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LCSiLEACH: LWZ Compressive Sensing Based iLEACH

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ABSTRACT

In the application based WSNs circumstance, vitality and transmission capacity of the sensors are esteemed assets and vital to consume competently. Data collection at the sink by individual sensor nodes results in flooding of the requests which results in most extreme energy use. To decrease this issue another data aggregation technique has been used in this paper which has enhanced the execution of the iLEACH principle by utilizing the LZW compressive sensing based between cluster based data accumulation; additionally called mixture data aggregation strategy, where gathering of nodes will be carried out on the principle of the available clustering procedures and gathering of cluster heads is likewise done to use the peculiarities to utilizes the cluster head based data aggregation. The proposed technique serves to diminish the energy utilization issue, furthermore transmission of the aggregated data in proficient way. The proposed technique has been designed and implemented in MATLAB by considering various issues of the WSNs. The comparison among the iLEACH and LEACH has shown the effectiveness of the proposed technique.

INDEX TERMS: LZW COMPRESSIVE SENSING, LEACH, INTER CLUSTER, DATA AGGREGATION.

1. INTRODUCTION

Modern progresses in digital electronics[2], micro-electro-mechanical system, and wireless communications have empowered the growth of small-sized sensor nodes, which have low-power, low-cost and are multifunctional. These sensor nodes have capability to sense and communicate. Wireless sensor networks[1] are made up of a large number of sensor nodes, densely deployed either inside the region or very near to it. Energy conservation is the major matter in wireless sensor network. Limited power nodes which cannot be replaced can be carried by sensor nodes. In WSN, sensor nodes sense data and transmit it to the base station. Since data from neighbouring sensor nodes[3] may be redundant, it becomes complex for base station to process large amount of data. Moreover, sensor nodes have their own energy. Due to redundant transmissions and loss of energy, lifetime of sensor nodes can decrease. To increase lifetime, data aggregation[3,4] is performed. Data aggregation means to collect and aggregate data[3,5] from multiple sensors to eliminate redundancy and conserve energy. In iLEACH, the organization of nodes is done into clusters for the fusion of data. The fused data is transmitted from various sensors in the cluster to the sink by a selected node called cluster head after performing aggregation of data. Cluster head is more energetic than all the other sensor nodes in the cluster. This helps in reducing the amount of data sent to the sink. The fusion of data is done at the cluster heads at regular intervals. iLEACH involves the two necessary phases: the set-up phase and the steady phase. In set-up phase, organization of clusters is done and in steady phase transmission of data from sensor nodes to cluster head and from cluster head to base station takes place. Akyldiz et al. [6] This paper presents modern progresses in digital electronics, micro-electro-mechanical system, and wireless communications that have empowered the growth of small-sized sensor nodes, which have low-power, low-cost and are multifunctional. Wireless sensor networks having a wide range of applications in areas such as security, military, environmental, home, commercial and health are explored. Various factors which influence a sensor network design such as power consumption, scalability, operating environment, hardware constraints, fault tolerance, production costs, sensor network topology, and transmission media, are outlined. These factors provide help in designing a protocol or algorithm for sensor networks. The protocol stack, used by the sensor nodes which has following layers: application layer, transport layer, network layer, data link layer, physical layer, power management plane, mobility management plane and task management plane, along with the algorithms and protocols that are developed for each layer, are focussed. Research issues for the wireless sensor networks are also presented. A list related to research projects of current sensor networks is shown. . Thiemo Voigt et al.[7] In some of the applications of WSN, power harvesting is necessary, mainly when sensor nodes are in an area such as battlefield. For this, Solar-aware Low Energy Adaptive Clustering Hierarchy (sLEACH) has been proposed. In sLEACH, improvement in lifetime through solar power is done. Solar power facilitates sensor nodes which act like cluster heads depending on their solar status. sLeach extends both LEACH and LEACH-C. G. Smaragdakis et al. [8] This paper 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 cluster head. 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 V. Loscri et al. [9]This paper has presented a two-levels hierarchy for low-energy adaptive clustering hierarchy (TL-LEACH). In this protocol, data is gathered by a cluster head from other members of the cluster as in case of LEACH. Although, instead of sending data directly to the base station, one of the cluster heads in the path to the base station is used as a relay station. R.Rajagopalan et al .