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International Journal of
Electrical and Electronics Research (IJEER)
Research Article | Volume 11, Issue 4 | Pages 877-885| e-ISSN: 2347-470X

A Novel Modified Energy and Throughput Efficient LOYAL UN-Supervised LEACH Method for Wireless Sensor Networks

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ABSTRACT- Data Sensing Devices (DSD's) have gained lot of traction for various use cases like border control, vehicle tracking. Data Sensing device network (DSDN) is shaped with the aid of combining lot of DSD's across a random area. Like this multiple groups are formed. In each of the group the specific DSD is elected which is responsible for communication between two independent groups. Each of the group head has multiple attributes with first attribute based on distance, the second attribute based on remaining energy. These attributes will be input for the group head selection based on machine learning, The entire DSD's inside a group are classified into HIGH, MEDIUM and LOW. The first priority will be given to HIGH followed by others for the primary group head selection. LEACH is a classical method used for transmission of chunks to the control center in a DSDN network. The selection of head DSD by LEACH will happen by making use of the random selection of DSD in each group using random probability selection mechanism. During the data chunk deliver the scanning process will happen from the initiator DSD to head DSD and from there the link is established with the base station (BS), the BS will then scan each group until the destination DSD is reached. The selection of head DSD by LEACH causes more holes in the DSDN because there are chances that the non-performer DSD can become a head DSD. Secondly for the transmission of chunks there is lot of back-and-forth propagation between the BS and the normal DSDs which reduces the battery level of the DSD by a large amount. The Energy based LEACH is modified on top of LEACH by measuring the energy of the DSDs and then selecting the group heads but suffers from multiple group head maintenance as well as more number of links. The proposed method will improve this by reducing the links used for end-to-end communication. In the proposed system the communication will happen based on initiator DSD, primary DSDs in different groups and then destination DSD which will avoid overhead compared to existing methods namely E-LEACH and LEACH. The proposed method is compared with LEACH and E-LEACH with respect to time taken, link count, energy consumption, residual energy measure, lifetime and overhead.

Keywords: Unsupervised machine learning, energy consumed, lifetime ratio, throughput and residual energy.

ARTICLE INFORMATION

Author(s): Nirmala G, C D Guruprakash;
Received: 20/06/2023; **Accepted**: 04/10/2023; **Published**: 25/10/2023;
E- ISSN: 2347-470X;
Paper Id: IJEER230427;
Citation: 10.37391/IJEER.110401
Webpage-link:
https://ijeer.forexjournal.co.in/archive/volume-11/ijeer-110401.html

crossref member CROSSREF.ORG THE CITATION LINKING BACKBONE

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1. INTRODUCTION

There are more than one ambitions for a data Sensing device network (DSDN) and one in every of them is to provide the whole insurance of the vicinity underneath sensing consideration. Many use cases like tracking of gadgets, enemy intrusion in a struggle field type of application. in order to optimize the range or battery level spend by the DSDs may be blended into a set called cover set. DSDs within the cover set may be turned into one-of-a-kind modes particularly ON or OFF so that health ratio is stepped forward and also higher tracking is accomplished.

The DSDN can be classified right into a single vicinity DSDN or a multiple place DSDN. In a single place DSDN all DSDs are unfold in a particular place and for the multi place DSDN DSDs are unfold throughout more than one Groups. For communication between two DSDs belonging to one-of-a-kind areas Head DSD is chosen in every place that may help in inter location communication. in this work we're managing single group DSDN.

Figure 1 shows the placement of one hundred DSDs into an area of a hundred*a hundred each of the DSDs have their own vicinity (x1, y1) which isn't the same as other DSDs (x2, y2) for instance DSD-91 is positioned at the position (26,12), DSD-forty-six is positioned at the placement and other DSDs also have their own positions.

In a Inter group communication, the communication happens between two DSD's which are in different Groups. This communication requires a base station and group head DSDN to be elected. The communication link is usually established with the help of group head DSDN of multi-Groups for the data transmission.

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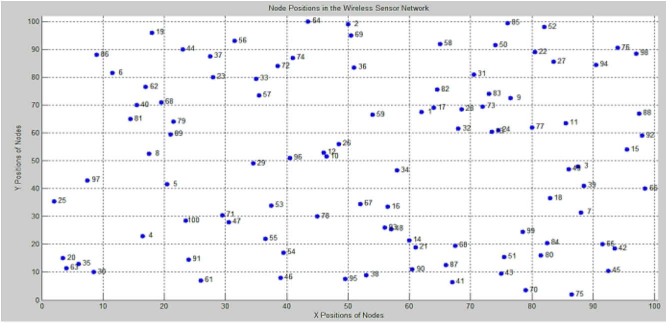

Figure 1: Data Sensing Device Network (DSDN)

Figure 1 shows the single territory PSD in which all the 25 PSD are spread in a territory with bound Figure 2 shows 4 Group DSDN. From the figure first Group has the 5 DSD's in the range of (1,50) and (1,50), For the second Group also there are 5 DSD's in the range of (51,100) and (1,50). For the third Group there are 5 DSD's in the range of (101,150) and (1,50), In the fourth Group there are 5 DSD's in the range of (151,200) and (1,50). ed limits (1,50) and (1,50). All the 25 PSD have their own unique location.

