Maximization Energy Efficiency by Novel LEACH-Based Protocol and Optimal Wireless Sensor Networks

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Abstract-Wireless sensor networks attract so much attention in current IoT-enabled industrial and domestic applications having either homogeneous or heterogeneous sensors deployed to acquire information of intent. WSNs are intended to work involving self-fueled sensor hubs as their decision of use is geographic basic. Such hubs should uphold energy effectiveness so that the network life span turns out to be high. Group head choice plays an essential stage in a WSN design which mostly centers around the minimization of organization energy utilization. It bunches sensor hubs so that a modern organization group is framed to have an improved lifetime other than a low powerutilization. A famous grouping procedure, known as LEACH and its variations, is viewed as energy effective contrasted with its partners. A novel fully connected energy-efficient clustering (FCEEC) mechanism using the electrostatic discharge algorithm to establish a fully connected network with shortest path routing from sensor nodes (SNs) to cluster head (CH) in a multihop environment. The proposedelectrostaticdischargealgorithm(ESDA)enhancesnetwork lifetimewhileattainingenergy-efficient full connectivity between sensor nodes. As a result of ESD, the dead node count is reduced significantly so that the network longevity is increased. In the end, simulation results exhibited improved performance metrics such as energy efficiency, dead node count, packet delivery, and network latency compared to a certain conventional CH selection approach.

I. Introduction

Wireless sensor networks (WSNs) showcase highly significant contributions across several applications such as environment monitoring, seismic control, agriculture management, security surveillance, furthermore, numerous other comparative regions. Lately, research on WSN has been fast developing for analysts given its one-of-a-kind qualities. WSN contains a few completely associated sensor hubs connected remotely. Each sensor hub is associated with gathering occasionsof expectation, obtaining information, and helps in directing back to a base station (BS). Remote correspondence happens between various sensor hubs with the guide of a sensor hub the board framework to empower network checking and information assortment for every single explicit assignment, and afterward, information transmission is performed by interfacing all elaborate hubs through an expert hub to a close-by RF terminal [1]. WSN correspondence among BS and organization bunch is laid out utilizing the customary CSMA convention; information move across sensor hubs (SNs) and BS happens to utilize a group head (CH) as circuitous access [2]. A keystage in any of the sensor hub models is the lifetime augmentation of the WSN. At the point when the hub isdepleted,asarule,itcan'tbere-energizedorsupplantedbybatteries.Situatingofhubsin

conventional WSN proficiency is lesser because of the power interest and intricacy. The synchronization process among hubs and CH is limited by a few organization requirements thatmake the group head choice interaction dreary on account of all predominant bunching calculations. Henceforth, different methodologies are associated with choices for the CH. One of the navigationsis completed by the assessment of the energy. As a general rule, a CH is picked given setting up a base energy measure utilizing energy edges to guarantee full network and dependability of the given WSN.WSNs are like the regular specially appointed sort of organizations containing many hubs relying on the organization scale, interconnected with separate CHs to detect the boundaries of expectation, and associated with information procurement and sending to BS which further transmissions to resulting RF focuses. Fundamental difficulties in a network the executives are tiedin with outlining an organization region alongside specific quality worries like adaptability, dependability, and asset the board [3]. limitations are taken from specially appointed networks and are remembered for the fruitful WSN geography of the executives. From the new exploration discoveries, it is apparent that organization bunching is the generally well-known geography procedure working using the gathering of hubs to impel the CH and hubs for additional administration of planned assignments.Bunching strategies do primarily focus on proficient energy utilization to achieve sturdy and solid organizations. Information accumulation and grouping processes really do principally zero in on decreasing generally speaking organization energy utilization by wiping out a specific measure of transmission information and henceforth expanding network versatility and lifetime. Different calculations, for example, counterfeit brain organizations, support learning, and a multitude of knowledge help in the decrease of send information sizeutilizing a portion of the distributive qualities of the organization. In light of a legitimate concern for holding command over the unique idea of organizations, effective calculations should be utilized to convey a dependable and productive sensor organization. A large number of the examination works fused AI strategies to dispose of excess information being sent. These strategies deliver different functional answers for exploit assetsusedfordelayingthe lifetimeofthe wholeorganization. In area- driven approaches, the CH choice is ordinarily performed by picking an advantageous hub near a beneficial area. CH choice in light of a regular area includes computational intricacy while finding a reasonable sensor hub, consequently prompting unfortunate choice exactness and copied hub determination.