[10] This paper presented different data aggregation algorithms which focus on the performance measures like energy efficiency, data accuracy, latency and network lifetime. Security and source coding are the necessary issues in data aggregation which have been discussed. Comparison of different hierarchical data aggregation protocols like low energy adaptive clustering hierarchy, the hybrid energy efficient distributed clustering, power efficient data gathering protocol for sensor information systems, hierarchical chain based protocol, energy aware distributed heuristic, power efficient data gathering and aggregation protocol on the basis of their organization type (cluster, chain or tree), objectives and characteristics has been presented. The focus is also on the network flow-based data-aggregation algorithms which are CMLDA, Maxconcurrent flow algorithm, restricted flow problem with edge capacities algorithm, shortest path tree algorithm and these are differentiated according to objectives and constraints, approach, limitations. Different approaches which characterize the trade-offs involved in data aggregation have been demonstrated. LanTien et al. [11] In this paper, Mobile-LEACH has been proposed. During set up and steady phase, mobility of sensor nodes and cluster head is allowed. During the selection of cluster head, residual power of the node is considered. All the nodes are homogeneous in nature. Base station is fixed. Modification of distributed setup phase of LEACH is done to choose appropriate cluster head. In M-LEACH, using attenuation model, election of cluster head is done. To lessen the power of attenuation, optimum cluster heads are chosen. On the basis of mobility speed, selection of cluster head is done. The node having low mobility and lowest attenuation power is chosen as cluster head in Mobile-LEACH. Then status is broadcasted by these cluster heads to all sensor nodes within range. After computing their willingness from multiple cluster heads, the non-cluster head nodes choose the cluster head with highest remaining power. In steady phase, if either nodes move away from cluster head or vice-versa, then other cluster heads turn out to be appropriate for member nodes. It results in an inefficient cluster formation. Handover mechanism is provided by M-LEACH for the nodes to switch on to new cluster head. On deciding to make hand off sensor nodes transmit disjoin message to current cluster head and also transmit disjoin message to current cluster head and also transmit join request to new cluster head. Rescheduling of transmission pattern by cluster heads takes place after occurrence of hand off. B. Elbhiri et al. [12] In this paper, a Stochastic distributed energy efficient clustering scheme (SDEEC) for heterogeneous wireless sensor networks, has been proposed that is a self-organised network having dynamic clustering approach. Here selection probability of cluster head is more efficient. On the basis of the residual energy of sensor nodes, the selection of cluster head is done. During allocated transmission time, data is transmitted to cluster heads by all the cluster member nodes. The receiver of cluster head should be active for receiving all the information coming from nodes in the cluster. Cluster head performs signal processing for compressing data into a single signal when all the information is received. After this, the aggregated data is transmitted by each cluster head to its chief cluster head. To save power each cluster member node switches to the sleep mode. The demerit of this protocol is that if cluster member node switches to the sleep mode while aggregation is performed by cluster head, how selection of cluster head in the next round will be known. Dilip Kumar et al. [13] In this paper, an Energy Efficient heterogeneous clustered scheme(EEHC), has been presented for heterogeneous wireless sensor networks in order to elect cluster heads in a distributed way in hierarchical wireless sensor networks. The residual power of a node weighs the election probability of cluster heads relative to that of the other sensor nodes which are present in the network. The algorithm is based on low energy adaptive clustering hierarchy. From the results, it has been discovered that this algorithm is much more effective in increasing the network lifetime in comparison with LEACH. B. A. Said et al. [14] In this paper, an Improved and Balanced LEACH(IB-LEACH) has been presented. It is a heterogeneous-aware protocol. This has proposed a new technique for decreasing the probability of failure nodes and enhancing the interval of time before the death of the first node (this period is called stability period) and prolonging the lifetime in heterogeneous wireless sensor networks. The impact of nodes heterogeneity has been studied, with respect to their power in wireless sensor networks which have been hierarchically clustered. In such kind of