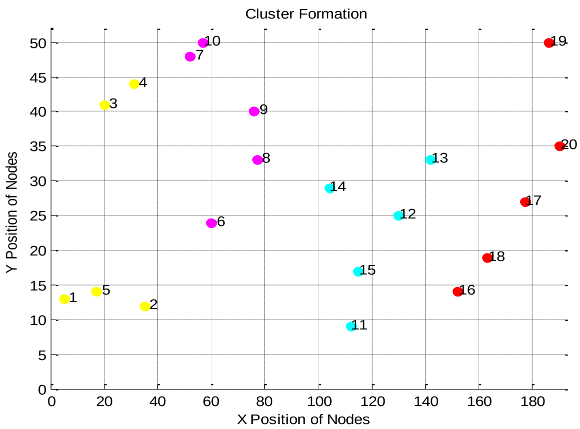

Figure 2: Multi Group DSDN

2. ENERGY DISSIPATION EXECUTIVE ANALYSIS

The usage of DSD inside the course may have its battery level reduced through a sure amount which depends upon link distance in conjunction with power spend for chunk era along with byte transport. The Energy dissipation by a Specific DSD is provided as below

$$Es(DSD1, DSD2) = 2 * Et(DSD1) + Eg(DSD1)\ dis(DSD1, DSD2)^{\delta} \ldots.(1)$$

where,

$Et(DSD1) =$ chunk transmission energy spend by DSD1

$Eg(DSD1) =$ chunk generation energy spend by DSD1

$dis(DSD1, DSD2) =$ link length between DSD1 and DSD2

$\delta =$ factor which can take values between 0.1 to 1

The energy spend by a selected DSD is dependent on energy generated, chunk transportation along with transmission energy. When specific DSDs are used in a repeated fashion then class label is assigned as either "Non-Data Performing" or "Data Performing" DSDs.

$$NBL(DSD1) = CBL(DSD1) - Es(DSD1, DSD2) \ldots(2)$$

Where,

$CBL(DSD1) =$ current battery level of DSD1

$Es(DSD1, DSD2) =$ energy spend between DSD1 & DSD2

Data Performing DSD are those DSDs which are having the remaining battery level higher than or equal to four times the initial battery level. Non-Data Performing are inverse of Data Performing DSDs. The data performing count will increase the value of PR as compared to Non-Data Performing. The Performance ratio is defined using *equation* 3.

$$PR = \frac{\text{Performant FSD Count}}{\text{Non} - \text{Performant FSD Count}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

The energy spend by a selected DSD is dependent on energy generated, chunk transportation along with transmission energy. When specific DSDs are used in a repeated fashion then class label is assigned as either "Non-Data Performing" or "Data Performing" DSDs. The rest of the paper is organized as follows, first the study of existing work on wireless sensor network (WSN) or Device Sensing Data Network (DSDN). This is followed by description of proposed Loyal UN-Supervised LEACH with details of how DSDN is formed, how multiple areas are formed inside the DSDN. The selection of group heads in each of the area and then end to end link formation. This is followed by study of methods in the literature namely LEACH and E-LEACH. After that the experiment results of LOYAL LEACH and comparison between the methods are done.

3. BACKGROUND

The process describes the steps involved in operating on customized bus, finding the drawbacks in custom designed bus machine, placement of stations together with planning of stations. From the drawbacks of study, a bus line in a custom way should be created which takes into consideration call for of travel through clients, processing of chunks, department of demand among buses this is executed with the aid of utilizing ant colony process [1].

The use of electric vehicles is on high demand and ultra-modern fashion. This generation has one undertaking namely charging of automobiles and this work have to be addressed by using the use of efficient routing mechanism. The complete mission is split into a couple of steps, step one is to resolve routing process after which 2nd step is charging of tool. For the first step ant colony-based totally routing alongside encoding is used. the second one step is used to perform the scheduling the chew transport closer to the vacation spot [2].

The DSD (data Sensing Device) is built with the assist of artificially built magnetic conductor. The combination of DSD in a DSDN could have each static in addition to cellular DSD's [3].

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The demanding situations for transport of chunks will growth due to use cases having dynamic topology, differentiation in time, measuring of QoS elements, strength challenge together with resources. Ant colony-based methods may be used to have higher mechanism which can satisfy the numerous use cases and are scalable and adaptable [4].

The optimization of routing link between DSD’s can be treated like a salesperson difficulty who is mobile in nature. Ant based methods carry in multiple features like convergence together with speed and parallel processing. The tuning of numerous attributes may be completed via utilizing Ant primarily based boundary location among variants of minimal and maximum value the development of delta pheromone is done via making use of the idea of data theory at the information chew to avoid longer stagnation [5].

The transportation enterprise wishes an intelligent machine. the connection among DSD’s can be computed by utilizing time-based totally window in conjunction with varying time. An Ant Colony based totally approach is used to pick the optimized course by using measuring the weight of numerous routes after which locate the path which has minimal site visitors load [6] whilst delivering the inventory selection thing on the numerous routes is computed [7].

