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Improvement of Network Lifetime Performance Using Load Balancing Clustering and Super Clustering Approach

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Abstract

Energy efficiency always be a very important parameter to prolong network lifetime. To deal with this issue one of the effective solution is clustering. This results in low energy consumption and may prolong the network lifetime. As due to numerous functionality of cluster head it deplete more energy. So load balancing is the important factor in prolonging the network lifetime. So the unequal load of the sensor node should be balanced and the problem of unequal load is called NP-hard problem or LBCP (Load Balancing Clustering Problem). To solve this issue there is two possible solutions one is clustering based and another load balancing based. Here we propose a new technique called Super Clustering Approach (SCHA). Which helps to prolong network lifetime using movement of super cluster head to its periphery to transmit the packets to BS and the super cluster head is chosen on the basis of fitness function. Before transmitting packets, it set the flag to one to stop other functioning of the network and to regain its original position it switching the flag to zero.

Keywords: LBCP; clustering; SCHA; super cluster head; base station; load balancing.

1. Introduction

In a wireless media the data receiving and transmitting, replacement of the power embedded batteries is generally impractical after all nodes are deployed. So energy is very important parameters in any WSN networks and has to be fixed to enhance lifetime [1-5]. There is various technologies available such as energy-aware (MAC) layer protocols [6]. Self-configuration and self-organization of sensor networks give it best advantage in wireless scenario. In terms of architecture, a traditional remote sensor system may contain numerous sensor hubs that can be easily positioned in an enormous ecological zone and they can get in touch with one another to transfer data. Numerous energy efficient routing protocols productive dependent on the structure of clustering.

In sensor arrangement, gathering of sensor hubs into a cluster is called clustering. Cluster head is leader of cluster. Clustering is the base of wireless sensor systems (WSN) which provide visible solution to various system assignments, and acting working systems as neighborhood controllers [7]. There is different obligations of cluster head, for example, information accepting, transmission, information accumulation, validation, task management. Due to numerous functioning of cluster head the energy consumption is very high. It shows that cluster head bear great load then other members of cluster. The activity which cause high dissipation of energy are sending control packets, receiving data. A cluster head may be pre appointed or selected by the members of the cluster but generally on the basis of energy. All sensor nodes give data to cluster head within cluster and transfer to destination (base station). The sensor transmits such coupled data, usually via radio transmitter, to a common center (sink) either directly or via data directed center i.e. a gateway.

1.1. Load balancing based

Load balancing is a technique which help to reduce the load on cluster head. By applying some kind of algorithm by which we can not only just reduce the load but also increase significant amount lifetime and also throughput increases. Some of the well-known load balancing protocols are (EDAs) and DECA (Distributed Estimation Clustering Approach).

