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Increasing Energy Efficiency of Network in WSNs with Clustering Strategies

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Abstract: ***Wireless Sensor Networks (WSNs) are made up of hundreds or thousands of sensor nodes which are distributed in a particular area to monitor environmental conditions like temperature, sound, pressure etc. and cooperatively pass their data to the base station. WSN is gradually developing technology. There are large scale applications in WSN like environmental monitoring, battlefield awareness, temperature sensing etc. therefore, there is need of increasing network lifetime in WSN as changing sensors frequently is not possible practically all the time. Assuming these drawbacks the proposed load-balanced clustering algorithm for WSNs can overcome previous clustering algorithms. In the previous techniques, the clustering of nodes is not balanced and this can make the network energy unbalanced. On the basis of their distance and location, making it essentially different from the Proposed Location Based Clustering Algorithm (LBC) can perform better than exiting LEACH and Rescue Phase to form a cluster. In LBC algorithm the location of each and every present node in the network are calculated with respect to X, Y- coordinates. This can help to avoid random selection of nodes in clusters. It improves the balancing of the network and energy of network can be saved. Proposed Centre Point Detection Clustering Algorithm (CPDC) determines the center of the cluster and nearest node to that point with high energy selected as Cluster Head (CH).***
Keyword: Wireless sensor networks, energy efficiency, clustering, Cluster Heads, Network lifetime.

I. INTRODUCTION

Wireless Sensor Networks (WSN), are spatially distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound, pressure, etc. and to cooperatively pass their data through the network to a main location. WSN is formed by hundreds or thousands of nodes that communicate with each other and pass data along from one to another and compulsorily connected to at least one base station.

Successful operation of wireless sensor network depends upon battery life of sensor nodes. Harsh/Remote application area and less human interventions make it quite impossible to recharge or replace battery of sensor nodes. Therefore, efficient energy consumption of nodes to extend network lifetime is a prime design issue for wireless sensor networks [1]. A number of cluster protocols based on energy efficient have been proposed in the literature.

These approaches attempt to minimize energy consumption by reducing the transmission of redundant data. Clustering approaches focus primarily on the communication process during cluster organization and CH election and neglect the effect of information processing on energy consumption [2].

Routing in WSNs is very challenging due to the inherent characteristics that distinguish these networks from other wireless networks like mobile ad hoc networks or cellular networks. Hierarchical cluster-based routing methods is essential for sensor network applications where a large number of sensors are deployed for sensing purposes. If each sensor starts to communicate and engage in data transmission in the network, a great network congestion and data collisions will be experienced, which results in draining of the limited energy from the network. Node clustering will address these issues. In clustered networks, nodes can be partitioned into a number of small groups called clusters.

Each cluster has a coordinator, referred to as a cluster head (CH), and a number of sensor nodes (SNs). Clustering results in a two-tier hierarchy in which CHs form the higher tier while SNs form the lower tier.

The SNs transmit their data to the respective CHs. The CHs aggregate the data and forward them to a central base station (BS) directly or through other CHs. Clustering through creating a hierarchical WSN facilitates efficient utilization of limited energy of sensor nodes and hence extends network lifetime. [3]. In [1] author focuses on balanced network using clustering. But the random selection of nodes as cluster head reduces the chances energy enhancement of network. Random selection of CHs can lead to the probability of selection of node with low energy.

II. LITERATURE SURVEY

A fair amount of work is done is in the discipline of wireless sensor networks to boost the network lifetime. In the process of data transmission from one node to another much more energy is used. Energy saving of nodes and network is the priority while designing the network.

Vipin Pal, Girdhari Singh and R P Yadav [1] introduced a balanced cluster size clustering approach to have prolonged network lifetime. Cluster heads are selected on the basis of probabilistic approach. Each node select a random number between 0 and 1.

M. Eshaftri, A. Y. Al-Dubai, I. Romdhani and M. B. Yassien [2] proposed a Load-balancing Cluster Based Protocol. In LCP, the clustering operation is divided into several rounds, each round has two phases: the setup and the steady state phase. LCP is similar to HEED. The LCP algorithm sets an initial percentage of node become Cluster head. Thus, each sensor node establishes its probability of becoming a CH based on the reaming energy according to HEED.

Chunjuan Wei, Junjie Yang, Yanjie Gao and Zhimei Zhang [3] done survey on Cluster-based Routing Protocols in Wireless Sensor Networks. They have discussed challenges for clustering algorithms.