The DSD's are combined to form DSDN. The forward DSD within the link between DSD's is received by measuring consider level, amount of battery level of DSD along with hyperlink-based measure. Like this step are done until vacation spot DSD is reached. The most beneficial direction is determined based totally on most fee of total course standards which depends upon attributes specifically agree with, battery level and link measure. Opportunity DSD's are selected to if the battery levels are lower than threshold battery in order that health of DSDN is advanced [8].

The nearby improvement at the side of structural adjustments is required to have better logistics procedure. The fee of transmission of information can be decreased through the use of the path that's strength green as well as incorporate low amount of value [9].

DSDN is shaped with the aid of combining the DSD's in a place. the amount of battery level is reduced due to energy spend on the link. Ant Colony primarily based method improves the suitableness as properly fitness ratio of DSDN. The Ant primarily based technique is in comparison with Random technique together with power consumption comparison [10].

DSD's in a DSDN are designed to feel the chunks and then transmit the chunk statistics. The whole DSD's are divided into more than one Groups. every vicinity could have set of DSDs. For each group head DSD is selected for appearing conversation among extraordinary areas. the selection of head DSD is based on measure of ultimate battery degree and deciding on a DSD which has maximum battery level. Particle Swarm Optimization in conjunction with restoration of DSD are completed by using detecting and replacing the DSD's which do now not carry out well based totally on mobile Agent. The chunks are accrued from DSD's after which send toward head DSD, from head DSD the chew transport is accomplished closer to the cellular agent and then in the direction of the sink [11].

To supply the statistics that is sensed by means of the DSD it's miles important to divide them into chunks and additionally shield the information in opposition to diverse type of attacks. trust level is computed for every DSD and then DSD is chosen which has most believe. Like this all steps are carried out till destination DSD is reached. For the entire hyperlink between DSD's the sum of believe level is introduced to obtain course consider. In a similar way direction trust is computed for all routes and route which corresponds to maximum fee of accept as true with is used for chunk delivery [12].

A Group is created by the combination of the DSDs. The data is sent from the DSD to the head DSD of the Group, and then it is sent to the control center sink. The DSD that is closest to the Group's center is picked as the head DSD when a central selection mechanism is employed. A DSD will eventually become a hole DSD if it is frequently utilized for communication. Dynamic pathways can be selected to have higher performance by using load balancing and fewer communication channels, resulting in performance that is superior to LEACH [13].

The selection of head DSD is based on energy and distance factor along with determination of chance factor in order to obtain the final selected DSD [14]. A DSDN is a tiny gadget that runs on a battery's meagre supply of energy. In order to address issues with routing protocols that are present in DSDN group, group head will be computed based on delay and data loss, the group head is frequently used. The LEACH group head method was calculated in this work to develop a communication protocol with the formation of a group head, where the group head computation is intended to identify which DSD will be become head DSDs and other DSD are group members. In order to build the protocol for the DSDN, the LEACH algorithm goes through three steps. The first stage makes sure that every DSD is a group head and that the group head location is neither fixed nor alternate [15].

Energy conservation in DSDN has grown to be a major problem. Clustering is one of the most effective ways to manage the residual power in DSDs and prolong the life of the network. The secret to an energy-efficient clustering is creating homogeneous, stable groups and selecting the best group head. This is a balanced fuzzy c-mean clustering approach-based Energy Aware group Head Selection Protocol. This strategy suggests combining a modified centroid and a balanced fuzzy c-mean algorithm to produce stable, homogenous groups. Three factors, including the DSD's residual energy, its distance from the base station, and its distance-ratio, are taken into account when choosing the group head [16].

Multiple DSD form a Data Sense Detection Network (DSDN), which transmits data to a base station for data collecting. An energy-efficient routing strategy is required to decrease DSD energy consumption and increase network lifetime because

DSDN nodes are battery-powered devices that lose energy primarily during transmission. The disadvantages of the current routing protocols include the selection of cluster heads with low residual energy and the construction of different-sized groups, which results in unequal energy consumption by the nodes. Therefore, a Low Energy Adaptive Clustering Hierarchy (LEACH-ACO) protocol based on Ant Colony Optimization is suggested in this research for Data Sense Detection Network (DSDN) transmission [17].

For many uses, including healthcare, the military, the environment, the home, and other areas, DSDN are beginning to take up a significant portion of daily life. Small batteries that DSDs need for power can be installed in hazardous environments where it is challenging to replace or recharge them. DSDN are hence energy- constrained. Several routing techniques are suggested in this area to increase network longevity and reduce energy usage. Routing protocols, however, cannot ensure the dependability of communications. Channel coding in the physical layer is suggested in order to meet the high-reliability needs of data delivered utilizing routing protocols [18].

Due to their growth in terms of equipment and cost reduction, DSDN have advanced significantly in recent years. Based on the network architecture and the application, various protocols have been developed. One of the DSDN environments' most energy-effective methods is the LEACH (Low Energy Adaptive Clustering Hierarchy) mechanism. Using the group head functionality of the DSDs, this hierarchical protocol collects and transmits data from group members to a fixed sink DSD. By giving the sink DSD the option to move and balancing the group head election decision based on the distances between the DSDs and the remaining energy of the potential group head [19].

