# Journal of Applied Sciences

ISSN 1812-5654

Journal of Applied Sciences 13 (24): 5672-5681, 2013
ISSN 1812-5654 / DOI: 10.3923/jas.2013.5672.5681


# Active Clustering Rule for LEACH Model in Wireless Sensor Network

[1]V.S. Anita Sofia, [2]S. Arockiasamy and [1]P. Ranjit Jeba Thangaiah
[1]Department of Computer Applications, Karunya University, Tamil Nadu, India
[2]Information System, University of Nizwa, Oman

**Abstract:** Wireless Sensor Network (WSN) is an assortment of spatially distributed and dedicated autonomous nodes with limited resource which monitors the physical and environmental conditions. Though sensor nodes of WSN have confinements in memory, energy and computations, it has been widely used in numerous real time applications at present scenario for sensing the environment. Clustering of dispatch nodes and data ensemble technique affords energy conservation and resource utilization. Aggregating the data sent by the cluster members comprehend in draining network load and amending the bandwidth. In order to minimize the energy dissipation of sensor nodes and optimize the resource utilization, cluster head is elected for each cluster. The cluster heads contribute for adequate communication with the base station. Active Clustering Rule for LEACH model (ACR-LEACH) endeavors on the cluster formation and cluster head selection, contemplating the factors such as energy, concentration and centrality. The approach paves a way for increasing the lifetime of the network by adept cluster head selection schema. The primal authority algorithm called base station control algorithm elects the optimal cluster-heads that acquaintance with the base station. The proposed methodology is an immense method of cluster head selection on the resource constraint network.

**Key words:** Sensor network, clustering, data ensemble, cluster heads, sensor node, energy consumption, network lifetime

## INTRODUCTION

Wireless sensor networks are a progression of the past few years which involves in the deployment of a large number of small sensor nodes for sensing the environment and reporting to the base station via pliable network architecture. The randomly dispersed sensor nodes of wireless sensor network provide the essential functionalities; ability of monitoring the physical and environmental conditions in real-time based on the factors such as temperature, pressure and relative humidity, ability to consummate devices like switches, actuators and motors that control the environmental conditions and the ability to afford adept and reliable communication over wireless networks (Chengfa *et al*., 2005; Tufail, 2012).

Power management, energy management and resource management are most substantial factors in WSN. Henceforth a methodology called ACR-LEACH is developed for conserving the above-mentioned factors with a data ensemble (Maraiya *et al*., 2011; Katiyar *et al*., 2011). The data aggregation process reduces the number of message exchange between the nodes and the base station and saves some energy. In order to combine the data from dispersed sensor nodes, clustering is formed. The deployed sensor nodes are clustered in accordance with the distance between them and the hop count. For aggregating the data from various sensor nodes, there is a requirement of aggregation point. While considering the aggregation point, it is apparent to have heads for each cluster named cluster heads which provides communication between the cluster members and the base station. In this affirmed work, a schema is defined for cluster head selection with energy efficiency for an adequate attainment of WSN (Wang and Ramamurthy, 2007; Singh *et al*., 2010).

The sensor nodes of WSN allow arbitrary deployment in inaccessible terrains which means the self-organized protocol feature and the cooperative effort of the nodes in wireless sensor network. Herewith, the base station acts as an interface between the internet and the user. As is well known, the nodes of wireless sensor network acquire limited energy, lower power, dynamic network topology and mobility support. It needs multi-hop routing and large scale dispersal, since it operates with low power and energy. In Fig. 1, the architecture of wireless sensor network is shown with clustering. With a relevant hop count, sensor nodes are grouped to form clusters which provide minimum energy and power consumption. CM represents the cluster members of a particular cluster whereas CH represents the cluster heads that is responsible for data ensemble and communication with the base station. Thus, the cluster

**Corresponding Author:** V.S. Anita Sofia, Department of Computer Applications, Karunya University, Tamil Nadu, India

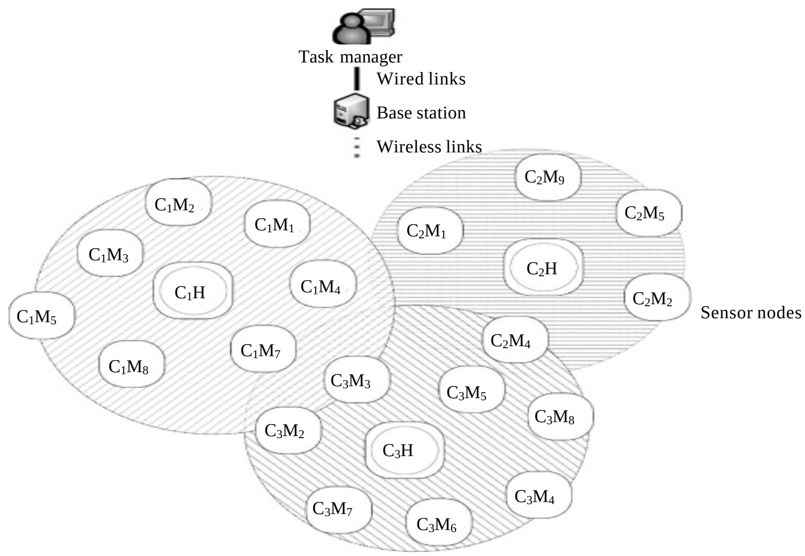


Fig. 1: Architecture of WSN

head of a cluster in WSN has to be elected in an adept manner with the consideration of energy, concentration and centrality.

