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Research paper

Energy efficient cluster-based routing protocol using leach and charged system search algorithm in WSN

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Abstract

There are several sensor nodes in a wireless sensor network (WSN). Their energy, storage and processing abilities are constrained. One important task associated with the sensor nodes is to gather the data and relay it to the base station (BS). Thus, for designing effective data collection techniques in WSN, the critical factor is the network lifespan. This is because every sensor node has restricted energy resource. The literature presents a scheme for data collection based on clustering which can effectively save energy .The Low Energy Adaptive Clustering Hierarchy (LEACH) protocol is used for accumulating clusters and changing CH positions so that the energy is uniformly disseminated throughout the nodes. The literature specifies that the design of an energy-balanced clustering for peak network lifespan of WSN is a Non-deterministic Polynomial (NP)-hard problem. In the recent past, several meta-heuristic approaches on which the clustering schemes are based have been suggested for solving the NP-hard problem. Nonetheless, these clustering schemes suffer from uneven consumption of power. This research suggests an optimized Cluster Head (CH) selection algorithm that makes use of Charged System Search (CSS), for solving the aforementioned issue. It has been shown via empirical outcomes that compared to LEACH (Low-Energy Adaptive Clustering Hierarchy) protocol, this suggested scheme provides better throughput. Thus the suggested CSS optimized CH selection is promising for extending the network lifespan.

Keywords: *Charged System Search (CSS); Clustering; Cluster Head (CH) Selection; Energy; Low Energy Adaptive Clustering Hierarchy (LEACH); Routing; Received Signal Strength Indicator (RSSI) and Wireless Sensor Network (WSN).*

1. Introduction

There are several tiny sensor nodes contained in the Wireless sensor Network (WSN). These can collate the data sending the same to the base station (BS). These networks are low energy-digital circuits and the data transmission is wireless because of which their applications are widely used in habitat monitoring, object tracking and in military applications. The sensor nodes in the WSN are arbitrarily spread all the data acquiring units and sensors pick up the signals. These are then processed and sent to the sink node. By sending a query throughout the network, the sink requests for information of sensors. A response message is returned to the sink node when the node finds the information which matches the query [1].

Data from a sensor node is used by a data aggregation algorithm. These algorithms like LEACH, centralized approach and Tiny Aggregation (TAG) are used for collecting the data. By choosing an effective path, the aggregated information is forwarded to the sink node. This process is done effectively so that the network lifetime is enhanced. Data is collected in a distributed system architecture and dynamic access by means of wireless connectivity in WSNs. The objective of data aggregation protocols is elimination of superfluous data transmission and improvising power which is restricted in WSN. The data forwarding in WSN follows the multi-hop format. Here, a node sends the data to a node present in the vicinity of the sink. As the nodes are closely spaced in this approach, all of the nodes may sense the same data and this leads to energy wastage. One improvisation to this would be clustering using which, a node forwards the data to a CH and this performs aggregation over raw data, thereby forwarding it to the sink [2].

An effective scheme for energy conservation in sensor networks is data collection. The objective here is eliminating the superfluous data and conserving transmission power. There are a few aggregation schemes included in the data gathering algorithms for minimizing the data traffic. This decreases the amount of messages exchanged between the BS and the node. On the basis of how fast the sensing data can be collected and relayed to the BS/ sink node, the performance of data aggregation in WSN can be characterized. Specifically speaking, the speculative measure for capturing the drawbacks of the data aggregation in WSN is its ability to permit many-to-one data collection. The measure of how effectively the sink can collect the sensed information when interference exists is shown by the data gathering capacity. When data gathering is done over the CH, there is considerable wastage of energy. In homogeneous sensor networks, the cluster head soon perishes and re-clustering has to be done which results in greater power consumption [3].

In case of WSNs, clustering algorithms are considered to be effective for power conservation. After partitioning the nodes into autonomous clusters, a CH is chosen for every cluster. The data sensed by the node is sent to the corresponding CH which aggregates the data. Thereby, the data is reduced to that which comprises information required and this is forwarded to the BS. The distance between the two nodes determines the energy consumed during their interaction. The long distance communication is preempted by clustering. The interaction between the BS is only by CH. The CH has to rotate among the nodes in order to balance the load among all nodes. The selection of cluster head determines the performance of clustering algorithm. The determinant factor for the total intra-cluster distance and the total distance of the cluster heads to the base station is the amount of CHs. The total distance of the cluster heads to the base station reduces if the number of cluster heads is lesser; however, the total intra-cluster communication distance is enhanced. With the increased CH number, there is a reduction in the total intra-cluster communication distance; there is an increase in how farther the CH is from the BS [4].

