Clustering Based Energy Conservation Techniques for Wireless Sensor Network: A Survey

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Abstract— Life time of a sensor network is dependent on the power of the battery. In some applications scenarios, it is not possible to replace the dead batteries. Many researches are focusing on designing protocols and algorithms for wireless sensor networks to reduce the energy expenditure. Clustering is one of the best approaches to reduce the energy consumption. The Energy consumption is effected by the distance between sensors. In this Paper, we conducted a survey on the various approaches of clustering to study and design an energy efficient algorithm based on distance to make the clusters.

Keywords— Energy Consumption; Distance; Hierarchical Clustering

I. INTRODUCTION

Wireless sensor Network provides a new paradigm to sense and monitor the information from various environments. Now days smart WSN consists of many sensors which have wireless communication capability and they are enough intelligent for signal processing and networking the data. Wireless sensor network is used in environmental monitoring to detect distortion and structural problems in buildings in order to prevent disasters. It is used in Military and crime prevention applications. WSN is also used in Health applications such as tele-monitoring and telecommunicating. WSN consists of many nodes in which one of the components of sensor nodes is power source which is limited. As we know nodes depend upon the battery lifetime and in some applications there is no power replenishment. So many researchers focus on saving power. Hence the key role is to minimize the energy consumption. Senor nodes are used to transmit the data so more the distance it covered more the energy will be used which results in network failure. The solution of this problem is clustering in which sensor nodes are combined and together they form a cluster.

In all clusters a cluster head is selected and it is responsible for many tasks such as task assignment, association of node and authentication. It also maintains hardware failures and support sharing of clusters. Cluster head is central point so it must have low energy consumption as compared to other cluster members. As in traditional networks nodes directly send data to the base stations which consume more energy but by using clustering nodes can communicate with nearly nodes and can send data to the base stations which will cover less distance.

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II. ARCHITECTURES OF WSN

Wireless sensor network is a collection of sensor nodes which are used to sense or monitor the environment. These sensors are used to send the data to the destination. Sensors can easily communicate with each other directly or they can send data to other stations. This sensor network is used to gather the information that is needed in smart environments such as buildings, home, companies, transportation system or elsewhere. In all these environments wires and cables do not play the effective role so a fast wireless sensor network is required which is fast and easy to install.
There are two types of WSNs:
a) Structured
 b) Unstructured.

Unstructured WSN: is one that contains a dense collection of sensor nodes. Sensor nodes may be deployed in an ad hoc manner into the field. In this, since there are so many nodes so network maintenance such as managing connectivity and detecting failures is difficult.

Structured WSN: In a structured WSN, all or some of the sensor nodes are deployed in a pre-planned manner.

III. CLUSTERING : AN OVERVIEW

Clustering is a group of clusters which contains nodes. Two types of clustering is used Probabilistic clustering in which probability is assigned for the selection of cluster head and in the other case non-probabilistic clustering a deterministic criterion is selected which is based on degree, node and connectivity.

Cluster size directly affects the performance of clustering scheme. As it is easy to implement but it wastes much

energy according to network density. For example cluster A is located just one hop away from sink but the cluster B is located 2 hops away from cluster. The size of cluster is equal and more the distance, more is the energy consumed. So we can say that cluster B consumes more energy. So when a clustering scheme adopts equal cluster size then it degrades the performance of clustering scheme. This scheme is called equal clustering scheme. Hierarchal clustering is also done in which clusters are either divided or combined. In all clusters a cluster head is selected and it is responsible for many tasks such as task assignment, association of node and authentication. It also maintains hardware failures and support sharing of clusters. Cluster head is central point so it must have low energy consumption as compared to other cluster members. To support Network scalability and decreasing energy consumption through data aggregation, clustering has numerous advantages such as it can conserve the communication bandwidth because it reduces the redundant exchange of messages among sensor nodes. The cluster head enhance the network operation and prolong the battery life and network lifetime. Sometimes there may create several design and implementation issues and also the Cluster Head selection and Cluster Formation generate the best possible cluster.

