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Original Article

An Energetic Cluster Head Selection with Hand-Over Strategy for Un-Balanced Energy Consumption in Wireless Sensor Networks

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Abstract - *Wireless sensor networks play an important role in our daily lives by improving technologies for home automation, healthcare, temperature regulation, and energy use management, among other things. Energy usage is undeniably a massive and risky liability in real-world WSN applications. There are numerous clustering algorithms introduced for heterogeneous WSN. Clustering provides an effective solution to the sensor node's unbalanced load problem. We introduced even no sensor nodes for all clusters. This paper builds unique size clusters. This work's preliminary contribution was enacting an Efficient Cluster Creation with even no. Sensor nodes can expand the network lifetime and throughput of wireless sensor networks. We developed An Energetic Cluster Head selection with a hand-over Strategy using a counter node or Transportable sink after forming a uniform size cluster. This strategy is useful in resolving unstable energy consumption for each sensor node. The Network's lifetime was reduced as a result of unbalanced energy consumption. Our proposed strategy aids in maintaining unique energy consumption for each sensor node.*

Furthermore, using a counter node during the hand-over stage reduces Transmission delay diagonally to the Network. We compared our proposed algorithm to the Existing Mechanism SBCH by the Network Simulator 3.30. As with an existing system, our algorithm ensures that nearly 84.6 percent of sensor nodes have Remaining Energy of 0.41J to 0.62J and a 34.5 percent improvement in a lifetime. Energy utilization is even across all sensor nodes in our proposed system strategy, paving the way for WSN durability to increase.

Keywords - *Wireless sensor network (WSN), Lifespan, Energy Utilization, CH, Hand-over.*

1. Introduction

Wireless sensor networks are now used in numerous real-time applications. The Sensor has far less powerful batteries dispersed over organically isolated areas. The fundamental concern in wireless communication networks is energy consumption [4]. The amount of energy used by WSN nodes is proportional to their distance. The energy distribution to all nodes is unequal because sensor nodes are situated in various places, with the most significant energy usage and all wireless sensor nodes broadcasting and receiving simultaneously. Clustering is one of the options. The key clustering aims include scalability, fault tolerance, data aggregation function, load balancing, network lifetime optimization, enhanced network connection, decreased routing latency, collision avoidance, and creating sleeping techniques. Energy conservation is the most important and widely shared goal among all of these goals. Also, energy usage varies depending on the application. As a result, for energy efficiency in WSN, a hybrid routing protocol is required. Unbalanced energy distribution is a topic many WSN research groups are working to overcome. The Low-energy Adaptive Clustering Hierarchy Protocol [5] is a common WSN Clustering protocol. Using WSN energy is predicted to increase the longevity of wireless communication networks. It is divided into two phases: setup and steady-state.WSN was divided into clusters during the setup phase (sets of nodes).

The cluster chooses a CH node based on the metrics of certain sensor nodes in the WSN, while the remaining modes in the cluster are known as Member sensor nodes. MNs sense and transfer information to CH scientifically in a steady-state phase. The forwarding process has been successful in allowing Time Division Multiple Access schedules. CH conducts data reduction and redundant data avoidance. Clustering is commonly performed in WSNs network energy balancing and extends operating system time. Data connection across cluster heads requires less energy in the most suitable path, resulting in low overall system energy. The primary purpose of this study is to provide a consistent cluster creation method for WSNs that does not require additional network energy. The equitable distribution of clusters and cluster heads is achieved by developing an energy-efficient usage of virtual grids in the Network. By deploying a mobile sink during the handoff stage, the DCHHS technique reduces the delay effect in transmission and improves the inequality of average energy consumption, increasing the WSN lifespan. In this study, we propose a Hybrid Cluster creation and Dynamic Cluster Head hand-over approach to increase the overall Wireless communication network lifespan and average energy utilization throughout the hybrid cluster process. The following is how the rest of the documentation is organized: Part 3 contains a system model and a recommended strategy. Part 4 includes simulation results and a discussion of the hybrid strategy that has been presented. Finally, in Part 4, we bring the work to a conclusion.

2. Related Work

The Related Work suggests multiple Energy Balancing Approaches and Algorithms for Dynamic Cluster Heads.
[6] defines a "clustering approach based on K-means++ and the CH process based on the Fuzzy logic scheme." The sink node uses this algorithm to calculate k clusters. Because of its lower computational complexity, the Fuzzy Logic System is highly recommended for heterogeneous CH selection. This research considers these two key characteristics' node position and residual energy.

