E_{mn} = [E_{elec} + E_{mn} + \mu_{fs} d_{mn-CH}^n] b \quad (11)$$

Where, E_{elec} is the electrical energy, E_{mn} is a energy of a member node, μ_{fs} is fading signal of transmitter, d_{mn-CH}^n is the distance between member node and cluster head. Total energy spent for 'n' number of member nodes consumes energy in the cluster as:

$$E_{mn} = [E_{elec} + E_{mn} + \mu_{fs} d_{mn-CH}^n] n b \quad (12)$$

The total energy spent on transmitting b bits for each cluster head can be expressed as:

$$E_{CH} = [E_{elec} + E_{data} + \mu_{mp} d_{CH-CH}^n] \quad (13)$$

Total energy dissipation within cluster for b bits can be expressed as:

$$E_c = E_{mn} + E_{CH} \quad (14)$$

Each cluster head dissipates energy receiving signals from the member node. The member node inside a cluster have short distance d_{jtoCH} . Thus based on the energy of cluster we derive the first objective function,

$$f1 = 2N_n b E_{elec} + N_n b E_{mn} + b \mu_{fs} \frac{M^2(n_{mn} + 1)}{2\pi} + \frac{N_n b (E_{elec} + \mu_{mp} d_{CH}^n - CH_s)}{n_{mn}} \quad (15)$$

In our optimization function we need to provide the more valuation to the energy of a node associated with the particle p_i ,

$$f2 = \sum_{\substack{i=1 \\ x_i \in X}}^{N_n} p_i / \sum_{\substack{c=1 \\ mn_c \in C_c}}^{|C_c|} E(mn)_c \quad (16)$$

f2 measures the particles energy with respect to the other nodes. This will help to prolong the energy for a node.

$$f3 = \max \left\{ \sum_{z_j \in C_{pn}} d_{z_j, CH_{pn}} / |C_{pn}| \right\} \quad (17)$$

Where, z_j is member of the node in the cluster, CH_{pn} represents n^{th} cluster head of the particle, $|C_{pn}|$ is the number of nodes that belongs to cluster c_n of particle p .

$$d_{z_j, CH_{pn}} = \left\{ \left((CH_{pn} - z_j)^{\alpha-1} (CH_{pn} - z_j) \right)^{1/2} \right\} \quad (18)$$

The computation of the distance between each particle and its neighbors that measures the closeness depends on the third objective function, f3. For each particle in the population every dimension of the particle is traversed according to the order of their experience. Cluster head election procedure is not a periodic and it is invoked at starting and rarely when the network node joins in the cluster or moves away from the cluster.

At the end of every round that is until it reaches the maximum iterations, the particle whose properties optimizes the functions such as f1, f2, and f3 is chosen as the gbest position for the CH. The member node adjacent to the gbest place is selected as the CH for the current round. The selected node acts as CH until its energy drops beyond a specified level. The following table 3 describes the symbols used in OC-AHPPSO.

Table 1: Symbols used in OC-AHPPSO.

C_{\max}	Maximum Number of clusters.
C_{\min}	Minimum number of clusters.
N_n	Number of nodes in the network.
mn_c	Member node in the 'c' cluster
mn_n	n^{th} member node mn
C_n	n^{th} node of the c cluster
$ C_c $	Total number of nodes in the c^{th} cluster
M	set of nodes in the network
C_{CH}	set of cluster heads in the clusters. $C_{CH} = \{CH_c c = 1, 2, \dots, C_{\max}\}$
X	$\{x_1, x_2, \dots, x_s\}$ is the swarm of s particles such that x_i indicates particle $x_{i,c}$ with $c=1, 2, \dots, N_C$
M_p	Optimized cluster
C_i	Number of clusters used by the clustering solution represented by particle x_i such that $C_i = \sum_{c=1}^{C_{\max}} x_{i,c}$ with $C_i < C_{\max}$
C_{CH_i}	is the clustering solution represented by particle x_i such that $C_{CH_i} = CH_c \forall c : x_{i,c} = 1$ with $C_{CH_i} \subseteq C_{CH}$
C_p	Clusters <i>pbset</i>
C_g	is the number of clustering solution represented by <i>gbest</i> such that $C_g = \sum_{c=1}^{C_{\max}} x_{i,j}$
CH_p	Cluster heads <i>pbset</i> $CH_p = (CH_c) \forall c : \hat{g}_c = 1$ $CH_p \subseteq C$
CH_g	is the number of cluster head solution represented by <i>gbest</i> such that $CH_g = (CH_c) \forall c : \hat{p}_{yc} = 0$

/* Pseudo Code for PSO to check the particle*/

1. Initialize swarm X, s particles to contain n selected CH.
2. **Initialize** the position of the particles, c1, c2, max_iterations, target_fitness, X_{\min} , X_{\max} , X_{id} , v_{\min} and v_{\max} .
3. Send(E_r , TR_{ix} , LQ, SP, Tpt, del, M_{size}) message to the vicinity node .
4. Compute the weight ω of each node.
5. Nodes of higher grade are elected as cluster heads.
6. The computed nodes are sorted according to the value of the objective function which is the sum of all ω values of cluster-heads in a particle.