The pioneering protocol in WSN is LEACH which is cluster based hierarchical routing protocol. This can divide the nodes into clusters. Every cluster comprises a special node which has special traits. This node is called the cluster head. It has the onus of formulating and changing the schedule of Time Division Multiple Access (TDMA). It is also responsible for sending the collected data from the nodes to the base station. Here, the data is received using CDMA Code Division Multiple Access (CDMA). All the other nodes are referred to as cluster members. The communication process is split into iterations by LEACH. Set up phase and steady state phase are the two phases that are associated with each iteration. The following are the benefits of LEACH: (1) In a certain round, any node which was chosen as the CH, cannot be the cluster head again and due to this, the load on the CH can be disseminated between the nodes to an extent. (2) The CHs are prevented from colliding due to TDMA schedule. (3) In order to preempt excessive energy dissipated, the members of the clusters can start or stop the communication interfaces in accordance with the time assigned to them [5].

There are, however, some drawbacks also associated with LEACH. (1) The hop from the CH to BS is a single hop routing which cannot be done in huge area networks. (2) CH is elected in terms of probability, without taking into account energy considerations. Thus, despite CH rotation being performed, LEACH cannot assure that when nodes have varied initial energies, there will be load balancing in the real sense. Thus, when sensors associated with low initial energy are cluster heads for the same number of rounds as the other nodes, the ones having higher power suffer premature death. (3) It is challenging for the cluster heads which are pre-ordained to be distributed uniformly throughout the network as the election of the CH is on the basis of probabilities. (4) Extra overhead results due to dynamic clustering. For instance, there may be increased energy consumed due to changes in CH and advertisements.

The CH choosing process is a NP-hard problem which is also an optimization problem. When the network is being scaled up, canonical optimization schemes are not that effective. This scheme has been used in several engineering domains for handling many of the hard optimization problems. They are shown to be better than many of the existing meta-heuristics like particle swarm optimization (PSO), Ant Colony Optimization (ACO), genetic algorithm (GA) etc. NP hard problems can also effectively be solved using CSS algorithm. There are several benefits of the CSS algorithm including its ease of implementation, its ability to provide solutions of high quality and its extremely effective exploitation and exploration features which result in rapid convergence and escaping the local minima [7]. This work suggests CSS optimized CH selection in WSN, the remainder of the investigation is structured as follows: the related works in literature are discussed in the second section. The different schemes used in the work are explained in the third section. The empirical outcomes are discussed in the fourth section and the conclusion of the work is given in the fifth section.

2. Related works

A GA based scheme for optimizing heterogeneous sensor node clustering has been suggested by Elhoseny et al., [8]. The suggested scheme has the ability of extending the network lifespan as well as mean improvisation concerning the next most effective performance on the basis of first-node-die (33.8%) and last-node-die (13%), in comparison with the five other state-of-the-art techniques. This balanced consumption of power could improvise the network lifespan and also allowed even depletion of the sensor node. While the overall mean time across all experiments is 0.6 seconds with a standard deviation of 0.06, this technique has a comparable computational efficacy with the other schemes.

The linear/non-linear programming (LP/NLP) formulations of these problems have been presented by Kuila & Jana [9]. This is succeeded by the two suggested schemes on the basis of Particle Swarm Optimization (PSO). The formulation of the routing heuristic is done with an effective multi-objective fitness function as well as particle encoding scheme. The energy conserved at the nodes by means of load balancing has been used for presenting the clustering algorithm. After experimenting the suggested algorithm pervasively, the outcomes have been contrasted with the present algorithms. Their superiority has been shown in terms of total packets delivered to the BS, energy consumption, perished sensor nodes and superior network lifespan.

Artificial Bee Colony (ABC) algorithm based scheme which makes use of effective and rapid searching ability, is a biologically motivated and energy effective clustering protocol formulated by Ari et al., [10]. The clustering adopted in the suggested scheme is centralized. However, the collection of data and routing are distributed. After various experiments performed on the suggested scheme, the outcomes are contrasted with some of the popular clustering as well as routing schemes. The outcomes derived show the efficacy of the suggested scheme in terms of the number of transferred packets and the network lifespan.