networks, nodes having high energy which are called normal nodes, cluster heads and gateways, became cluster heads for aggregating data of the cluster nodes and then send it to the selected gateways which needs the minimum power to communicate for minimizing the power utilization of CH and decreasing the failure nodes probability. From the results, it has been shown that this protocol is power efficient and has helped in enhancing the lifetime of network and stability period in comparison with LEACH and SEP. BrahimElbhir et al. [15]In this paper, a clustering technique known as a developed distributed energy-efficient clustering scheme for heterogeneous wireless sensor networks has been proposed. This protocol is an adaptive power aware clustering protocol. On the basis of initial and remaining power of sensor node, each and every sensor node elects itself independent as a CH without knowledge of power during each round. The probability of sensor nodes for becoming a cluster head in an efficient manner has been altered dynamically in order to distribute same amount of power between sensor nodes. From the results, it has been demonstrated that this protocol has better performance as compared to SEP, DEEC in terms of lifetime of the network and stability period. D kumar et al. [15]This paper 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 cluster head 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. From the results, it has been discovered that 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. A.A. Khan et al. [16] This paper has been proposed after ESEP. The rising distance between the cluster head and sink results in growing the sending power since most of the power is consumed in the sending process. HSEP aims at falling the transmission power between the cluster head and base station. It brings into thought the clustering hierarchy which lowers the transmission cost and therefore the power. In this type of clustering two types of cluster-heads are used: one is primary and other is secondary. The secondary cluster heads can be chosen from the primary cluster heads and are elected with respect to the probability from those nodes which had already become the primary cluster heads. The primary cluster heads only can select the secondary cluster heads. They confirm distance between each other and the ones that are at minimum distance from them and that are chosen the secondary cluster heads. It also utilizes advance nodes and normal nodes. The process of utilizing the primary cluster head is same as in SEP by generating a random value between 0 and 1 and then comparing it with the threshold value. These primary cluster heads then aggregate data gathered from other nodes and send it to the secondary cluster heads which further send it to the sink. Therefore, reducing the transmission distance between the secondary cluster heads and the sink results in less power utilization. Thus HSEP weigh the more merits than other protocols because it is based on clustering hierarchy in which cluster heads are of two levels. This hierarchical clustering minimizes the transmission distance and so results in small amount of power dissipation. Moreover, the stability period of HSEP is superior in comparison to others. Therefore, power heterogeneity should be one of the main factors to be considered when designing a robust protocol for the network. The objective is to design a modified protocol that is more robust and can ensure longer lifetime of network while taking performance measures into consideration. A. Kashfaq et al. [17] Initially, the early protocols, stable election protocol and extended stable election protocol were heterogeneity-aware protocols that develop the stability period and network lifetime although a main disadvantage of heterogeneity is that the enlarged throughput ultimately minimizes the network lifetime. As a result, to manage the trade-off between the efficiency, accuracy and network lifetime, a new protocol has been proposed known as threshold-sensitive stable election protocol(TSEP). It is a reactive routing protocol that senses information constantly over the network although sends only when there is a drastic alteration in the value of sensed attributes. The communication takes place only when a precise level of threshold is attained. Three levels of heterogeneity are used by considering three types of sensor nodes: normal, intermediate and advance nodes. The highest power nodes are advance nodes followed by intermediate and normal sensor nodes. DnyaneshwarMantri et al. [18] This paper proposed two tier cluster based data aggregation(TTCDA) algorithm for minimizing the cost of communication and computation where the nodes are randomly distributed. As this algorithm helps in minimizing the transmission of the number of data packets to the base station, so this is power and bandwidth efficient. Additive and divisible functions have been at cluster head for the process of aggregating data. Spatial and temporal correlation have been considered and then each node applies these additive and divisible functions on the basis of the generation of data packets.

