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Neural Network based LEACH Clustering Algorithm in WSN

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Abstract - Wireless sensor networks (WSNs) are very popular in the real world applications such as battlefield monitoring; estimating traffic flows, monitor the natural phenomena, environmental changes etc. The limited size of battery is the main drawback of WSN. When the battery is exhausted then the several nodes die and of no use. To remove such type of failure in the network, many researches are carried out in the energy saving scheme. Clustering is the main issue in the wireless sensor network because it enhances the network lifetime. Many optimization techniques applied while selecting the cluster head selection. Here, we present survey on the neural network based clustering concept which enhances the network lifetime of the network.

Keywords - *Wireless Sensor Network, Clustering, Neural Network.*

1. Introduction

Wireless sensor network [1] is gaining popularity to its crest today, since the users want wireless connectivity irrespective of their geographic position. A wireless sensor network of spatially distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound, pressure, etc. Wireless sensor network should be able to provide fast, secure and reliable multicast communication in Environmental/Habitat monitoring, Acoustic detection, Seismic Detection, Military surveillance, Inventory tracking, and Medical monitoring. Sensor network mainly consist of small or large nodes called the sensor nodes. These nodes are varying in size because in the each application they have their own sensors. The approximate cost of sensor nodes is 20K but they vary application to application. Energy consumption [2] is the main issue in wireless sensor network. Several routing protocols have been designed in the wireless sensor network. They are based on flat based or data centric routing protocols, hierarchical based or we can say cluster based routing protocol and third one is location based routing protocol. In flat routing protocol, all the nodes have same functionality.

In the hierarchical routing protocol, the higher energy nodes are used for processing and lower energy nodes are performed the sensing operation and in the location based protocol, as the name justify we sense the nodes with their respective location.

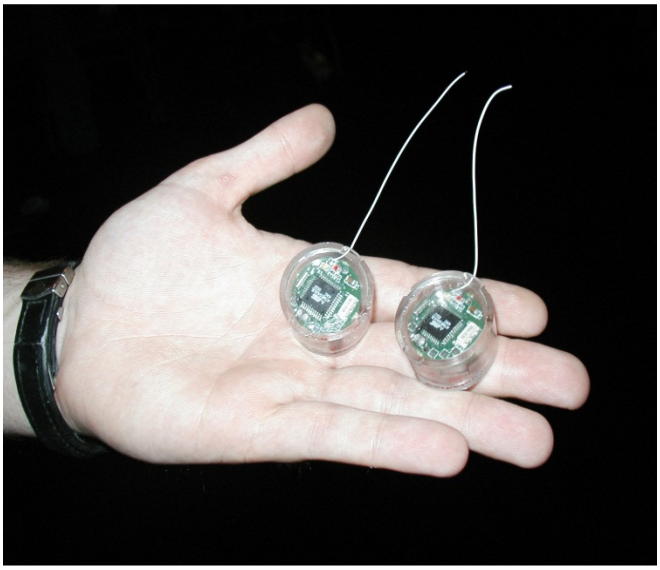

Fig 1. Sensor node

In the WSN, we have several terms which are the main parts of WSN. They have been classified as the following:-

1.1 Sensor Node

It is the main component of WSN. It senses the whole data and stores it and also defines the route with the processing of data.

1.1 Clusters

The smallest units in the wsn, used to simplify the tasks by the communication process.

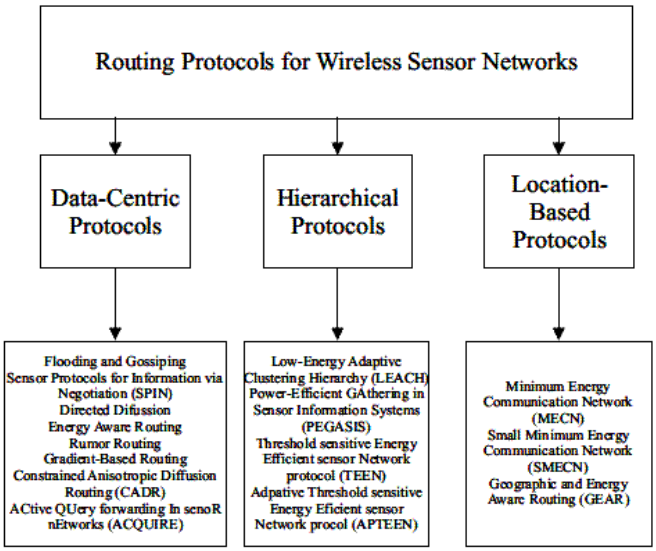

Fig 2. Structure of WSN Enviornment

1.3 Cluster Heads

Cluster heads act as the monitors among sensor nodes. Sensor nodes send their data to cluster head and cluster head aggregates that data from the sensor nodes and also remove the duplicity and further send it to the base station.

