Modified Data Aggregation & Compression Approach for Homogeneous and Heterogeneous Protocols in Wireless Sensor Network

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Abstract -- In the application based wireless sensor networks (WSN) situation, energy and bandwidth of the sensors are valued resources and essential to consume proficiently. Data aggregation at the base station (BS) by individual nodes causes flooding of the data which consequences in maximum power utilization. To diminish this problem a new data aggregation technique has been proposed in this paper which has improved the performance of the low energy adaptive clustering hierarchy (LEACH) and stable election protocol (SEP) by using the inter-cluster based data aggregation also called hybrid data aggregation method, where grouping of nodes has been done on the basis of the available clustering techniques and grouping of cluster heads (CHs) is also done to utilize the features to inter cluster data aggregation. The proposed algorithm helps to reduce the energy consumption problem, aggregates and transmit the data in an efficient manner. In addition, the additive and divisible data aggregation function has been used by the proposed technique at relay node and BS to minimize the power consumption and also controls flooding at BS. Lempel-Ziv-Welch (LZW) based data aggregation is also applied on the relay node to enhance the results further.

Keywords — LZW Compression, LEACH, SEP, data aggregation.

I. INTRODUCTION

Modern developments in digital electronics [1][2] micro-electro-mechanical system, and wireless communications have empowered the rise of small-sized sensors, having low-power, low-cost and are multifunctional. These sensors can sense and communicate. WSN [1] are made up of a several sensors that are densely deployed either inside the area or very close to it. Functioning of WSN is shown in Fig. 1. Power conservation is the chief issue in WSN. In WSN, sensors sense information and send it to BS. As data from neighbouring sensors [3] may be duplicate, it becomes difficult for BS to process huge amount of information. In addition, nodes have their own power. Because of redundant transmissions and loss of power, lifetime of sensors can decrease. Data aggregation [3][4] is done for maximizing lifetime.

Data aggregation means to accumulate and aggregate data [3][5] from multiple sensor nodes for eliminating duplicate data and save power. WSN have several applications in areas [2] such as security, military and health. For instance, a doctor can monitor the physiological data about a patient remotely. The current health condition of the patient is better understood by the doctor. Foreign chemical agents can be detected in the air and water with the help of sensor network. Pollutant’s type, amount and location can also be identified.

In cluster based data aggregation, the network is divided into various clusters. A cluster is formed by the sensor nodes themselves and these sensor nodes elect a node as a CH [1]. The sensor nodes transmit the sensed data to the CH, where aggregation of data is performed, and then data is sent to the BS. Clustering helps in reducing power consumption and collision. If the sensor nodes present in the network have the equal amount of energy, then the network is called homogeneous sensor network. If the sensor nodes available in the network are equipped with extra energy as compared to the remaining nodes in the same network, then the network is called heterogeneous sensor network.
This paper proposes a new data aggregation technique which will improve the presentation of the homogeneous and heterogeneous networks by using group based data aggregation also called hybrid data aggregation method. Here, grouping of nodes has been done on the basis of the available data and correlation in the intra-cluster and grouping of some CHs at the network level.

The technique used in the paper focuses on reducing the energy consumption problem, aggregating and transmitting the data in efficient manner. In addition, the additive function (at relay node) and divisible data aggregation function (at BS) will be used as in-network processing to minimize power consumption to modify LEACH and SEP by using inter-cluster data aggregation. Additionally, LZW compression will be applied at the relay node that has low complexity and fast speed. Relay node sends aggregated data to BS and cluster members (CMs) send data to CH.

The rest of the paper presents literature survey in section II, existing protocols in section III, our proposed work in section IV. The simulation results are given in section V. The conclusion is shown in section VI.