Additionally, in order to extend the life of the network and boost data transmission. As compared to LEACH the modified method works better because for a threshold set of iterations all DSDs would have lost their energy whereas modified method has better energy levels till the threshold iteration count [20].

4. LOYAL UN-SUPERVISED LEACH

The Proposed method is discussed in detail from the Data sensing device network (DSDN) formation, multiple group formation, group head selection in each group, link formation between two different groups.

4.1 Data Sensing Device Network (DSDN)

Single Group Formation is responsible for placing the Data Sensing Device (DSD's) at random locations in a Group which is bounded by the limits of *x*y*. The input to the single Group formation will be number of DSD's, end points of *x* dimension, end points of *y* dimension. The first DSD will be assigned a value of 1. The *x* location for the DSD will be generated in a random fashion between $\{xs, xe\}$. The y location for the DSD will be generated in a random fashion between $\{ys, ye\}$. The triplet is formed with a value of (k, x_{DSD}, y_{DSD}) K is the unique identifier for the DSD, x_{DSD} is the location of *x* for the DSD, y_{DSD} is the location of *y* for the DSD. The location of DSD is defined in such a way that the two DSD's will never have the same location. The DSDN formation can be summarized in *Process 1* random fashion between $\{ys, ye\}$. The triplet is formed with a value of (k, x_{DSD}, y_{DSD}) k is the unique identifier for the DSD, x_{DSD} is the location of x for the DSD, y_{DSD} is the location of y for the DSD. The location of DSD is defined in such a way that the two DSD's will never have the same location. The DSDN formation can be summarized in *Process 1*. To create a multi-group formation with unique end positions for each group, the single area formation is run more than once.

Process 1: Single Area Formation
Data Input: N_n, x_S, x_E, y_S, y_E
Data Output: A set of Data Sensing Device information $DSDN - I$
Details:

a) $k = 1$
b) $k: 1 - -- > N_n$
c) Generate one dimension location of DSD which can be in the range of $x_S to x_E$ which can be defined as
$$x_k = xv \text{ any } xv \text{ which satifies}$$
$$x_S \le xv \le x_E \ \& \ xv \ne x_{his}$$
d) Generate second dimension location of DSD which can be in the range of y_S to y_E
$$y_k = yv \text{ any yv which satifies}$$
$$y_S \le yv \le y_E$$
and $yv \ne y_{His}$ x_{His} – history of one dimension previously assigned
&
y_{His} – history of other dimention previously assigned
e) Form the k^{th} row matrix

DS Did	Location
k	(x_k, y_k)

f) $k = k + 1$

4.2 Group Head Formation

For each group, a DSD Head will be chosen depending on the battery level, the distance between the DSD and the base station.

The DSD are categorized into multiple categories using unsupervised clustering techniques which are applied to parameters. First the machine learning classification is done on distance, secondly the classification is done on residual battery energies of DSD Based on the combination a multi parameter *k* means algorithm is executed and then DSD's are classified into LOW, MEDIUM and HIGH Loyal Group heads. The classification of DSD is summarized below in *Process 2*.

Process 2: Group Head Selection Strategy
Data Input:
DSD map - DSD present in group
BL map - battery level for FSPs in group
Distance DSD map - Distance of each DSD with other FSP
Mobility map- Mobility vector for FSP
Output: One of the DSD chosen as group DSD Head
Process

1. Find the Count of number of DSD in the group N group
2. m=1
3. m<=N group
4. Find the distance between m[th] DSD to Base Station d (FSP, BS)
5. Obtain the battery level for m[th] DSD
6. A column matrix of distance called 'D' and then battery level column matrix called "BL" are formed.
7. Find the maximum value of distance and since the distance can be labelled into NEAR-BS, CLOSER-BS and FAR-BS.

$$0 >= k <= D\,max/3\,(NEAR-BS)$$
$$D\,max/3+1 >= k >= D\,max/2\,(CLOSER-BS)$$
$$D\,max/2 >= k >= D\,max \quad (FAR-BS) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where,

$$D\,max = dis\tan c\,e\,of\,fartest\,DSD\,wit\,BS$$

8. Find the maximum remaining battery level of the DSDs within the group

$$0 >= k <= BL\,max/3\,(BAD)$$
$$BL\,max/3+1 >= k >= BL\,max/2\,(OK)$$
$$BL\,max/2 >= k >= BL\,max \quad (GOOD) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Where,
$BL\max$ is the maximum value of battery level.

9. The value of DSD distances is plotted on the x line and then battery level is plotted on the y line
10. The DSDs are classified into High LOYAL, Medium LOYAL and HIGH LOYAL
11. If any DSD exists as HIGH LOYAL then one of it will be chosen

4.3 Link Formation

By building a path from the initiator DSD to the destination DSD, the path formation procedure will be carried out. The head DSD will send the RREQ to the head DSD's of all the regions before sending the ACK to the head DSD that holds the destination DSD. From the destination DSD head, the connection is formed with regard to the destination DSD.