M. Patil and C. Sharma [4] said that the existing clustering protocol designed based on $LEACH$ is not efficient in term of life time of network so there was a necessity for a better clustering protocol to increase network lifetime. Here the author proposed an energy efficient clustering protocol namely $PS-LEACH$ to improve energy efficiency of sensor network.

A. Amwary, D. Maga and T. Nahdi [5] modified the LEACH protocol. Modified LEACH is divided into two main phases at the first setup phase and at the second steady state phase. In the first phase nodes are spread randomly allover network area and cluster heads should be elected randomly. CH algorithm has been modified to assign CH only from advanced nodes set.

S. Jannu and P. K. Jana [6] proposed Unequal Clustering Algorithm. It works in two phases: CH selection followed by cluster formation phase. In the first phase, the weight of all SNs is calculated to select the best sensor nodes as CHs from the normal sensor nodes. The weight is derived by considering residual energy and average distance of an sensor nodes.

D. Jia, H. Zhu, S. Zou and P. Hu [7] proposed the optimized cluster heads selection process. Initializing the network. The base station can get the location of all the sensor nodes in monitoring area (ID) and the residual energy of the nodes. The monitoring area is divided into some clusters by Voronoi diagram, and the perception probabilistic model is proposed. Select network redundant nodes by the attenuation probabilistic algorithm and these nodes are taken as the first kind of hibernation cluster head node. The death of a current cluster head node makes another redundant node active to be the cluster head. If the death node is a current common node, another redundant node ends dormancy to be an ordinary node.

N. Kumar and S. Kaur [8] proposed the implemented distance based angular clustering algorithm. Proposed model use the sensor nodes location to assign the circular and angle based cluster. Distance based clustering uses the 250 meter distance to divide the whole network into circular clusters. Angular clustering divide the circular cluster into angle based cluster clusters to narrow down the responsibilities of cluster heads. Clustering process uses the centre node to apply the clustering algorithms.

A. Patra and S. Chouhan [9] introduced energy efficient hybrid clustering scheme. In EEHCS, the CH set-up algorithm is executed at the BS to reduce control message overhead and sensor nodes are responsible for forming clusters, sensing data, forwarding packets and transmitting information to BS. The operation of WSN is distributed into rounds where each round is made up of a set up phase and a steady state phase. The set up phase consists of two steps: CH selection and cluster formation.

K. T. Kim, M. Y. Kim, J. H. Choi and H. Y. Youn

[3] proposed scheme which employs tree topology in each cluster to evenly distribute the energy load among the sensors in the network. The proposed scheme consists of two phases, clustering phase and data transmission phase.

III. PROPOSED SYSTEM

The proposed system discussed in this paper is to improve the performance of the network and to improve the lifetime of the network is the main motive.

A. LBC Algorithm

1) Input: no of nodes and no of cluster.
2) Output: location based balanced clustering.
3) Generate network.
4) N=no. of Nodes, C= No. of Cluster.
5) Balanced no. of node=N/ C.
6) Setup network with balance no. of node.

*7)*Location =X, Y coordinates of node.
*8)*Clustering based on balance no. of nodes and location

B. CPDC Algorithm

1) Input: Number of nodes (n), Number of clusters
2) Output: Balanced cluster with Cluster Head Selected
*a)*Enter the No. of Node.
*b)*Generate Network.
*c)*location wise balanced Clustering.
*d)*Calculate approximate Center (X, Y) of each cluster.
*e)*Calculate distance from (X, Y) to every node.
f) Detect node N with least distances from (X, Y) with high energy.
g) select node N as Cluster head based on high energy and least distance from centre point.