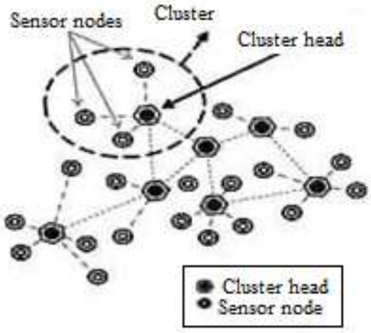


Fig.1. Clustering in WSN's

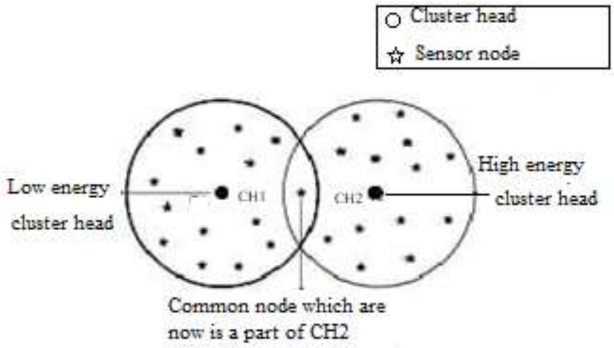


Fig.2. Load balancing

1.2. Load balancing algorithm

In circulated frameworks used in additional than one processor to execute the program. employment a processor is that the vary for coming up with time that takes to execute all strategies given resolute that a processor [8-9]. Load Balancing includes the conveyance of occupations all through various processors, along these lines enhances execution by expanding throughput without a need to acquire extra or speedier PC equipment. Load balancing is to grantee that each processor in the framework does likewise measure of work any time of time. An essential issue here is to choose how to accomplish an adjust in the heap dispersion between processors with the goal that the treatment forms are finished in the briefest conceivable time [10]. Load adjusting procedures are frequently utilized for adjusting the workload of coursed frameworks. Load adjusting strategy is completely orchestrated into two sorts particularly "Static load adjusting" and" Dynamic load adjusting". Dynamic load adjusting techniques reply to the present framework state, whereas static load adjusting strategies to be dependent upon simply on the standard leader of the structure memory the top focus to change the work of the structure trade decisions are liberated from the energy current framework state. This makes dynamic ways essentially than static one. Yet, dynamic load reconciliation ways are accepted to own most well-liked execution over static ones [5].

1.3. Categories of load balancing algorithm

Load balancing calculations is divided into 3 classifications seeable of however the procedures started as

- Sender Initiated

Writing the load reconciliation calculation is introduced by the sender. In such a count, the extraordinary stack node appearance for daintily stack hub to acknowledge the load

[9, 14-15].

- Receiver Initiated:

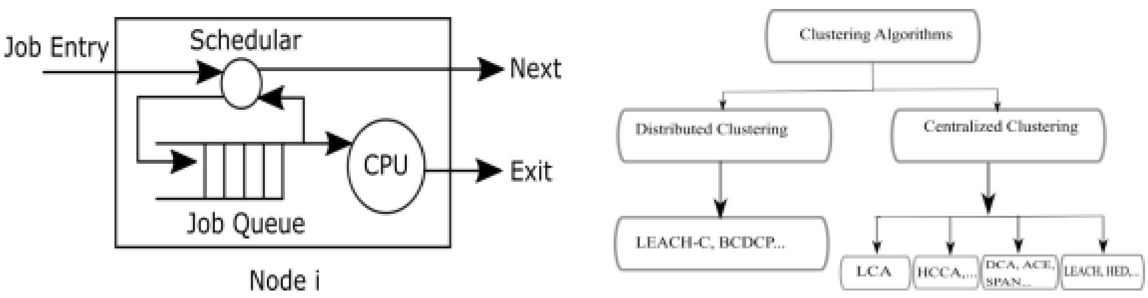
Here, we compose the load balancing calculation is started by the recipient. In such a count, the calmative of the over that the soft stack hub inquiry of an intense node get the load from it. The recipient sends ask for messages until it search the sender which will get the load [9, 14-15].

- Symmetric

Here we write a mix of senders started and recipient started relying upon the current condition of the framework [9, 14-15].

1.4. Load balancing in WSNs

In this paper, we look at the proposed Load balancing calculations for remote sensor systems. Load balancing can be utilized to elaborate the lifetime of a sensor organize by decreasing vitality consumption. Load balancing utilizing grouping can likewise build arrange adaptability. Remote sensor connect with the nodes with diverse vitality levels can draw out the system lifetime of the system and furthermore its unwavering quality.



a **b**

Fig. 3. (a). Fusion of queue and rate adjustment policy node model; (b) Clustering algorithms type

1.5. Clustering based techniques

Clustering is also one of the viable solution of Load Balancing Problem (LBCP). In which various strategy is used to compact the cluster so that no sensor lies outside the cluster such as LEACH, PEGASIS and HEED etc. Clustering strategy is for the most part utilized in the WSNs to arrange lifetime and bringing down the vitality ingestion by giving the force productive, adaptability, and security. Now a day's, sensor nodes are predominantly utilized as the homogeneous nodes in which all the nodes has the twin handling limit, vitality and functionality, however to build the system lifetime analysts has been built up a technique by coordinating the heterogeneity in nodes of WSNs, for example, to give distinctive vitality level of circulation in certain nodes. Cluster calculation ought to be energy productive. Here are some basic types of clustering networks and their protocols.