4.4 Existing Methods

This section describes the methods used to compare the existing methods namely LEACH and E-LEACH with LOYALTY based LEACH.

4.5 LEACH Method

In a LEACH technique, the head DSD will be chosen in a random, probabilistic manner. Every group in the Multi group Wireless Sensor Network goes through this procedure again. The path generation for the LEACH-based approach starts at the initiator DSD, which sends the data to the head DSD. From the head DSD, communication occurs to the base station, which then scans each group one at a time until it reaches the destination DSD.

4.6 E-LEACH

The network was separated into numerous portions by ELEACH similar to LEACH, including chunk delivery via path construction and head DSD selection. Energy level and distance from the base station are taken into consideration when choosing the head DSD, which increases longevity in comparison to LEACH but still has throughput and link count issues because chunk delivery is dependent on LEACH.

Table 1: Comparison of methods LEACH, E-LEACH and Loyal Un-Supervised LEACH

Parameter	LEACH	E-LEACH	Loyal UN-Supervised LEACH
DSDN Formation	Based on number of groups the DSD's are spread in a random fashion	Based on number of groups the DSD's are spread in a random fashion	Based on number of groups the DSD's are spread in a random fashion
Group Head Formation	The group head is selected based on random probability computation	The group head is selected based on combination of distance along with residual energy	Selection of group head is done based on k means machine learning algorithm which takes distance with respect to base station, residual energy. In each group the DSD's are grouped into Low, Medium and High Loyal
Link Formation	LEACH will form the end-to-end path by having communication from source DSD to group head DSD, and then communication happens to base station. The base station scans each of the areas until processing centre has been reached	E-LEACH link formation same as that of LEACH	The link formation is done from initiator DSD to head DSD in the initiating group, head DSD sends the RREQ packet to all other group heads, the head DSD which has the processing center will send ACK packet to initiator head DSD and then link is established between initiator head DSD to processing center group DSD and then towards the processing center

5. RESULTS AND DISCUSSION

The Experimental runs are carried out on proposed LOYAL UN-Supervised LEACH and then it is compared with LEACH and E-LEACH

5.1 LOYAL UN-Supervised LEACH

Table 2 describes the experimental setup of Loyal Un-Supervised LEACH method and *figure 3* shows that all the DSD's will be initiated with a value of 500 mJ. All the 40 DSD's have the same value. *Figure 4* shows the Group formation. All the four groups have 10 DSD's each. In the Group1 the DSD's are {DSD1 to DSD10}, For the Group2 the DSD's are {DSD11 to DSD 20}. For the Group3 the DSD's are {DSD 21 to DSD 30} and then for the Group 4 the DSD's are {DSD 31 to DSD 40}

Table 2: Experimental Parameters

Name	Data value
Run Count	50
End point of X & Y dimension	(1,100) (1,100)
Energy for Chunk Generation	5 mJ
Energy for Chunk Delivery	10 mJ
Environment Factor	0.8
Source & Destination DSD	1, 38
Group Dimension	50*50
First Group	Xmin=1, Xmax=50 Ymin=1, Ymax=50
Second Group	Xmin=51, Xmax=100 Ymin=1, Ymax=50
Third Group	Xmin=1, Xmax=50 Ymin=51, Ymax=100
Fourth Group	Xmin=51, Xmax=100 Ymin=51, Ymax=100
Battery Level All DSD	500 mJ
DSD Count for Group1, 2, 3, 4	10, 10, 10, 10