One of the popular and efficient protocols which induce the nodes to minimize the energy consumptions in the networks is LEACH (Low Energy Adaptive Clustering Hierarchy). This protocol arranges the nodes into groups, so that each cluster acts a cluster-head for a specific period for its own cluster. LEACH randomly elects the cluster-head in each round by which the energy will be evenly distributed. In this approach the base station is fixed and other nodes are energy constrained in nature.

Clustering provides an adequate way of perpetuating the network lifetime in WSN. Basically the clustering algorithm is needed for electing cluster heads with more surplus energy and whirling the cluster heads periodically. There should be balance energy and load maintenance among clusters. The network routing protocol of WSN should involve in providing inter-cluster communication of sensor nodes to prolong the lifetime of the network. Hence, the appropriate selection of cluster heads minimizes the energy consumption and increases the network lifetime in WSN, a fuzzy logic approach had been proposed for considering the energy, deliberation and centrality (Gupta *et al*., 2005). The modification of the shape of each fuzzy set, the network lifetime can be further increased. This proposal focuses on the efficient cluster head selection schema which supports the WSN by consuming less energy and involves inadequate data ensemble to forward that to the base station.

## RELATED WORKS

Sensor nodes are compactly deployed over the wireless sensor network that provides the sensing results with very similar data. The transmission of such data to the base station may constitute some redundancy (Al-Karaki and Kamal, 2004). While clustering, the sensor nodes combine and condense the data together and forward only the compact data to the base station with efficient data ensemble process (Patwari *et al*., 2005). Thus, diminish the localized traffic in individual group. Since wireless sensor network is an energy constraint network, in requires multi-tier architecture for data forwarding (Gupta and Younis, 2003). There followed a hierarchical mechanism for data transmission. When there is a failure occurred at the highest level of hierarchy, there arises a limitation in accessibility of nodes under their supervision. Hence, they proposed an efficient mechanism to recover sensors from the failed part. The study composed two phases namely, detect and recover the fault forbearance from the failed clusters without re-clustering the network. The future enhancement of this approach based on the accumulation of bootstrapping and energy-routing mechanisms.

A proposal illustrated a constant time clustering algorithm that provides minimal redundancy of exchanges messages and reducing the size of the routing table (Hesong and Jie, 2005). Ahmed *et al*. (2008) explained a Hybrid Energy Efficient Distributed Clustering (HEED) algorithm using some extended probabilistic determinations. The mechanism was developed with the assumption that the sensor nodes are deployed in a rectangular area in the network.

Layered Clustering Hierarchy (LCH) communication protocol was proffered in which the sensor nodes are formulated as a layered cluster structure. The process based on the randomized rotation of cluster head selection in each layer for the distribution of energy load evenly throughout the sensor network. The LCH constitutes two stages namely initialization stage and distributed clustering protocol stage (Liu, 2012). The below mentioned stage was further divided into two phases called cluster formation and data transmission. As future work, the performance evaluation of LCH could be made with different clustering algorithms.

LEACH (Low Energy Adaptive Clustering Hierarchy) is one of the prominent clusters-based structures in wireless sensor network. Conventionally LEACH uses TDMA based MAC protocol for balanced energy consumption, the proposed work by Yang and Sikdar (2007) stated that they applied a sleep-wake up dependent decentralized protocol to LEACH, following that they framed an analytic composition for optimal cluster head selection. Their proposed methodologies for efficient probabilistic evaluations for obtaining appropriate cluster heads in small and large sensor network scenarios.

A mechanism by Ahmed (2008) demonstrated that the cluster head can be elected using decision trees in WSN. In the prescribed methodology, in order to increase the lifetime of the network (Hamzeh *et al*., 2008), the sensor nodes form into distinct clusters with the gateway (Low *et al*., 2007), represented here as high energy nodes called cluster heads (Narwal and Tyagi, 2011). An adaptive method for cluster head selection was described by Nam *et al*. (2008) stated, cluster heads of each cluster involve in reducing the energy consumption and collects the sensing data from the neighborhood sensor node. The data gets aggregated and transmitted to the sink node (base station). According to the proposal, the cluster head selection is based on the reorganization of the clustering and by the consideration the position between the cluster members and the cluster heads in a particular cluster of WSN.

A study describes the cluster head selection based on the fuzzy logic in cluster routing (Hu *et al*., 2009). The cluster head selection methodology defined here was based on random probability model rather than the consideration of distribution of sensor nodes and the enduring energy of sensor nodes. They compared their efficiency with the LEACH algorithm. There was a description about the cluster head selection on the homogeneous wireless sensor network by Koucheryavy and Salim (2009). The concept based on the Voronoi diagram which favors the node deployment in densely distributed networks as better active sensor nodes, cluster heads and routers. Though cluster heads involved in minimizing energy consumption, it is vulnerable to attack and was being as the attractive destiny of attacks (Buttyan and Holczer, 2009). Commencement of private cluster head selection method in this paper avoids the leakage of information about the cluster heads during the cluster head selection process from the attackers.

