Numerous Clustering Techniques with Application and Limitations in Wireless Sensor Network

Arvinda kushwaha, Mohd Amjad

Abstract: ***Wireless Sensor Network (WSN) is a very common area to work with different technology which is very useful for real time application. There are various application works with the help of WSN .some of internet of things, machine learning, big data etc. in WSN there are four basic component of WSN that is sensing unit, transceiver unit, processing unit, and storage unit. Energy is the important critical design issue in WSN. By applying clustering approach we can save the energy and attain load balancing of a network. Sensor nodes are viewed as homogeneous since the looks into in the field of WSNs have been advanced, however, a few nodes might be of various energy levels and it is draw out the lifetime of a WSN and its unwavering quality. Clustering methods are required so that sensor networks can work long time with different area. In this paper, we discussed the various clustering techniques those are helpful to maximize the lifespan of WSN.***

Keywords: clustering, wireless sensor networks (WSN), cluster head, LEACH, weight based clustering.

I. INTRODUCTION

WSN is a collection of tiny device e.g sensor node they are communicating to each other through wireless connection[1]–[3]. These sensor nodes deploy in environment and they collect the information about humidity, pressure, unwanted attack, movement of vehicle etc. WSN used in wide range of application like industrial application, health, military, security etc[4], [5]. There are various challenge and issue in WSN. The problem of routing is one of the crucial challenges. The view of WSN [6], [7] can be an structured or unstructured network. A structured network has fixed topology where as an unstructured systems do not have fixed topology. Energy is a big research issue in WSNs. Clustering performs the task to reduce the unruly of energy consumption of node in this way we select the cluster head (CH) from the cluster and transmit the sensed information to the sink[8]. To decide this issue clustering computations for WSN are proposed which gives a sorted out strategy for correspondence for unstructured WSN. This computation detaches WSN node into gatherings picking up a CH which aggregate data taking care of
assignment for whole gathering thusly saving essentialness. CH therefore exhausts more essentialness than various hubs. Clustering is the activity [9] of making sets of practically identical things. Diverse asks about are performed on clustering. Nodes in an assembled WSN can similarly be named basic nodes and cluster nodes. Basic nodes can perform data gathering and data dealing with limit rather discretionary nodes just performs data sending limits. Clustering makes the system flexible and enhance lifetime. It avoids imperativeness by appropriating load by taking astute decision. Nodes having high essentialness are allotted more loads thus contribute in growing the lifetime of the network. The clustering is done as such that data needs to travel least. Simply cluster heads talks with pack head along these lines decreasing the data reiteration which standard speaking happens when each hub play out its own one of a kind data mixture and transmission [10] work autonomously. This figuring gives profitable technique for correspondence in sensor network. Such estimation makes easy to care for computations. Clustering in WSN makes them proper for use in critical situation. On the basis of clustering we discussed various clustering strategy which is more helpful in WSN. Point is less a great part of the time discussed through diagrams. So finally clustering performs a progressive task for WSN.

Every sensor node in the network comprises of three subsystems: The sensor subsystem: This comprises of at least one sensors which are utilized to detect the natural parameters, for example, temperature, humidity, pressure, sound and so forth. The handling subsystem: It has microcontroller which plays out the neighborhood calculations on the detected information and controlling activities and inward memory to store information. The correspondence subsystem: This is in charge of moving the detected information to the BS. The internal structure of sensor node shown in figure 1.

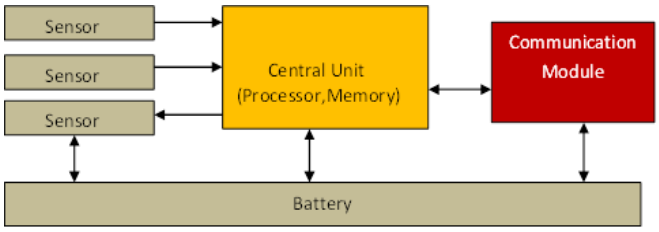

Fig. 1 Structure of Sensor node

II. LIMITATIONS OF WSNS

The environment of WSN has limitation, listed as follows:-

- Less capacity for storage – in kb (kilobytes).
- Less processing power-e.g 8MHz.
- Sending and receiving message thorough limited distance.
- Requires minimums energy – constrains the protocols.
- The life time of battery is limited.

Revised Manuscript Received on October 15, 2019

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III. Advantages of Clustering

A. Data aggregation

It reduces the redundancy of collected data by sensor node.

