HBO Based Clustering and Energy Optimized Routing Algorithm for WSN

Selvi M
Dept. of IST
CEG, Anna University
Chennai, India.
selvimunuswamy@auist.net

Nandhini C
Dept. of IST
CEG, Anna University
Chennai, India.
nandhinipsgc@gmail.com

Thangaramya K
Dept. of IST
CEG, Anna University
Chennai, India.
thangaramya112@gmail.com

Kulothungan K
Dept. of IST
CEG, Anna University
Chennai, India.
kulo@auist.net

Kannan A
Dept. of IST
CEG, Anna University
Chennai, India.
kannan@annauniv.edu

***Abstract*—Wireless sensors are used to acquire the data from different environments such civilian applications, military, tracking, seismic measurements and monitoring applications in order to take necessary actions or to prevent the disasters, to do so all sensors consumes more energy. Since, the sensor is a battery operated device the lifetime of each sensor is reduced. Therefore effective cluster formation and routing is needed to prevent the sensor node to die earlier. The existing approach consumes excess energy during routing. This was due to increased overhead on the cluster head that has to perform all the work. The proposed work introduces a technique named as Honey Bee Optimization that aims to reduce the energy consumption by finding an optimal route with low cost. The proposed approach is to extend the lifetime of a network and throughput and it delivers better performance than existing method in terms of the energy efficiency, link quality, and scalability. Hence, we build the energy clusters by the biologically inspired efficient searching features of the artificial bee colony approach. The experimental verification of this technique is planned to be carried out on MatLab.**

Keywords—Wireless sensor network, Energy Efficiency, Honey bee optimisation, Honey bee based Clustering.

I. INTRODUCTION

WSN is an infrastructure less network with many sensors to sense the environment conditions and it passes the information to the base station or sinks through relay nodes. All sensors equipped with a processor, memory, transmitter, receiver, sensing unit, and a power supply. All the above components are energy consumers it is the main challenging issue which affects a lifetime of a WSN. Sensor node requires more power for data gathering, data processing, and data communications. Even a sensor node remains in an idle state it loses its energy. In this paper, optimization algorithm is used to find the optimal solution for a clustering problem in order to satisfy the objective function. Honey bee optimization is bio inspired technique which helps to study about the behavior of honey bees. It improves the lifetime of network by building effective low power clusters.

Wireless sensors are used to acquire the data from different environments such civilian applications, military, tracking, seismic measurements and monitoring applications in order to take necessary actions or to prevent the disasters, to do so all sensors consumes more energy. Since, the sensor is a battery operated device the lifetime of each sensor is reduced. Therefore effective cluster formation and routing is needed to prevent the sensor node to die earlier.

In this paper, a new optimization technique called Honey Bee Optimization is proposed for reducing the energy consumption and increase the lifetime of the network by using energy efficient clustering method which is based on the biologically inspired efficient searching features of the artificial bee colony approach. Rest of this paper is organized as follows: Section 2 provides the literature review. Section 3 explains the proposed work. Section 4 shows the experimental results. Section 5 gives conclusion of this work and also suggests some future enhancements.

II. RELATED WORKS

Energy efficient routing and sensor network life time prediction are important challenges in wireless sensor network. In the past, many cluster based routing protocols [3] [6] [12] have been proposed a clustering a protocol which reduces energy consumption to extend the network lifetime. Mohammad M. Abdellatif [5] is proposed Self-organization and auto-configuration of algorithms that allow the nodes to identify their closest neighbors, relative location using the RSSI value automatically which contains various advantages such as energy efficiency and error in the performance of the algorithm is reduced. Many clustering based routing protocol (JiWang [8], Gobi Saminathan Arumugam [4], D. Yi [7]) have been proposed for effective clustering by considering the energy efficiency, packet collection rate, less delay to improve the network performance.

Among them, LEACH protocol [11] is the first proposed cluster based communication protocol which follows a hierarchical routing approach which contains various advantages such as energy efficiency, load balancing, data aggregation abilities and simplicity. Hail in [10] proposed a new method for cluster based routing protocol which follows a fan shaped clustering approach which contains various advantages such as energy efficiency and packet collection rate using different energy saving methods such as efficient cluster head, relay selection and locality of re-clustering.