Overlapping multi-hop clusters are formed for providing efficiency in inter-cluster routing (Youssef *et al*., 2009), node localization and time synchronization protocols in WSN (Youssef *et al*., 2009). It provided a solution for overlapping cluster problem with the parameters such as average overlapping degree and cluster size. The investigation on approximation factor over tight bounds had been left for future work. The life span of wireless sensor network has been increased by assuring the homogenous distribution of sensor nodes in the clusters (Singh *et al*., 2010). In this study, the cluster head selection is based on the residual energy of enduring cluster heads, hold-back value and the hop distance of the nearest sensor node.

Distributed clustering in WSN with energy efficiency, creates hierarchical network architecture over the flat network (Dimokas *et al*., 2010). The cluster formation technique in this proposal is based on the construction of dominating set in a node cluster and energy considerations. It provided a protocol, based on the localized metric for the determination of the value of the sensor node by rebroadcasting. This proposal afforded an efficient energy balancing over the dispersed sensor nodes in WSN. Maximization of network lifespan and denigration of energy dissipation is the major concern for the design of distributed energy efficient clustering protocol (Chamam and Pierre, 2010). The protocol was based on the three-way message exchange every cluster and its one hop neighbor. The protocol design for a multiple transmission range had been departed for future work.

Zone based cluster head selection algorithm explained by Taruna *et al*. (2011) in accordance with the residual energy of the existing cluster heads, hop distance of the nearest nodes. They're demonstrating the evaluation of various network parameters such as energy consumption, network lifespan and number of channel heads in each round. The proposal of this study concentrated on homogeneous WSN and could be further extended with heterogeneous networks. A comparative study about the cluster head selection algorithms was made by Ramesh and Somasundaram (2011). Selection of cluster head on rotation basis greatly impacts the energy efficiency of the network. The parameters they have analyzed are multi hop data forwarding, the distance between the forwarding cluster head and the intermediate cluster head and data gathering.

A novel approach for energy optimization by adaptive clustering had been discussed by Shamroukh *et al.* (2012) based on the minimization of interim among first sensor node death and the last one that efficiently saves the energy. The use of fuzzy logic in clustering minimizes the difficulties in mathematical calculations. Another approach discussed based on the energy efficiency (Sharma *et al.*, 2011) in clusters for wireless sensor network called Energy Efficient Level Based Clustering Protocol (EELBCP) method. Diwakar and Kumar (2012) articulated that efficient utilization of sensor node energy provides prolonged network lifetime. The approach described that the network was partitioned into annular rings based on the various power levels at base station and each ring might have various sensor nodes. As future work, the number of levels maintained in the network can be optimized for efficient energy consumption and increasing network lifetime.

## PROPOSED WORK

In WSN, the sensor nodes to make autonomous decisions without energy efficiency and centralized control. In order to avoid energy dissipation of sensor nodes (Liu, 2012), ACR-LEACH approach is proposed. While considering the clustering in wireless sensor network (Buttyan and Holczer, 2009), it is imperative to elect a cluster head to unicast the data of cluster members. Clustering is an adept methodology for data ensemble in WSN, in which the cluster head is termed as aggregated node performs data accumulated from the received cluster member data. In this affirmed work, efficient method derivation for cluster head election than LEACH with active clustering methods is focused. As is well known from above explanations, Cluster Heads (CH) is obliged only for aggregation process over the received data from the cluster members and transmits that to the base station. When there a case arise that the energy level of the cluster head becomes lower than the cluster nodes energy, the Associate Cluster Head (ACH) takes the charge of cluster heads to perform its functionalities.

The major inducement of this proposal is to optimize the energy consumption of sensor nodes and to maximize the network lifespan. In LEACH methodology, the cluster head will depart earlier than other nodes in the cluster because of its overloading operations sending, receiving and overhearing the data. When this situation occurs, the cluster under the supervision of the above CH becomes ineffective where the gathered data will never reach the sink, thus, the selection of Cluster Head is much more extensive and that should be acquired greater energy than the other nodes of the cluster.

A clustering technique reduces the energy consumption of the nodes by allowing a particular node to communicate with the base station. Furthermore, the bandwidth can be reused for the optimal resource allocation and power control. LEACH approach has recently been used for cluster head election in WSN (Kour and Sharma, 2010). The protocols like LEACH gather the local information of the nodes in order to select the cluster-heads. While electing such clustering-heads by their local information, some drawbacks have occurred. We compare the results of this approach with LEACH methodology.

**Clustering formation procedure:** Formation of clusters in sensor network depends on the time duration for receiving the neighbor nodes message and the residual energy of the neighbor node. Thus, the clustering protocol is divided into rounds where each round is triggered to find the optimal cluster heads for each sensor node in the network. Assume the sensor nodes exchange beacon messages with its neighbor that composed the list of neighbors and its residual energy (Alippi *et al.*, 2009). It is also defined that two nodes do not transmit data in the same time slot in order to reduce the interference.

The time duration of the cluster formation procedure is taken as $T_{CFP}$ which is triggered every network operation time duration and duration of cluster formation termed as rounds for selecting new cluster heads (Yu *et al.*, 2011). Since WSN depends on multi-hop hierarchical network architecture, the hop distance and the hierarchy level play the vital role in the cluster formation procedure.