B. Fewer loads

Load is an important factor in WSN to avoid load in WSN, data Aggregated play an important role in transmission.

C. Minimize energy utilization

The energy utilization is less only meaningful information send from source to base station (do not send redundant information).

D. Clash Avoidance

Data transmission have fix slot and on the basis of which we can divide the resources orthogonally for collision free data transmission.

E. Load equalization

Sizes of cluster play a important role for load Equalization in WSN .with the help of clustering we can upsurge the network life time by minimizing the energy depletion of WSN.

F. Scalability

A new node easily added in clustering because sensor node divided in various assignment levels.

G. Fault avoidance

Re-clustering should be possible if a node suffers from energy depletion.

H. Quality of Service

In WSN there are various parameter use to improve the quality of WSN clustering protocol is one of them it delivering a quality and aggregate data to the BS (Base station).

IV. Objectives of Clustering

Various clustering algorithms apply to a uniquely identified task to choose the CH and making the group in the network for better result and maximize the network life time

Load balancing

It is necessary to balance the load among CH so that they can achieve their goal. Load balancing is one of the tough tasks of WSN. Setting of equal sized cluster become very important because it not only prevent from exhaustion of energy but also increase the lifetime of n/w. similar count of nodes in the cluster also help in the data aggregation so as to make data almost ready for the further processing.

A. Fault-tolerance

WSNs will operate in harsh environment which help them to deal with the risk of physical damage and malfunctioning. Fault-tolerance helps in maintaining the important sensor data. The natural way to recover from a CH failure is to re-cluster the n/w. but the re-clustering not only creates extra burden of resources on the node but also disturb the on-going network operation. The most notable approach for CH failure recovery is assigning backup CHs. Every cluster has some radio range if a CHs have long radio range then neighboring cluster heads can adopt the sensors in the failing cluster. The roles of CHs rotate every round of protocol for sensor node because of avoidance of fault-tolerance.

B. Delay reduced & connectivity increased

Inter-CH connectivity is a necessary requirement in most of the applications. The connectivity can be ensured by providing the route between each CH to base station. Delay is based on the max number of nodes say "k" allowed on data path.

C. Less cluster count

The n/w designers always try to select low number of CH nodes since they are expensive and vulnerable than non CH sensor nodes. The cluster count is also low due to the complexity of deploying them. The size of cluster is also larger than sensor and it also can be easily detectable which is undesirable in many applications, so lowering the cluster count is beneficial for us.

D. Maximize the n/w lifespan

The n/w lifespan of the WSNs is very much important especially in the tough and risky environment. Here the n/w lifespan can be increased either by the following methods- when the CH contain large resources as compared to sensors than it is necessary to lessen the use of energy for intra-communication. On the other hand, if the CH contains sensors then its life time can be extended by limiting the no. of loads on them. The n/w lifespan can also be increased by combining the cluster and setting up route for them.

E. Build network topology

Nodes are structure in the form of cluster and every cluster has CH and this CH is responsible for any topological changes at the cluster level. Hierarchal architecture is better for managing the n/w topology instead of flat architecture. Whenever any node dies or moves to other cluster than these changes are registered and informed by CH to BS so that re-clustering can be done to maintain the n/w efficiency.

V. Various Types of Clustering Used in WSN

There are various types of clustering algorithm used in wireless sensor network. Some important clustering algorithms are discussed below.

A. Event to Sink Directed Clustering (ESDC)

In ESDC form the cluster time to time when it is required, means that is when event occur. A sensor node sends this gathered information to CHs without redundant information. ESDC intend to attain energy-efficient clustering in two ways.

- Clustering performs when event is occurring in WSN, so no unnecessary clustering need to perform.
- ESDC follows directed clustering concept and select CH towards the BS to decrease the delay of dataflow. Finally, dataflow is directed over the clusters that are selecting the shortest path from the event area to the BS.

CH is selected from higher energy sensor nodes and non-CH nodes are elected from lower energy sensor node. So stream of data is practically unidirectional. The author in [11] has implement the performance of ESDC. In his paper ESDC in WSNs" and differentiated it and LEACH estimation. They maintained complete reporting to base station of any type of event occur by the sensor nodes .They evaluated that per hop delay in ESDC in WSN was approximately 200 ms in comparison to LEACH which had 460 ms delay of nearly double ESDC.