As in traditional networks nodes directly send data to the base stations which consume more energy but by using clustering nodes can communicate with nearly nodes and can send data to the base stations which will cover less distance.
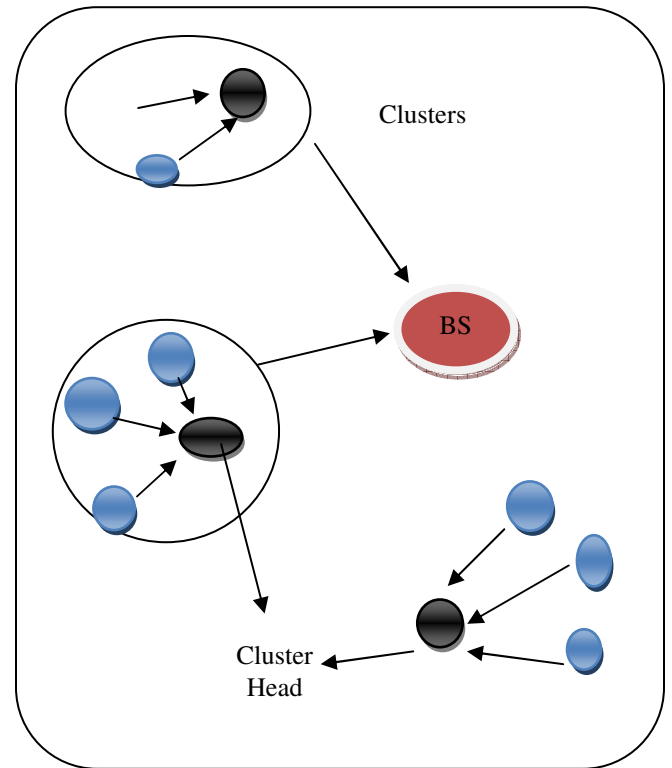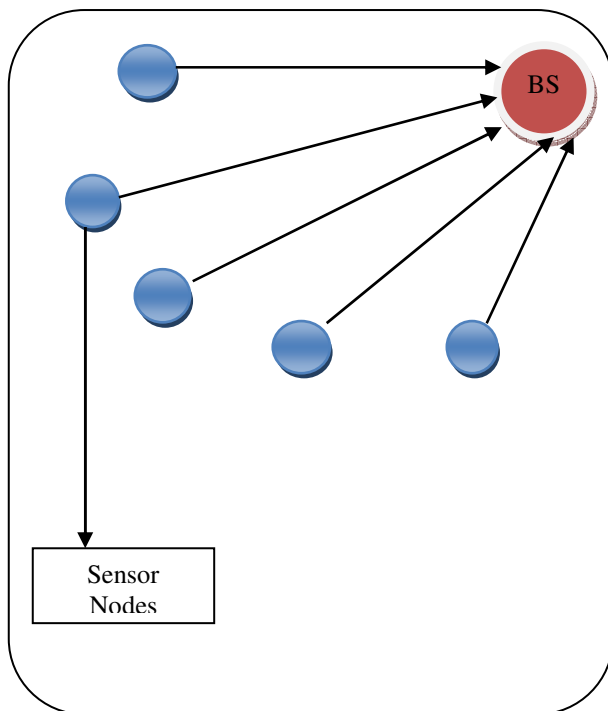

Figure 2: Wireless Sensor Network with Clustering of Nodes

IV.   RELATED WORK

Jenq et al. [1] in this paper a new technique REAC-IN which is Regional energy aware clustering with isolated nodes has been taken into account. In this technique cluster head is selected on the basis of residual energy and regional average energy. This helps the isolated nodes to decide to send data to either cluster head or sink. A comparison has been done among many techniques such as LEACH, HEED, and DEEC in which cluster head is selected on the basis of predetermined probability, residual energy and ration of residual energy to average energy of network respectively. This new scheme REAC-IN improve the life time of network and number of alive nodes which is better than other protocols .It also helps to solve the problem of node isolation.

Chamam et al. [2] in this paper, a centralized mechanism which is based on Tabu algorithm which computes a near optimal network configuration in which each sensor can be activated as a cluster head or it will be in sleep mode. The problem consists of finding optimal state to sensors which helps in maximizing the network time which is called OPT-ALL-RCC. This new technology is based on an example of coverage configuration protocol. In this paper various comparisons have been done such as TABU- RCC with

respect to its lower bound CPLEX and TABU- RCC versus EESH. In future they intend to try new heuristic and distributed algorithms to maximize the life time.

Tarhani et al.[3] In this paper a new distributed algorithm which is called scalable energy efficient clustering hierarchy which selects the CH and Relay node separately based on the eligibility of nodes such that the node with high degree is considered as CH and with low degree as Relay. In this paper cluster head and Relay selection is done by using Set up method and Steady Method. In set up method all the information of path and location of nodes are calculated and in steady phase data is collected from nodes and send it to CH or sink directly. This SEECH algorithm is suitable for periodical data gathering applications in harsh and remote environment which have more network life time than LEACH and TCAC protocol. In SEECH algorithm Comparison has been done with LEACH and TCAC protocols which give less network lifetime than SEECH algorithm. It provides better Cluster Head distribution.