In spite of the presence of all these works many challenges still to be addressed in order to solve quick drain of energy in WSN. Motivated by this work this paper presents on effective clustering mechanism to reduce the energy consumption while performing its duties and this mechanism is used to extend its lifetime and network throughput. The proposed clustering

978-1-5090-5888-4/16/$31.00@2016 IEEE

mechanism provides better performance than existing clustering mechanism in terms of the energy efficiency, link quality, and scalability. Therefore, all constraints regarding energy consumption is achieved through honey bee optimization technique.

III. Proposed Work

In this paper, we propose, a new technique by modifying the existing distributed HBO algorithm for effective clustering of nodes in sensor networks. The main advantage of the proposed work is that it reduces the energy consumption and delay by selecting the optimal path for routing in which the cluster heads are used to perform the routing process. The main modification provided in this work is the use of intelligent agents for collecting information about all the possible routes and the energy level of nodes. This work has been implemented using MATLAB simulation.

A. Honey Bee Optimization Algorithm

Honey bee optimization (HBO) technique is used in this work to perform effective clustering of nodes based on the distance from the food sources. Moreover, it considers the fitness of the food source which is nothing but the energy available in the nodes. In this model, two types of bees are considered namely employed foragers and unemployed foragers. Among the unemployed foragers two types of bees namely scout bees which are responsible for searching the food and onlookers which are responsible for watching the hive are used in this work. The different types of bees communicate with each other through intelligent communication agents which are deployed in nodes and are able to move from one node to another.

This work uses a modified version of the algorithm proposed by ado Adamou et al [1] by modifying the algorithm with minimum movement of scout bees by the use of the intelligent agent for this purpose it uses the fitness function.

$$V_{jk} = X_{jk} + \varphi_{jk} \times (X_{jk} - X_{kl}) + A_v \quad (1)$$

Where, V_{jk} produces the new solution, φ_{jk} is a random number between (-1,1) , l={1,2,…,EB}, EB is the number of employee bees. k={1,2,..,D}, D is the number of optimization parameter and A_v is the agent node.

In this model the ith node which is a food source considered in this model is represented by the simple Xi which is a vector consisting of the elements$\{X_{i1}, X_{i2}, \dots, X_{in}\}$ and FS is the number of food sources. This model chooses the best food source by finding the probability of all food sources and selecting the best one using the formula shown in equation 2.

$$P_i = \frac{f(X_i)}{\sum_{m=1}^{FS} f(X_m)} \quad (2)$$

A new solution Xij is obtained using the formula in equation 3.

$$X_{jk} = lb_k + rand(0;1) \times (ub_k - lb_k) * c_j \quad (3)$$

Where c_i is the adjustment factor, $lb_k \le X_{jk} \le ub_k$

B. Network Model

This work uses the network model proposed by Elhabyan at al [2] and adopted in Ado Adamou et al [1]. For this purpose 100 nodes were considered in this work which is grouped into 5 clusters initially using k-means clustering algorithm. Now the clusters are modified using honey bee optimization which focuses on distance and energy.

Total energy consumed by each sensor E_i is measure based on E_s and E_r as shown in equation 4

$$E_i = \sum(E_s + E_r) \quad (4)$$

Where E_s is energy spent within in a cluster, and E_r is the energy spent between the clusters

C. HBO clustering

1) Initialization and setup:

In this work, all sensor nodes are assumed to have full energy which is represented by 1 and 0 is used to represent no energy. The nodes are randomly deployed and one base station is available for final data collection. The nodes are static in nature and hence intelligent mobile agents are deployed in each node of the sensor network for effective communication. The neighbour nodes are understood by this system by sending hello messages through flooding. Based on the time taken for reply, the neighbour nodes are identified. It also uses the Received Signal Strength Indicator (RSSI) value for knowing the neighbours

2) Cluster formation:

After initialization, cluster formation, cluster head selection and routing activities are performed. In the cluster formation, the RSSI value, distance, and agent feedback value are used in this model. Therefore, a modified version of k-means clustering algorithm enhanced with honey bee optimization and intelligent agents is used in this work for forming clusters. The clusters thus formed are equal sized clusters and hence communication will be more effective. Cluster heads are selected periodically by selecting the nodes with maximum capability as a food source and uses the formula

$$CH_i = \max(E_i + D_i + RSSI_i + A_i) \quad (5)$$

This work uses the fitness function given in equation 6 to check whether a node is eligible to participate in the communication process.

$$minimize\ fit = \alpha \times f^{energy} + \beta \times f^{Qos} + \gamma \times A \quad (6)$$

3) The proposed routing algorithm:

The proposed algorithm consists of four processes namely cluster formation and cluster head election, route discovery, routing and route maintenance. The steps of the algorithm are as follows

Step 1: Read the energy levels of sensor nodes Si, i={1,2,…,n}

Step 2: Send hello packets to all neighbours and find the neighbour nodes using RSSI and time.
Step 3: Call clustering algorithm to divide the network into k clusters.
Step 4: Perform cluster head selection for each cluster using energy as the food sources and by considering the distances.
Step 5: find the shortest path by repeated flooding through the cluster heads and the acknowledgments received from the base stations.
Step 6: Send data collected by nodes through the shortest path formed through cluster heads.
Step 7: use mobile agents to modify and maintain the paths.
Step 8: Collect data at base station.

IV. RESULTS

This work has been implemented using MATLAB simulation. Figure 1 shows the node deployment in sensor field. 100 nodes are deployed randomly in 100X100 areas.

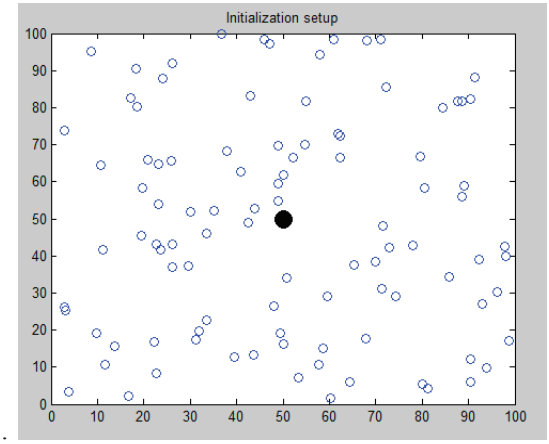

Fig. 1. Initialization Setup

From Fig. 1, it is observed that numbers of nodes are randomly deployed and it is the initial step to sense the environment.

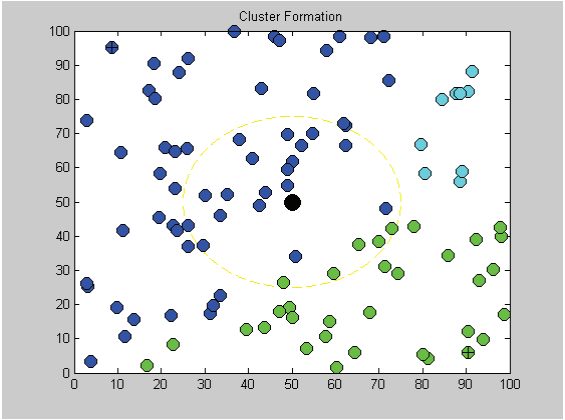

Fig. 2 Cluster Formation

Fig. 2, shows the cluster formation of the sensors, different colors of the nodes denoted as same color node belongs to one group. Fig. 3 shows the number of dead nodes for each round in the network.