2. System model

It has been observed a lot research work has been done in the field of energy efficient algorithms because energy is the main source in the field of sensor network but there is great lack in the of network throughput and network life time. In this paper clustering algorithms is concluded so that we can enhanced the network's throughput and life time. The performance is measured by sending the packets through simulation from node to cluster head and cluster head to BS.

2.1. Energy consumption model

Fundamental elements are the key of the energy consumed by sensor nodes but it is in special cases like sensing, processing and wireless communication (refer to Fig.5(a)). EP is the energy utilization cost of a processing module, ES is the energy utilize by the sensing module and EW is the energy utilization cost of a wireless communication module and showing the net energy of a node is signified by ET. Therefore, the net energy consumption of a node ET is enumerated by the given eq.

$$E_T = E_s + E_p + E_w \quad (1)$$

2.2. Clustering algorithms used

The distance between the center vector and the input vector is calculated in standard K-means algorithm [15].

$$\|y(n) - p_i(n)\| = \sqrt{y_i(n) - p_i(n)^2 + \cdots - y_m(n) - c_{mi}(n)^2} \quad (2)$$

Where Y (n) is the input, pi is the center vector i, m is the vector's dimension and the number of centers are N winner is declared with center Q having minimum distance.

$$Q = argmin\|y(n) - p_i(n)\| \qquad i = 1,2,3 \ldots N \quad (3)$$

A fraction η is moved by winning center towards the input

$$p_i\,(n + 1) = p_i(n) - \eta[y(n) - p_i\,(n)] \quad (4)$$

η may be constant which is a learning rate or with a fraction it descendant. Example are

$$(n + 1) = -\eta(n) - \frac{1}{N} \quad (5)$$

The randomly initialized weights usually at the input value. We applied eqs. 2 and 3 continuously until convergence of algorithm starts or fixed as the specified value is by number of iterations respectively the descending learning rate becomes negligibly small. A "dead unit problem" is suffered by classical K-mean algorithm (see Fig. 4). It occurs when the center is start miles aside from the log data set relative to the other centers. It will loose the rivalry so updating occurred no results in the dead unit [27-28].

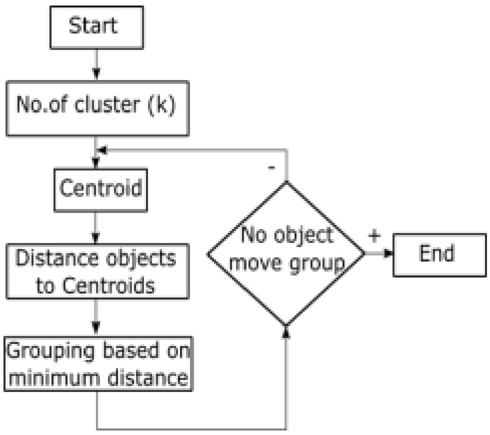


Fig. 4. k-mean flow chart.

2.3. The frequency competitive algorithm

It is the major solution of "dead units" problem. An algorithm introduced called as "Frequency Sensitive Competitive Algorithm" [28]. Reduction of learning rate occurred to that center which won so many times and a counting is done corresponding to that center in each and every time. If competition is won by center, then it itself get demoralized and discard itself towards the competition. The FSCL is the viable solution of K-mean algorithm, and all the relations which get modified they are-

$$Q = argmin\,\gamma i\|y(n) - p\_i\,(n)\| \qquad i = 1 \ldots . N \quad (6)$$

With center ci and with winning frequency γi can be defined as –

$$\gamma_i = s_i / \sum_1^N s_i \quad (7)$$

Winner is called ci No of times ci announces winner called si so the past winning of centers is reduced and can be proportional with their frequency called γ. When the selection of winner is done. An updation is done by FSCL algorithm with the equation (3) in a same manner as K-mean did. Above relation is made for adjusting the corresponding si.

$$s_i(n + 1) = s_i(n) + 1 \quad (8)$$

FSCL can fully resolve the dead units problem by distributing N centers in to the input data set. But with the constrain that the cluster number should know Multihop Clustering Algorithm use for Load Balancing (MCLB) is one of the major profit of small transmission distance for many nodes, and it advantage through the cluster implementation for transmission of data to BS that's needs only a tiny node in transmission long distances to BS via adapting clustering and rotation of CH. The clustering algorithm is executed by LEACH. There are setup and steady phase, two different states in the MCLB. The CH and provisional CH are selected in steady state Steady phase is major superior then setup phase. All the nodes in the network are trained by the algorithm in the setup phase neighbor carry coverage area.