1.4 Base Station

It is the central part of the entire WSN, also called it as sink, The main role of the base station is to collect the data from different cluster heads. The position of the sink is static as well as moving. The movable sink is moving on one axis at a time.

1.5 End User

The data in a wireless sensor network used for a wide-range of applications and a particular application uses the data over the internet, or even a desktop computer. In a queried sensor network (where the required data is gathered from a query sent through the network). This query is originated by the end user. The clustering techniques play the main role in the entire network and affect the network performance, stability period based on several issues.

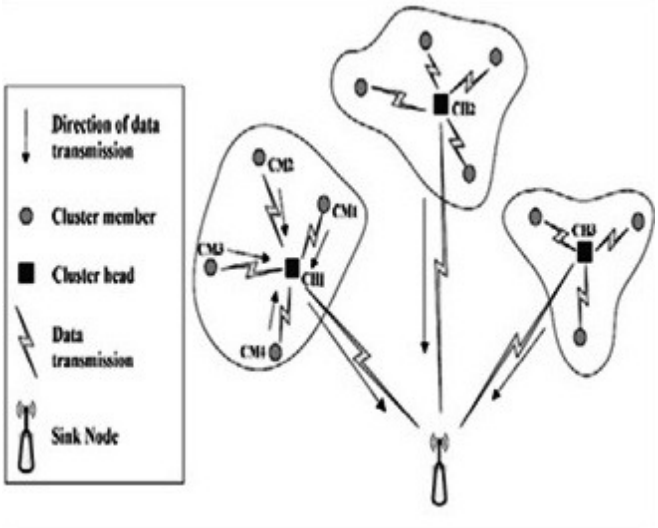

Fig 3. Nodes are organized in independent clusters

2. Clustering

Clustering [3][4] is the main issue of the wireless sensor network as they enhance the network lifetime by reducing the energy consumption. A wireless sensor network may be scalable by using the clusters. Monitor of the cluster is known as cluster head. The cluster head is selected by the sensor nodes or pre-assigned by the designer of the network. Many clustering algorithm[5] have been designed in WSN for scalability and efficient communication. The main idea of cluster based routing is utilized to perform the energy efficient routing in WSN. The clustering formulas are produced is dependent on homogeneity and heterogeneity of sensor nodes. The Maximum clustering approach is for the heterogeneous nodes.

2.1 Clustering Advantages

- It reduces the size of the routing table by localizing the route setup.
- It conserves the communication bandwidth.
- Cluster head enhances the battery life of the sensor nodes and the lifetime of the network as well as optimized management strategies.
- Clustering also cuts on topology maintenance overhead.
- Cluster head performs the aggregate operation from several nodes and also remove the duplicate data.
- A cluster head also reduces the rate of energy consumption.

2.2 Cluster Properties

To study the cluster properties, several relevant attributes have been studied. They are following in terms:-

- **Cluster count**: - The selection of cluster head is predefined in many approaches. Cluster head selection algorithm is generally pick the CH from the deployed sensors.
- **Intra-Cluster Topology**: - There are two type of communication: - inter and intra communication. When the communication is direct between the sensor and cluster head called the intra-communication and otherwise inter communication is required. Intra is called within communication and inter is outside communication.

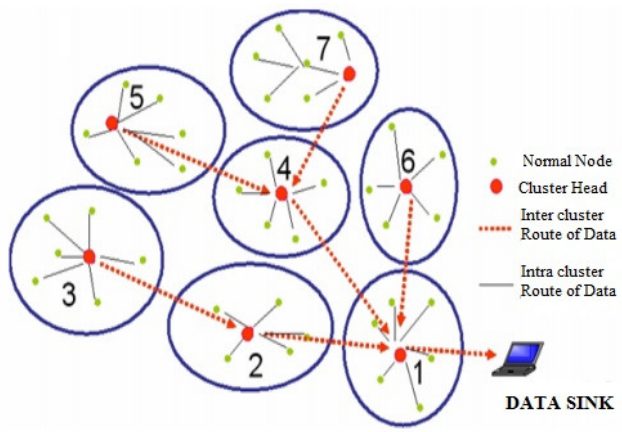

Fig 4. Inter and intra cluster route in WSN

- **Connectivity of CH to BS:-** The cluster head send their data to the sink directly or indirectly with the help of cluster heads called single-hop communication or multi-hop communication.

2.3 Cluster Head Capabilities

To select the cluster head, the following factors have been classified:-

- **Mobility: -** Two types of cluster head is found in nature. the first one is stationary[6] and other one is mobile. In many cases, the cluster head is stationary but sometimes it is movable in nature .the cluster head moves within a limited region for repositioning themselves. The cluster head is movable for the better performance of the network.
- **Node Types: -** Sensor nodes are deployed in the environment and based on properties we select the cluster head from these nodes. The nodes which have more computation and communication resources are selected as cluster head.
- **Role: -** the main role of the cluster head are relaying on the traffic, aggregation or fusion of the sensed data.