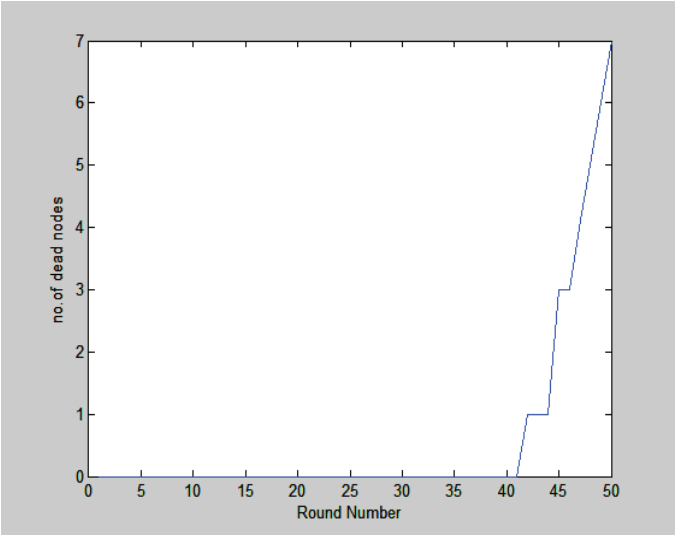

Fig. 3. Number of dead nodes for each round in the network.

From Fig. 3. It is observed that after round 40, only one node is died. Lifetimes of nodes are increased by using HBO. The average energy spent by the nodes for each round is calculated. Table I show the average's sensor energy consumption and standard deviation comparison between the LEACH protocol, PSO, ACO protocol and the proposed HBO based protocol.

In this model, simulations were carried out by deploying one base station and two base station scenarios with 50 member nodes to 200 member nodes which are sensors used to perform data collection as well as routing using the proposed model.

TABLE I. ENERGY CONSUMPTION OF SENSORS AND ITS STANDARD DEVIATION

Protocols	**Average energy consumption (J)**	**Standard deviation**
HBO	73.98	1.54
PSO	89.39	3.28
ACO	132.71	3.67
LEACH	179.65	4.09

From table I, it can be seen that the average's energy consumption and standard deviation in the proposed work is less when it is compared with LEACH, PSO, and ACO. The energy consumption is reduced in the proposed work by selecting different cluster heads for data collection and routing.

The performance of the energy consumption for different protocols are evaluated and shown in Fig 4.

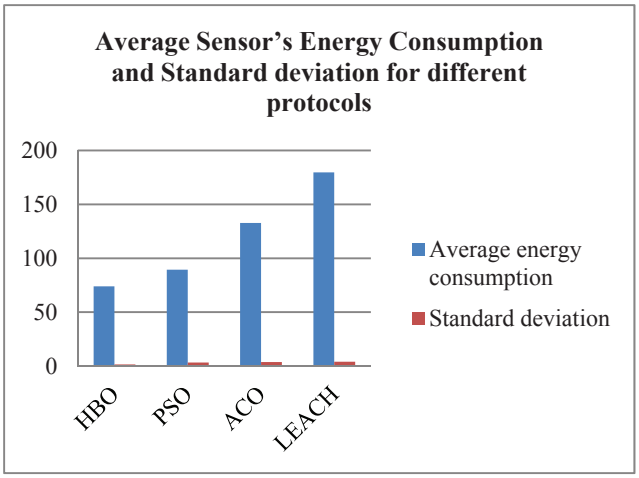

Fig. 4 Average energy consumption and standard deviation

Figure.5 shows the mean of the throughput and standard deviation comparison between the LEACH protocol, PSO protocol, ACO protocol and the proposed Proposed-HBO routing based approach.

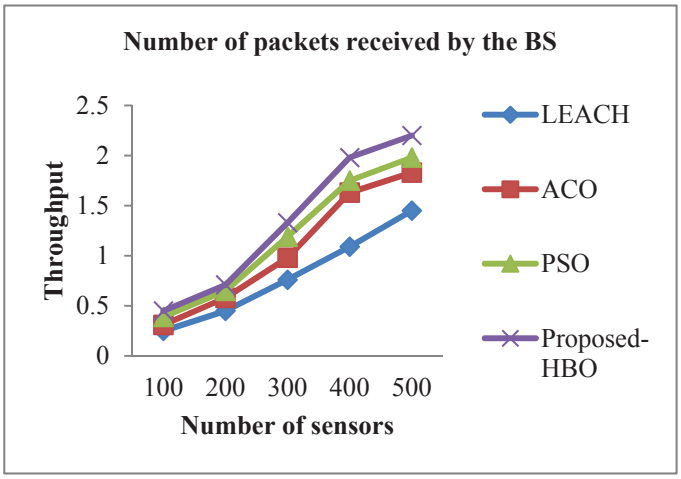

Fig. 5. Number of packets received by the Base Station

From Fig. 5, it is observed that the packet delivery rate is higher than LEACH, PSO, and ACO protocol. In this work, the packet delivery rate is improved by providing continuous power supply through energy efficiency using HBO routing based approach.