Fractional Lion (FLION) clustering algorithm is a promising optimization based scheme that has been presented by Sir Deshpande & Udupi [11]. This can formulate a routing path which is energy efficient. Here, by means of rapid selection of CH, the suggested scheme can improve the energy conserved as well as the network lifespan. Additionally, the suggested multi-objective FLION clustering scheme can formulate novel fitness functions based on parameters like delay, normal node energy, CH energy, distance between clusters and distance between nodes in a cluster. Here, to look for a fast cluster centroid for an effective routing path, the suggested fitness function has been used. The outcomes have proven that there is an enhancement in the lifespan of the WSN using the suggested FLION multi-objective clustering scheme when compared to the other protocols.

Using the Firefly with Dual Update Process (FFDUP) algorithm, Shankar & Jaisankar [12] implemented a security constraint CH selection methodology. This can attain goals like energy minimization, delay, distance and enhancement of security. The scheme is experimented for parameters like how much can be borne by the network, how the cluster heads are distributed, how secure the network is and trade-off in comparison with the suggested FFDUP algorithm. The analysis of outcomes has been compared with those of the conventional protocols like FABC, Firefly (FF) and ABC- Dynamic Scout Bee (ABC-DS) and ABC. The experimental outcomes have proven that the suggested CH selection scheme allows for better performance when compared to the existing algorithms.

An ABC based energy efficient clustering scheme as well as factional calculus for enhancing the network energy as well as the network lifespan by means of optimal CH selection. The hybrid optimization scheme is known as multi-objective Fractional ABC (FABC) has been formulated for controlling the convergence rate of the ABC. This is done with the newly formulated fitness function which takes into account parameters like energy consumed, distance travelled and delays encountered for minimizing the overall goal. Network lifespan and energy are the parameters considered for comparing the performance of the suggested FABC – based CH selection with LEACH, PSO and routing based on ABC. The outcomes have proven that the lifespan of the nodes is minimized using the suggested FABC schemes.

The selection of CH in WSN is as NP-hard optimal data aggregation scheme with power conservation is challenging to be solved in polynomial time. For improving the network performance, the firefly algorithm has been modified by Baskaran & Sadagopan [14]. This is known as synchronous Firefly Algorithm (FA) which can improvise the network performance. Simulations are performed extensively for comparing the suggested scheme with LEACH and energy-efficient hierarchical clustering. There is a reduction is the ratio of packet loss by a mean of 9.63% , using the suggested scheme. There is an improvement in the efficiency of energy in the network when compared to schemes like LEACH as well as Energy Efficient Hierarchical Clustering (EEHC).

In literature, multi-hop LEACH protocol has been suggested, however, the scheme has been proven to be ineffective as the optimization of CH is a NP-hard problem. Choosing the CH routing was discussed by Vijayalakshmi & Anandan [15]. This helps improve not only the energy efficiency of the network but also the network lifespan. Many meta-heuristic schemes, especially, Particle Swarm Optimization (PSO) exist, that have been formulated and used effectively. However, a drawback with the scheme is the poor optima issue. PSO and Tabu Search (TS) algorithms form the basis for the suggested scheme. Outcomes have proven that the proposed scheme based on Tabu-PSO can improve the efficiency of the clusters formed, the proportion of nodes that are alive and also a decreases the mean packet loss ratio along with the mean end-to-end latency.

The objective of the clustered network is selection of CHs which decrease the expenses associated with transmission as well as the energy consumed. Selection of CH is a NP hard problem and optimal selection of CH is necessary for peak network lifespan. Of late, nature inspired heuristics like PSO and Ant Colony Optimization (ACO) have been incorporated in this domain and have exhibited their effectiveness. For achieving goals like decreased end-to-end latency, packet delivery ratio, improvised cluster formation and network lifespan, Rajagopal et al., [16] adapted Bacterial foraging Optimization (BFO) for CH selection. Another new hybrid algorithm used for analyzing the number of clusters formed, end-to-end latency, packet loss ratio and lifetime is the BFO - Bee swarm Optimization (BSO).