II. LITERATURE SURVEY

W. Heinzelman et al. [8] proposed LEACH, which is a protocol architecture. The ideas of power-efficient cluster based routing and media access control has been combined along with application-specific data aggregation in order to gain high performance. Algorithms for the selection of CH, cluster formation and data transmission has been presented to improve system lifetime. G. Smaragdakis et al.[10] proposed a new protocol SEP which is heterogeneous aware. In the entire network, the initial energy of a node as compared to that of other nodes weighted the probabilities of electing nodes to become a CH. Before the death of the first node which is called stability period, the interval of time has been prolonged. Longer stability period and higher average throughput has been provided by SEP as compared to existing clustering protocols that are heterogeneous-unaware. The sensitivity of this protocol to heterogeneity parameters capturing power imbalance has been studied. In consuming the extra power of advanced nodes sensibly, SEP is more durable than low-energy adaptive clustering hierarchy. Woo-Sung Jung et al. [21] proposed a hybrid approach for cluster based aggregation of data in wireless sensor network which has improved the efficiency of aggregating data in applications to track several mobile targets. A suitable clustering technique has been adaptively selected by the proposed approach that depends on the position of the entire network. This has helped in raising the efficiency of aggregating data, power utilization and successful data sending proportion. D. kumar et al. [27] presented an energy efficient clustering and data aggregation (EECDA) protocol for heterogeneous wireless sensor networks. This protocol has helped in combining the ideas of power efficient cluster based routing and data aggregation for attaining a better performance in terms of lifetime and stability. In this protocol, a novel technique for the election of CH has been included and for the transmission of data, a path has been chosen with maximum amount of power residues instead of the way with minimum power utilization. This protocol has helped in balancing the power utilization and extending the lifetime of network. A comparison between this protocol, low-energy adaptive clustering hierarchy, energy efficient hierarchical clustering algorithm and effective data gathering algorithm has been demonstrated. In [15], the group based data aggregation technique has been proposed and evaluated. On the basis of existing data and association in the intra-cluster level, nodes have been grouped. At the network level, CHs have been grouped. These would help in reduction of power utilization. Moreover, additive and divisible functions have been used at CH as in-network processing for reducing power utilization. Aggregated information has been transmitted to BS by CH and data has been sent to CH by CMs. Increase in the network lifetime has been indicated by the reduction in power consumption in transmission of aggregated information.

To evaluate the gaps in existing research; latest published papers of some well-known journals have been evaluated. The survey has shown that the most of the existing data aggregation techniques are for homogeneous WSNs[8-9][35-38].But in real time applications WSN comes up with heterogeneous sensor nodes. Many WSNs data aggregation at the base station by individual nodes causes flooding of the data which consequences in maximum energy consumption[15]. Also most of data aggregation methods[8-14] are based upon the clustering based approach but the use of additive and divisible data aggregation has been ignored by the most of the researchers. The use of data compression for efficient communication between BS and CH has been ignored in the most of existing research on WSNs[1-15][21-38].So using the LZW data compression, additive and divisible data aggregation
in homogeneous and heterogeneous WSN is the main motivation of this research work.

III. EXISTING PROTOCOLS

In our work, we will discuss two protocols: LEACH for homogeneous and SEP for heterogeneous WSNs.

A. LEACH

LEACH, for WSN is proposed by [8]. It is distributed and it assumes that all the sensor nodes have sufficient energy to reach the BS if required that is each and every sensor node has the potential to become a CH and carry out fusion of data. It is also assumed by LEACH that all the sensor nodes have data to transmit at regular intervals. All the sensor nodes have an equal quantity of power capacity in each and every round of election in LEACH that is based on the supposition that being a CH grades in equal power utilization for each and every node. In LEACH, the association of sensors is done into clusters for the combination of information. The combined data is sent from various nodes in the cluster to the BS by a particular chosen node called CH after performing aggregation of data. CH is extra active than all nodes present in the cluster. This helps in plummeting the quantity of information transmitted to the BS. The combination of information is done at the cluster heads at regular intervals. This protocol involves the two phases such as: the set-up phase and the steady phase. In set-up phase, association of clusters is done and in steady phase sending of information from sensors to CH and from cluster head to sink takes place.