The primary explanation for WSN is Energy. Each energy consumption sensor node is unique. The authors of [4] suggested a Power line link system, which uses power lines to connect every Node, determines the shortest path among the sink & sensor nodes and estimates transmission power loss. As a result, the Sensor can only pass information messages in the perfect direction, increasing device lifetime, redeeming whole energy, and suggesting.

The authors proposed a 'balanced energy-consuming and hole alleviation & energy-aware balanced energy-consuming algorithm in [11]. Which was associated with a nearly balanced load distribution of the complete WSN network? This dissertation was mostly concerned with data forwarding and routing collection in general. Strategy for wireless networking.

[7] proposes 3 algorithms: 'Randomize parent collection,' 'Round-robin through different avenues,' and 'Weighting RR based on SP of parent energy level.' The Randomize Path algorithm generates a small change in the parent sensor node's chosen range technique to moderate the probability. Several paths are used in Round-robin to distribute the load equally among all member nodes in the network contact. 'Weighting RR based on SP of parent energy level' is the third suggested algorithm for imbalance and energy. This algorithm resolved the parent energy level, equal residual energy levels.

The authors of [2] suggested an energy-efficient cluster head re-usability method in WSN to maximize network longevity and average. A WSN cluster's remaining energy. The channel gain (g) and the residual Energy of the BS decide the community of Sensor nodes that CHs nominates first. The mechanism is used in WSN to address resource imbalances and the handoff solution.

The 'Scalable and Energy-Efficient Routing Protocol' algorithm in [14] broke various network regions, including subzones & Relay nodes, depending on the BS size. The arrangement is improved by SEEP. The authors of [9] created a Bio-Inspired Algorithm (GA) that selects the CH with the highest fitness value. The best solution is based on the genetic algorithm principle. Lowering energy demand could result in a longer WSN lifespan. The GA series of rules is expected to be more scalable for real-time implementations.

To highlight cluster formation restrictions, Rowsan Jahan Bhuiyan et al. [3] proposed a strength load balancing mechanism.' The size determines the minimum and maximum threshold values in this case. The load balancing apparatus switches nodes to neighboring nodes if the size of the cluster reaches the Threshold. Sending data over long distances limits the amount of energy used.

The authors of [12] developed an "updated CH selection algorithm" to overcome the challenges of energy dissipation. The algorithm shows improved results for homogeneous networks. Depending on the distance and residual, the 'Cluster-dependent Technique, The Fractional Artificial-Bee Colony' process selects the first and second stage CH. [5] the energy was listed.

The 'Low Energy Adaptive Clustering Hierarchy-Double CH' is used in [10] to choose 2 CHs, the first and second, depending on the distance, centroid to the drain. A 'virtual Area Partition-Double CH' algorithm is introduced in [9]. In this case, CH's choice is based on a probabilistic strategy.

3. Our Contribution

The foremost goal of our work was to introduce an Efficient Cluster Creation with an even number of sensor nodes that would grow network life period and throughput. WSN service saves a considerable amount of energy. Unbalanced clusters of varying sizes consume a significant amount of energy. We attempted to alleviate this chaotic condition by limiting various cluster size threshold values. The proposed strategy confirms an ideal solution for unbalanced energy consumption and inefficient cluster creation. The Hand-over technique is the driving force behind our work. This improved strategy reduces data latency throughout transmission time and enhances network lifetime for individual sensor nodes present in the WSN. The CHs node consumes more energy during the data aggregation process. It is more likely that you will expire as soon as possible. The Hand-over phase selects a Counter-Node (CN) or Transportable Sink depending on the exposure range, ideal minimum distance, and likelihood. When the Cluster Head node reaches the hand-over threshold value, it switches from Active to De active mode. The CN node is now acting as a CH node. The Cluster's Counter Node performs data aggregation. In the WSN, our Fusion Strategy shows residual energy for each sensor node percent.