The issue of balancing the power at the node and CH routing to the sink has been taken into account by Gupta and Jha [17]. An improved Cuckoo Search (CS) based energy balanced node and clustering protocol has been suggested in this work. This makes use of a novel objective function so that the CHs are uniformly distributed. Additionally, in order to route the data packets between the cluster heads and the sink, an improved harmony search (HS) based routing protocol has been suggested. By making use of the network lifetime, number of perished nodes, surviving nodes and mean energy consumed, the suggested integrated clustering and routing protocol's efficacy has been analyzed. Considerable improvement has been shown using the suggested Cuckoo based HS integrated clustering and routing protocol compared to the state-of-the-art protocols.

3. Methodology

An effective area of research in the WSNs is cluster based routing. This section discusses CSS optimized clustering, LEACH protocol and RSSI based LEACH protocol.

3.1. Low-energy adaptive clustering hierarchy (LEACH) algorithm

An auto-organizing, adaptive clustering protocol is LEACH. It makes use of randomization so that the energy load is evenly distributed across the sensors in the network. Set up phase and the steady state phase is the two rounds in the LEACH operations. In the former, after formulating the clusters, data is transferred to the BS. Every node can decide whether or not to become a CH in the current round. This decision depends on how many CHs are there in the network and how many times a node has become CH. Here, for every node n, a random number between 0 and 1 is selected. If this number is less than a threshold 'T(n)', the node becomes the CH for the current round [18].

The threshold is set as (1):

$$T(n)=\begin{cases}\dfrac{p}{1-p*\left(r \bmod \dfrac{1}{p}\right)} & if \ n\in G \\ 0 & otherwise\end{cases} \quad (1)$$

Where, the required proportion of the CH is denoted by p, the current round is given by r, the nodes that have not functioned as CHs is denoted by G, in the last (1/p) rounds. This threshold can be used by the node for functioning as CH until s point within (1/p) rounds. A node can decide its cluster and convey its decision to the CH. Then, the data is transferred from the CHs to the base station. The nodes send the data during the time allocated to them, to the CHs, assuming they always have the data that they should send. Each transmission males use of least energy computer using the first order radio energy prototype. During the transmission, every non-CH node can be switched off until its allocated time and in this manner, the energy dissipation in the nodes can be contained.

3.2. Received signal strength indication (rssi) based clustering algorithm

After measuring the power of the radio signal obtained, the corresponding RSSI value is evaluated. This measurement of RSSI is supported by majority of the IEEE 802.11 and 802.15.4 radio modules [19]. The association between RSSI and the power obtained (P_{Rx}) has been demonstrated as follows in formula (2):

$$RSSI = 10\log_{10} P_{Rx} \quad (2)$$

The Friis transmission equation is generally described as the propagation of radio communication. This equation gives the relation between transmission distance (D) and received power (P_{Rx}) as (3):

$$P_{Rx} = \frac{P_{Tx} G_T G_R \lambda^2}{(4\pi)^2 D^2} \quad (3)$$

The RF signal wavelength= k
Transmission power= P_{Tx}
Transmission antenna gain= G_T
Receiving antenna gain= G_R

In the beginning of the CH selection algorithm, initially every node can take a decision if it has to become a cluster head or not. An arbitrary number is selected between 0 and 1 by the node. The node becomes the CH in case this number is lower than a particular threshold T(n) and the criteria for the required number of CHs in this area is not fulfilled. The same process goes on for the remainder of the sectors leading to the formation of optimum number of clusters. RSSI will determine the selection of clusters. The association of the nodes from the sensor nodes to the CHs and then to BS must be communicated by the nodes to the cluster heads. In the beginning the location information of all nodes is directed to BS which logically partitions the network based on the collated information. There are four quadrants into which the network is divided and the information is relayed to the nodes. In every partition, based on the threshold, a few of the nodes have been chosen as cluster heads in every partition. Based on RSSI, normal nodes select their CHs inside their own quadrant. Nodes send their requests to the cluster heads for associations. For communication among the nodes without congesting, TDMA slots have been allocated to every node which communicates in this assigned slot with its CH [20].

Using the TDMA, based on the information collected from the attached nodes, assured time slots are assigned to the nodes. This data is again send to the sensor nodes in the cluster. This is used to delineate the relationship of the node with its CH. The nodes which are not CHs would place themselves in regions where they belong after which they look for the possible cluster heads and start associating themselves based on the RSSI. This process goes on until the association stops. When the set up stage is completed, the nodes are allocated the TDMA slots each time the node communicates at its allotted time interval. The remaining time radio of every non-CH node will be switched off for optimal energy usage. After receiving all the information from the nodes at the CH, the data is aggregated and sent to the BS. After the completion of this round, a new round for CH selection will be initiated.