B. SEP

SEP, for clustered heterogeneous WSNs is proposed by [10]. It is a heterogeneous conscious protocol. In the complete network, the early power of a sensor node as compared to that of other sensors weighted the probabilities of electing sensor nodes for becoming a CH. Before the loss of the first sensor that is called stability period, the time interval has been maximized. Longer stability period and superior average throughput has been made available by SEP in comparison to clustering protocols which are unaware of heterogeneity. Consider that the total number of nodes present in the network is denoted by \( n \). Also the fraction \( m \) of the \( n \) nodes is referred to as advanced nodes, and the fraction \( (1 - m) \times n \) is referred to as normal nodes. It is assumed that all sensor nodes are distributed randomly in the field. Let an optimal percentage \( P_s \) of sensor nodes has to become CHs in each and every round. Also the number of rounds be \( \frac{1}{P_s} \) are referred to as \( e_{ph} \) of the network. Let \( \alpha \) be the additional power factor between normal and advanced sensor nodes. SEP helps in maintaining well balanced power utilization to extend the stable region. Spontaneously, advanced nodes will become CHs more often as compared to normal nodes. Suppose the initial energy of each and every normal node is \( E_o \) and the energy of each and every advanced sensor node is \( E_o \cdot (1 + \alpha) \). Then, the total amount of energy for this heterogeneous setting will be

\[
n \cdot (1 - m) \times E_o + n \cdot m \times E_o \cdot (1 + \alpha) = n \times E_o \cdot (1 + \alpha \cdot m)
\]

(1)

This equation shows that the total power of the whole system is increased by \( (1 + \alpha \cdot m) \) times. The initial perfection to the live LEACH is to raise the \( e_{ph} \) of the network in ratio to the power increase. For optimizing the stable section of the organization, the fresh \( e_{ph} \) must turn into \( \frac{1}{P_s} \cdot (1 + \alpha \cdot m) \) since the arrangement has \( (\alpha \cdot m) \) extra nodes (with the equivalent energy as that of the normal nodes).

IV. OUR PROPOSED APPROACH

The proposed algorithm works in subsequent stages which are: construction of cluster (choice of cluster head), intra-cluster data aggregation (combination of sensors for sending of data packets to cluster heads for aggregation), inter-cluster data aggregation (combination of cluster heads for sending of aggregated packets to a relay node) and compression of information as shown in Fig. 2.

![Block diagram of proposed algorithm](http://www.ijctjournal.org)

**A. Procedure for modified LEACH**

1) **Initialization Phase**

The arbitrarily distributed nodes have been categorized into clusters.

2) **Setup phase**

Cluster head selection has been done using the equations given:

\[
P_s(t) = \begin{cases} \frac{k}{n \cdot \text{mod} \left( \frac{m}{P_s} \right)} & : H_2(t) = 1 \\ 0 & : H_1(t) = 0 \end{cases}
\]

(2)
Where N is the number of nodes, k is the number of clusters, r is the number of rounds. If \( H_2(t) = 1 \), then nodes has not been a CH in the recent r mod(N/k) rounds. And if \( H_2(t) = 0 \), then nodes has been a CH. Elected CH broadcast the message to sensor nodes. On the basis of received signal strength, sensor nodes join CH. CH allocates TDMA schedule to CMs.

3) Transmission Phase 1
Data is transmitted from CMs to CH as per TDMA schedule.

4) Intracluster Aggregation of Data
CH is dependable for aggregation of packets sent by the sensors in that cluster. In intra-cluster aggregation of data, CH sends the data and gathers the packets from various sensors at periodic breaks. By using existing data aggregation functions, data is aggregated by CH. Existing data aggregation functions are:

(a) Addition = \( \sum_{j=1}^{X} (A_i) \) for \( (A_i) = \) Distinct Data

(b) Division = \( \sum_{j=1}^{Y} (B_j) \) for \( (B_j) = \) Similar Data

5) Relay Node Selection
Distances between current CH and BS are calculated by using equation:
\[
\text{Distance} = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}
\]
That CH will become the relay node whose distance from BS is less as compared to other nodes.

6) Transmission Phase 2
CH gathers on the basis of data obtained from each and every CH to attain the further aggregation for sending data to the BS. Data is transmitted from CHs to relay node.