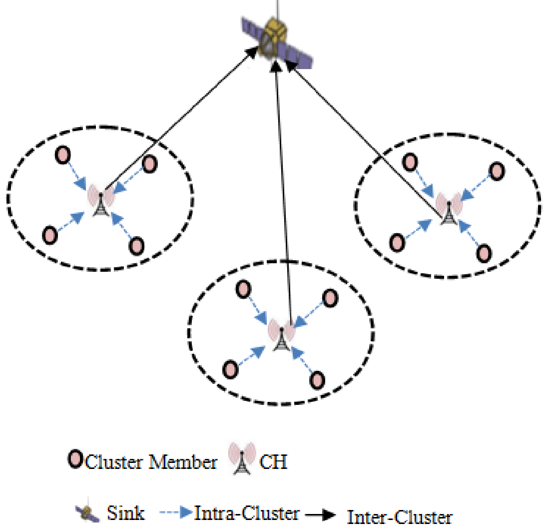


Fig. 1 Transportable Sink data Collection

3.1. Proposed Algorithms

3.1.1. Efficient Cluster Formation

Initially, several nodes were chosen located in a certain region near BS. These nodes can connect with BS directly. This cluster is well-known for its magnificence. For the next moves, we can make use of other nodes. If the Base station and sensor node distance are smaller than the distance between CH nodes, this process will be repetitive; otherwise, additional energy will be disbursed. If the distance between the slight Node and the BS > the distance between the CH nodes, the Node would be excluded from the special cluster. Due to the greater distance between BS and CH, interacting with them will take more energy. The maximal number of clusters (k) will be used, and k will be calculated using the formula below. (1).

$$\boldsymbol{k} = \frac{\sqrt{N}}{\sqrt{2\times\pi}}\sqrt{\frac{\epsilon f_s}{\epsilon_{mp}}\frac{M}{d^2{}_{toBS}}} \quad (1)$$

Where, MM: Network area range, k: N: the total no. of nodes in the cluster; $d_{to\ BS}$: the average distance amid the SN & BS. €*f*s and $€_{mp}$ is the chosen energy for transmitting 1 bit to d0, an appropriate BER in allowing multipath model and Space, respectively. Later computing k, we performed the k-means algorithm to build a primary cluster. We used the k-means algorithm to pick CH and form clusters, resulting in the CH-LEACH method [15]. We now have k clusters; virtually all of them may be vacant, some may be overflowing, some may be familiarly filled, and some may be regular. We will eliminate this chaotic condition by balancing the load across clusters. To set the values of Min -TH and Max-TH for each cluster. We can set a soft threshold of 14% more than Max-TH and 14% less than Min-TH. The value of a cluster's Max-TH and Min-TH must be calculated such that the value of these terms is as close to BS as possible. The closest BS Cluster would have a high Max-TH and Min-TH.

Furthermore, the cluster with the greatest gap would have the lowest Max- TH and Min-TH. As a result, more large-distance clusters would have fewer nodes. As a result, the size of the packet will be diminished. Because we employ single-hop communication, CHs require more energy to communicate with the BS because of the increased distance, and larger data packets consume more energy. The nodes in these clusters need less energy to interface with the BS because they are thin.

As a consequence, a potentially dangerous situation can be avoided. Once you've decided on the Max-TH and Min-TH values for every cluster, delete any empty clusters and clusters with fewer nodes than the Lower value, then apply these nodes to the cluster closest to them. Then we can choose clusters with a larger number of nodes than Max-TH. These nodes can be removed from these clusters and merged into the nearest cluster. We will now investigate clusters that have fewer nodes than their Min-TH. As determined by their Max-TH, several nodes from neighbor clusters with a higher number of excellent nodes will be connected to this cluster, and those nodes will be deleted from neighbor clusters.

Algorithm 1: Efficient Cluster Formation

1	:	Base station Calculate Network Size
2	:	Sensor nodes updated by BS
3	:	Sensor node to Base station Distance Calculation
4	:	Finest no of clusters using formula (6)
5	:	SET the value of Max-TH, Min-TH based on probability, Max-TH=0
6	:	Max-TH. & Min-TH assigned random value.
7	:	if (!(k ≤ Max-TH&& k ≥ Min-TH)) Go to 4 th step
8	:	Each cluster will have an equal no of sensor nodes
9	:	If (BS and Sensor node distance < CH and Sensor node distance) Nodes are Straight communicated to Base Station.
10	:	Go to Hand–over Strategy Algorithm

3.1.2. A Dynamic Cluster Head Selection with Hand-over Strategy (DCHHS)

Step 1: The R_{thres} Remaining threshold and the distance from the Base station (BS) to all sensor nodes d with the least distance between the Base Station (BS) and the sensor nodes are used to run DCHHS. Sensor Nodes that satisfy the first condition are applied to determine how well their channel gain and residual power are used. CHs are selected from among the Nodes that meet the second criterion.