V. Conclusion

In this paper a new cluster based routing algorithm is proposed in which Honey bee optimization techniques are used to select the optimal route. This work focuses on energy efficient routing that balances the energy consumption by reducing the communication overhead using clustering approach. The main advantages of the proposed algorithm are the increase in throughput and reduction in energy consumption. This work has been compared with existing algorithms namely LEACH, ACO, and PSO based routing algorithm and it is proved that the performance of the proposed algorithm is better than the existing algorithms interms of the energy efficiency, link quality and throughput. Future works in this direction can be the use of mobility parameters in order to enhance the coverage area.

References

[1] Ado Adamou Abba Ari, BlaiseOmerYenke, NabilaLabraoui, IrepranDamakoa, Abdelhak Gueroui, "A powerefficient cluster based routing algorithm for wirelesssensor networks:Honeybeesswarmintelligencebasedapproach", Elsevier, Journal of Network and ComputerApplications vol.69 pp.77–97,2016.

[2] Elhabyan,R.S.,Yagoub,M.C.,2014.PSO-HC:particle swarm optimization protocol for hierarchical clustering in wireless sensor networks.In:2014 International Conference on Collaborative Computing: Networking, Applications and Work-sharing (Collaborate Com).IEEE, Miami,Florida,USA,pp.417–424.

[3] BongsueSuh, Steven Berber, (2016).Rendezvous points and routing path selection strategies for wireless sensor networks with mobile sink.167-169.

[4] Gobi Saminathan Arumugam, Thirumurugan Ponnuchamy. Development of energy efficient leach protocol for data gathering in wireless sensor networks. EURASIP Journal on Wireless Communications and Networking.76 (2015).

[5] Mohammad M. Abdellatif, Jose Manuel Oliveira, Manuel Ricardo.2016.The self-configuration of nodes using RSSI in a dense wireless sensor network.62 (2016) 695–709.

[6] M Selvi, R Logambigai, S Ganapathy, L Sai Ramesh, H Khanna Nehemiah, Kannan Arputharaj, "Fuzzy Temporal Approach for Energy Efficient Routing in WSN", In Proceedings of the International Conference on Informatics and Analytics ACM, 2016, doi:10.1145/2980258.2982109

[7] D.Yi, H.Yang.(2016).A delay-aware and energy-efficient routing protocol for wireless sensor networks. 2016, 155-173.

[8] Ji Wang, XiaoliRen, Fang-jiong Chen, Yankun Chen, GuobaoXu.(2016) On MAC optimization for large-scale wireless sensor network. 22 (2016) 1877–1889.

[9] Mohamed Elhawary&Zygmunt J Haas 2011. Energy-efficient protocol for cooperative networks. IEEE/ACM transactions on networking 19 2(2011), 561-574.

[1]

[10] Hai Lin, Lusheng Wang, and Ruoshan Kong.(2015).Energy Efficient Clustering Protocol for Large-Scale Sensor Networks. IEEE Sensors Journal,2015.

[11] Heinzelman, Chandrakasan, and Balakrishnan, "Energy-efficient communication protocol for wireless micro sensor networks," In Proceedings of IEEE 33rd annual Hawaii international conference on system sciences, 2000.

[12] K. Kulothungan , S. Ganapathy , S. Indira Gandhi , P. Yogesh and A. Kannan, "Intelligent Secured Fault Tolerant Routing in Wireless Sensor Networks Using Clustering Approach", International Journal of Soft Computing, Vol.6, Issue 5, pp.210-215, 2011.