These functions has minimized the packet count that have been reported to the base station and has presented the transmission of duplicate packets of data thereby improving power utilization. Dnyaneshwar Mantri et al. [19] This paperproposed bandwidth efficient heterogeneity aware cluster based data aggregation algorithm. Utilization of existing bandwidth effectively in terms of reduced data packet delivery proportion and throughput has been the major design aim. For efficient gathering of data with in-network aggregation, this algorithm has offered the solution. The entire network along with heterogeneous sensor nodes in terms of power and sink that is mobile for the aggregation of the data packets has been considered. On the randomly distributed sensor nodes , the most favourable method by Intra and inter-cluster aggregation with changeable data creation rate while routing to base station has been embodied. To apply the aggregation function on data generated by sensor nodes, the correlation of data inside the data packet has been used. Results have been compared with two tier cluster based data aggregation and energy efficient cluster based data aggregation.

2. PROPOSED ALGORITHM

The proposed algorithm will function in following stages i.e. Cluster formation(Selection of cluster head), intra-cluster aggregation(grouping of nodes for transmission of packets to cluster heads for aggregation), inter-cluster aggregation(grouping of Cluster heads for transmission of aggregated data packets to the relay node) and compression of data.

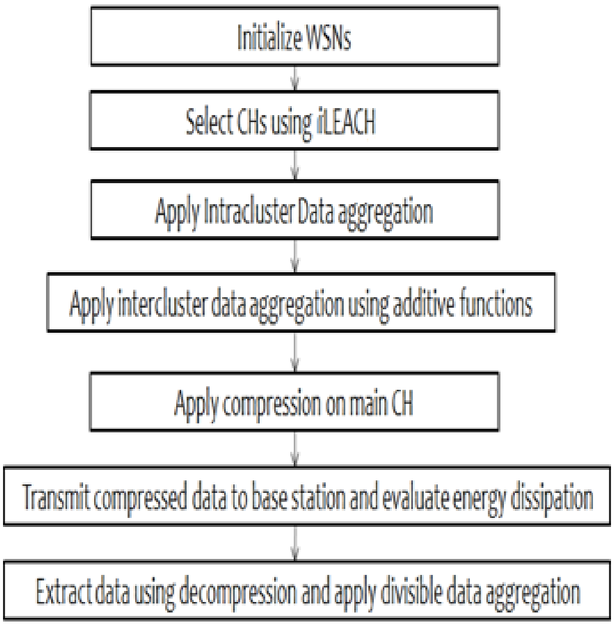

Fig 1:The flow chart of the proposed algorithm

Step 1.Initialize WSNs: The randomly distributed sensor nodes will be categorized into the ‘n’ number of clusters.

Step 2.Select CHs using iLEACH:The cluster head will be selected in each cluster according to the methods used by iLEACH.

Step 3.Apply Intracluster Data aggregation:CH will be responsible for aggregation of data packets produced by the sensor nodes within that cluster. In intra-cluster aggregation, CH will transmit the broad cast data and collect the data packets from several sensor nodes at periodic breaks. It will perform the aggregation of data packets using equations used in iLEACH. This step will come in action recursively for all the clusters within the WSNs.

Step 4.Apply intercluster data aggregation using additive functions: CH assemblies according to the obtainable data from each CH to achieve the additional aggregation for transmission with the base station. A relay node will be selected by the cluster heads on the basis of distance. Then, inter-cluster data aggregation will be applied using additive function at the relay node.

Step 5.Apply Compression on main CH: LCSiLEACH compression will also be used to compress the data.
Maximum compression ratio of LCSiLEACH=9.42

Compressed packets size (CPS) is defined as $CPS = \frac{APS}{9.42}$ where APS is the actual packet size.

Therefor new energy dissipation for compressed data will be as:

$$S(i).E = S(i).E - ((Tx_{energy} + EDA) * CPS + AMP * CPS * d^4 : if d > d_o$$

$$S(i).E = S(i).E - ((Tx_{energy} + EDA) * CPS + EMP * CPS * d^2 : if d < d_o$$

Here S(i).E - the energy of i^{th} node

EDA- effective data aggregation cost.

Tx_{energy}- Transmitter energy

AMP- multipath fading channel cost

EMP- Free space channel cost

d- is the evaluated distance between the cluster head and the base station.

$d_o$is the minimum allowed distance.