Step 2: The selected Cluster Heads are classified using a specific recognition system. The grade is named in descending order, and support is calculated by remaining energy(r) and network channel gain(g).

Step 3: CH is chosen from the nominated Sensor Nodes with the uppermost grade. Per Cluster has a Cluster Head id assigned to it.

Step 4: The Cluster Head (CH) broadcasts the CH id to any Member Node (MN) in the cluster, which collects the packet and forwards it to the Cluster Head. Assume that the residual CH energy has dropped less than the H_{thres} hand-over threshold. In that case, Cluster Head is deactivated to prevent us from calculating Cluster head chance and comparing it to priority. If the CH likelihood is less than a priority, the base station initiates a hand-over process with the help of adjacent nodes Counter node (CN).

Step 5: The counter node choice technique is carried out. BS determines each sensor node's distance by comparing CH neighbor node distance to a node coverage radius. Based on neighbor sensor nodes, coverage area, distance, and best distance amongst BS, BS chooses the best Node. For that cluster, the optimum Node serves as a Counter node. For this cluster, the Counter node has been changed to CH. Any member node receives the Counter node id from the counter node. The data is sent from the member nodes to Counter Node, which then sends it to BS. The Sensor Node goes into Deactive mode after the hand-over and begins collecting energy.

Step 6: Then, find a transportable sink T_S in the network area. Check the number of transportable sinks roaming in the network region. Each cluster head must locate the minimum distance T_S on the Network. T_S Will broadcast the announcement of its arrival in a region with its location points. The announcement received cluster heads calculate the distance M_{CD} between them based on location points and verified both are located in the same coverage area T_R.

$$M_{CD} = D_{ist} < T_R$$

If they are located on the same T_R, update the T_S entry. At the same time, check the energy usage and transmission probability continuously. In addition, check the base station distance and maximum probability if gain, transmission power, and signal-to-noise ratio are high. Initially, assign random grades to the sensors. Then assign grade as per the gain and transmission power variation. And increment grades one by one. Then mark the highest-grade Sensor among the coverage set sensors to declare as the cluster head.

4. Simulation Results

To assess the efficacy of the proposed approach, a few efficiency indicators, namely Delay, Jitter, and Avg. For this experimental setup's total energy consumption and residual energy, we have 50 to 300 sensor nodes (n) and simulation times ranging from 100 seconds to 200 seconds. The NS3.30 simulator assesses the strategy's strength. Figure 3 depicts the implementation of SNs in the fixed network region, as well as data propagation over the WSN, Efficient cluster creation, and An Energetic Cluster Head Selection with a Hand-over Strategy with a Network Simulator. Figures 4 and 5 show the improved simulation results in terms of simulation interval and the no. of sensor nodes with PDR, Delay, Jitter, and Avg. Energy Consumption, network Lifespan, and Throughput as opposed to SBCH. Compared to an established system, our Hybrid Strategy ensures that approximately 84.6 percent of sensor nodes have Remaining Energy of 0. 41J to 0. 62J and a 34.5 percent improvement in a lifetime. Energy use is consistent with our strategy, resulting in increased WSN lifetime. As a result, sensor nodes can solve unpredictable energy conditions.

Table 1. Simulation Parameters

Parameters	Values
H_{thres}	3 joule
C_{thres}	-125 dBm
SNR_{thres}	-125 dBm
Tp	9dBm
n	100 to 300
$d_{c\ to\ BS}$	2.5 Meters
Path-loss Exponent	3.6
$£_{fs}$	0.000000000004J per bit per square meter
$£_{mp}$	0.00123 pJ per bit per meter^4

4.1. Result Analysis

4.1.1. Simulation-scenario 1: Simulation Time

Our Efficient cluster creation and an energetic cluster selection with Hand-over Strategy are evaluated and compared with the current protocol [1], Simple Balanced Cluster Head Selection Method (SBCH). We mainly simulate using Simulation. The result shows the time ranges from 100 seconds to 500 seconds. PDR, Average Delay, Jitter, Throughput, Total Energy Consumption, Network Lifetime, Average Energy Consumption, Good put, and Average Remaining Energy are the seven parameters we consider. The simulation results show that in the proposed process, PDR is advanced by 12.57 percent, the delay is decreased by 25.83 percent, Jitter is reduced by 11.04 percent, throughput is enlarged by 12.27 %, and Avg. Energy-Consumption is improved by 98.01 percent, and the WSN Network lifetime is increased by 1.63 % related to EECHRM.