Repeat

```

7. FOR each particle  $s_i, i=1,2..X$ 
8. FOR each node  $n_i, i=1,2,..N$ 
9. Initialize position
randomly,  $X_{\min} \leq X_{id} \leq X_{\max}$ 
10. Initialize velocity  $v_{id}$ 
randomly,  $v_{\min} \leq v_{id} \leq v_{\max}$ 
11. Calculate distance
 $d(n_i, CH_c)$  between node  $n_i$  and  $CH_c$ 
12. END FOR
13. END FOR
14. Iteration  $k = 0$ 
15. DO
16. FOR each particle  $i$ 
17. Calculate the fitness value  $f1, f2, f3$ .
18. Select particle neighbors for updating its velocity.
19. For each  $s_i$  in  $X$ 
20.  $p_i = s_i$  iff
21.  $f1(p_i) > f1(CH_{pi})$  and  $f2(p_i) > f2(CH_{pi})$  and  $f3(p_i) > f3(CH_{pi})$  then
22.  $C_{CH_i} = s_i$ ;
23.  $CH_g = s_i$ ;
24. Update the position of gbests and pbests.
25. END IF
26. END FOR
27. END FOR
28. FOR each particle  $i$ 
29. FOR each dimension  $d$ 
30. Calculate velocity according to the equation(12)
31. Update particle position according to the equation(12)
32. Restrict  $v_{id}$  within  $v_{\min}$  and  $v_{\max}$ .
33. Restrict  $X_{id}$  within  $X_{\min}$  and  $X_{\max}$ 
34. END FOR
35. END FOR
36. Report the global best particle as the solution of the problem
37. Reinitialize  $M$ .
38.  $k = k+1$ 
39. WHILE  $k \leq \max\_iterations$  AND  $fitness(g_{best}) < target\_fitness$ 
40. Repeat steps 2 to 31 until the maximum iteration is reached.
41. END WHILE
END

```

When OC-AHPPSO comes to an end M_p will be the resultant optimum set of cluster heads, K_n will be the optimum number of clusters in Z .

Simulation and Result Analysis:

In this section, we evaluate the performance of our proposed technique in terms of various parameters, for case network lifetime (number of alive nodes), energy consumption, average number of packets delivered. We assume ideal conditions at the physical level such that the probability of wireless interference is negligible. The network simulation model was built using Ns2. The network parameter and the swarm parameters are defined in Table 4. The PSO starts with a “swarm” of nodes randomly generated.

Initially cluster head is selected based on the weight which is calculated from the grade of importance. Based on the transmission range nodes are moved and located in their final position. For optimizing the clusters fitness functions are calculated. Optimized clusters are found in order to apply the objective functions. Fig 2 shows the optimized cluster with 3 cluster head (CH). In cluster 1 (green nodes) node 48 is the cluster head which have the highest grade of importance. Node 251 and 130 are the cluster heads for the cluster 2 (blue nodes) and cluster 3 (pink nodes) respectively.

Network lifetime is evaluated in fig 3 in terms of number of nodes stay alive over a time for the simulation in the network area considered. Our OC-AHPPSO technique network lifetime increases significantly compare to other protocols. The motivation behind the noteworthy attainment is optimized cluster formation using the objective functions place the cluster head (CH) in optimized location by swarm optimization which leads lower energy expenditure and produce better clustering with minimum energy dissipation.

Table 3: Simulation parameters.