Figure1:Structureof wirelesssensor network
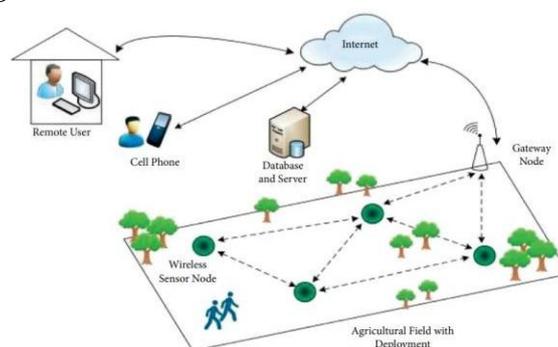
The energy expenses in a WSN comprises of firstly sensing the intended parameter and secondly connecting the data to BS. The fact is that WSNs consume maximum energy during datatransmissionoverthesensingandprocessingstageswhichleadstodrainingofpowersources

rapidly, leaving many nodes to die at a fast pace, and as a result, reducing the network life expectancy. However, the network fails when even a single node in the chain fails to involve in the data transmission process with its head node. Hence, it is firmly ascertained that WSNs are hypersensitive and highly vulnerable to working energy than any of the standard wireless networks. In the case of direct transmission from the sensor to BS, the sensor nodes get easily exhausted and become dead soon which is not a good sign in a WSN. The life span of a network shall be enhanced by employing power-efficient clustering architecture while carefully choosing sensor quality, network area, and the number of WSN nodes. It is concluded that WSN clusters do support careful power consumption and efficient energy utility with an added advantage of network longevity and packet delivery. Altogether, this approach helps to enable the remote data acquisition of physical processes from a global geometry and make that available in the Internet cloud through popular IoT technology to take deep leaps of wireless connectivity across men and machines as artificial intelligence (AI) initiative.

II. **SystemModel**

\It is clear from different writing sources that remote sensor network engineering centers around accomplishing beneficial energy productivity while cautious administration is completed on limitations, specifically, heterogeneity, versatility, energy saving, life length, and so on A very much positioned gathering of hubs is algorithmically coordinated to shape a bunch to raise the energy effectiveness of remote sensor organizations. Here, the key concluding boundaries are the nature of administration, load adjusting, and energy minimization. Every one of the hubs associates with a group head which then, at that point, gathers and passes sensors' information on to the objective.CHS introduces transmission through different hubs in the organization are individuals that immediate information from the hub to BS remotely. In the bunching approach, any data sentthrough asset obliged hubs straightforwardly causes energy consumption, failure, and impedance. A portion of the examination works is as of now completed in light of the study of WSN grouping. A few bunching strategies like HEED, BEENISH, FLOC, and LEACH are proposed with expected assortments and expansions thinking about equivalent and inconsistent groups. A superior LEACH convention [7] known as LEACHImpt is accounted for in the writing which shows preferable execution over customary strategies. Drain Impt contains different disjoint ways inside the bunch hubs as a constituent of the directing geography. An ideal way is chosen to dispense with power utilization and lingering energy while the steering jumps across hubs. The proposed LEACH-Impt has less energyutilization than its standard partners. ArbitraryCH determination is one disadvantage of this approach causing misfortunes in gathered data and thus communicated. A productive fluffy rationale for CH determination [8] has been proposed to pick the best group head (CH) which uses capable coordination between the hubs in WSN by joining the fluffy deduction framework. In the proposed FBECS, the likelihood is conveyed to each hub of the organization concerning thedistance-related utilizing fluffy rationale. The execution proportions of FBECS show better burden adjusting, dependability, and expanded lifetime. Another CH choice is performed by a bunch chain weight measurements (CCWM) approach given the positioning system [9]. The hub with a higher worthofpositionmeasurementsinsideitsorganizationrangeisviewed as CH.Itispresumedthatthe proposed CCWM technique offered adaptable weight factor changing qualities which upgraded the organization throughput.