7) Intercluster Data Aggregation Using Additive Data Aggregation functions at relay node
Assume that \( \text{max}_{data} \) is a kind of frame that holds the aggregated data. If \( \text{max}_{data} \) is empty, then following equation will be used:
\[
\text{max}_{data} = j \cdot \text{data}
\]
where \( j \) is a node belonging to CH, \( j \cdot \text{data} \) is the data belonging to \( j \) node.
In case the sum of \( \text{max}_{data} \) and \( j \cdot \text{data} \) is less than or equal to the \( \text{channel limit} \), where \( \text{channel limit} \) is the maximum capacity of network to transfer data, then use following equation:
\[
\text{max}_{data} = \text{max}_{data} + j \cdot \text{data}
\]
If the sum of \( \text{max}_{data} \) and \( j \cdot \text{data} \) is greater than the \( \text{channel limit} \), then assign \( \text{max}_{data} \) to a complete label \( \text{additive packet}(m) \), empty the frame and then initialize a new additive packet \( m \) using equation:
\[
m = m + 1
\]

8) LZW Compression
Utmost compression ratio of LZW=9.42
Compressed packet size \( (\text{CPS}) = \frac{\text{APS}}{9.42} \)
where APS = actual packet size.
Therefore, new energy dissipation for compressed data will be as:
\[
S(i)E = S(i)E - [(\text{Tx}_{\text{energy}} + \text{EDA}) \cdot \text{CPS} + \text{AMP} \cdot \text{CPS} \cdot \delta^{d_i} : \text{if } d_i > d_0]
\]
\[
S(i)E = S(i)E - [(\text{Tx}_{\text{energy}} + \text{EDA}) \cdot \text{CPS} + \text{EMP} \cdot \text{CPS} \cdot \delta^{d_i} : \text{if } d_i < d_0]
\]
Here \( S(i)E \) - the power of \( i^{th} \) node,
EDA = Effective data aggregation,
\( \text{Tx}_{\text{energy}} \)= Transmitter energy,
AMP= multipath fading channel cost,
EMP= Free space channel cost,
\( d \) = the distance between the CH and the BS,
\( d_0 \) = the lowest allowed distance.

9) Transmission Phase 3
Compressed data is transmitted from relay node to BS. The data is extracted using LZW decompression.

10) Apply Divisible Data Aggregation
Divisible aggregation has been applied on the data at the BS. The data is extracted from the packet having a complete label \( \text{count_additive_packet} \) and decrement the packet until no more packets remains using the equation:
\[
\text{count_additive_packet} = \text{count_additive_packet} - 1
\]
Collection of the sensors in intra-cluster and gathering of CH at inter-cluster lessen the packet count at the BS. It minimizes the definite power vital, which results in prolonging the network lifetime.

B. Algorithm for modified LEACH
/*Initialization of WSN*/
/*Initially nodes are deployed randomly*/
/*Setup phase*/
/*Transmission phase*/
/*Transmission phase*/
1. Initially nodes are deployed randomly
2. Apply equation for selecting CH.
3. Elected CH broadcast the message to sensor nodes(SNs).
4. CH allocate TDMA schedule to CMs(cluster members).
5. for CHs, for CMs
6. Data sent from CMs to Ch as per TDMA schedule.
7. Intracluster Data aggregation using existing data aggregation functions from equations 3 and 4.
8. end for CMs.

/* Relay node selection*/

9. for relay node

10. while status = 0 // node is not processed

11. find distance between current _tx and BS using Euclidean distance from equation 5.

12. if distance < min_distance then

13. Assign distance to min_distance

14. Assign current_tx to relay node

15. end if

16. end while

17. Set status = 1 // node is processed

/*Transmission phase2*/

18. Send data from CHs to relay node.

19. End for CH

20. Intercluster Data Aggregation using

    Additive Data aggregation functions from equations 6, 7 and 8 and then Repeat these equations till the status of all CHs not equal to inactive.

21. end end

/* LZW Compression*/

22. Apply LZW Compression using equation 9 and evaluate

    energy dissipation using equation 10 and 11.