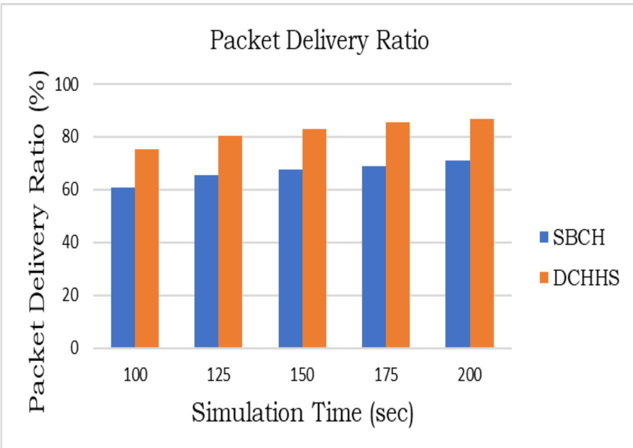


Fig. 2 Packet Delivery Ratio vs. Simulation Time

In comparison to earlier investigations, Figure 2 shows the PDR for DCHHS. The given strategy's PDR grows considerably when the simulation time is 200s. It indicates that destination nodes are experiencing the least degree of interference and conflict, resulting in maximum packet delivery. Consequently, while using the proposed strategy for channel allocation, the PDR increases by 12.56 percent.

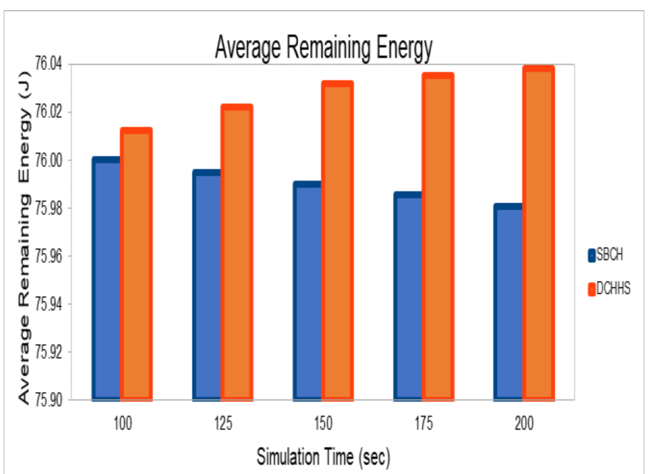


Fig. 3 Average Energy Consumption vs. Simulation Time

Figure 3 compares the overall average residual energy of a WSN cluster over time with different rounds. Unfortunately, the first CH died, and no way to reuse it has been presented.

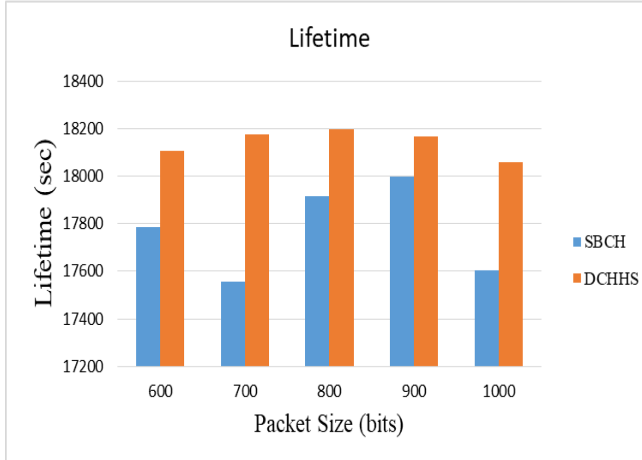


Fig. 4 Network Lifetime vs. Packet Size

We compared the lifespan of a WSN against the Packet Size in a WSN cluster in Figure 4. Our method uses a group of CHs rather than a single CH may explain the increase in the lifespan of a WSN generated by our recommended Technique.