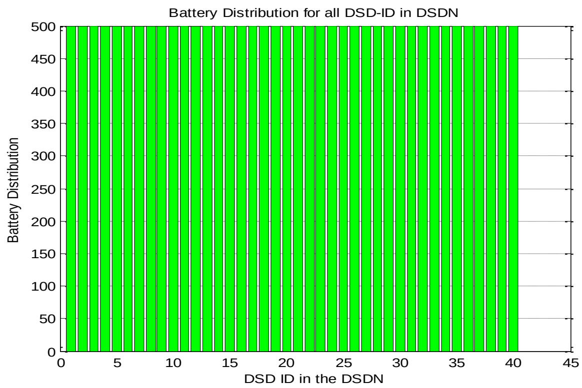

Figure 3: Battery Level

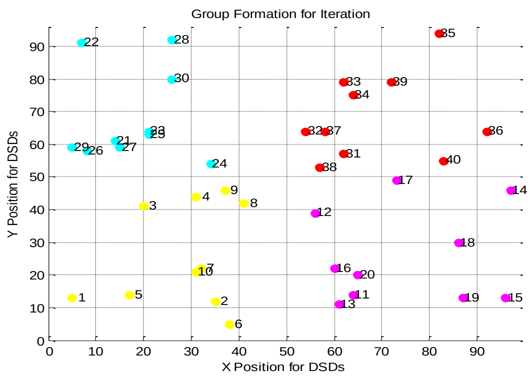

Figure 4: Group Formation

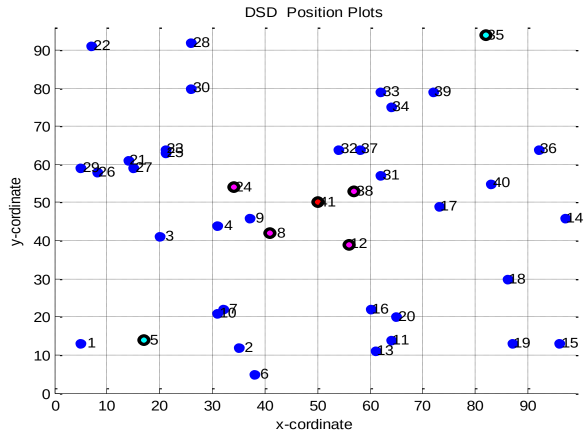

Figure 5: Group Heads

Figure 5 shows the group heads elected in pink circles, initiator and destination DSD in green color and base station in red color. The group heads are selected based on Un-Supervised machine learning based algorithm. The group heads are DSD-8 for Group1, DSD-12 for Group2, DSD-24 for Group3 and DSD-38 for Group 4. DSD-41 is present at the center of all groups and is the base station.

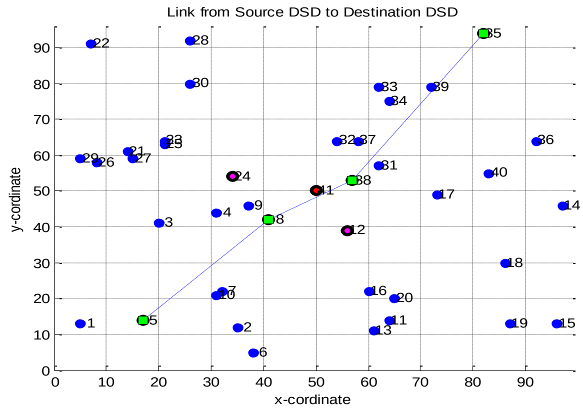

Figure 6: Link Formation

Figure 6 shows the link formation. From the *figure 6* DSD-5 communicates to DSD-8 which is the group head, from the *Table 3*: Experimental setup to compare LEACH, E-LEACH with LOYAL-LEACH. DSD-8 the communication happens to DSD-38 which is the group head of Group 4 and then link is established with DSD-35.

5.2 Comparison Results

This section will compare LEACH, E-LEACH with LOYAL-LEACH with respect to various parameters namely End to End Delay, hop count, energy consumed, alive nodes, dead nodes, lifetime ratio, throughput and residual energy and the experimental setup is shown in *table 3*.

Figure 7 shows the DSD's spread across four groups. The first group has 5 DSD's, the second group has 10 DSD's, third group has 5 DSD's and fourth group has 10 DSD's. Each group is on an independent area. For instance, the group1 is spread in a boundary of (1,50) on the *x* and (1,50) on the *y*.

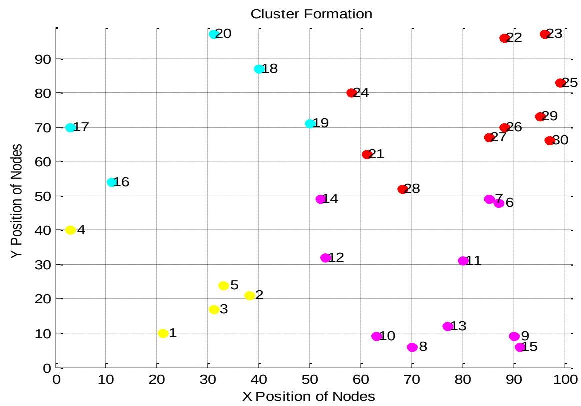

Figure 7: Group Formation for Comparison

Figure 8 shows the battery level for all the DSDs. All the DSD's will be initialized with the same battery level with a value of 500mJ. The end-to-end delay is measured by taking the time difference between the time at which the RRES is received to the time at which RREQ is send.

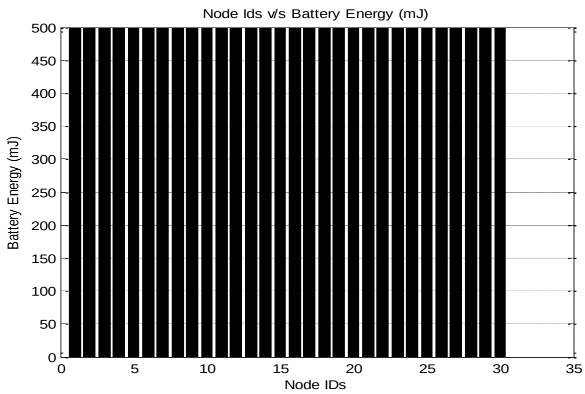

Figure 8: Battery Level for DSDs

Table 3: Experimental setup to compare LEACH, E-LEACH with LOYAL-LEACH

Name	Data value
Run Count	25
End point of X & Y dimension	(1,100) (1,100)
Energy for Chunk Generation	5 mJ
Energy for Chunk Delivery	10 mJ
Environment Factor	0.8
Source & Destination DSD	1, 38
Group Dimension	50*50
First Group	Xmin=1, Xmax=50 Ymin=1, Ymax=50
Second Group	Xmin=51, Xmax=100 Ymin=1, Ymax=50
Third Group	Xmin=1, Xmax=50 Ymin=51, Ymax=100
Fourth Group	Xmin=51, Xmax=100 Ymin=51, Ymax=100
Battery Level All DSD	500 mJ
DSD Count for Group1 & 2	5, 10
DSD Count for Group3 & 4	5, 10