3.3. Proposed charged system search (CSS) optimized cluster head selection algorithm

The clustering issue is solved using the CSS algorithm in this section. Finding the optimal cluster points for assigning n nodes to k clusters in R^n is the objective of this algorithm. The CSS algorithm takes the cumulative of the square of the Euclidean distances as the objective function for the clustering problem. The nodes are allocated to the centre of the cluster with least Euclidean distance between the centres of the clusters. The algorithm begins by defining the starting position as well as the velocities of the K number of charged particles (CPs). The initial CP positions are defined arbitrarily. In the CSS algorithm it has been assumed that CPs are charged spheres of radius ‘a’. The initial velocity is adjusted to 0. The algorithm begins with arbitrarily defined centre points and ends with optimal cluster centres [21].
One of the novel meta-heuristic algorithms that has been formulated is the CSS. It is used for the optimal designing of various types of structures. The basis for the CSS algorithms is the governing physics laws. There are agents/CPs comprised in the CSS which can influence each other on the basis of the Coulomb and Gauss’s laws from electrostatics. The resultant force affected on every CP will determine the progress of optimization process in the CSS algorithm. Then, the agents are sent to their new locations as per the Newton’s laws of motion. The algorithm moves towards the optimum solutions due to the successive movements of the CPs [22]. By considering the solution quality, the magnitude of charge can be defined as given in equation (4):

$$q_i = \frac{fit(i) - fitworst}{fitbest - fitworst},\ i = 1,2,...,N \tag{4}$$

Where the worst and the best fitness of all particles is defined by fitworst and fitbest respectively. The fitness of the agent i is defined by fit (i). The number of CPs present totally is given by N. The initial CP positions in the search space are randomly found using (5):

$$x_{i,j}^{(o)} = x_{i,\min} + rand_{ij}.(x_{i,\max} - x_{i,\min}),\ i = 1,2,...,N \tag{5}$$

The initial value of the ith variable for jth CP is based on $x_{i,j}^{(0)}$. The least allowable ith variable value is $x_{i,\min}$. The most allowable is given by $x_{i,\max}$. An arbitrary number between 0 and 1 is $rand_{ij}$. The beginning velocities of the charged particles are shown by (6)

$$v_{i,j}^{(o)} = 0,\ i = 1,2,....,N \tag{6}$$

The electric forces of the CPs can be imposed on one another. The distance between the CPs determines the magnitude of force for a CP inside a sphere. . For a CP that is located outside the sphere, the force is inversely proportional to the square of the distance between the CPs [23]. Using a force parameter ar_{ij}, the attractive or repelling forces are defined as in (7):

$$ar_{ij} = \begin{cases} +1\ k_t < rand_{ij} \\ -1\ k_t > rand_{ij} \end{cases} \tag{7}$$

Here, the type of force is decided by ar_{ij}. The attractive forces are denoted by +1 and the repelling forces by -1. The parameter for controlling the effect of the forces is decided by k_t .Generally speaking, the agents in the search space are collected by attractive forces. These agents are driven away by repelling forces.The resultant force is redefined as (8):

$$F_j = \sum_{i,i \neq j} \left(\frac{q_i}{a^3} r_{ij}.i_1 + \frac{q_i}{r_{ij}^2}.i_2 \right) ar_{ij} p_{ij} (X_i - X_j) \left\langle \begin{array}{l} j = 1,2,...,N \\ i_1 = 1, i_2 = 0 \Leftrightarrow r_{ij} < a \\ i_1 = 0, i_2 = 1 \Leftrightarrow r_{ij} \geq a \end{array} \right. \tag{8}$$

Where F_j is the resultant force acting on the jth CP; r_{ij} is the separation distance between twocharged particles defined as (9):

$$r_{ij} = \frac{\| X_i - X_j \|}{\| (X_i + X_j)/2 - X_{best} \| + \varepsilon} \tag{9}$$