B. Low Energy Adaptive Clustering

LEACH [6] is a very important protocol used in WSN. In this protocol most of the node transmit the message to CH, CH collect and compress data and send to the sink. With the help this protocol we determine the

sensor node will become a cluster head or not after each round. A sensor node has radio powerful which directly reaches to the BS or cluster head. In LEACH if the node has been CH it cannot be CH again after *P* round where p is the percentage of Cluster head. In LEACH each sensor node has a 1/p probability to become a CH again; non cluster head join the nearest CH for transmitting the sensed data. The CH creates the Schedule for each node in its cluster to transmit its data. CH works with TDMA schedule, so that minimum energy required reaching the sense data to CH.CDMA also used by LEACH because reduce the interference between clusters.

LEACH involves two stage of operation.

- Setup phase.
- Steady phase.

In Set-up stage formation of clusters takes place and a CH is chosen for each cluster. CH is chosen dependent on a probabilistic factor. Likely of a node to turn into a CH is determined based on two components which are as per the following.

- A node can be CH. If it has verity of properties in terms of maximum energy, distance, centrality etc.
- Recommended complete classification of a CH by WSN.

If the value of sensor node is smaller than a threshold, then its miles elected as CH. Inconsistent state segment all records collected via CHs is dispatched to a base station. The drawback of Low-energy Adaptive Clustering is that there is no record founded about the initial energy of a CH. So Nodes that have come to be CHs for the same range of time as others, however, have much less initial energy than different nodes are in all likelihood to come to be useless sooner than nodes which have excessive preliminary energies. The set of rules does no longer work nicely with huge sized sensor networks due to the fact set of rules utilizes the single-hop inter-cluster method which isn't top-quality for big length networks.

C. Hybrid energy-Efficient Distributed Clustering

Hybrid energy-efficient distributed (HEED) approach is also very important approaches which apply in WSN. The parameters used by sensor node for selection of CH are as per the following:

- Remaining Energy
- Intra-cluster communication cost

The primary objective of HEED algorithm is that all the CHs inside the system get consistently circulated. Formula conserves additional energy and is more scalable. The disservice of Hybrid Energy-Efficient Distributed algorithm is that for the most part, it chooses the extra CH. As CHs expend extra energy in this manner energy of network altogether diminishes.

D. Load Balanced Clustering

Shujuan Jin, Keqiu Li [10] propose a load balanced clustering scheme . Because the CH is accountable for additional work, like receiving and aggregating information from its member sensor nodes, then send all information to the Base station. the CH is probably going to die of too significant burden, that affects the total network's life. To balance the energy load within the cluster, we propose a methodology for choosing associate assistant node within the cluster to assist the CH to transmit the aggregate information to the BS. In different words, when the CH computes the received information, it sends the aggregate information to its assistant node. Then this assistant node is accountable for the information transmission to the BS. In WSN if the distance of node is far from the BS and they continuously transmit to the base station. It is likely to die out quickly, this concept based on single hop methodology, so in this method we adopt a multi-hop communication method for aggregate data transmission method.

E. K-Means Clustering

It is Clustering evaluation scheme [9] which make use of two factors for the election of CH:

- Residual energies of nodes.
- Euclidian distances.

Each node sends its data to a key node which stores it in a list. It conducts the k-middle clustering algorithm after collecting information from all its nodes. This procedure operates better, instead of centrally, when the clustering is carried out by a distributed method. If a key node is installed at a single location, the whole network will disintegrate if that node fails. Even if a single node does not work, it cannot damage other nodes in distributed computing. In centralized networking there are more chances of packet loss as packet loss is not available for reaching other nodes. Even if a packet fails to a node, in distributed network, the node can get it in another manner, as each node in the receiving field transmits its packets to its neighbors.