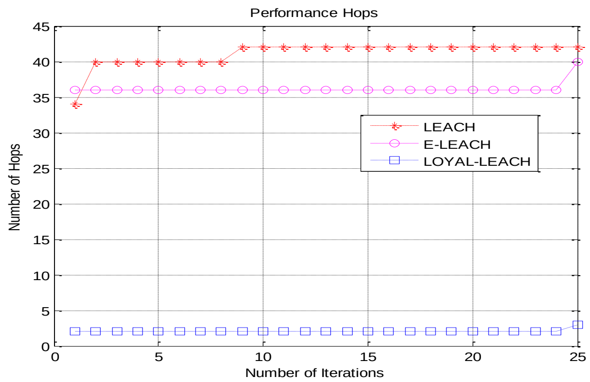

Figure 9: Number of Hops

Figure 9 shows the number of hops. From the *figure 10* it is evident that the LOYAL-LEACH method has the lowest hops followed by E-LEACH and LEACH method. Hops is number of links between initiator to destination DSD.

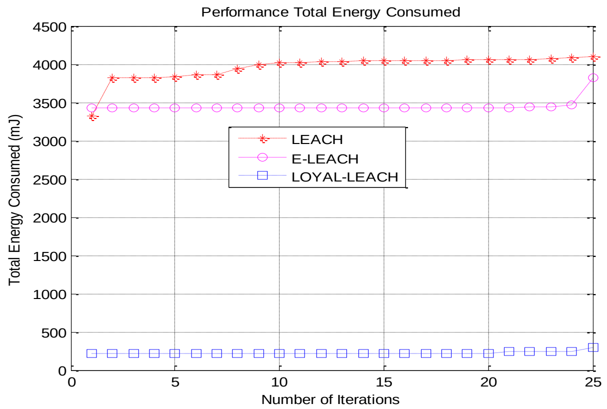

Figure 10: Total Energy Consumed

The energy consumed is obtained by adding the individual link energy. The individual link energy is computed based on transmission energy, attenuation factor and generation energy. The total energy consumed is defined as

$TEC(p) = sum(EC(lj, lk))$
Where,
$TEC(p)$ = path total energy consumed
$EC(lj, lk)$ = energy consumed between lj and lk...(1)

The link energy can be computed using the following

$Ec(lj, lk) = 2 * Etx + Eg * d^{\wedge} at(f)$.....(2)
Where,
Etx = transmission energy
Eg = generation energy
d = distance between DSDs
$at(f)$ = attunuation factor

Figure 11 shows the alive DSD's count. As the number of iterations will become more the count of alive DSD's will become lesser. LOYAL-LEACH will have alive count which is higher across all the iterations followed by E-LEACH and LEACH. At the end of 25 iterations there are around 2 alive

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DSD's followed by E-LEACH which has around 9 DSD's as alive and finally for LOYAL-LEACH the count of alive DSD's are around 26.

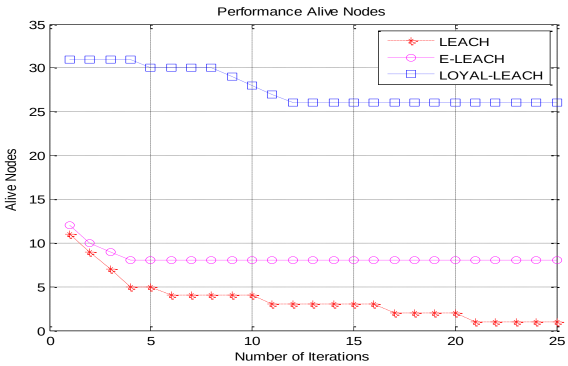

Figure 11: Alive DSD's Count

The *figure 12* shows, count of Dead DSD's is measured by making use of following equation

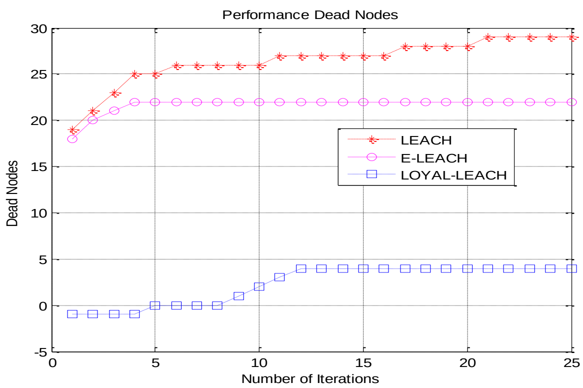

Figure 12: Dead DSD's Count

$$DDSDC = (DSD \text{ with } RE < IB/4)\ .$$

Where,

$DDSDC$ = Dead DSD count

RE = residual energy

IB = Initial Battery Level.....(4)

Figure 13 shows the lifetime ratio for DSDs. From the figure it is evident that LOYAL-LEACH will be having highest Lifetime ratio followed by E-LEACH and then finally LEACH. The lifetime ratio can be summarized as below.

