International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 06 | June 2020 www.irjet.net p-ISSN: 2395-0072

A Survey Paper on Various Energy Efficient Clustering Algorithms in Wireless Sensor Networking

Sharvari Gaikwad[1], Saurabh Ghewande[2], Uday Kale[3], Rushikesh Sumbe[4]

[1,2,3,4] *Student, Department of Computer Science and Engineering, PCCOE, Pune, India*

Abstract - *Wireless Sensor Network (WSN) is the next big thing the world has to adapt. It is composed of finite set of sensing devices, geographically distributed in a given indoor or outdoor environment which aims to gather the environmental data. Here sensed information is transmitted via wireless media. Consisting of cluster heads, base station and non-cluster heads. These sensors are battery driven and hence subjected to power loss and energy drainage. Therefore, energy saving' is the most important in task of WSN operations. The sensor nodes are un-rechargeable, so it leads to an issue regarding lifetime of the network. As per the Communication Technology, most of the energy is consumed by transmission of energy followed by processing and then sensing. In this paper we have presented various Clustering approaches and Routing protocols that can optimize the wireless sensor network (WSN).*

Key Words: **Wireless sensor networking, cluster head, clustering, energy**

1. INTRODUCTION

Traditionally down the ages, energy *'Consumption vs Conservation'* has been a highly alarming issue. Recent advances in wireless communications, networking, electronics and microprocessors have enabled the development of low-cost, low-power wireless-sensor nodes that are small in size and can communicate over short distances. Each of the sensors in WSN contains a Battery for power, Transmitter for transmitting the information and Receiver for receiving the information. Energy consumption can be reduced by using proper cluster-management techniques and routing protocol. Clustering techniques includes hierarchical clustering for heterogeneous nodes, maintaining cluster size, hot-spot problem elimination etc. while Routing deals with single hop, multi- hop network transmission, multi-path selection, probabilistic approaches and inter-clustering routing. LEACH (Low-Energy Adaptive Clustering Hierarchy) and DSP (Dynamic Source Routing) protocols are widely used in Clustering and routing respectively.

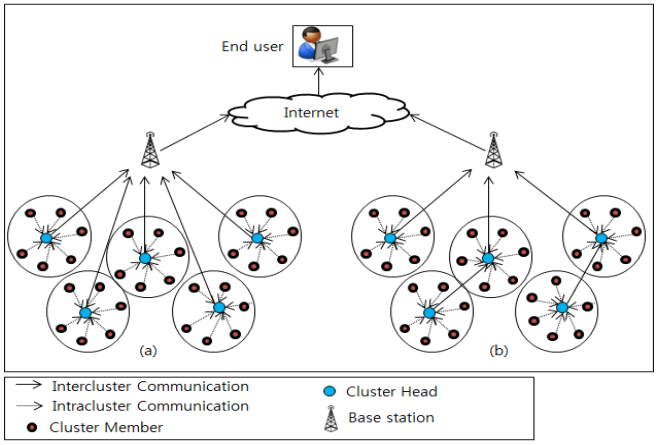

Fig-1: Basic architecture of WSN

RELATED WORKS:

Based on LEACH protocol called as LEACH-TLCH. Due to randomness of the clusters forming the new algorithm proposed. This algorithm based on LEACH, where the process of cluster-head selection and cluster formation is same as LEACH protocol. Selection of the cluster is based on the threshold value. A secondary Cluster head (SCH) is elected in the same cluster. Cluster divided into two categories cluster with secondary cluster head and cluster without secondary cluster head. Path for data transmission: Receive Data from Sensor node and pass to SCH -> Data Fusion-> Send to CH-> Sent to BS by single-hop method. Effective lifecycle of the improved algorithm is 9% longer than LEACH. Stable period of lifecycle increases 15% than LEACH. The energy efficiency and the lifetime of network are better than LEACH protocol.

EDCH(Effective Distance Cluster Heads)-a clustering algorithm which is described in the two phases-EDCH1 and EDCH2.