F. Power Collection capability Clustering

Another method is applied to improve clustering efficiency [12] in WSNs, which is called the power collection capability. Nodes with energy capacity can produce energy from different sources, such as water, sun and air, etc. As nodes are loaded over and over again through conventional energy sources, so they will never be lost. However, because of multiple infrastructural constraints it is not possible to incorporate energy capacity in all nodes of a WSN. Thus, energy-recovery nodes are spread uniformly across wireless systems. CH cannot be used as the nodes with harvest capacity, since their energy source is not reliable and extremely dependent on nature. But these nodes can be used as relay nodes between the head of the cluster and the base. In its paper, author suggested single cluster algorithm. This algorithm chooses the best CH position. The head of the cluster must be selected so that its battery life can be maximized. The impact of installing the relay knots between CHs and base stations was then noted. There has been an algorithm that has taken advantage of the node used to collect energy, which improved the network's life by roughly 8.59 per cent. The ordinary concept of network life[13]is that the time it takes is only now dead on the network. This idea does not however go well with the lifetime of the WSN. Because wireless sensor nodes are energy-related. Instead of CHs, CHs consume heavy power, using relatively less power than CHs. In terms of time, a cluster has functioned correctly for the network life of a WSN network can be better described. However, the only way to evaluate network performance is by using network life. Additional variables, such as information collection, play also an important role. Tianqi Wang, Wendi Heinzelman and Alireza Seyedi [13] proposed "The maximization in information collection in clustered wireless networking networks in order to maximize the quantity of information that is collected

during the life of a network has been suggested

G. Energy Efficient Hierarchical Clustering

Energy Efficient Hierarchy Clustering [14] represents a clustering probabilistic algorithm. Algorithm was a various hope architecture version of LEACH expanded. Every node chooses first whether or not it could become a head of the cluster. It advertises its existence to all its neighboring nodes when it became a CH, node (non-CH) receive the message and send the request for join to CH. After joining the CH, sensor node send the data CH and CH send the aggregate data to the base station. Applying this methodology the life time of network increased. Every round of sending and receiving the message to the BS the role of CH changed on the basis of residual energy.

H. Weight-Based Clustering Protocols

Weight-based clustering (WBC) [15], [16] is a clustering method commonly used in heterogeneous systems. CH selection in weight-based clustering is based on the weight of SN of the network. Weight is measured on the basis of various parameters like energy, distance of node. Each cycle of clustering node compute its weight. On the basis of weight, Clustering take place in such a manner that least energy utilization follows in WSN. It chooses the better node heads and hence improves WSN's lifetime and throughput with its successful clustering calculation. The goals of WBC are as per the following:

- To increase the life of sensor nodes by choosing sensor nodes with elevated remaining energy.
- To prevent choosing low-powered SN as CHs.

WBC calculation selects CH in such a way that CH consistently has the best remaining energy. Remaining energy is energy left in a node in the wake of playing out its preparing and data transferring functions. It avoids selecting low powered SN as CHs. It overhauls the WSN's lifetime. Residual energy and distance from base station is another way to find the CH in group. A SN is regarded dead if its energy falls below a specific threshold level. After each clustering round, each node broadcasts an "I am alive" message. Thus it calculates each node's amount of live neighbors. Then, using the first order radio power model, it calculates the remaining power of each node. The node with the greatest remaining energy is chosen as the head of the cluster. But this system has a disadvantage in choosing additional CHs unnecessarily. As CHs take more energy, it degrades the network's effectiveness somehow.

I. Fuzzy based Clustering

Fuzzy is incorporated for energy efficient clustering[17]–[19]. Mehra et al. [20] proposed FBECS. In this algorithms they talk about the cluster head selection scheme with the help of various parameter e.g energy, distance, node density .all these parameter set as a input for FIS (Fuzzy Inference System) for CH selection. This protocol also tells about the load balancing of network through cluster formation. In conclusion the experimental outcome has endorsed the better performance in terms of stability period [21], increase the life span of the WSN and transmit more and more sensed data to sink.

J. Energy Aware Hierarchical Clustering

Ke et al. [22] have proposed NEAHC. This routing protocol have two objective: first one is to minimize the energy consumption for increasing the life time of network using different parameter and second one is ,this protocol provide the surety to maintain the energy level among the sensor node. They have also formulated the evolved algorithm through experimental works to increase the life time of network.

K. Cluster Chain Weight Clustering

Mahajan et al. [23] have proposed a CH weight selecting model labeled as CCWM. They have also use a various parameter to improve the network life time .in this model first CH selection then cluster formation .CH selection based on weight matrices. This model satisfies two issue, energy conservation and load balancing of a WSN. To reduce the cost of simulation and communication, consider clustering approach. This model is very important as compare to LEACH and M-LEACH in terms of energy consumption and network longevity.

VI. CONCLUSION

Some clustering approach uses unnecessary used of CH .they maximizes the complexity of a network. Compared to other clustering methods, there are few limitations like sensing power, energy, processing speed etc the more effective clustering approach is Weight based clustering. This is the best approach in all clustering methods. Clustering method based on weight is more effective; minimize the energy consumption of a network.

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