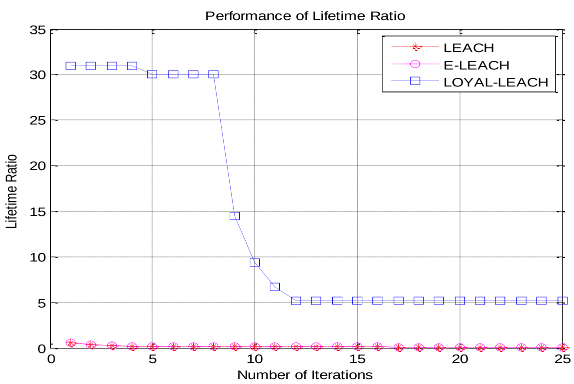

Figure 13: Lifetime Ratio for DSD

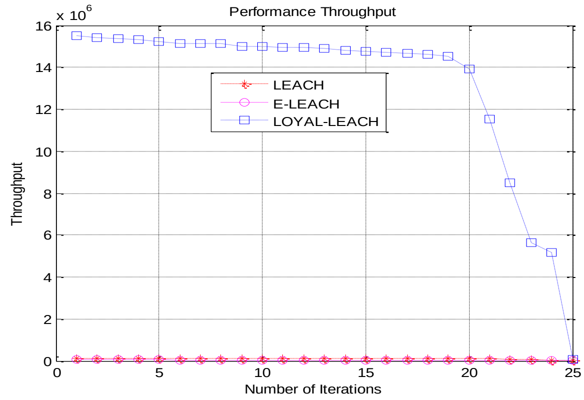

Figure 14: Throughput Performance

From *figure 14* the value of throughput is measured based on number of data packets delivered with respect to unit time. LOYAL-LEACH is having highest throughput followed by E-LEACH and LEACH. LEACH is around 0.8 Mbps, followed by E-LEACH which is around 1 Mbps and LOYAL-LEACH has around 15 Mbps during the start and then it reduces as number of iterations increases.

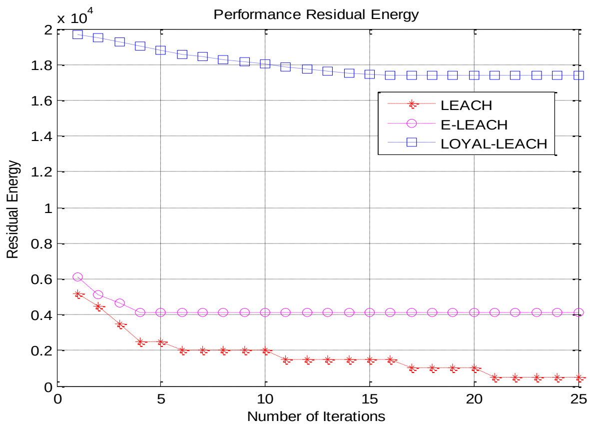

Figure 15: Residual Energy Performance

Figure 15 it is evident that LOYAL LEACH has the highest residual energy followed by E-LEACH and then LEACH. LOYAL LEACH has around 18000 J followed by E-LEACH which is around 4000 and then LEACH will have around 1000 J at the end of 25 iterations. *Table 4* shows the performance improvement in percentage compared to E-LEACH and LEACH. For all parameters LOYAL-LEACH has improvement compared to existing methods namely E-LEACH and LEACH.

Table 4: Performance measures of LOYAL-LEACH

Name	Improvement with E-LEACH	Improvement with LEACH
Hops	49.26%	43.01%
Energy Consumed	48.90%	42.16%
Alive DSD Count	61.19%	49.13%
Dead DSD Count	47.82%	38.40%
Lifetime	95.53%	93.94%
Throughput	89.79%	90.21%
Residual Energy	67.74%	57.33%

International Journal of
Electrical and Electronics Research (IJEER)
Research Article | Volume 11, Issue 4 | Pages 877-885| e-ISSN: 2347-470X

6. CONCLUSIONS

In this paper first Data Sense Device Network formation is described followed by group formation. The head device is found in each of the group by making use of unsupervised machine learning method. The head is selected in a efficient manner and those are used in the link formation along with packet delivery process. The LOYAL-LEACH is studied and experimental execution is made for the same method. The head selection is made based on energy levels along with distance with respect to base station but based on un-supervised classification levels. There are nine parameters across which the LOYAL-LEACH is compared with existing E-LEACH and LEACH methods and it is proved that LOYAL-LEACH performs the best.

7. FUTURE SCOPE

1. The method can be future improved by doing the grouping of DSDs based on k means clustering method.
2. The method can be extended to use QAM modulation technique in order to improve the throughput.

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