Step 6.Transmit Compressed data to base station and evaluate energy dissipation:After applying LCSiLEACH compression, data is transmitted to base station by relay node and energy dissipation is evaluated.

Step 7.Extract data using decompression and apply divisible data aggregation:The data is extracted using LCSiLEACH decompression. Divisible data aggregation will be applied on this data at the base station.

Assemblage of the sensor nodes in intra-cluster and assemblage of CH at inter cluster will reduce the data packet count at the base station. It will reduce the actual energy essential, which will result in increase in the network lifetime.

3. RESULTS AND DISCUSSIONS

Fig 2 has shown the active environment of LCSiLEACH protocol. Green circled nodes are representing normal sensor nodes whereas nodes with diamonds are representing cluster heads. The magenta lines, forming hexagonal shape are cluster head area also called cluster field. Each cluster field has a single cluster head. Red lines are representing communication of cluster head with the root cluster head also called relay node and blue line is representing communication of root cluster head with base station. The base station is residing outside the sensor field.

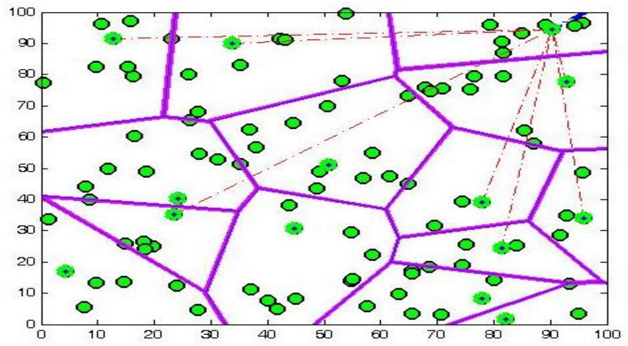

Fig 2 : when all the sensor nodes are alive

Fig 3 has shown the active environment of LCSiLEACH. Green circled nodes are representing normal sensor nodes whereas nodes with diamonds are representing cluster heads. The magenta lines, forming hexagonal shape are cluster head area also called cluster field.

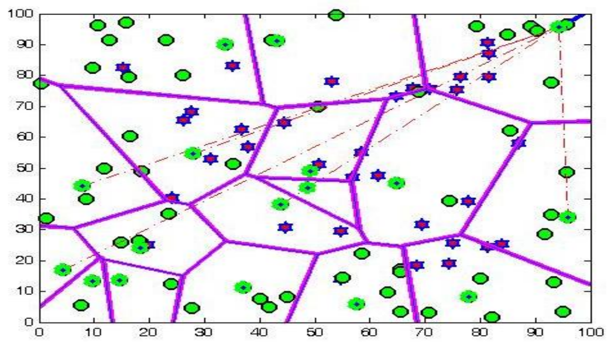

Fig 3: when some of the sensor nodes are dead

Each cluster field has a single cluster head. Red lines are representing communication of cluster head with the root cluster head also called relay node and blue line is representing communication of root cluster head with base station. The base station is residing outside the sensor field. Stars with red colors are representing normal sensor nodes that are dead. A node is known as dead if it has zero energy that is it is no longer available for communication.

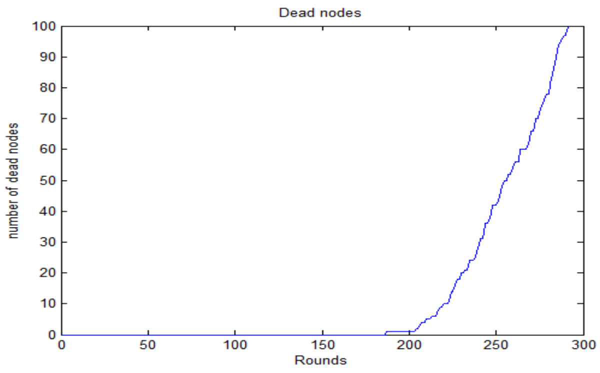

Fig 4: dead nodes

Fig 4 has shown the total number of dead nodes. The first node becomes dead at round 186 and the last node becomes dead at round 291.