III. ProposedLEACH Technique

The acronym LEACH denotes low energy adaptive clustering hierarchy. Currently, one of the well-proven network routing and clustering protocols operates with the time division multiple access (TDMA)protocol. Thefundamental objectiveofthis protocol is to conserve energyduringtheactive performance of a sensor network. Generally, WSN is a collection of sensor nodes that are interconnected in a particular manner, providing a strong impact on many monitoring applications in dailylife. Thedisparities foundinenergyconsumptioninanongoingtransmissioncertainlydrainthe sensor battery. LEACH uses the distributed algorithm to organize the sensor nodes into a cluster. Every cluster identifies its CH which establishes a transmission link to BS (sink node). The basic architectureofLEACHisshownin Figure2. In LEACH,theCHnodes aggregatedatareceivedfrom clustered nodes, accumulate, and forward to the sink. It is proficient in the self-organizing capability of the cluster and by its adaptability in nature. The LEACH protocol is recognized by aroundconcept. For each round, there will be a new CH to initialize data transmission. Each round of the LEACH protocol involves two main phases, namely, the setup and steady-state phases, respectively.The setup phase contains CH selection and formation of cluster stages whereas only the transmission of data takes place in the steady-state phase. To select a typical head node, all nodes in the network broadcast their probability at the beginning of everyround. The formula to calculate CH to BS distance is shown as follows:

$$dBS = \sqrt{\left[(x - 100)^2 + (y - 100)^2 \right]}$$)

wherexandyformtheBSpositioninthesearchspace.Theoptimumnumberofclustersiscalculated using cluster optimization techniques as follows:

$$k_{opt} = \sqrt{\frac{Tn}{2\pi}} \ x \ \sqrt{\frac{free\,space\,energy}{multipath\,energy}} \ x \ \frac{L}{dBS^2}$$ (2)

where Tn is the total number of nodes, and L is the network length/width. Initially, CH is selected based on the available energy level. CH will be sending the advertising message to all its member nodes on the CSMA mode. Upon receiving signal strength information from one CH node, the remaining nodes start to determine a new CH to lead the upcoming iteration. Then, the CH node schedules TDMA slots for data packet transmission and coordination within the cluster. As per the TDMA slots, sensor nodes update concerned data to the destined CH which, in turn, aggregates all nodes' information. In the uplink process, CH to BS communication is carried out using spread spectrum modulation. A unique spreading code is used by every cluster to communicate with BS to avoid interclass interference.
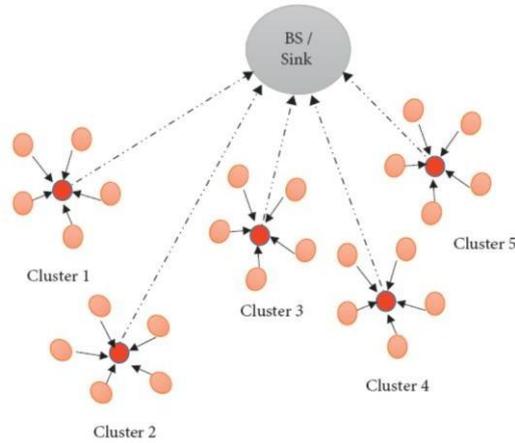
Figure2:ThebasicarchitectureofLEACH.

After completion of data transfer in round one, the network enters into the setup phase initializingCH for the next round and following its routine iterations. Figure 3. illustrates the LEACH process flow. Apart from its advantages such as energy efficiency and network life, it maximizes network coveragewithminimumlatency. Thesuccessrate of LEACHisdetermined bythefollowingcriteria:

(i) Distancebetween CH toBS decidesthe number ofhops andenergydissipation

(ii) (ii)Energy must be low for nearer nodes and high for farther nodes delivered across the BS from even the farthest node. Here are the sequential flows of the ESD algorithm.