Here, the position of ith CP is given by X_i and that of jth CP by X_j ; The location of the best present CP is X_{best} and ε is a small positive number to avoid singularity. The possibility of a CP moving towards the other is given by p_{ij} as in (10):

$$p_{ij} = \begin{cases} 1 & \frac{fit(i) - fitbest}{fit(j) - fit(i)} > rand \vee fit(i) > fit(j) \\ 0 & else \end{cases} \tag{10}$$

The new location of the CPs is determined by the resultant forces as well as the laws of motion [24]. Under the action of the resultant forces and the prior velocities, at this stage, every CP moves towards its new position as in 11 and 12:

$$X_{j,new} = rand_{j1}.k_a.\frac{F_j}{m_j}.\Delta t^2 + rand_{j2}.k_v.V_{j,old}.\Delta t + X_{j,old} \tag{11}$$

$$V_{j,new} = \frac{X_{j,new} - X_{j,old}}{\Delta t} \tag{12}$$

Two random numbers in the range [0,1] with uniform distribution: $rand_{j1}$ and $rand_{j2}$
Acceleration coefficient: k_a
Velocity coefficient for controlling the influence of prior velocity: k_v
The position of a CP exiting the search space is corrected making use of harmony search. Additionally, Charged Memory (CM) is the memory used for saving best outcomes.

4. Results and discussion

In this section, the LEACH and CSS optimized CH selection methods are used. The number of clusters formed, average end to end delay, average packet drop ratio and percentage of nodes alive as shown in tables 1 to 4 and figures 1 to 4.

Table 1: Number of Clusters Formed for CSS Optimized CH Selection

Number of nodes	LEACH	CSS Optimized CH Selection
150	19	23
300	36	43
450	54	62
600	61	68
750	74	85
900	85	96

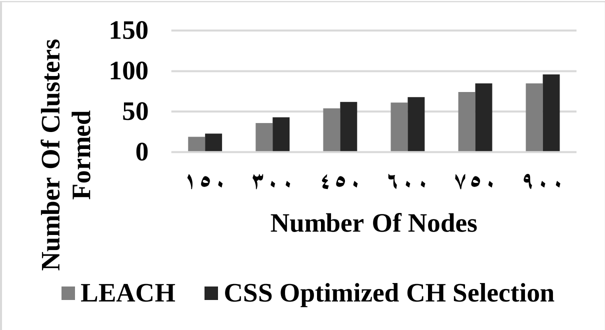

Fig. 1: Number of Clusters Formed for CSS Optimized CH Selection.

From the figure 1, it can be observed that the CSS optimized CH selection has higher number of clusters formed by 19.04% for 150 number of nodes, by 17.72% for 300 number of nodes, by 13.79% for 450 number of nodes, by 10.85% for 600 number of nodes, by 13.83% for 750 number of nodes and by 12.15% for 900 number of nodes when compared with LEACH.

Table 2: Average End to End Delay for CSS Optimized CH Selection

Number of nodes	LEACH	CSS Optimized CH Selection
150	0.05822	0.04387
300	0.06145	0.04464
450	0.0632	0.04667
600	0.06531	0.04769
750	0.06774	0.0473
900	0.07093	0.04858

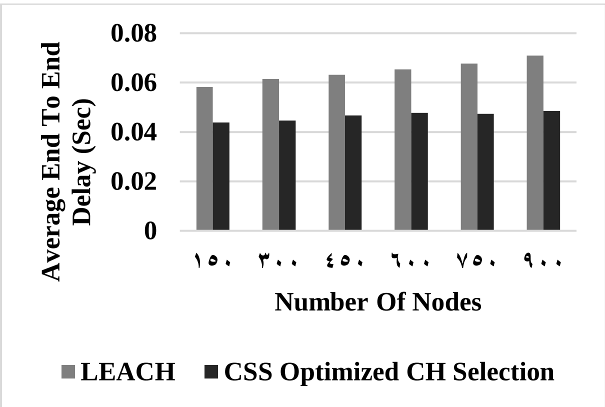

Fig. 2: Average End to End Delay for CSS Optimized CH Selection.

From the figure 2, it can be observed that the CSS optimized CH selection has lower average end to end delay by 28.11% for 150 number of nodes, by 31.69% for 300 number of nodes, by 30.09% for 450 number of nodes, by 31.18% for 600 number of nodes, by 35.53% for 750 number of nodes and by 37.4% for 900 number of nodes when compared with LEACH.