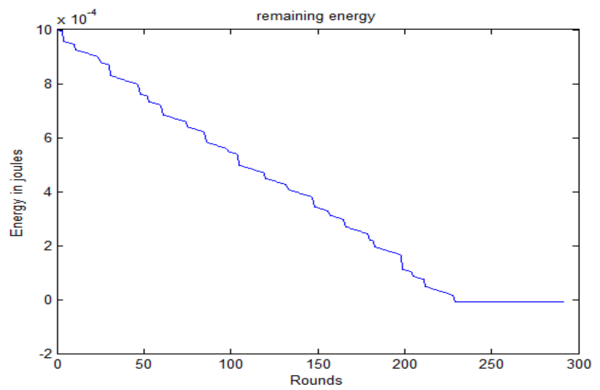

Fig 5: residual energy

Fig 5: has shown the remaining energy.

In order to implement the proposed algorithm, design and implementation has beendone in MATLAB. Table 1 shows the parameters used in the implementation along with their values.

Table 1 WSNs characteristics

Parameter	Value
Area(x,y)	100,100
Base station(x,y)	150,150
Nodes(n)	100
Probability(p)	0.1
Initial Energy	0.1J
transmiter_energy	$50 * 10^{-9}$J/bit
receiver_energy	$50 * 10^{-9}$J/bit
Free space(amplifier)	$10 * 10^{-13}$J/bit/m^2
Multipath(amplifier)	$0.0013 * 10^{-13}$

	J/bit/m^2
Effective Data aggregation	$5 * 10^{-9}$J/bit/signal
Maximum lifetime	4000
Data packet Size	4000 KB
m (fraction of advanced nodes)	0.2
a (energy factor between normal and advanced nodes)	1
LZW compression	9.42

Performance Evaluation Of Ileach And LCSiLEACH When TEST SCENARIO 1 When N=100

Network Lifetime:

It is the amount of time that a Wireless Sensor Network would be fully operative. It is the time interval from the start of the operation until the death of the last alive node.

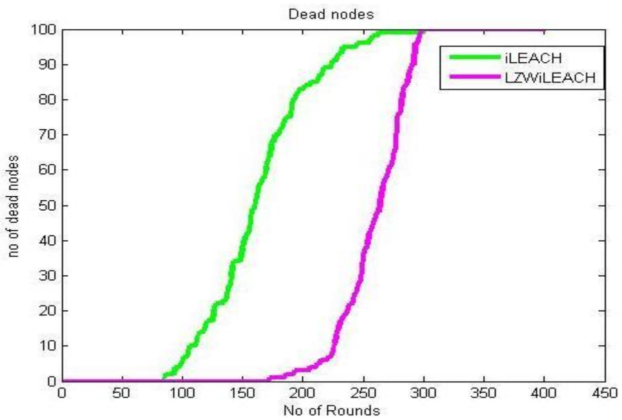

Fig 6: Dead nodes during network lifetime

Figure 6 shows the comparison of total number of dead nodes of ILEACHand LCSiLEACH protocols. X-axis represents the total number of dead nodes. Y-axis represents the total number of rounds. It clearly depicts that the PROPOSED is most efficient than iLEACH in terms of network lifetime.

It is measured by the total rate of data sent over the network, the rate of data sent from cluster heads to the sink as well as the rate of data sent from the nodes to their cluster heads.

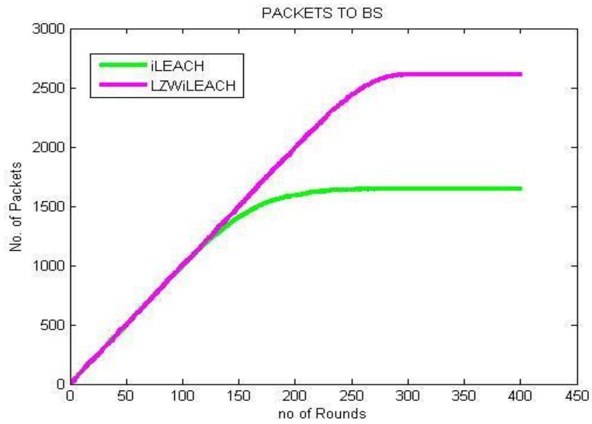

Fig 7: Total number of packets sent to base station

Figure 7 shows the comparison of throughput of iLEACH and PROPOSED protocols. X-axis is representing packets sent to base station. Y-axis is representing the total number of rounds. It depicts that data sent to base station is more for PROPOSED than iLEACH. Thus this figure clearly shows that the PROPOSED is most efficient than iLEACH in terms of packet sent to base station.