Kumar et al. [4] Efficient clustering is used for increasing the life time of network, but a balances clustering is always not possible so In this paper an efficient balanced clustering is used for cluster head Selection/Rotation and data routing to increase the lifetime of network. Balanced cluster head Selection/Rotation helps to achieve the balanced energy consumption. In these paper shortcomings of various algorithms such as LEACH, HEED, TEEN, PEGASIS and ERP-SCDS has been overcome. A virtual concentric circular band based clustering protocol is used which give us the uniform cluster formation. In this cluster formation is done only once and it thus saves energy. The simulation results show that the network life time is increased.

Yang et al. [5] in this paper they proposed a new scheme Energy Efficient Clustering Division Scheme for the energy consumption in which cluster is divide into non-uniform concentric rings and obtain the optimal thickness of the ring. In this paper various algorithms such as LEACH, PEGASIS, and EACLE is discussed. Two types of sensor nodes are used, one kind is cheap non uniform CH node whose function is sensing and short distant transmitting the data and the other kind is expensive CH node whose function is sensing, data aggregating and long distant transmitting of data. In this Non uniform clustering division scheme they realize the reduced energy consumption and longer lifetime of cluster hierarchy. In this two approaches are used after the cluster expires. One is to continue with the remaining nodes and move it to the appropriate location and other is to deploy new nodes in cluster.

Park et al. [6] in this paper LUCA which is location-based unequal clustering algorithm in which the concept of different size of cluster is taken. Earlier the equal clustering

algorithm in which the same size clusters were taken and it determined that the equal cluster far away from sink consumes more energy so on the basis of this concept LUCA was considered. In LUCA each sensor senses the information of cluster based on its location. Random trade off time is used to determine the CH. In this network model is used to get the location of cluster. In LUCA two types of clustering is used one is intra clustering and second one is inter clustering. Firstly nodes send its data to its CH based on location information and then CH aggregates the data and sends it to the sink. In this two modes sleep mode in which the node turn off its radio and saves the energy and in other is wakeup mode in which nodes send the messages when necessary. The simulation results show that the performance of LUCA is better than the equal clustering algorithm.

Heo et al. [7] in this paper, an algorithm Energy Efficient Deployment Algorithm for clusters is proposed in which combination of cluster structuring and peer to peer algorithm is used. In this the combination helps us to provide increase in local control over entire ROI, each node decides its mode whether it would like to be in clustering mode or peer to peer mode based on its density and remaining energy. The concept of uniformity, coverage and distance is taken to get the best performance to increase the lifetime of network. The performance of algorithm is calculated by the percentage of region covered, deployment time and the uniformity of network. The simulation results show that this algorithm gives a uniform distribution from uneven distribution of efficient energy manner.

Singh et al. [8] in this paper, an Energy Efficient Homogeneous Clustering Algorithm for wireless sensor network is proposed for increasing the lifetime of network and to save power. In this nodes are distributed homogeneously and a new cluster head is selected on the basis of residual energy of existing cluster head, holdback value and nearest hop distance of the node. In this every node in a cluster is a cluster head or a member of cluster. Only cluster head broadcasts their messages so to prolong the lifetime of network. In this paper Limitations of Radio model is discussed. The main objective of this proposed algorithm is to keep sensors operating for as long as possible.

Mukhrjee et al. [9] in this paper, a survey has been done on the general approaches of energy conservation. First is Duty Cycling Approach in which sleep and wake mode is taken, when there is no network activity then node should be sent to sleep mode. Second is Data Driven Approach in which unwanted communication is reduced which result in energy consumption. In this technique data is sensed within a range and data compression is done. Last technique is Mobility in which multihop communication is done as more

data is loaded over nodes. This scheme is done by two schemes one is Mobile Relay in which hierarchy level of nodes is set in which nodes roam to get the data and it then send to destination and the other one is Mobile Sink in which it focus on energy consumption and network lifetime.

Jin et al. [10] An Energy Efficient Clustering Technique is used for Multihop data delivery scenarios. In this paper, Size of cluster depends upon the hop distance to the data sink to balance the Traffic load and the energy consumption. Cluster head is selected on the base of initial energy levels and the selected CH transmit their advertisement messages and the residual energy. The candidates which have more residual energy than CH becomes the CH... The comparison of EC algorithm has been done with HEED and UCR Algorithms and finds a better result than these algorithms. In EC algorithm effectiveness of EC is evaluated and the main focus is on energy conservation. Performances results show that it provides node equalization instead hop distance to the sink at different locations.