2.4 Cluster Head Selection Criteria

- **Initial Energy: -** It is the main parameter of the entire wireless sensor network. When any routing protocol starts their work, always consider the initial energy factor of sensor nodes.
- **Residual Energy:-** When some rounds are completed, them the selection of cluster head is based on the remaining energy in the nodes.
- **Energy Consumption Rate:-** The energy consumption rate is calculated by the initial energy subtracted from the residual energy of each node divided by current round.
- **Average Energy of the network:-** This is the reference energy of the network. It is the ideal energy of each node in current round to make the network alive.

3. Leach

LEACH[7] (Low Energy Adaptive Clustering Hierarchy) is an adaptive clustering routing protocol. It is a kind of self-adaptive cluster-organized topological algorithm. Nodes organize themselves into clusters; one node in every cluster would acts as cluster head (CH). The operation of LEACH is broken up into rounds, where each round begins with a set-up phase when the clusters are organized followed by a steady state phase when data are transferred from the nodes to the cluster head and on to the BS.

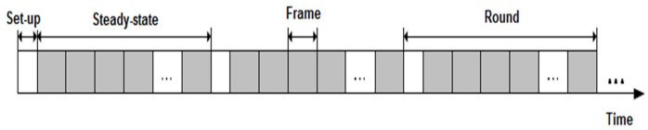

Fig 5. Phases of leach protocol

The steady-state phase duration is usually much longer than set-up phase duration. However, the first phase is more important, in which sensor nodes are allowed to elect themselves as cluster-heads randomly, and then divided into clusters. Each node that becomes the cluster head (CH) will create a TDMA schedule for the sensor nodes within the cluster. That allows the radio components of each non-CH node to be turned off all times except during their transmit time. The selection of CH depends on decision made by the node by choosing a random number between 0

and 1. If the number is less than a threshold), the node becomes a cluster- head for the current round. The threshold is set as

$$T(n) = \frac{p}{1 - p * \left(r \bmod \frac{1}{p}\right)} \; if \; n \in G$$

0 Otherwise (1)

Where P is the desired percentage of cluster heads (e.g. =0.05), r = the current round, and G is the set of nodes that have not been cluster-heads in the last 1/P rounds. Using this threshold, each node will be a cluster-head at some point within 1/P rounds. Nodes that have been cluster heads cannot become cluster heads for a second time for P rounds. After that, each node has a 1/p Probability of becoming a cluster head in every round. At the end of every round, every node that is not a cluster head select the nearest cluster head and joins that cluster to transmit data. The cluster heads combine and compress the data and forward it to the base station.

Problems within the LEACH protocol are following:-

1) The cluster head node is randomly selected in LEACH protocol. There are some shortcomings attributable to the likelihood of every node to be selected as cluster head is same. After numerous rounds, the node with or containing greater remaining energy and the node with smaller remaining energy have same likelihood or probability to be chosen as cluster head. If the node which has smaller remaining energy is chosen as cluster head, it'll run out of the energy and more die quickly, due to which network's robustness can be affected and life of the network become short.
2) The standard LEACH Protocol divides clusters randomly, additionally results in uneven distribution of clusters simply. Eventually the divided clusters might not be the simplest or best. As an example some clusters have a lot of nodes than others whereas some clusters have fewer nodes. Some cluster heads within the relatively central of clusters whereas some clusters heads may be in the edge of clusters far away from members. These phenomena will cause increase in energy consumption and make harsh impact on the total performance of the network.
3) In steady state, cluster head usually send information to the sink or base station directly, Cluster head that is farther from the sink communicate with the sink directly mostly spend a plenty of energy. Thus it'll crash earlier as a result of it runs out of energy, it effect on the network life seriously.

In order to overcome these problems, in this paper, we use neural network for cluster formation.

4. Literature Survey

S. Mottaghi et al. [2015] proposed an algorithm that mixes the utilization of the LEACH clustering algorithm, MS and rendezvous factors (RP). Simulation benefits indicated that this technique is more efficient than LEACH in terms of energy usage, especially in large regions. The lower energy flexible clustering hierarchy (LEACH) algorithm can be an efficient clustering algorithm where nodes inside a chaos send their information to a local chaos head. Some researchers recommend a portable sink (MS) as an easy way to cut back energy usage and a rendezvous node (RN) to behave as a store point for the MS.