Parameters	Values
Total number of nodes N_n	400
Network dimensions d	300x300m
Number of particles p	20
Initial energy E	0.25J
Inertia weight ω	0.8
c1,c2	2
r1,r2	[0,1]
Total iterations	6000
Routing Protocol	DSDV
Transmitter Power e_{tx}	1291w
Receiver power e_{rx}	11.081w
Transmission Range	35
Weight parameters	$\omega_1, \omega_2, \omega_3, \omega_4$
Speed of the particles	5 to 50 units

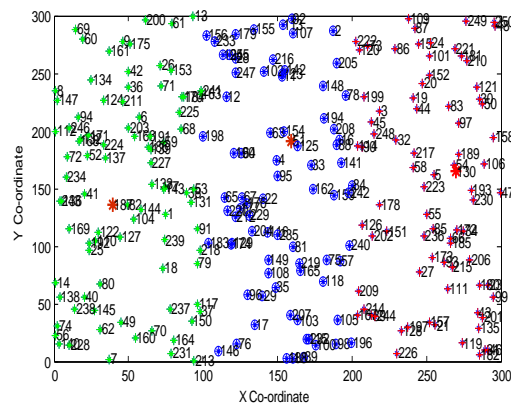


Fig. 1: Optimized Cluster formation.

The PSO-C operates with centralized base station so it leads high delay and energy may lose because of the transmission information from member node to sink. LEACH distress mostly because of poor network clustering and cluster head selection.

Fig 4 shows the total number of nodes involved in the cluster head (CH) selection measured in rounds maintained by the active nodes in the network. The following figure shows how long the nodes are alive in different energy level such as 0.25 J, 0.5 J and 1 J. Our OC-AHPPSO energy efficiency is high compared to other protocols. From the 6000 rounds supported by our work, it realized that the first node dies at the 1011 rounds in OC-AHPPSO while 801th and 420th round itself the first dead nodes available in PSO-C and LEACH respectively. From the observation, AHP takes different criteria to select the optimized cluster head and also maintain the proper association there by, prolonged existence is attained. Adding together, the optimal broadcasting is adopted to reduce the energy consumption.

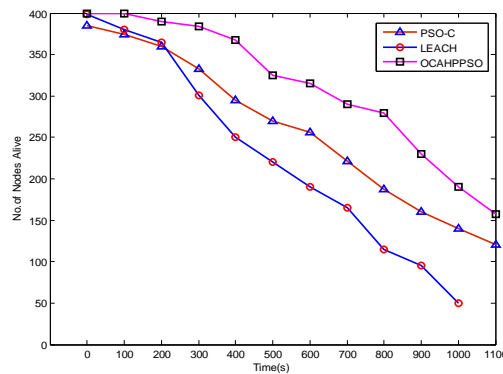


Fig. 2: Cluster network lifetime.

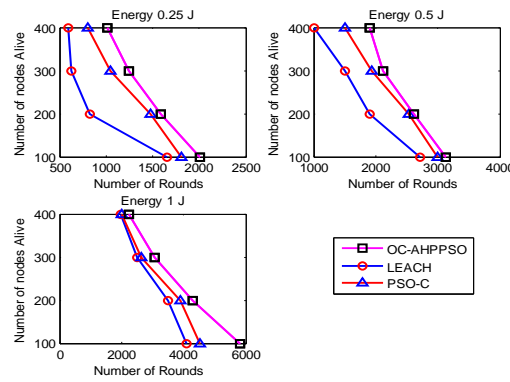


Fig. 3: Cluster Head selection in rounds.

The Life Time of the node with different amount of energy expended while selecting a cluster head is shown in table 5 and it also shows the comparisons of LEACH, PSO-C with our proposed protocol OC-AHPPSO algorithm. It shows when the first node lost their energy during different energy levels 0.25J, 0.5J, 1J. OC-AHPPSO prolonging their life time of the node compare to the other protocols.

Table 4: Lifetime Of The Nodes.

LEACH	420	806	0.25
PSO-C	801	1809	
OC-AHPPSO	1011	2010	
LEACH	934	2951	0.5
PSO-C	1501	3001	
OC-AHPPSO	1901	3125	
LEACH	1851	3961	1
PSO-C	2002	4510	
OC-AHPPSO	2251	5805	

The amount of packets to the cluster head against time is plotted in fig5. Total number of packets delivered to the CH is considerably increase while we increasing the simulation time. This will increase up to 't' seconds, after some sec it will gradually drops towards the end due to the energy scarceness in the network. This is mainly due to the fact that the AHP requires more control messages in order to collect the information about the various attributes used but it ignores the energy dissipation while sending control messages. However it takes optimum power and sustains the successful packet delivery. In PSO-C endure to maintain packet transmission but it finally the performance is low due to the centralized nature of swarm optimization.