Table 3: Average Packet Drop Ratio for CSS Optimized CH Selection

Number of nodes	LEACH	CSS Optimized CH Selection
150	0.13783	0.0818
300	0.14172	0.0837
450	0.14682	0.0869
600	0.15373	0.0866
750	0.15804	0.0908
900	0.16503	0.0943

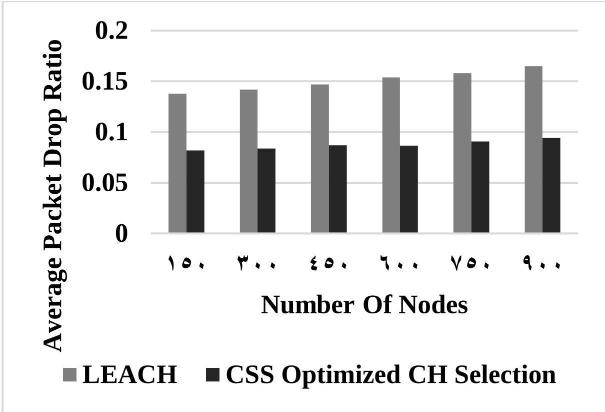

Fig. 3: Average Packet Drop Ratio for CSS Optimized CH Selection.

From the figure 3, it can be observed that the CSS optimized CH selection has lower average packet drop ratio by 51.02% for 150 number of nodes, by 51.47% for 300 number of nodes, by 51.27% for 450 number of nodes, by 55.86% for 600 number of nodes, by 54.04% for 750 number of nodes and by 54.54% for 900 number of nodes when compared with LEACH.

Table 4: Percentage of Nodes Alive for CSS Optimized CH Selection

Number of rounds	LEACH	CSS Optimized CH Selection
0	100	100
100	100	100
200	87	100
300	80	98
400	67	89
500	55	82
600	50	71
700	43	59
800	27	53
900	8	44
1000	0	37
1100	0	22
1200	0	5

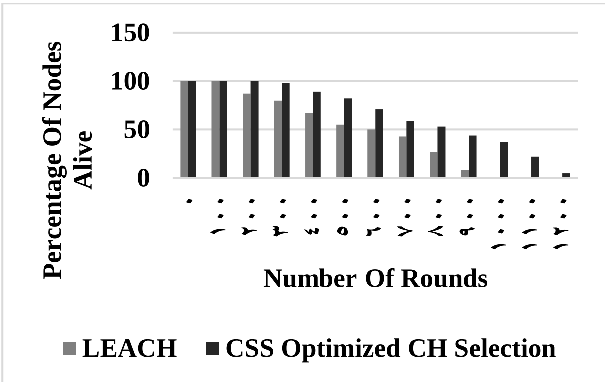

Fig. 4: Percentage of Nodes Alive for CSS Optimized CH Selection.

From the figure 4, it can be observed that the CSS optimized CH selection has higher percentage of nodes alive by 13.9% for 200 number of rounds, by 20.22% for 300 number of rounds, by 28.2% for 400 number of rounds, by 39.41% for 500 number of rounds, by 34.71% for 600 number of rounds, by 31.37% for 700 number of rounds, by 65% for 800 number of rounds and by 138.46% for 900 number of rounds when compared with LEACH.

5. Conclusion

The developments of late in the field of wireless sensor networks have resulted in the designing of several protocols that are energy-efficient. For WSNs, energy plays an important role. For energy sensor networks, the critical challenges that exist for designing the clustering algorithms are energy efficiency and load balancing. Such a high proportion of the nodes can be managed using clustering as effective mechanism. This can aid the reduction of the energy consumed by the nodes. This work suggests energy efficient CH selection algorithm based on CSS which has been used for solving the clustering problem. Optimal cluster centres are obtained using Newton's second law of motion. However, actually it is the electric force that plays a crucial role for obtaining the optimal cluster centres. For initiating the local search, the CSS algorithm makes use of the Coulomb and Gauss laws from electrostatics and also for global search, Newton's second law of motion from mechanics is employed. Results show that the CSS optimized CH selection has higher number of clusters formed by 19.04% for 150 number of nodes, by 17.72% for 300 number of nodes, by 13.79% for 450 number of nodes, by 10.85% for 600 number of nodes, by 13.83% for 750 number of nodes and by 12.15% for 900 number of nodes when compared with LEACH.

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