Yu Gu et al. [2013] discussed a good framework for examining this mutual sink mobility, redirecting, delay, and therefore on. Then, we generalize these alternatives and propose a polynomial-time optimum algorithm for the source problem. In simulations, they showed the benefits of concerning a portable sink and the impact of system variables (e.g., the number of detectors, the delay destined, etc) on the system lifetime. Moreover, they examine the effects of different trajectories of the sink and provide essential insights for designing mobility schemes in real-world cellular WNNs.

Wang Liu et al. [2012] proposed an over-all MADC model which includes many essential variables such as for instance the number of cellular sinks, the velocity of a portable sink, and the traveling journey of a portable node. Then build a thorough theoretical approach to obtain the achievable throughput capacity and lifetime. By applying the proposed approach, they investigate the behaviors of WSNs with a number of cellular sinks. Our evaluation not merely shows how a WSN with cellular sinks can outperform a static WSN but in addition offers insights on how can regulate the MADC variables to boost the data selection charge and to maximize the lifetime.

Pantziou, G. et al. [2013] proposed project aims at minimizing the overall system expense and energy expenditure associated with the multihop information access method while also ensuring healthy energy usage among SNs and extended system lifetime. That is reached through making chaos structures contains member nodes that path their calculated information with their assigned chaos head (CH). CHs perform information selection upon raw information exploiting possible spatial-temporal information redundancy and ahead the filtered data to appropriate conclusion nodes with sufficient extra energy, located in

vicinity to the MS's trajectory. Simulations benefits verify the potency of our approach against in addition to its efficiency obtain over alternative methods.

Melese et al. [2010] effort has been prepared for balancing the energy use throughout the system in order that survival time of all nodes may increase. Optimization of the ability use has been concentrated by getting consumed energy as an important factor for standards of cluster head selection. Energy use factor have contributed more effortlessly in improved system entire life of WSN as opposed to extra energy. By considering energy use, new system has been planned to calculate tolerance value. To be able to enhance energy use and increase system life time, it is required to stability energy among nodes.

5. Neural Network

Neural network consist of parallel or distributed processing components called neurons which are connected in the form of graph topology. All these neurons are connected via weighted connections which are called synapses. These weighted vectors called synapses connect the network input layer to the output layer. The knowledge of neural network is stored on the weights of its connections so that's why the neural network does not need any data storage.

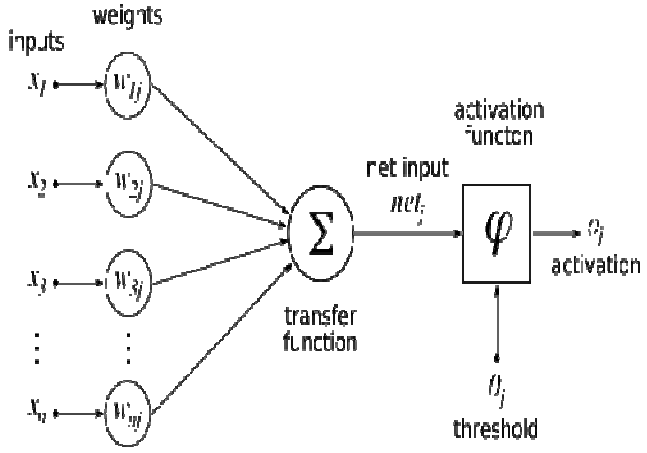

Fig 6. Structure of Neural network

Neural network[5] are the arithmetic algorithms which learns the complicated mapping between the input and the output according to supervised training and also classify the input data in a unsupervised manner. One of the problems occurring while using NN is topology. The different type of training rules especially inspired from biology science determines the way of NN to learn. In NN, the training is totally based on learning by example. A set of correct data of input and output is given to the network, and the network change the weights values and produce the new correct output, we called it as learning. One of the major property of NN is to find the affected data by noise and remove variations after learning. The capability of neural network is depend upon its structure, dynamics and training rules. The main application of neural network is prediction, classification and identification.

5.1 Advantages of the Algorithm

- Used to perform nonlinear statistical modeling.
- Requiring less formal statistical training.
- Ability to implicitly detect complex nonlinear relationships between dependent and independent variables.
- Ability to detect all possible interactions between predictor variables, and the availability of multiple training algorithms.

5.2 Disadvantages of the Algorithm

- Its "black box" nature.
- Greater computational burden.
- Proneness to over fitting.
- Empirical nature of model development.

6. Conclusion and Future Scope

This paper concluded a survey of the most important application of neural network. The main purpose of the study is to select the cluster head which aggregates the data and send it to the sink by the use of neural network which enhances the network lifetime. The learning factor is the important factor in neural network. The neural network is the intelligent tool which deals with the problem associated in sensing and processing data at the end of sensor node. The most important application of NN is data prediction, data fusion, path discovery in routing and nodes clustering which lead to less communication cost in WSN. In the future work, more concentration is on network topologies and on the energy conservation.

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