Step 1: firstly, we initialize with a random size of the object denoted as "Obj_Size," i.e., the total number of electrical equipment in the design space

(i) Position of nodes decides the fitness value. If the fitness value is more, the equipment is safe from ESD

(ii) (ii)Besides,eachpieceofequipmentcontainsacountertoaccountforthemaximumnumberof attacks. This is called the initialization stage

Step2:Secondly,theinitializationprocessisrepeated"Max_Iter"timestofindasolutionforthe identified optimization problem

(i) Threeobjects(source,load,andvictim)arerandomlyidentifiedineveryiteration,andthebestis kept at first

(ii) (ii) "n1" random number is generated. If n1 > 0.5, only two objects are involved; otherwise, all thethree do take part

(iii) (iii)In the caseof two objects, ifthe least fitness object movestowardsthe best fitnessone(object 2 to object 1), it is represented as

$$P_{3\_update} = p_2 + 2\alpha_1 p_1 - p_{2} \quad (3)$$

in which

(iv) p2_update is the updated position of object2. p1 and p2 are the past locations of both objects. α1 isan arbitrary number with mean and SD values 0.7 and 0.2, respectively

(v) In this case, as object 2 gets closer to object 1, an ESD affects object 2 (victim) is called direct ESD incidence in cases where n1 < 0.5, three elements participate to cause an ESD. Assuming that the third object moves towards the other two elements, then

$$P_{3\_update} = p_3 + 2\alpha_2 p_1 - p_3 + 2\alpha_3 p_2 p_3 \quad (4)$$

IV.   Resultsand Discussion

A typical WSN is constructed using the FCEEC algorithm to validate the energy efficiency and packet delivery across CH and BS. The simulation results are compared with LEACH, LEACH-C, BO-LEACH, and ESD algorithms. The authors have considered the following design parameters which areasare listed in Table 1. Simulation results are described concerning energy retention, dead node count, packet delivery, and network latency. The variation in the total energy of all the nodes after every round is shown in Figure 3. It is observed that after 500.

Table1:Designparameters.

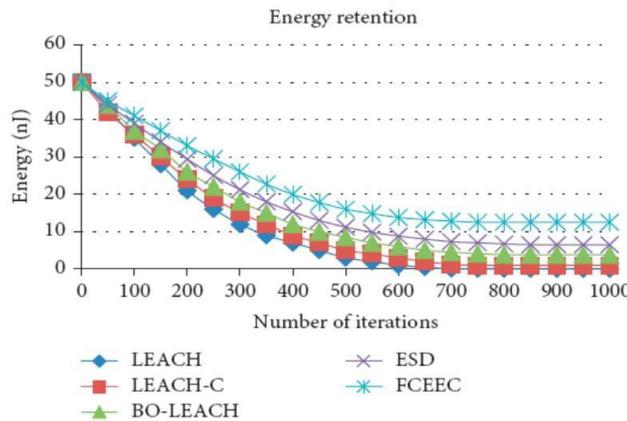| Number of nodes	100
Network size	100×100 square units
Max. energy of each node	50 mJ
Network topology	Arbitrary
Energy of transmit bit (Et)	50 nJ
Energy of receive bit (Er)	50 nJ
Energy at free space	10 pJ

Figure3:Energyretention.

rounds of execution, the proposed FCEEC increases total energy savings by 81.25% than LEACH, 68.75%thanC-LEACH, 46.87%than BO-LEACH,and 30%than ESD. Theenergyretention further rises to a maximum of 96% compared with LEACH, 92% than C-LEACH, 69.6% than BO-LEACH, and 48% than ESD when the number of rounds reaches 1,000. Energy retention analysis after 500 and 1,000 rounds ofiterations forvarious algorithms is shownin Figure 4. Thedead node count after every round of iteration is shown in Figure 5. It is identified that after 500 rounds of execution, the proposed FCEEC reduces thedead node count by 55.5% from LEACH, 46.15% from C-LEACH, 33.3% from BO-LEACH, and 20% from ESD. TheFCC reduces the dead node count by 25.8% from LEACH,20.69%fromC-LEACH,16.86%fromBO-LEACH,and6.75%fromESDafter1,000