EDCH1: Focused on the formation of clusters of equal size so that the energy not wasted. After election of first cluster head follows usual LEACH procedure. Divides of the cluster into smaller cluster with each small cluster having cluster head.

EDCH2: Derived a formula for selection of the Cluster head. So that more number of sensor nodes

having the probability to be CH.

T'(n)=T(n)+(1-T(n)) x f , where 1. T'(n) is novel threshold value 2. T(n) is basic formula in LEACH to calculate threshold value. 3. F is constant. This formula is used to calculate threshold value in every round. The result shows that using optimum value of f EDCH2 shows the improvement to reduce energy utilization and hence increase network lifetime. Compared with LEACH, EDCH1 shows up to 5.6% development in saving energy and up to 7.25% in extend network life. Compared with LEACH, EDCH2 shows up to 13.01% development in saving energy and up to 30.01% in extend network life.

A two stage energy proficient balanced clustering method. Here they consider parameters such as residual energy, intra-cluster cost, inter cluster cost, communication distance. Protocol composed of two stages: 1. Cluster formation : Cluster formation and CH selection is done by k-means algorithm 2. Load Balancing : phase inter and intra cluster cost and communication distance is considered. Used Omnet++ simulator for simulation. Offered good load balancing within the network. Network life time increases. Future work: Network life time decreases as nodes increases.

A strategy for the data transmission to efficiently extend the network life time using the same energy.

a) Cluster selection methods:

- Method 1: We select the node that has the minimum of means of distances to all other nodes belongs to the cluster as cluster head.
- Method 2: We select the node that has the minimum of maximum distance from all nodes as cluster head.

b) Transmission Strategy :

The transmission strategy is proceeds by the CH election process and the classification of nodes into active nodes and sleeping nodes. The transmission strategy uses either cooperative or non-cooperative scheme. The first step consists of calculating the necessary transmit power to transmit data via non-cooperative scheme. They apply the relay selection algorithm based on Dijkstra's algorithm to select the set of relays that cooperate to retransmit data from the source node to the CH node with the minimum transmit power. Here they proposed new energy saving algorithm using on Dijkstra's algorithm. It is applied to a clustered WSN where each node belongs to the closest cluster according to their distance to the cluster center. Energy consumption is reduced using this strategy for both methods of CH selection. This strategy increases the rate of saved energy. The new transmission strategy saves more energy than previous techniques (it can reach up to 90%).

The main focus is on the two Parameters that are a. Average communication distance and b. Lingering energy. Average communication distance is the distance from central to I th node. For selection of CH following formula is used:

ACD=sum of distance of ith node(Di)/n,
where n is number of nodes

In the above formula, Di is the distance to I th node and n is number of nodes. Another method is Lingering energy which is also called as residual energy. On the basis of lingering energy, Cluster head is selected.

Lingering Energy: Residual Energy
=Etx(k,d)=kEelec+k*epsilon*d^2

Here in this paper, there are two modes are applied in the algorithm. If first mode is applied i.e. ACD, then ACD is calculated according to formula. If ACD of node is less than other then it is considered as CH. Cluster is formed on the basis of distance from that CH.
Threshold Distance = under root of epsilon Fs / epsilon mp

The FND (First Node Die) and LND (Last Node Die) ratio is better than LEACH and SEECH. CUDP (Complete useful Data percentage) is higher LEACH and SEECH. Time simulation is good.

Heterogeneous network is considered. The parameters used are residual energy, transmission range, number of transmission. In this method, first transmission energy, Consumption rate, Delay is calculated.

Delay= (E(i)-E(r)/E(i)+x)*RTD

From the above formula, delay of node is calculated. E(r) is the residual energy.

On the basis of delay, Node which has low delay is consider as CH. After that nodes which are closest to CH, Cluster is formed of that nodes.