Through multihop clustering propel the zone scope of a neighbour is set up that conditions if the focal edges of the division drawn by contacting purposes of two zones furthermore, the hub itself, and if the resultant point is more noteworthy than or then again equivalent to 360, at that point, the entire detecting territory is completely secured by its neighbours. If there should arise an occurrence of two contiguous hubs, now and again the detecting territory is additionally concealed in light of its extraordinary player control. In this recreation, we don't trust this territory coverage.

2.4. Lifetime definition

There is many definition [17-23] exist of lifetime but the most suitable one is the time till the first cluster head drained all its residual energy. Cluster head lifetime (chi) can be calculated as

Where the Eresidual (chi, r) and Ereq (chi, r) can be derived as eq. (9)

$l(ch_i)$ = [Eresidual (chi, r) / Ereq (chi, r)] (9)

Eresidual (chi, r) = Eresidual (chi, r-1) / Ereq (chi, r) (10)

Ereq (chi, r) = Emessage (chi, r) + Epacket (chi, r) (11)

Emessage (chi, r) = Emb(chi, r) + Emr(chi, r) + Emt(chi, r) (12)

Epacket (chi, r) = ciER(chi, r) + ciEDA(chi, r) + ET(chi, r) (13)

In eq. (10), (11),(12) & (13) show the energy consumed by cluster head chi denoted by Ereq (chi, r), is consist of Emessage (chi, r) which intake by broadcasting message and during delivering packets in each round Epacket (chi, r) is consumed. Remember Emessage (chi, r) is consist of three parts: (1) Emb(chi, r), during cluster head broadcasting energy consumed to its member nodes, (2) Emr(chi, r)sensor node si replies with acknowledgement during energy consumption (3) Emt(chi, r), acknowledgement message send by cluster head during energy consumption to sensor node si. Standard deviation of the cluster head period and variance of distance between cluster heads and its members to balance the load however it ignores the space between cluster head and base station. One of the solution of this objective function is that it assigns too many sensor nodes. When cluster head far away from base station the resultant consequences is that more energy starts consuming and results in an end of cluster head life. So in order to enhance cluster head lifetime we need a perfect solution which also focus on energy dissipation One of the adopted way to forecast the lifetime of the cluster head is to considering the residual energy [24-29]. This is the one of the reason to make objective function (eq. 14) which majorly depends upon residual energy Eresidual (chi, r) and requested energy Ereq (chi, r).

By clustering head max predicted lifetime L given as

L = MaxMinl(chi) (14)

Our aim is to max min lifetime.

2.5. Maximization of Lifetime using Super Clustering Head Approach (SCHA)

When the cluster head is unable to send packets BS then it broadcast control packet (Which tells everyone that it is going to send the packets) then all the cluster head calculates Fitness Function (FF) and acknowledge back to the cluster head who wants to send the packets [27]. Then a local search starts based upon FF and cluster head. Now it able to choose the super cluster head. When super cluster head receiving packets from other cluster head to minimize distance it goes to its periphery by switching flag 1 before moving towards to its periphery to stop other functioning of the network and turn it in to 0 after transmitting and regaining its original position. Similarly, this happened in each and every round and super cluster is chosen on the bases of FF.

3. Simulation parameters and results

We have evaluated proposed results via high performance MATLAB simulation.

Parameters	Value
E elec	50 nJ/bit
Efs	10 pJ/bit/m
Eda	5 nJ/bit
Emp	0.0013 pJ/bit/m
Packet size	4000
R max	50
Message size	4000
No of message	5
d- threshold	87.0
CH radius	20 m
CH energy	10 J
Sensor energy	1 J
No of cluster heads	12
No of sensor nodes	40

In the below Table.1 we conclude several parameters of super cluster head like its shifted axis, its initial and final energy, and the time taken by cluster head to finish the task. These parameters show performance of super cluster head which helps us to draw certain results like its time complexity, its performance towards energy dissipation and its space complexity in terms of its co-ordinates. Where first column refers to no of rounds in which the below conclusion drawn [28-29].