The cluster formation procedure comprises four phases:

- **Phase 1:** Phase 1 operation involves in gathering the information about the neighbor nodes by broadcasting the beacon messages. Then, the respective nodes collect reply messages from the neighboring sensor nodes for the broadcast beacon messages
- **Phase 2:** In phase 2, a sorting algorithm is executed to obtain the list of neighbor nodes regarding its hop distance. The list of neighbor nodes is enacted in descending order

- **Phase 3:** When its two-hop neighbor node is not enclosed, analyze all the members of phase 2 one-by-one and crown any one two-hop neighbor for being as a candidate for the cluster
- **Phase 4:** Phase 4 operation handles in the execution of sorting algorithm based on the residual energy of the neighbor nodes

Each round of cluster formation procedure operates in all the four phases for effective clustering to provide better communication with the sensor nodes and the data ensemble.

**Active cluster head selection:** Generally, the cluster-head node is elected based on the probabilistic methods, so there possibility of contradiction if two nodes have same probabilistic value. The cluster-head will be selected based on the nodes which are located adjacent to the edges in the networks, by this process other nodes spends a large amount of energy to transmit cluster-head nodes. Another factor 'centrality' in the network also dissipates the measurable amount of energy during the node transmission. Whenever the node is placed central to a network, the other nodes find the energy efficiency to transmit the data. The concentration of the nodes in a given region also affects in some way for proper cluster-head election (Yu *et al*., 2011). It is more reasonable to select a cluster-head in a region, where the node concentration (Liu, 2012) should be high to aggregate the data from the cluster members. The main motive of this approach is to create an active primal approach to group-based selection. This is based on the three parameters namely energy, centrality and concentration. A fuzzy logic system makes real time decisions (Shen *et al*., 2007), provided with the smaller information. Based on the network configurations network lifetime can be calculated by selecting the cluster heads with their information. The node which is selected by the base station is having the more chances to be a cluster-head with three parameters, they are the energy consumption in every nodes and node centrality among every node and minimal energy consumption which increases the lifetime.

In cluster head selection, every node in the network with high residual energy becomes the cluster head (Ta *et al*., 2007) with same probability P which is the predefined threshold value. The rest of the nodes in the network will be under sleeping state (Chengfa *et al*., 2005), till the cluster head selection process terminates. Suppose $H_i$ be the tentative cluster head that has the contention range $R_{con}$ function. There is another condition that, if $H_i$ is the cluster head, then there should not be any other cluster head $H_j$ within the range of $R_{con}$.

**Step 1:** $\mu \leftarrow$ RAND (0,1)
**Step 2:** if $\mu < T$, then
**Step 3:** be TentativeHead $\leftarrow$ TRUE
**Step 4:** end if
**Step 5:** if be TentativeHead = TRUE, then
**Step 6:** Intactheadmsg (ID; $R_{con}$; $R_{Energy}$)
**Step 7:** Else
**Step 8:** EXIT
**Step 9:** End if
**Step 10:** On receiving a INTACT-HEAD-MSG form node $H_j$
**Step 11:** If $d(H_i, H_j) < H_j, R_{con}$ OR $d(H_i, H_j) < H_i, R_{con}$, then
**Step 12:** Add $H_j$ to $H_i.S_{CH}$
**Step 13:** End if
**Step 14:** While be TentativeHead = TRUE do
**Step 15:** If $H_i.R_{Energy} > H_j.R_{Energy}, \forall H_j \in H_i.S_{CH}$ then
**Step 16:** FinalHeadMSG (ID) and then EXIT
**Step 17:** End if
**Step 18:** On receiving a FINALHEADMSG from node $H_j$
**Step 19:** If $H_j \in H_i.S_{CH}$ then
**Step 20:** DepartElectionMsg (ID) and then EXIT
**Step 21:** End if
**Step 22:** On receiving a DepartElectionMsg from node $H_j$
**Step 23:** If $H_j \in H_i.S_{CH}$ then
**Step 24:** Remove $H_j$ from $H_i.S_{CH}$
**Step 25:** End if
**Step 26:** End while

Fig. 2: Pseudocode for cluster head selection

The cluster head selection process is ultimately based on the energy level of each node in the cluster which is performed on the basis of rounds. Figure 2 demonstrates the pseudo code for the operation performed with cluster head selection. Each sensor node will be analyzed for its energy level ($\mu$) for all the randomly distributed nodes present in the network, ranges from 0-1. Each $H_i$ broadcasts an intact-head-MSG with contention radius and the residual energy. Each tentative cluster head upholds a set $S_{CH}$ of its neighborhood tentative cluster heads which is being constructed by the steps 10-13 of the pseudo code. The steps 14-26 involves in the determination of a cluster head with high residual energy ($R_{Energy}$) for the particular contention range. The cluster head is selected in accordance with the distance between the contention nodes and the base station. Once the cluster head is selected, the corresponding node broadcasts the final-head-msg to all the contention nodes. Then, the sleeping nodes wake up and each cluster head sends CH-ADV-MSG to all distributed nodes in the network. Each prevailing node joins with the closest cluster head by the largest received signal strength and acquaints the cluster head by join-cluster-MSG. The approach has come from the MIT's $\mu$-AMPS process which develops an energy optimized solution for wireless sensor network architecture and protocol when the location of the base station is far away from the sensor nodes. It also involves in effective local data correlation for all energy constrained sensor nodes. In this approach the communication energy for the sensor nodes and the base station is cost higher and so it is complex for the sensor nodes to gather their data and resend to the base stations. If the selection of the cluster-heads is non dynamic then the selected nodes will lose its power and eliminate quickly. Priorities are given to data aggregation and data fusion technique rather than the electing the cluster-heads. The main approach of this algorithm is to reduce the unwanted noises and exhibits the optimal signals. A cluster-heads need regular energy distribution over the networks.