Energy Consumption Rate= E(i)-E(r)/CR-1

Energy consumption rate over other protocol is uniform. FND is more than LEACH. Uniform network. Time taken to reach the packet is less

Two phases : Initial and Rescue phase. Distance parameter use for cluster formation. Th (cluster) is calculated by using formula=N/X, where N is active nodes and X is the number of CH nodes. Now in first phase i.e. in initial phase Th defines the number of member nodes in each cluster. In second phase i.e. in rescue phase nodes join the possible cluster. For this Th formula is used. By using Th formula first limit is calculated and then cluster members are decided to follow the cluster. Nodes will join the nearest cluster head if the rescue phase condition is not satisfied.

Threshold T(n)= P(opt)/1-P(opt)*(rMod /P(opt))
General formula for calculating the nodes in cluster defined by formula N/X.

Total cluster Distance=Σ i=1 to x Σ j=1 to n Dist (j,i)
Number of active nodes are more. Improved lifetime of network. Balanced load over LEACH.

The technique uses, a particular message is sent to nodes and according to that after getting message each node update its neighbouring table.(Update the neighbour's routing table with the help of message broadcasting). Various parameters like energy consumption, delay, transmission, etc. are stored in matrices. These metrics are then compared and the matrix which contains higher residual energy considered as a cluster head. The nearest members form particular cluster. First, message is sent by server to members. A CH is selected among them. By distance parameter, a cluster is formed with their CH. If cluster head is selected, then INVITE message is sent to other members in cluster. After participating in cluster, members send ADHESION message to Cluster head. Means they are now members of that cluster head. More efficient than LEACH, CHEATS, EEUC. Reduce the energy consumption. Spend much lower energy in every round as compared to other protocols. Threshold energy concept use for selecting cluster head and Distance parameter used for cluster formation. Setup and steady phase are described. In Setup phase clusters are formed. In steady phase, Cluster and members are selected. TDMA mechanism is used to communicate with nodes.

Threshold T(n)= P(opt)/1-P(opt)*(rMod1/P(opt))
Sending l-bit data packet:

Energy consumption (l,d)
=E (tx) (elec)(l)+E (tx) amp (l,d)
=l*E (elec)+l*epsilon (fs) *d^2 d<d0
=l*E (elec) +l *epsilon (amp)*d^4 d>=d0
Epsilon (fs) and epsilon (amp) are consumption of amplifying radio. 'd' is the propagation distance, E(elec) represents energy consumption, epsilon Fs and epsilon(amp) represents the energy consumption of amplifying ratio. Residual energy and distance are main factors of ICT2TSK protocols. Active nodes alive ratio is higher. More efficient than LEACH. Prolong lifetime of network.

Extended version of LEACH. Time management concept is used. A particular area is taken and divide it. Suppose area is 100*100, then area is divided into 10*10m. Cluster is formed with equal residual energy. If area is of size 10*10 then each cluster will contain 20 nodes at-least. If any cluster contain less than 20 node then it will request the other cluster which has more than 20 nodes. Then it will share its member with other that has less member. Now process flow is as:-Initially the node with higher residual energy, consider as a cluster head. After every 60sec new cluster head is selected. On 50th sec CH check routing table and node which has highest energy selected as CH. On 56th sec, new node become CH. Cluster is formed according to size of area. Energy consumption is uniform. No effect of unbalanced cluster on consumption energy.

TEEN is designed for applications where data is sent to the base station when a specific event occurs. Advantages of this protocol are that Reducing the number of transmissions to the BS(Base Station) so that the approach is more energy- efficient. Data-centric nature of TEEN makes it suitable for time-concerned applications in which a quick response from the network is urgent for user. Disadvantages: Some nodes may die while the user is not aware of their death because it does not receive feedback. Defining the exact value of the thresholds according to the application is not very easy. Not suitable for the applications in which a periodical feedback from the region is needed, like the monitoring of a forest.