Table 1: Parameters of super cluster head

Rounds	SCH Id	Co-ordinates				Time taken (Sec)
		Initial (X)	Initial (Y)	Final (X)	Final (Y)	
1-10	2,3,5,6,7,8,11,12	97.97	101.30	99.33	99.99	3.0284e-06
11-20	2,3,5,9,12	96.65	98.82	97.56	98.32	6.2747e-06
21-30	5,6,9,10	98.88	99.91	95.45	96.62	7.2999e-06
31-40	7,9,10	93.15	95.65	98.82	99.91	3.4826e-06
41-50	7,10	95.62	97.31	91.03	93.62	3.1733e-06

In Table.2 we conclude brief comparison between LBCP and SCHA. In which it can be clearly conclude that SCHA is better approach to enhance lifetime. Here as we see that conclusion is done by using suitable objective function like in our case we use standard deviation of several parameters like lifetime and residual energy. Here we only encounter two parameters Lifetime and Throughput of residual energy because these two are the backbone of any network [29-30].

Table 2: Comparison of attributes between SCHA and LBCP

Cluster Head	SCHA		LBCP	
	SD Residual Energy (J)	SD Lifetime	SD Residual Energy (J)	SD Lifetime
1	2.8240	118.00	1.023	110.00
2	2.8239	133.056	2.132	131.04
3	2.6398	125.57	2.31	124.04
4	2.6238	77.36	3.1	78.00
5	2.2024	33.24	1.92	31.00
6	2.4265	71.51	2.39	70.02
7	2.2312	98.14	2.32	96.14
8	2.6435	108.616	2.12	107.61
9	2.6383	87.96	2.68	86.91
10	2.2015	33.01	2.43	32.01
11	2.1813	34.30	1.82	35.00
12	2.1763	26.30	2.00	21.00

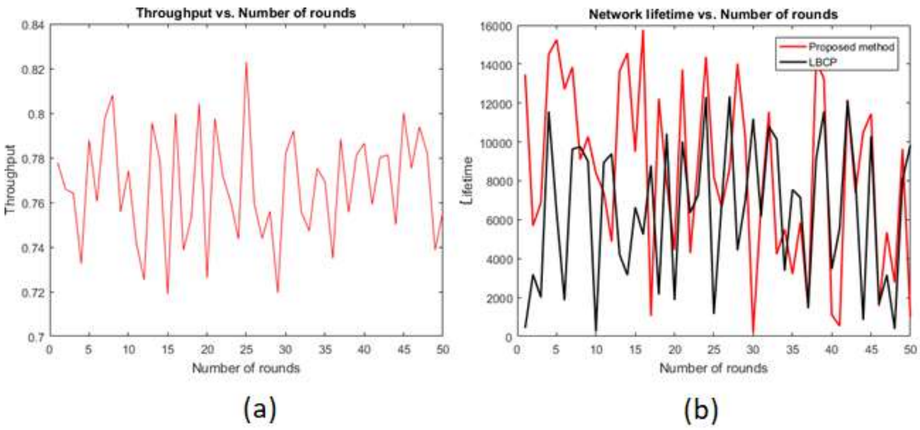


Fig. 5. (a) represents the throughput variation; (b) represents the lifetime of the network

In Fig.5a, we simulated Throughput always will be very important parameter to examine a network. Here as we can conclude that by seeing the Fig.5b the lifetime of our proposed network SCHA is far better the existing LBCP

5. Conclusion

In this paper, we see the effect of cluster algorithm which improves several parameters and reduce load on cluster head by choosing high energy cluster head called super cluster head, help cluster head to send its packets. If it unable to send the packets to BS. It increases significant amount of throughput which is around 3.5% more the LBCP based K-mean algorithm. And Significant increase in the lifetime which is approximately 30% more than LBCP and decrease energy consumption which is 1.5% less than LBCP.As a part of future work, we can use intelligence algorithm to Time taken to go its periphery transmit packet and come again to its original position and resume internal functioning by particular flag should be minimize and this two things energy and time [30].

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