**Data ensemble in cluster based wireless sensor network:** Data Ensemble is defined as the methodical accumulation of sensed data from multiple sensor nodes to be transmitted eventually to the base station for refinement. Since sensor nodes in WSN are energy constrained, it is inept for all the sensors to handle on the data directly to the base station. Data generated from neighboring sensor nodes are often superfluous and highly correlated. In addition, the amount of data produced in large sensor networks is usually massive for the base station to process. Hence, there is a need for techniques aggregate the data into high-quality information on the sensors or transiting nodes which can condense the number of packets channeled to the base station and ensuing in conservation of energy and bandwidth. This can be consummated by data ensemble which tends to the elimination of redundant data transmission. There are so many methods defined for data ensemble based on network topology, network flow and the quality of services. In cluster based WSN, the data from various sensor nodes are aggregated by the local aggregator called cluster heads and transmitted to the base station. There are some distinct protocols for data aggregation in cloud based wireless sensor networks such as LEACH, E-LEACH (Energy LEACH), TL-LEACH (Two Level-LEACH), M-LEACH (Multi hop-LEACH), LEACH-C (LEACH with centralized Algorithm), V-LEACH (Vice-LEACH) and chain based data aggregation.

In this ACR-LEACH model, the chain based data aggregation in hierarchical network setup, bonding with LEACH, in order to provide efficient results is followed. Sensor nodes of WSN transmit data to the cluster head where data ensemble has been performed. However, if the cluster head is far away from the sensors, they may disburse indulgent energy in dissemination. Further improvements in energy efficiency can be obtained if sensors transmit only to close neighbors. In PEGASIS (Power Efficient Data gathering protocol for Sensor Information Systems), nodes are linearly ordered to form chain to perform efficient data gathering. The farthest sensor node from the base station commences chain formation and at each step whereas the contiguous neighbor of a node is selected as its successor in the chain structure. In each data congregation round, a node acquires data from one of its neighbors, combines the data with its own and transmits the combined data to its other neighbor node along the chain.

**Base station control algorithm:** The base station is the one which has the overall knowledge of the network; we use the primal authority algorithm in the base station which elects the optimal cluster-heads of cluster members. Obviously Base stations will be having more memory, energy and storage than that of the sensor nodes. Energy is consumed in order to bring the local knowledge about the nodes to the base. Wireless Sensor Networks are distributed over the geographical area for sensing the gathering knowledge. Let us have an assumption that nodes having minimum mobility and sends the local information on the initial phase is sufficient. The cluster-head is the node that is responsible for high energy transmission to the base station, if the cluster-head is elected as a static one then all the powers would be exhausted rapidly. In our approach, the cluster-head election is done with rotation based algorithm with their probabilistic values. Hence, all the nodes are getting chances based on their probabilistic values and then the cluster-heads are elected. The centrality has been calculated by summing the square of the distance of other nodes from the given node for electing suitable cluster-head. The main motto of the approach is how the different argument nodes affect the election criterion to conserve energy.

Then we use the primal control algorithm inside the base. The base has enough storage, power and memory which outperforms the resource constrained problem in the local node clustering. Base station elects the cluster-heads based on three parameters namely, energy, concentration and centrality. Our approach based on dynamic centralized domain that overcomes the complexity of the mathematical model. With the help of the three parameters and joining the rules dynamic centralized approach produces the optimal results. The energy alone makes the cluster-head node to form the cluster centrality which gives the minimal energy consumptions. By the experimental results, the centrality level and the efficient energy consumption of our ACR-LEACH method is obtained.

## SIMULATION RESULTS

The affirmed work is compared with the results produced by LEACH methodology to assess the efficiency of ACR-LEACH methodology using NS2 simulations. In this simulation, research model performed on 100 nodes which are arbitrarily deployed and dispersed in a 100×100 $m^2$ area. Sensor nodes restrain two kinds namely, sink nodes with no energy constraints and the common sensor nodes with limited energy.

The simulation results are analyzed and compared to LEACH with the parameters such as throughput, variance of energy, energy consumption, average energy utilization, End to end delay and Packet Delivery Ratio (PDR).

Table 1 shows the simulation parameters that have taken for producing simulation results for ACR-LEACH approach. Here, the sensor nodes are randomly distributed with initial node energy as 2 J. The location of the Base Station (BS) is assumed as (110, 45) and when the energy of the node becomes less than or equal to 0, the node is considered as the dead node. With these parameters simulation results are produced.

Table 2 reveals the comparison between the results of LEACH and ACR-LEACH methodologies with quality analysis metrics. It is obvious from the results that the proposed method is more efficient than the existing. Figure 3 exemplifies the correlation between simulation time (milliseconds) and throughput (Mbps). From the pictorial representation, it is apparent that our proposed ACR-LEACH model produces higher throughput than the LEACH clustering model. Our adduced method provides improved rate of effective message delivery through the communication channel than the comparison mechanism.