/*Transmission phase3*/

23. Send compressed data from relay node to BS.

24. End for relay node

25. Extract data using LZW decompresion at BS

26. Apply divisible data aggregation function at base station using equation 12.

27. End of code

C. Procedure for modified SEP

1) Initialization Phase

The arbitrarily distributed nodes have been categorized into clusters. Identify normal and advance nodes using line 2 and 5 of the algorithm and assign energies to them using 3 and 6 line.

2) Setup phase

Cluster head selection has been done by first calculating the weighted election probabilities for both nodes using equations:

\[ P_n = \frac{P_a}{1 + \alpha} \]

\[ P_a = \frac{P_a}{1 + \alpha} \times (1 + \alpha) \]

Threshold values can be calculated using equations:

For normal nodes

\[ T(S_n) = \begin{cases} 1 - P_n & \text{if } S_n \in G' \\ 0 & \text{otherwise} \end{cases} \]

For advance nodes

\[ T(S_a) = \begin{cases} 1 - p_b & \text{if } S_a \in G'' \\ 0 & \text{otherwise} \end{cases} \]

Elected CH broadcast the message to sensor nodes. On the basis of received signal strength, sensor nodes join CH. CH allocates TDMA schedule to CMs.

Rest of the steps are same as that of modified LEACH from transmission phase 1 to apply divisible data aggregation.

D. Algorithm for modified SEP

/*Initialization of WSN*/

1. Initially nodes are deployed randomly.

2. Identification of normal nodes :

    \[ \text{if}(\text{tampifier}_{\text{max do_{rnd}}}) \geq m \times n + 1) \]

3. \[ S(i).E = E_0 \] Initial energy

4. end if

5. Identification of advanced nodes :

    \[ \text{if}(\text{tampifier}_{\text{max do_{rnd}}}) < m \times n + 1) \]

6. \[ S(i).E = E_0 \times (1 + \alpha) \]

7. end if

/*Setup phase*/

8. Apply equation 13, 14 and 15 for selecting CH.

9. Elected CH broadcast the message to sensor nodes (SNs).

10. CH allocate TDMA schedule to CMs (cluster members).

/*Transmission phase1*/
11. for CH, for CMs
12. Data sent from CMs to Ch as per TDMA schedule.
13. Intrachannel Data aggregation using existing data aggregation functions from equations 3 and 4.
14. end for CMs

/* Relay node selection*/
15. for relay node
16. while status = 0 // node is not processed
17. find distance between current_Ch and BS using Euclidean distance from equation 5.
18. if distance < min_distance then
19. Assign distance to min_distance
20. Assign current_CH to relay node
21. end if
22. end while
23. Set status = 1 // node is processed

/*Transmission phase 2*/
24. Send data from CHs to relay node.
25. End for CH

26. Intercluster Data Aggregation using
   Additive data aggregation functions from equations 5, 7 and 8 and then Repeat these equations till the status of
   all CHs not equal to inactive.
27. end, end

/* LZW Compression*/
28. Apply LZW Compression using equation 9 and evaluate energy dissipation
   using equation 10 and 11.

/*Transmission phase 3*/
29. Send compressed data from relay node to BS.
30. End for relay node
31. Extract data using LZW decompression at BS