Uses a random method for CH selection, each node produces a probability p, based on which announces itself as a CH within its cluster range. This announcement is forwarded to all the nodes within the

range of k hops from the CH. Then each node sends a request to all the CHs from which it has received the announcement. KOCA, which tries to solve the overlapping clustering problem.

Methodology used:
1. Calculating the number of neighbors
2. CH election
3. Cluster formation
4. Determining TDMA schedules

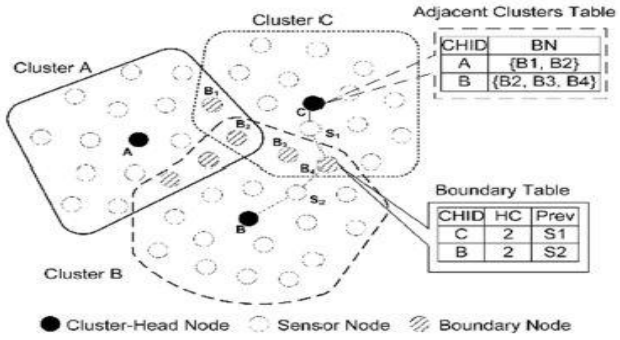

Fig -2: Clusters along Clusters table

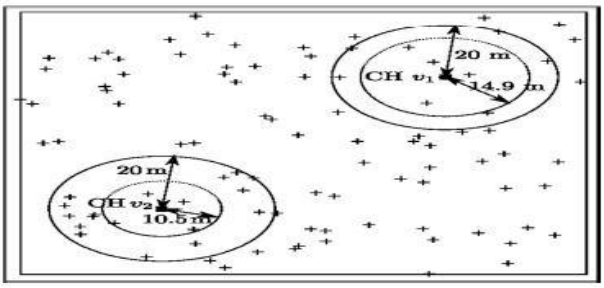

Fig-3: Area of cluster w.r.t CH

Cluster head selection- hybrid combination of residual energy (primary) and communication cost (secondary) such as node proximity Number of rounds of iterations taken into consideration. Tentative CH(Cluster Heads) are formed. Final CH until CHprob=1. Disadvantages: Repeated iterations, Complex algorithm, Decrease of residual energy. Smaller probability-number of iterations increased.

Updated form of SEP(stable election process) where CH nodes are selected upon residual energy Er and distance parameter. They have formulated new selection criterion on four layered energy model consisting normal cluster heads, advanced cluster head, super cluster head and ultra-super cluster heads. In SEP they are:

$$P_{adv} = \frac{p_i(1+\alpha)}{1+\alpha m}$$

$$P_{nrm} = \frac{p_i}{1+\alpha m}.$$

Using P: probability of selecting advanced nodes and P-nrm : probability of selecting normal node as CH. Here alpha is constant and m is related to round number. In E-BEENISH algorithm they have added more parameter i.e. distance.

In DEEC algorithm :

$$p_i = \begin{cases} \dfrac{p_i E_i(r)}{(1+h\cdot\alpha\cdot(h_0\,\beta))\,E_{avel}} & s_i \text{ is normal node} \\ \dfrac{p_i\cdot(1+\alpha)E_i(r)}{1+h\cdot\alpha\cdot(h_0\,\beta))\,E_{avel}} & s_i \text{ is advanced node} \\ \dfrac{p_i\cdot(1+\beta)E_i(r)}{1+h\cdot\alpha\cdot(h_0\,\beta))\,E_{avel}} & s_i \text{ is super node} \end{cases}$$

while in E-BEENISH algorithm they have added more parameters and one extra layer i.e. ultra-super CH nodes.