C. System Architecture

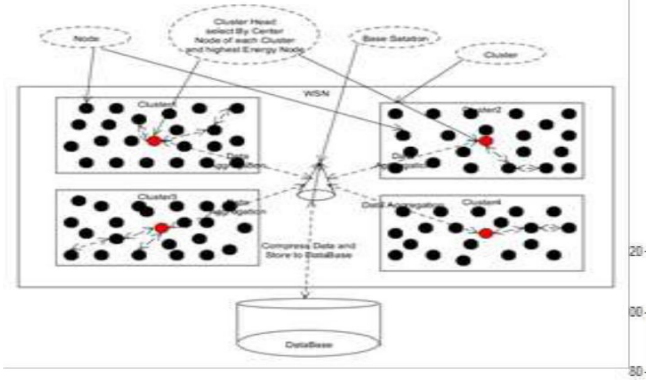

Fig. 1 System Architecture

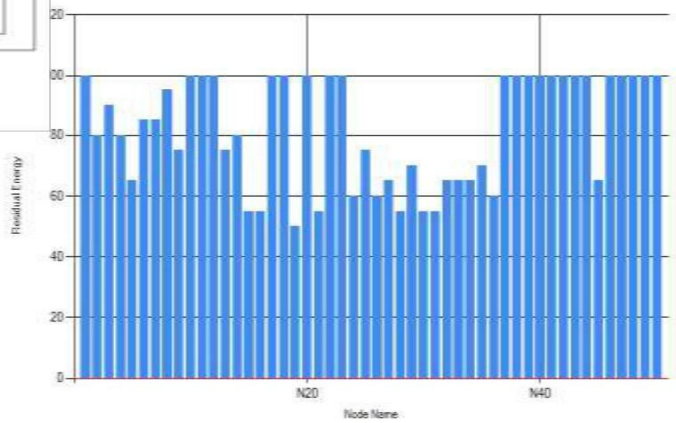

Fig. 2 LEACH Algorithm Graph

Fig.1 shows formation of balanced clustering. The nodes in each cluster are approximately equal in number. The centre point is calculated in each cluster. Node near to the centre point with high energy is selected as Cluster Head . Database stores the location data of each node.

Assume that there are *S* no. of sensor nodes in the network. Nodes are randomly deployed in the area. They are divided into *Z* no. of clusters. The set of cluster heads can be define as, H= $\{H_1, H_2, H_3 \ldots H_{j \ldots} H_n\}$

Set of non-cluster head nodes =$\overline{H}$.

In the proposed system, cluster heads coordinate with the sensor nodes in their respective clusters, aggregate intercluster data and send it to the base station. To select the cluster head location and energy level are considered. Clusters should be balanced with equal no. nodes in each cluster approximately.

Function can be mathematically expressed as,

$$\alpha \times R^{H}_{energy} + (1-\alpha) \times R^{H}_{location}$$

fH=

Where, α is the constant, contribution to R_energy^H and R_location^H.
R_energy^H is the ratio of cluster head's average residual energy to non-cluster head node's average residual energy.
R_location^H is the ratio of average distance between cluster head and base station to the average distance between non cluster head node and base station.
The location of the nodes are obtained by X, Y coordinates of that respective node. If a node is near to the center point of the cluster head with high energy is more likely to become cluster head.

IV. RESULTS AND DISCUSSION

The simulation results shows that nodes use energy to perform their tasks. More work done by the nodes is directly proportional to reduction in network lifetime.

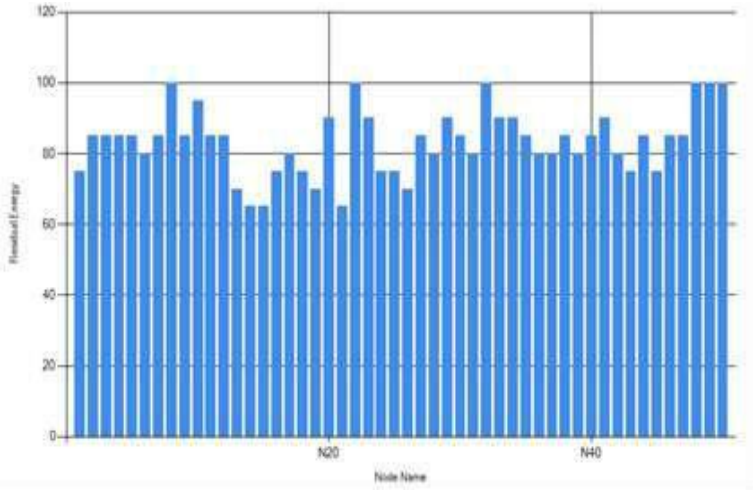

Fig.3 LBC Algorithm graph

In the above fig. 2 & 3 LEACH and LBC Algorithm graphs are shown. The performance is calculated with respect to sensor nodes on X-axis and residual energy on Y-axis. To generate the results a simple text file data is sent from node to cluster head and cluster head to base station. The transfer of data uses energy of nodes. Results show that LBC algorithm performing better than LEACH. After transferring the data file, the energy level of nodes in LEACH is decreased below 60 and in LBC energy level is maintained above 60. The residual energy saves more in LBC.