32. Apply divisible data aggregation function
   at base station using equation 12.
33. End of code

V. SIMULATION RESULTS

A. Experimental Setup

In order to implement the proposed algorithm, design and implementation have been done in MATLAB. Table 1 shows the parameters used in the implementation along with their values required to successfully simulate the WSNs. The taken values are benchmark for WSNs.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area in terms of x-axis and y-axis</td>
<td>100, 100</td>
</tr>
<tr>
<td>Number of nodes</td>
<td>100</td>
</tr>
<tr>
<td>Initial Power</td>
<td>0.1 J</td>
</tr>
<tr>
<td>Receiving Power</td>
<td>$50 \times 10^{-7}$ J/bit</td>
</tr>
<tr>
<td>Multipath</td>
<td>$0.0013 \times 10^{-12}$ J/bit/m²</td>
</tr>
<tr>
<td>Utmost Lifetime</td>
<td>4000</td>
</tr>
<tr>
<td>Fraction of advanced sensors</td>
<td>0.2</td>
</tr>
<tr>
<td>BS in terms of x-axis and y-axis</td>
<td>150, 150</td>
</tr>
<tr>
<td>Probability</td>
<td>0.1</td>
</tr>
<tr>
<td>Transmitting Power</td>
<td>$50 \times 10^{-7}$ J/bit</td>
</tr>
<tr>
<td>Free Space</td>
<td>$10 \times 10^{-13}$ J/bit/m²</td>
</tr>
<tr>
<td>Effective Data Aggregation</td>
<td>Data</td>
</tr>
<tr>
<td>Packet Size</td>
<td>4000 kb</td>
</tr>
</tbody>
</table>

B. Modified additive and divisible function along with LZW compression algorithm for homogeneous (LEACH) and heterogeneous (SEP) WSNs protocols.
To simulate the modified approach we have taken some additional parameters and also some of the existing equations has been modified. Subsequent section contains various parameters to simulate the desired requirements.

1) Experimental results of modified LEACH

On applying additive and divisible data aggregation functions, following results will be achieved.

Fig. 3 Alive nodes

Fig. 3 shows the active situation of modified LEACH protocol. Green nodes are indicating normal nodes, diamonds indicating CHs. The CH regions are called cluster fields. Each and every cluster field has a CH. Dotted lines with red color are indicating interaction of CH with the relay node and dotted line having blue color is indicating interaction of root CH with BS.

Fig. 4 Some dead sensors

Fig. 4 shows Stars, indicating dead normal nodes. A dead node has zero power which means it is not available for interaction.

Fig. 5 Number of Dead nodes

On applying above data aggregation functions along with LZW compression, following results will be achieved.

2) Experimental results of modified SEP

On applying additive and divisible data aggregation functions, following results will be achieved.

Fig. 7 Alive nodes

Fig. 7 shows the active situation of modified SEP protocol. Blue nodes having circular shape are indicating normal nodes, plus signed nodes are indicating advanced nodes but nodes with stars are indicating CHs. Each and every cluster region has a single CH. The BS is residing outside the sensor field. Red dotted lines are indicating interaction of CH with the relay node and blue line is indicating interaction of relay node with BS.

Fig. 8 Some dead nodes

Fig. 8 shows the red dots, indicating dead nodes.
Fig. 9 shows in which round a sensor node becomes dead.

On applying above data aggregation functions along with LZW compression, following results will be achieved.

Fig. 10 has presented in which round a sensor node becomes dead.

Table 2: Comparative analysis

<table>
<thead>
<tr>
<th>Protocols</th>
<th>Energy consumption per round(J)</th>
<th>Total data sent</th>
<th>Total data received</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEACH</td>
<td>0.00033333</td>
<td>6105390</td>
<td>361516</td>
</tr>
<tr>
<td>SEP</td>
<td>0.0165</td>
<td>31572</td>
<td>4390</td>
</tr>
<tr>
<td>DA LEACH</td>
<td>0.00033445</td>
<td>3754940</td>
<td>418550</td>
</tr>
<tr>
<td>DA SEP</td>
<td>0.0109</td>
<td>142500</td>
<td>8946</td>
</tr>
<tr>
<td>LZW DA LEACH</td>
<td>0.00033223</td>
<td>4300020</td>
<td>482757</td>
</tr>
<tr>
<td>LZW DA SEP</td>
<td>0.0095</td>
<td>166600</td>
<td>10115</td>
</tr>
</tbody>
</table>

In table 2 and 3, the comparative analysis has shown that the lifetime of LZW_SEP is 15.01% better than SEP. The lifetime in case of LZW_LEACH is 36.37% better than LEACH. Data transfer rate of LZW_LEACH is 11.23% but in LEACH, it is 5.92%. The percentage of packets transferred in case of LZW_SEP is 6.071% whereas it is 13.904% in SEP.