$$p_i = \begin{cases} \dfrac{p_i E_i}{\left(1+m\left(\alpha+m_0\left(-\alpha+b+m_1\left(-b+c\right)\right)\right)\right)E_{ave}} & s_i \text{ is normal node} \\ \dfrac{p_i\cdot(1+\alpha)E_i}{\left(1+m\left(\alpha+m_0\left(-\alpha+b+m_1\left(-b+c\right)\right)\right)\right)E_{ave}} & s_i \text{ is advanced node} \\ \dfrac{p_i\cdot(1+b)E_i}{\left(1+m\left(\alpha+m_0\left(-\alpha+b+m_1\left(-b+c\right)\right)\right)\right)E_{ave}} & s_i \text{ is super node} \\ \dfrac{p_i\cdot(1+c)E_i}{\left(1+m\left(\alpha+m_0\left(-\alpha+b+m_1\left(-b+c\right)\right)\right)\right)E_{ave}} & s_i \text{ is ultra-super node} \end{cases}$$

Advancement of DEEC protocol where traffic factor is considered. When there is lot of traffic over a CH node then there will be more energy drainage rate than expected hence leading to dead link eventually failure of network hence in this protocol as DEEC they are using probabilistic approach to find threshold energy and comparing Eth with probabilistic values from path of every NCH. Here considering nodes to be of

heterogeneous energy levels and E0 be the lower bound and E0(1+alphathi) be the upper bound of i'th node then total energy of network can be calculated by summing the every nodes value which is Etot . Eavg value is determined for every round. Probability of NCH to become CH is determined by following formulae:

$$p_i(r) = \frac{p_{opt}.N\left(1+\alpha_{eh_i}\right) N(1+\alpha_{th}-\alpha_{eh_i})E_i(r)}{\left(N+\sum_{i=1}^{N}\alpha_{eh_i}\right)(N+N\alpha_{th}-\alpha_{Tot})E_{Avg}(r)}$$

Routing protocol in which sensing node floods the neighboring node with route request message (RREQ). Similarly neighboring node also floods it neighbors with RREQ this process is followed till there is destination is achieved or already RREQ is sent. This message is passed to one by one nodes. If node is having sufficient energy then it adds its own id to data packet and send to next node. Once the RREQ reaches the destination, Destination selects the best path from given solutions and reply back with RREP message. IF there is any conflict between two path the average energy of path is considered to select the path. If any intermediate node is dead then RERR message is sent to source so that the node is avoided. This performs good but transmission delay is more and can consume more energy in case of redundancy and dense network.

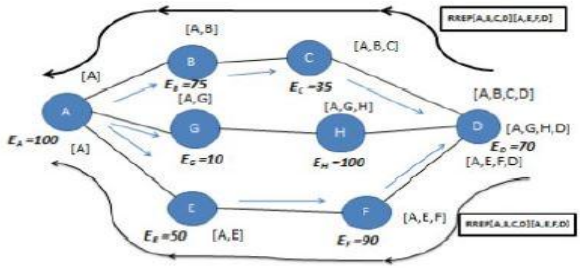

Fig- 4: Find path to transfer data within cluster

It is similar to the FTEERP but here they considering the energy level of intermediate path with the distance from source to destination for example let P and Q are source and destination . If there exits to solution for intermediate transmission path for packet transfer. Selection of solution is dependent on E1D2=E2D1 where E1 is total energy of nodes in path no 1and D1 is distance in path1, similarly for E2 and D2.

An improved ant colony optimization algorithm,

- Step 1: Divide the TSP problem into several sub-problems, and each sub-problem corresponds to one subpopulation.
- Step 2: Initialize the parameters of the ICMPACO algorithm. These parameters include the number of ants (k), pheromone amount (Q), the maximum number of iterations (T), the parameter (α and β), volatility coefficient (ρ), etc. with WSN parameters include energy of path , energy drainage rate.
- Step 3: Randomly select the initial position for each ant. i.e. that of sensed node.
- Step 4: Each sub-population independently execute the search process. The transition probability of the next state is calculated according.
- Step 5: Locally update the pheromone concentration of the passed path of ants in each subpopulation.
- Step 6: Locally update the pheromone concentration of the adjacent path according to the pheromone diffusion mechanism for each subpopulation.
- Step 7: Globally update the pheromone concentration for each passed path.
- Step 8: If each ant executes Step 4 - Step 7 in this iteration, then continue to execute next step, otherwise go to Step 4.
- Step 9: Determine whether the maximum number of iterations (T) is achieved or the obtained solution has met the requirement. If this end condition does not meet, then execute Step 4 in order to start a new evolution,otherwise go to Step10.
- Step 10: After ten iterations are completed, the obtained solutions of all sub-populations are exchanged in order to select better solutions.