Table I. Simulation parameters

Parameter	Value
Deployment field	300m×260 m
Data packet size	200 bytes
Control packet	10 bytes
Number of node	50-100
Sink position	(150,130)
Initial energy	100j
Deployment method	Random

V. CONCLUSION

In this paper clustering of sensor nodes in wireless sensor networks is discussed. To design an optimum WSNs we have to minimize energy consumption and hence extend the network lifetime are major challenges. The identified challenge of decreasing lifetime of WSN network can be resolved in future using proposed clustering method. The proposed algorithm LBC for balanced network and CPDCA for the selection of cluster head can give better result for data transmission and energy efficiency.

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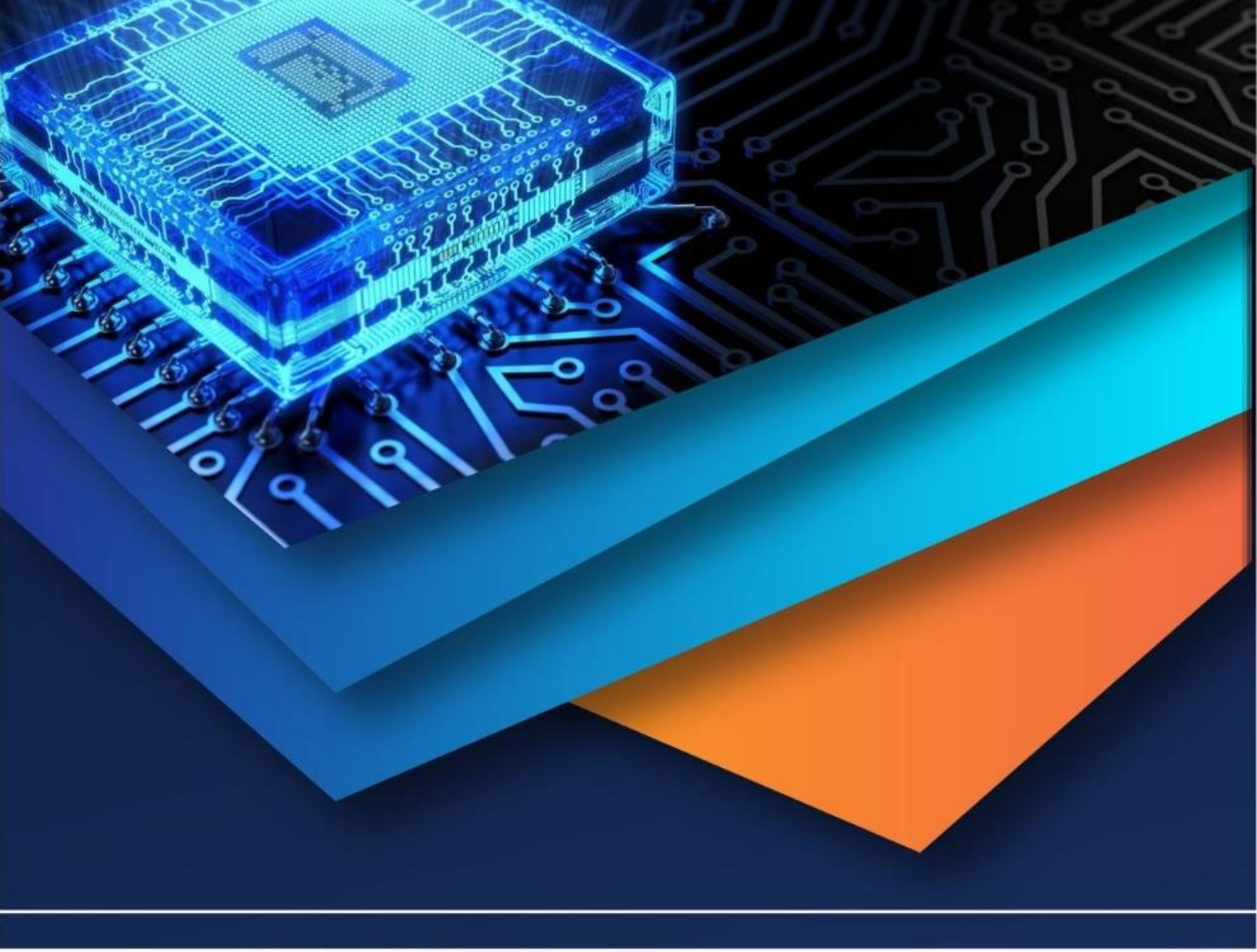

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