In order to provide evidence of this proposed methodology that it is designed by the consideration of energy efficient mechanisms, the simulation result in Fig. 4 demonstrates the relationship between simulation time and variance of energy (n J) for the existing LEACH and ACR-LEACH methods. The graphical representation of Fig. 5 illustrates that our affirmed methodology consumes less energy than LEACH approach since the eminent conceits of clustering models and cluster head selection is used. The main concern of this proposal is to afford a method for optimal energy consumption in wireless sensor network using energy efficient cluster selection mechanism. The above mentioned result shows that the average energy utilization is considerably reduced in this approach by the trasmission of data done with cluster heads.

Table 1: Simulation parameters

| Parameters | Values |
|---|---|
| Network size | (100×100 m) |
| Node distribution | Random |
| Initial energy | 2 J |
| BS position | (110,45) |
| No. of sensor nodes | 100 |

Table 2: Comparison-LEACH and ACR-LEACH

| Metrics | LEACH | ACR-LEACH |
|---|---|---|
| Total remained energy | 391.963900 | 563.989400 |
| Average | 39.196390 | 56.398940 |
| Energy difference | 30.697080 | 10.234750 |
| Packet delivery ratio | 69.321660 | 83.870970 |
| Average end2end delay | 5.832408 | 2.912155 |
| Average No. of hops | 9.961538 | 8.961538 |
| Control packet overhead | 531.000000 | 382.000000 |
| Throughput | 28.432480 | 32.355120 |
| Data packets sent | 31.000000 | 31.000000 |
| Data packets received | 15.000000 | 26.000000 |
| Simulation end time | 48.214940 | 48.214940 |
| Total delivery time | 53.896210 | 75.716020 |
| Total No. of hops | 148.000000 | 233.000000 |
| Dropped reply messages | 15.000000 | 4.000000 |
| Maximum No. of hops | 38.000000 | 33.000000 |
| Minimum No. of hops | 10.000000 | 8.000000 |

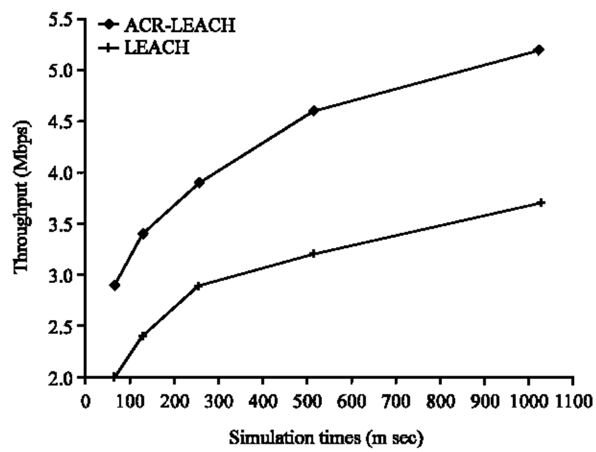


Fig. 3: Simulation time (m sec) vs throughput (Mbps)

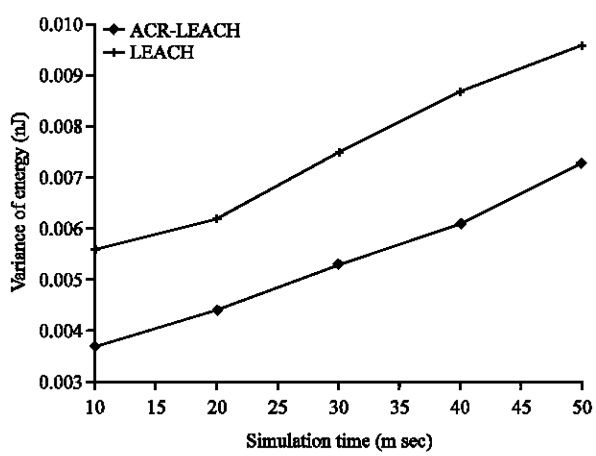


Fig. 4: Simulation time (m sec) vs variance of energy (nJ)

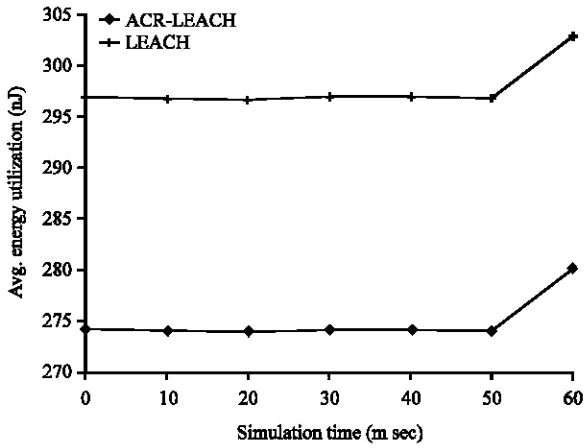


Fig. 5: Simulation time (m sec) vs avg energy utilization (nJ)

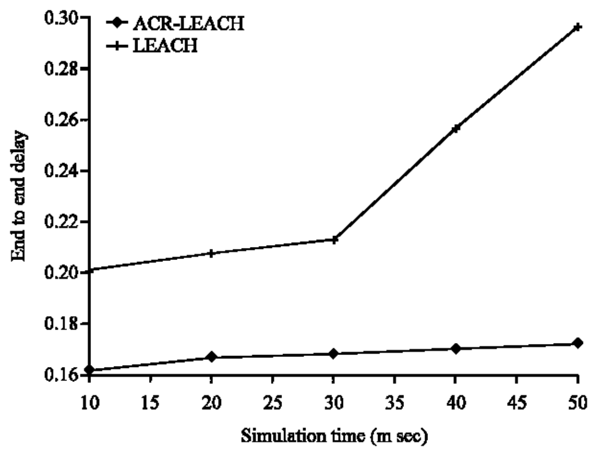


Fig. 6: Simulation time (m sec) vs end to end delay (m sec)