Kumar et al. [11] in this paper, EECP which is Energy Efficient Clustering Protocol algorithm is used in which high energy nodes become the gateway and this gateway helps in transmitting the data of the cluster members to their base stations. In this distance based probability scheme is used in which the nodes which are near to sink have greater chances to become the cluster head. Two rounds are used setup phase and steady phase in setup phase cluster head is selected and in steady phase data is send to the base station. This technique is advanced research on LEACH in which the concept of heterogeneity is used.

Patil et al. [12] in this paper, data aggregation technique is used to reduce the redundant data transmission .In this they combine the similar data from the nearby areas to reduce the transmission. Energy efficient cluster based aggregation protocol (EECAP) has been used which focus on the divergent sink placements such that when sink is at the centre of sensing field, corner of the field or at some random locations. In this Comparison with LEACH and SEP algorithms has been done which is used for homogeneous network. In this paper, improvement of LEACH algorithm is done. Threshold equations of LEACH is multiplied by Node Energy remaining coefficient(NERC) and thus we get a cluster head which broadcast itself as a cluster head and wait for other nodes to join it .Now the nodes send messages to cluster head ,it aggregates the data and send to the base station. Non cluster head and non-member nodes can send data directly to the base station .The simulation results show that the EEPAC gives good performance in case of energy efficiency.

Taruna et al. [13] in this paper, Cluster based routing protocol is implemented in which residual energy of nodes is taken to increase the network lifetime. The work has been done on heterogeneous networks. In this paper a cluster based routing protocol is described which is based on LEACH algorithm in which residual energy has been taken to reduce the unwanted consumption of energy and to increase the network lifetime. Three phases are used, first is setup phase in which based on threshold function cluster head is selected randomly. In the second phase, steady phase in which each member send its residual energy information to the cluster head. In the third phase which is pre –setup phase in which cluster head send all the residual energy information to the base stations and base station find the maximum residual energy values and send back to the cluster head and cluster head broadcast the value and each node save this value for next round. The result has been verified by taking various parameters and different positions of base stations and results are compared with the LEACH algorithm.

Stefanos et al. [14] in this paper, a new improved algorithm is made named as Equalized Cluster Head Election Routing Protocol (ECHERP) in which using balanced clustering energy is conserved. In this paper many algorithms has been discussed and also many comparisons have been done between all those algorithms. It has been shown that in some algorithms such as LEACH, TEEN, SHORT they all use different-different mechanism to select the cluster head which is based on the residual energy to increase the network lifetime. But what we discuss in ECHERP the energy spent by the nodes is taken as linear system, by using Gaussian elimination method it selects the cluster head. Linear method helps to calculate the energy efficiency in this cluster head is selected which minimizes the total energy consumption in the network. A multi- hop scheme is used in ECHERP to transfer the data to the base station .In this comparison with different algorithm is shown through simulation. In future Quality of service related work will be done.

Dawood et al. [15] in this paper, Location Aware protocol is used in which a concept of radio power is introduced. In this radio power will be controlled. The nodes will be aware of their location and sink too with the help of it which help them to save more energy. As we know more energy is consumed in finding the location of sinks .In this paper comparison with LEACH and HEED algorithms has been made. LEACH algorithm is not good for large networks but this Location Aware protocols is efficient for large networks. The nodes are distributed in Location Aware algorithms sensor and its routing capabilities have been checked with normal distribution and location aware algorithm, thus we get the best results of energy saving in location aware algorithm. The NS2 simulator is used to get

the simulation results. QOs and security threats will be entertained in the future.

V.   ANALYSIS

Earlier many algorithms have been used such as LEACH.HEED, ECHERP. In all these algorithms a cluster head is used randomly or on the basis of probability. But In these techniques many typical algorithms and formulas have been used and also some of these algorithms are used for only homogeneous networks which do not give good performance. Also in LEACH the cluster head remain active for much time than other nodes which in result they lose their energy very soon.   Analysis has been that clustering is used on the basis of distance. As distance increases, energy will also be increased, so to reduce energy consumption distance should be reduced. Based on Many previous algorithms, new concept of distance based clustering is determined to reduce the energy consumption so that we get the best reduced distance and get a good performance which will be better than other any algorithms.

VI.   CONCLUSION

From this paper, we concluded that to reduce energy consumption and to increase life time of network clustering play a vital role. As the lifetime of sensor network depends upon the battery lifetime so clustering is best solution to save the energy. In Clustering group of clusters are formed. The cluster head which is the central point is responsible for many tasks such as task assignment, association of node and authentication. As more the distance is more the energy will consumed. In Clustering cluster head will send data to the base station and the other nodes which are near to it send data to cluster head thus the distance is reduced hence energy will be consumed. Energy is the important factor here as it affects the lifetime of network.

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