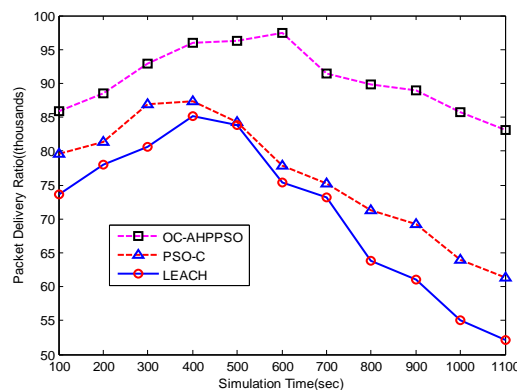


Fig. 4: Packet delivery ratio vs. Time.

Conclusion:

In this paper, we have proposed an OC-AHPPSO algorithm for cluster head selection using a mathematical model and particle swarm optimization algorithm. Our cluster based approaches improve network performance as compared to the existing methods. The proposed OC-AHPPSO decreases the cluster distance within the same cluster from the cluster members to the cluster head. The position of the cluster head is optimized by the proposed objective function applied by AHP and PSO. Additionally it improves network lifetime and avoid the frequent re clustering, and also improve the packet delivery compared to algorithms such as LEACH, and PSO-

C. The simulation results demonstrate that our OC-AHPPSO gives better performance than the LEACH, PSO-C.

REFERENCES

- Bandyopadhyay, S., Coyle EJ 2003. 'An energy efficient hierarchical clustering algorithm for wireless sensor networks'. IEEE INFOCOM, 1713-1723.
- Dhurandher, S.K., G.V. Singh, 2006. 'Power Aware Clustering Technique in Wireless Ad Hoc Networks', in ISAUHC '06. Proceedings of 'International Symposium on Ad Hoc and Ubiquitous Computing'.
- Handy, M.J., M. Haase, D. Timmerman, 2002. "Low Energy adaptive clustering Hierarchy with deterministic cluster head selection", in MWCN.2002: proceeding of the 4th IEEE conference on Mobile and wireless communication Networks, 368-372.
- Vieu .V.B., N. Nasser, N. Mikou, 2006. "A Weighted Clustering Algorithm Using Local Cluster-heads Election for QoS in MANETs". IEEE GLOBECOM.
- Natalia Vassileva, Francisco Barcelo-Arroyo, 2008. 'A Survey of Routing Protocols for Maximizing the Lifetime of Ad Hoc Wireless Networks', International Journal of Software Engineering and Its Applications, 2: 3.
- Javed Aslam, Qun Li and Daniela Rus, 2003. 'Three power-aware routing algorithms for sensor networks' Wireess Communications and Moile computing, 3: 187-208.
- Nen-Chung Wang, Jong-Shin Chen, Yung-Fa Huang, Yu-Li Su, 2007. A Power-Aware Multicast Routing Protocol for Mobile Ad-hoc Networks With Mobility Prediction", Wireless Pers Communication.
- Yin, Y.Y., J.W. Shi, Y.N. Li, P. Zhang, 2006. "Cluster head selection using analytical hierarchy process for wireless sensor networks". In PIMRC: proceedings of IEEE international symposium on personal, indoor and mobile radio communications, 11-14.
- Gupta, I., D. Riordan, and S. Sampalli, 2005. 'Cluster-Head election using fuzzy logic for wireless sensor networks'. In Proceedings of the 3rd annual communication networks and services research conference, 255-260.
- Huang, H.Q., D.Y. Yao, J. Shen, K. Ma, *et al.*, 2008. 'A multi-weight based clustering algorithm for wireless sensor network', Journal of Electronics and information Technology, 30(6): 1489-1492.
- Younis, O., S. Fahmy, 2004. HEED: A Hybrid, Energy-Efficient Distributed Clustering Approach for Ad Hoc Sensor Networks", IEEE Transactions on Mobile Computing, 3(4): 366-379.
- Student Peer Evolution "Analytical Hierarchy Process." Lees Fair Foundation Coalition, university of ALABAMA.
- Kennedy, J., R.C. Eberhart, 1997. "A discrete binary version of the particle swarm algorithm", IEEE Conference on Systems, Man, and Cybernetics.
- Fan Xiangning and Song Yulin, 2007. 'Improvement on leach protocol of wireless sensor network', Sensor Technologies and Applications conference Valencia, Spain, 260-264.
- Liang, J.J., A.K. Qin, P.N. Suganthan, S. Baskar, 2006. 'Comprehensive learning particle swarm optimizer for global optimization of multimodal functions', IEEE Transactions on Evolutionary Computation, 10: 281-295
- Kulkarni, R.V., G.K. Venayaga moorthy, 2011. 'Particle swarm optimization in wireless-sensor networks: a brief survey', IEEE Transactions on Systems, Man, and Cybernetics-Part C, 41(2): 262-267.