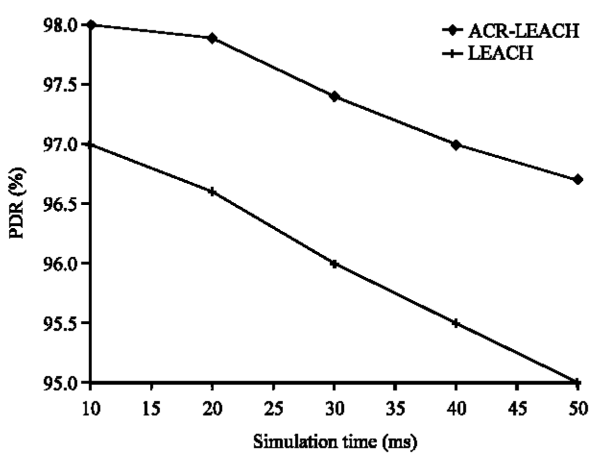


Fig. 7: Simulation time (m sec) vs PDR (%)

In accession to the optimal energy consumption, this approach provides minimized end to end delay. Figure 6 demonstrates the alliance between the simulation time and end to end delay which provides an evidence for the consistency of this proposed work.

The average time delay to transmit the packets to sink node or to the BS is termed as end-end delay which is significantly reduced in the adduced work than the existing LEACH.

PDR in WSN is described as the ratio between the numbers of receiving data packets to the number of generating data packets by sensor nodes. Figure 7 presented below evinces the relation between the simulation time and the packet delivery ratio that determines the accuracy and reliability of the communication between the sensor nodes in wireless sensor network. The simulation result provided beneath exhibits that PDR% of ACR-LEACH is greater than the LEACH results. Thus, this method produces results with higher precision rate. The Active clustering rule for LEACH contributes an innovative method for energy efficient cluster head selection with concentration and the centrality and data aggregation.

## CONCLUSION

In this study, we developed a distinctive approach called Active Clustering Rule for LEACH. It is extensively focused on energy efficient cluster head selection by the deliberation of the parameters such as concentration and centrality. With this proposal, the work towards framing clusters and outperforms the results of LEACH model. It also educe data ensemble in cluster heads for optimal energy consumption and to increase the network longevity. The base station control algorithm of this proposal reduces the complexity over mathematical calculations made for random cluster head selection of the densely distributed wireless sensor network. This study can be enhanced by designing a cluster model with both energy and power saving mechanisms. As for future work, it is intended to extend this proposal with cyclic vague-off and vague-on of the operations accomplished by sensor nodes that could save the power and energy in an adept manner.

## REFERENCES

Ahmed, G., 2008. Cluster head selection using decision trees for wireless sensor networks. Proceedings of the International Conference on Intelligent Sensors, Sensor Networks and Information Processing, December 15-18, 2008, Sydney, NSW, pp: 173-178.

Ahmed, G., N.M. Khan and R. Ramer, 2008. Cluster head selection using evolutionary computing in wireless sensor networks. Proceedings of the PIERS, March 24-28, 2008, China, pp: 883-886.

Al-Karaki, J.N. and A.E. Kamal, 2004. Routing techniques in wireless sensor networks: A survey. IEEE Wireless Commun., 11: 6-28.

Alippi, C., G. Anastasi, M. Di Francesco and M. Roveri, 2009. Energy management in wireless sensor networks with energy-hungry sensors. Instrumen. Measur. Mag., 12: 16-23.

Buttyan, L. and T. Holczer, 2009. Private cluster head election in wireless sensor networks. Proceedings of the 6th International Conference on Mobile Adhoc and Sensor Systems, October 12-15, 2009, Macau, pp: 1048-1053.

Chamam, A. and S. Pierre, 2010. A distributed energy-efficient clustering protocol for wireless sensor networks. Comput. Electr. Eng., 36: 303-312.

Chengfa, L., Y. Mao, C. Guihai and W. Jie, 2005. An energy-efficient unequal clustering mechanism for wireless sensor networks. Proceedings of the International Conference on Mobile Adhoc and Sensor Systems Conference, November 7, 2005, Washington, DC., pp: 599-604.

Dimokas, N., D. Katsaros and Y. Manolopoulos, 2010. Energy-efficient distributed clustering in wireless sensor networks. J. Parallel Distrib. Comput., 70: 371-383.

Diwakar, M. and S. Kumar, 2012. An energy efficient level based clustering routing protocol for wireless sensor networks. Int. J. Adv. Smart Sensor Network Syst., 2: 55-65.

Gupta, G. and M. Younis, 2003. Fault tolerant clustering of wireless sensor networks. Proceedings of the Wireless Communications and Networking Conference, Volume 3, March 20, 2003, New Orleans, LA., USA., pp: 1579-1584.

