Network Lifetime Enhancement in Wireless Sensor Networks Using Energy Aware Clustering with Fuzzy System

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Abstract. The lifetime of the network states that the failure time of the initial network nodes or if the building blocks of WSN modules in the network runs out of power. The successive exchange of messages leads to power loss and burdening of sensor nodes. It reduces the network lifetime. This paper presents the energy aware clustering algorithm along with fuzzy to contemplate the residual energy. In cluster based wireless sensor networks, the cluster head gathers all kind of information from each node and has the responsibility of passing of the collected data to the various destination nodes. It diminishes the message overhead, delay, increasing packet delivery ratio and enhancing the lifetime of network.

1. Introduction

Wireless sensor networks can be defined as the communication of gathered information through the wireless links by network of devices from the monitored field. Wireless sensor network (WSN) have long range of implementations in various areas namely monitoring of traffic, medical care, exploration of robotics and surveillance of agriculture. In WSN, the successive exchange of messages causes burdening of sensor nodes and increases the energy expenditure.

The cluster heads are sorted to pass the data to the destination nodes to lower the delay and power conservation. The network contains collection of sensor nodes which forms the cluster. Clustering is known as the process of partitioning the nodes into the number of groups such that the similar nodes are in the same group and the dissimilar nodes are in the other group.

![Fig.1 Wireless sensor network](image)

Fig.1 shows that the cluster heads are chosen among the group of similar nodes of clusters in the network. The data is dispatched to the cluster head from each network nodes which has the
responsibility to transmit the information to the corresponding cluster head which is the destination node through the medium of base station. Such that it minimizes the energy and the time consumption during the transmission of data.

Need for clustering:
- To deal with the noisy data
- Scalability
- Interpretability
- High dimensionality.

The node which has the high residual energy is said to be the cluster head node. The remaining nodes are the neighbouring nodes or the ancillary nodes.

2. Related Works
In existing technique, the modified approach of clustering is used along with machine learning. In [1] energy distance aware clustering computation is worn to build the clusters by adjusting the clusters using fuzzy interface system. Fuzzy logic is employed to handle the partial truth concept. Machine learning is the artificial intelligence subset which is involved in creating the algorithms which modifies itself without any human interventions to provide desired output by structured data feeding by itself.

![Fig.2 K-mean clustering algorithm](image)

For every clustering process, the header node enumerates its neighbouring refurbish cycle by the fuzzy interface approach. If there exists a miniature data rate, the lengthened update cycle is considered. If there arises large variations in the data rate, smaller updated cycle is considered. The distance of the node from the access point and the previous cycle mean rate concludes the adjacent upgrade cycle of the header node. For the lengthened time, the header node with the less residual energy does not scope up with its role. Such that the header node with the short duration of updated cycle is considered. The cluster members are broadcasted by the calculated update cycle. Input
A variable can be defined as the range of very low to very high. The readings from sensor node at uniform interlude are categorized by the cluster member depending on their similarities. The machine learning classifiers trains and tests those characterized samples so that it builds the machine learning model. It helps to categorize the consequent samples by classifying and recognizing the new samples. The cluster head receives the dissimilar data and the similar data are sent to the constituent header node currently.

For the purpose of better outcome various machine learning model classifiers are taken into consideration. KNN classifiers are used for solving of regression and classification. It assumes that close proximity exists in the similar things. The machine learning requires large data to train, it must be of good quality and inclusive. It requires sufficient time to learn and develop to satisfy considerable accuracy and relevancy of the algorithm. It has the major challenge to accurately elucidate the algorithm results. Machine learning is highly susceptible to errors. For the process of relay mote stationing the author [2] delineate the novel connectivity aware approximation algorithm which introduced local search approximation algozum to clear up the problematic low power eNodeBs solitary coverage. Low energy adaptive clustering hierarchy where the probabilistic threshold value elects the cluster head node on rotation manner [3]. The author [4] uses a semi distributed clustering approach for upper level head selection by the consideration of centralized gridding. Extensive self-sustaining tree-based energy balanced protocol which measures the broken sensor with the amount of overlay neighbouring nodes [5].