4.1.2. Simulation scenario 2: No of Sensor Nodes

We also looked at the no. of sensor nodes, which range from 100 to 350. Our DCHHS suggested solution outperforms SBCH by 34% in-network lifespan. In our hybrid strategy, energy consumption is uniform across all sensor nodes, paving the way for an enlarged lifespan. Each Sensor Node has an initial Energy of 10.5 J, which reduces by 0.7 J during packet transmission. Compared to the current process, almost 84.6 percent of nodes ensure Remaining Energy of 0. 41J - 0. 62J and 34.5 percent improvement in lifetime

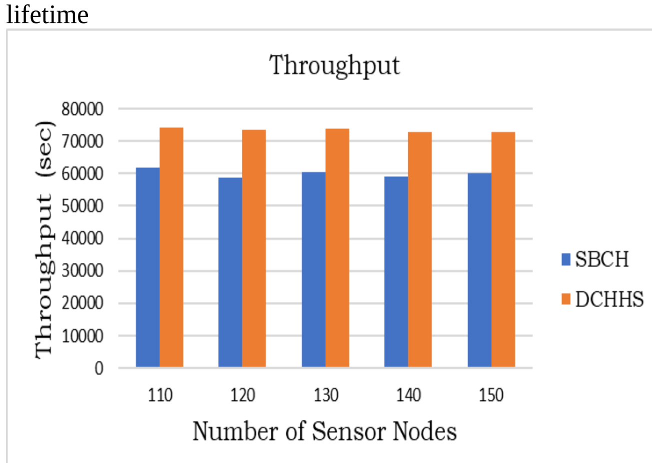
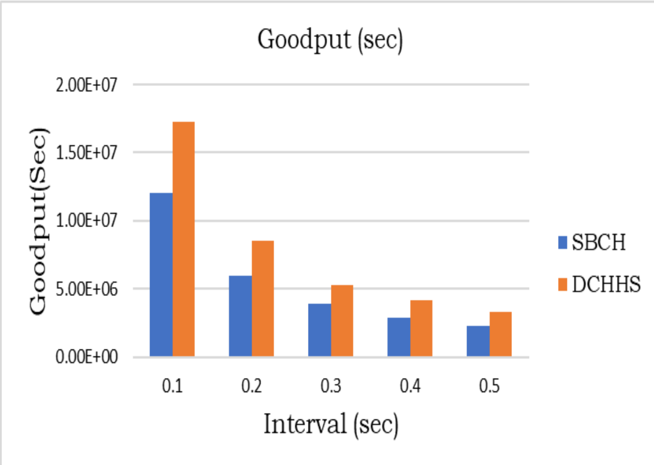


Fig. 5 Throughput Vs. No. of Sensor Nodes

Figure 5 demonstrates how the throughput (sec) of the recommended technique changes with the number of sensor nodes. The DCHHS's throughput increases as the number of SNs increases. As a consequence, when the suggested Technique is used to allocate channels, throughput improves by 12.26%



The received packet bit count and received data packet bit counts at the destination within the time are measured by throughput and goodput. Along with data packets, the throughput comprises retransmitted packets and control packets. The throughput counts are revealed at the destination end by the number of packets received in bit format according to the transmission. Good put, like throughput, focuses on delivering data packets in bit format without control and retransmission packets. Both packets provide information about the Network's quality of service. These two findings explain the performance of source and destination communication. The cluster network and transportable sink data collection have enhanced the performance. These findings indicate the protocol's strength and network connectivity quality if these findings perform well. If the receiving bits are fewer, the Network is notified of the loss and delay

5. Conclusion and Future Work

For the hybrid WSN structure, this paper proposes an efficient cluster creation and An Energetic Cluster Head Selection with a Hand-over Strategy. The main goal of forming an even no cluster is to reduce routing delays during the transmission cycle. The DCHHS reduces the disparities in average energy consumption. The experimental findings are administered by considering seven critical wireless Sensor network parameters. To simulate the success of our proposed strategy, a contrast was made with an SBCH. Furthermore, our proposed structure aids the cluster head's re-usability operation by consuming energy-harvesting efficiency. In the future, we'll use a distributed machine learning algorithm to improve data aggregation

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