3) Results of Comparison of LEACH, DA LEACH and LZW DA LEACH

Fig. 11 and 12 show the comparison between LEACH on which existing additive and divisible data aggregation functions are applied, DA LEACH on which modified additive and divisible data aggregation functions are applied and LZW DA LEACH on which modified additive and divisible data aggregation functions are applied along with LZW compression.
4) Results of Comparison of SEP, DA SEP and LZW DA LEACH

Fig. 13 and 14 show the comparison between SEP on which existing additive and divisible data aggregation functions are applied, DA SEP on which modified additive and divisible data aggregation functions are applied and LZW DA SEP on which modified additive and divisible data aggregation functions are applied along with LZW compression.

![Comparison on the basis of number of dead nodes](image_url)

Fig. 13 Comparison on the basis of number of dead nodes

![Comparison on the basis of remaining energy](image_url)

Fig. 14 Comparison on the basis of remaining energy

Table 4 Comparative analysis

<table>
<thead>
<tr>
<th>Protocols</th>
<th>Lifetime</th>
<th>First node dead</th>
<th>Last dead node</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEACH</td>
<td>383</td>
<td>73</td>
<td>383</td>
</tr>
<tr>
<td>SEP</td>
<td>652</td>
<td>88</td>
<td>652</td>
</tr>
<tr>
<td>DA LEACH</td>
<td>430</td>
<td>198</td>
<td>430</td>
</tr>
<tr>
<td>DA SEP</td>
<td>865</td>
<td>370</td>
<td>865</td>
</tr>
<tr>
<td>LZW DA LEACH</td>
<td>471</td>
<td>203</td>
<td>471</td>
</tr>
<tr>
<td>LZW DA SEP</td>
<td>1040</td>
<td>413</td>
<td>1040</td>
</tr>
</tbody>
</table>

Table 4 has shown the comparative analysis among the existing LEACH and SEP, Inter-cluster data aggregation SEP and LEACH and also LZW based proposed SEP and LEACH protocols. It has been clearly proven that the proposed LZW based data aggregation has quite significant results than available protocols. The results show that LZW based LEACH and SEP protocols outperform the present protocols on applying aggregation functions. As the main objective of clustering is to maximize the time of death of first node and last node. Therefore the LZW DA SEP has shown significant results over the available protocols when the number of nodes is 50 and 200.

VI. CONCLUSION

In the application based wireless sensor networks (WSN), power and bandwidth of the sensor nodes are esteemed resources and vital to consume capably. Data flooding is caused due to data aggregation at the base station (BS) by individual nodes that results in utmost power utilization. For diminishing this dilemma a novel data aggregation technique has been proposed. It has improved the performance of the low energy adaptive clustering hierarchy (LEACH) and stable election protocol (SEP) by using the inter-cluster based data aggregation. Grouping of nodes has been done on the basis of the available clustering techniques. Grouping of cluster heads (CHs) has also been done to utilize the features to inter cluster data aggregation. The proposed algorithm helps to reduce the energy consumption problem, aggregates and transmit the data in efficient manner. In addition, the additive and divisible data aggregation function has been used by the proposed technique at relay node and BS to minimize the power consumption and also controls flooding at BS. Lempel-Ziv-Welch (LZW) based data aggregation is also applied on the relay node to enhance the results further. The proposed algorithm has been designed and simulated in the MATLAB tool. The comparative analysis shows that the proposed LZW based data aggregation based LEACH and SEP protocols outperforms over the available protocols.

In near future swarm intelligence approach for data aggregation will also be implemented to optimize the results further. Not much effort has been done in this work for the CH selection, so CH selection will also be optimized in near future.

ACKNOWLEDGMENT

I would like to thank DAVIET for providing access to required material. It is of immense pleasure and profound privilege to express my gratitude and indebtedness along with sincere thanks to Mr. Rajeev kumar and Dilip kumar for guiding me. I am being holder to my family and friends for their blessings and encouragement. Last but not the least;
with the blessings of god, I have completed my work successfully.

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