rounds of execution. The number of dead nodes after 500 and 1,000 rounds of iterations for various algorithms is shown in Figure 8. The data packet delivery from CH to BS after every round of execution is shown in Figure 9. After 500 rounds of execution in the proposed FCEEC, the packet delivery is raised by 33.52% than LEACH, 28.25% than C-LEACH, 23.65% than BO-LEACH, and 13.78%thanESD.TheproposedFCEECimprovesthepacketdeliveryby32.28%thanLEACH,

28.24% than C-LEACH, 24.71% than BO-LEACH, and 17.13% than ESD after 1,000 rounds of execution. The number of data packets generated will be reduced if the number of dead nodes increases. In LEACH, more than 80 nodes will not be alive after 650 rounds of iteration. Hence, the number of packets generated will be very less compared
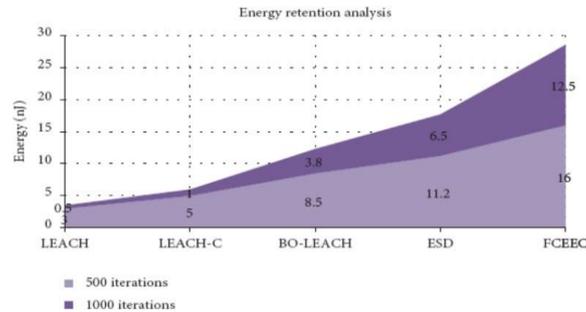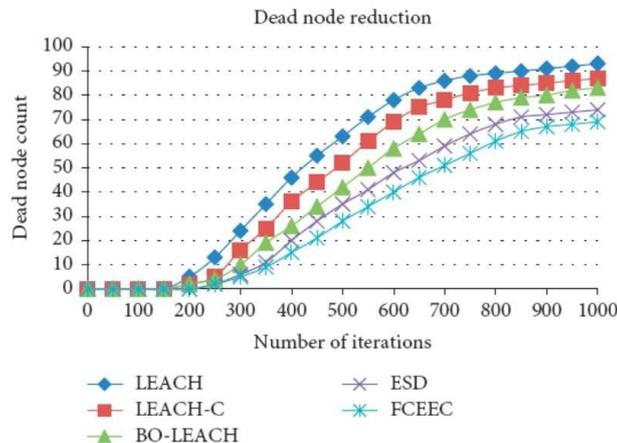

Figure4:Energyretention analysis.

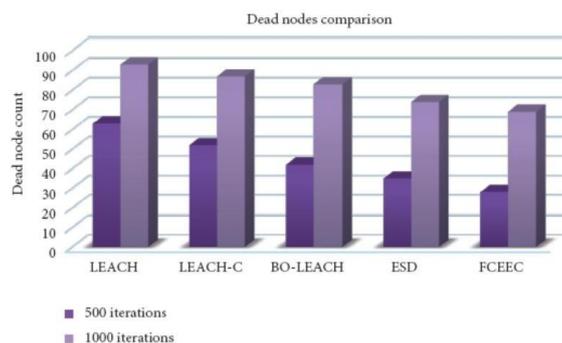**Figure5:Deadnode reduction.**

Figure6:Deadnode comparison.

with earlier rounds. The same scenario occurs when using other algorithms also. The packet delivery comparison after 500 and 1,000 rounds of iterations.

V.   Conclusion

Thus, it is observed from the above results that the ESDAbased FCEEC algorithm facilitates optimum CH-BS placement and the shortest path discovery for full connectivity of nodes. The proposed method improves the packet delivery rate, and most importantly, the energy efficiency of nodes is increased significantly whencompared with the generic LEACH and other conventional methods. Hence, it is concluded that the newly inducted FCEEC results in the optimization of WSN output parameters in terms of reduction in node energy by 96%, reduction of dead nodes by 25.8%, increase in the packet delivery rate by 32.28%, and the network latency by 66.46%, respectively.

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