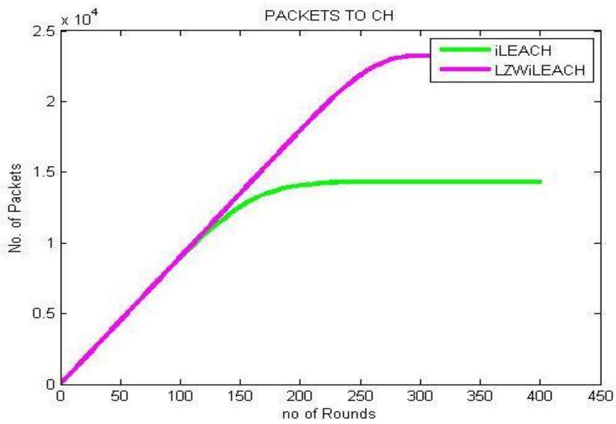

Fig 8: Total number of packets sent to cluster head

Figure 8 shows the comparison of total number of packets sent to cluster head of iLEACH and PROPOSED protocols. X-axis is representing packets sent to cluster head. Y-axis is representing the total number of rounds. It depicts that data sent to cluster head is more for PROPOSED than iLEACH. In this figure PROPOSED shows best throughput than iLEACH.

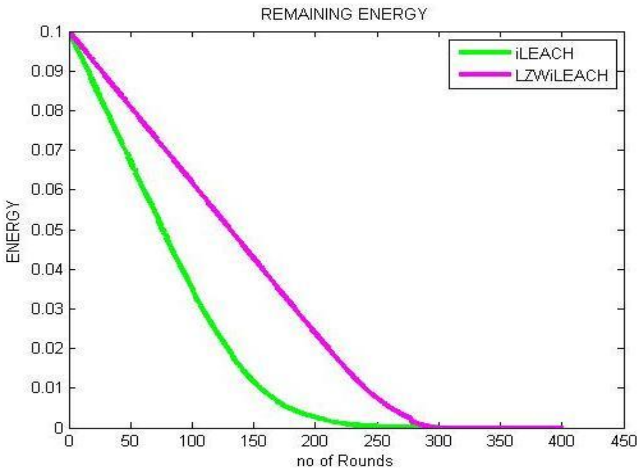

Fig 9: Remaining Energy

Figure 9 shows the comparison of remaining energy of iLEACH and PROPOSED protocols. X-axis is representing remaining energy. Y-axis is representing the total number of rounds. It shows that PROPOSED has more remaining energy than iLEACH. Thus this figure shows that the PROPOSED is most efficient than iLEACH in terms of remaining energy.

5. Conclusions and Future Scope

In the application based WSNs situation, energy and bandwidth of the sensors are valued resources and essential to consume proficiently. Data aggregation at the base station by individual nodes causes flooding of the data which consequences in maximum energy consumption. To diminish this problem a new data aggregation technique has been proposed which uses inter-cluster data aggregation and LZW based compression. It has improved the performance of the homogeneous and heterogeneous WSNs. The proposed algorithm has reduced the energy consumption problem and also aggregates and transmits the data in efficient manner. In addition, the proposed technique has used the additive and divisible data aggregation function at cluster head (CH) as in-network processing to reduce energy consumption. Cluster head communicates aggregated information to sink and cluster head nodes communicate data to CH. The proposed algorithm has been designed and simulated in the MATLAB tool. The comparative analysis has shown that the proposed LZW based data aggregation based iLEACH outperforms over the available protocols. In near future Ant colony based data communication strategy will also be used to enhance the results further.

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