Gupta, I., D. Riordan and S. Sampalli, 2005. Cluster-head election using fuzzy logic for wireless sensor networks. Proceedings of the 3rd Annual Communication Networks and Services Research Conference, May 16-18, 2005, IEEE., pp: 255-260.

Hamzeh, M., S. Arab, S.M. Fakhraie and C Lucas, 2008. An improvement on leach algorithm with a fuzzy processor. Proceedings of the Communications Society Asia-Pacific Conference on Communications, October 14-16, 2008, Tokyo, pp: 1-5.

Hesong, H. and W. Jie, 2005. A probabilistic clustering algorithm in wireless sensor networks. Proceedings of the Vehicular Technology Conference, Volume 3, September 25-28, 2005, IEEE., pp: 1796-1798.

Hu, Y., X. Shen and Z. Kang, 2009. Energy-efficient cluster head selection in clustering routing for wireless sensor networks. Proceedings of the 5th International Conference Wireless Communications, Networking and Mobile Computing, September 24-26, 2009, Beijing, pp: 1-4.

Katiyar, V., N. Chand and S. Soni, 2011. A survey on clustering algorithms for heterogeneous wireless sensor networks. Int. J. Adv. Network. Applic., 2: 745-754.

Koucheryavy, A. and A. Salim, 2009. Cluster head selection for homogeneous wireless sensor networks. Proceedings of the 11th International Conference on Advanced Communication Technology, Volume 3, February 15-18, 2009, Phoenix Park, pp: 2141-2146.

Kour, H. and A.K. Sharma, 2010. Hybrid energy efficient distributed protocol for heterogeneous wireless sensor network. Int. J. Comput. Appl.., 4: 1-5.

Liu, X.X., 2012. A survey on clustering routing protocols in wireless sensor networks. Sensors, 12: 11113-11153.

Low, C.P., C. Fang, J.M. Ng and Y.H. Ang, 2007. Load-balanced clustering algorithms for wireless sensor networks. Proceedings of the International Conference on Communications, June 24-28, 2007, Glasgow, pp: 3485-3490.

Maraiya, K., K. Kant and N. Gupta, 2011. Efficient cluster head selection scheme for data aggregation in wireless sensor network. Int. J. Comput. Applic., 23: 10-18.

Nam, C.H., H.J. Jeong and D.R. Shin, 2008. The adaptive cluster head selection in wireless sensor networks. Proceedings of the International Workshop on Semantic Computing and Applications, July 10-11, 2008, Incheon, pp: 147-149.

Narwal, P. and S.S. Tyagi, 2011. Density based protocol for head selection in wireless sensor networks. Int. J. Soft Comput. Engin., 1: 42-46.

Patwari, N., J.N. Ash, S. Kyperountas, A.O. Hero, R.L. Moses and N.S. Correal, 2005. Locating the nodes: Cooperative localization in wireless sensor networks. IEEE Signal Process. Mag., 22: 54-69.

Ramesh, K. and K. Somasundaram, 2011. A comparative study of clusterhead selection algorithms in wireless sensor networks. Int. J. Comput. Sci. Engin. Survey, 2: 151-165.

Shamroukh, R.M., A.A. Aladwan and A.A. Aladwan, 2012. A novel approach for energy optimization of wireless sensors network by adaptive clustering. World Comput. Sci. Info. Technol. J., 2: 74-78.

Sharma, A., K. Shinghal, N. Srivastava and R. Singh, 2011. Energy management for wireless sensor network nodes. Int. J. Adv. Engin. Technol., 1: 7-13.

Shen, S., G.M.P. O'Hare and M.J. O'grady, 2007. Fuzzy decision making through energy-aware and utility agents within wireless sensor networks. Artificial Intelli. Rev., 27: 165-187.

Singh, S.K., M.P. Singh and D.K. Singh, 2010. Energy efficient homogenous clustering algorithm for wireless sensor networks. Int. J. Wireless Mobile Networks, 2: 49-61.

Ta, X., G. Mao and B.D.O. Anderson, 2007. Evaluation of the probability of k-hop connection in homogeneous wireless sensor networks. Proceedings of the GLOBECOM, November 26-30, 2007, Washington, DC., pp: 1279-1284.

Taruna, S., J.K. Lata and G.N. Purohit, 2011. Zone based routing protocol for homogeneous wireless sensor network Int. J. Ad hoc, Sensor Ubiquitous Comput., 2: 99-111.

Tufail, A., 2012. Reliable latency aware routing for clustered WSNs. Int. J. Distri. Sensor Networks, 10.1155/2012/681273

Wang, Y. and B. Ramamurthy, 2007. Layered clustering communication protocol for wireless sensor networks. Proceedings of the International Conference on Computer Communications and Networks, August 13-16, 2007, Honolulu, HI., pp: 844-849.

Yang, H. and B. Sikdar, 2007. Optimal cluster head selection in the LEACH architecture. Proceedings of the International Performance, Computing and Communications Conference, April 11-13, 2007, New Orleans, LA., pp: 93-100.

Youssef, M., A. Youssef and M.F. Younis, 2009. Overlapping multihop clustering for wireless sensor networks. IEEE Trans. Parallel Distrib. Syst., 20: 1844-1856.

Yu, Z., X. Fu, Y. Cai and M.C. Vuran, 2011. A reliable energy-efficient multi-level routing algorithm for wireless sensor networks using Fuzzy Petri Nets. Sensors, 11: 3381-3400.