CONCLUSIONS:

Regarding Clustering protocols, the data transmission in the Dijkstra's algorithm technique is useful, saves the energy using shortest path method.

The cluster head selection process using four parameters is quite different from other techniques and still gives better result compared to LEACH-C and ECHS. Moving on to Routing protocols, Ant colony optimization, Swarm optimization, these techniques will reduce the network overhead, transmission delay considerably as it is maintaining own state as well as previous state so decision can be taken from table itself with observing energy drainage rate. The Wake-up radio module can be added to improve sleep scheduling and reducing further more energy. Water ripple technique can be used in addition with sleep scheduling to hibernate non-essential nodes to stop working. Traffic aware routing should be applicable in probabilistic approach of E-BEENISH etc. Energy drainage rate can be substitute the traffic congestion in many protocol for every round.

REFERENCES

[1]Wang, Mingzu, "Clustering in wireless sensor networks", 2017, IEEE

[2]Chunyao FU1, Zhifang JIANG1, Wei WEI2and Ang WEI "An Energy Balanced Algorithm of LEACH Protocol in WSN", 2016, IEEE

[3]Rajkumar and H. G. Chandrakanth "EDCH: A Novel Clustering Algorithms for Wireless Sensors Network", 2019, EJERS

[4]Md. Nurul Islam Khan, Md. Saiful Islam "A New Approach of Energy Efficient Load Balancing for Wireless Sensor Networks" 2019, IEEE

[5]Maha Abderrahim1, Hela Hakim1, Hatem Boujemaa, Farid Touati "Energy-Efficient Transmission Technique based on Dijkstra Algorithm for decreasing energy consumption in WSNs", 2019, IEEE

[6]Yuvaraj Padmanaban, Manimozi Muthukumarasamy "Energy-efficient clustering algorithm for structured wireless sensor networks", 2018 IET

[7]K. Johny Elma, Dr. S .Meeakshee "Ennergy Efficient clustering for lifettime maximization and routing in WSN",2018, IEEE.

[8]Vipin Pal, Girdhari Singh, "Balanced cluster size solution to extend lifetime of wireless sensor network", 2015, IEEE

[9]Said Harchi, Jean Philippe Georges "WS dynamic clustering for oil slicks monitoring", 2012, IEEE

[10]Feng Zhang, Qi-Ye Zhang "ICT2TSK:An improved clustering algorithm for WSN using a Type-2 Takagi Sugeno Kang Fuzzy Logic System ",2013 IEEE

[11]Tan Xian, "A modified energy efficient backup hierarchical clustering algorithm for WSN", 2015 IEEE

[12]Yin ghui Zhang, Xialou Zhang, Shuang Ning, Jing Gao, Yang Liu, "Energy-efficient Multilevel Heterogeneous Routing Protocol for Wireless sensor networks",2017, IEEE

[13]Deepak sharma, Amol P Bhondekar," Traffic and energy aware routing for heterogeneous wireless sensor networks", 2018, IEEE

[14]Zhenfei wang, Liying, Zhiyun Zheng, Junfeng Wang," An optimized RPL protocol for wireless sensor networking",2016, IEEE

[15]Hassan el alami, Abdellah Najid,"ECH: An enhanced Clustering Hierarchy approach to maximize lifetime of wireless sensor networks", 2019, IEEE

[16]Wu deng, Junjie Xu, Huimin Zhao. "An improved Ant colony Optimization Algorithm based on hybrid Strategies for Scheduling Problem", 2019, IEEE