The collaborative encoding and data transmission of sensors is done by using encoded sensing approach that it would drastically diminish communication disbursement in WSN. At the minimum 80% of energy saving is achieved by encoded sensing [6]. [7] Uses load aware rotation of cluster head which sets a dynamic threshold and reduces the premature cluster head death. In [8], with the particle swarm optimization cluster head nodes are determined. The author [9] uses wireless body area network and it pertains to coexistence, fault tolerance and power consumption. The author [10] uses fuzzy logic-based clustering technique with energy predication for even distribution of the workload and can be applicable to wireless sensor network.

The author [11] uses residual energy to elect the cluster head and uses three phases to outperform the alive nodes, average remaining energy, throughput, one way delay with the event-based routing protocol. Energy efficient clustering method using random update, preliminary clusters are divided based on spatial and temporal correlation. It uses cluster head rotation scheme and thee dynamic updated policy [12]. The cluster head is elected using hybrid power efficient distributed clustering based on hybrid residual energy, it ends o[1] cycles and low message overhead. It uses cluster head election approach to optimize energy and delay. The hop count is used to determine the trade off computation between power and delay [14]. Depending upon the process of cluster head election novel energy entropy is done in wireless sensor networks, by using entropy metrics, stable cluster head are selected with the new metrics of node stability [15].

The cluster head nodes are selected using low energy adaptive clustering hierarchy and makes the minimal power consumption [16]. To achieve load balancing, rounds are established by splitting the network operation into stable time span. The efficacy of FHRP in decreasing the clustering power overhead is revealed by the simulation outcome [17]. Functionalities of network and reduction in hardware costs of sensors is simplified by low energy adaptive clustering hierarchy. It outperforms the total transferred bits, network lifetime and energy dissipation rate [18]. This network node power is equalized into two phases when compared with the existing algorithm. It consists of the network lifetime as long [19]. The author [20] indicates that the categorization of smart phone implementation’ is done by using ML classifiers and the levels of interchange in background is dependent on the network traffic.
3. Framework methodology

In order to overcome the clustering overhead and high energy consumption, energy aware clustering algorithm is proposed along with the fuzzy. This method constructs the even sized clusters to maintain the energy utilization among the members of clusters. The forwarding tasks in the scarcely covered areas are increased by forcing the higher energy cluster nodes and next hop as few member nodes to achieve load balance among cluster heads. Each node has to send and receive data transmission process. The network node shifts between transmitting and receiving states during the process of transmission of data. At the time of data transmission, the sensor nodes consume energy.

Let the distance between sending and receiving ends be “d”. The transmission model will be embraced if the value of d is less. At first, the nodes are classified into different cluster using cluster based hierarchical routing protocols. Each node has different initial energy and the numeral of nodes present in the network. The cluster must have the communication costs between every node in the cluster. The member nodes which are close to the cluster head are added to the cluster. The information are sent from the nodes to the cluster head based on free space channel method.

When the cluster heads are selected at irregular manner, it results in high density of them in one area and few or no cluster heads in other areas. There may be uneven distribution of cluster head in the system. The cluster head broadcast the request to other nodes in order to join the clusters after the cluster head nodes in one iteration of communication is elected. The cluster head nodes receive the messages by the process of selecting the nearby cluster to get in link with the cluster until the process break off. There are more than one energy levels present in the sensor nodes; which consists of cluster head (CH) node and several non-cluster head (non-CH) nodes, which are known to be normal nodes this system routing model is based on a hierarchical routing protocol, the initial energy level of each nodes varies from one another. At the first stage, the data which are sensed by the normal nodes are transmitted to their respected cluster head, then the process of data fusion takes place at last the received information is forwarded to the Access point (AP).

In the process of data transmission each sensor node must receive and send information. There is presence of a single receiver and an emitting component which is known to be the emitter and in addition to that a powerful amplifier is present in the simplified sensor node in accordance with the power conservation. To identify that the sensor node is in receiving or radiating state at any instant time of transmission it keeps on switching from one state to another state. The energy is consumed by the sensor node during this process of absorption and radiation. While the emitter and power amplifier is in working state the energy is consumed by emitter. The receiving and sensing end are separated by a distance d, the free space transmission model is adopted if the value of d is small.

The process of combining the cluster are done by sending request to other nodes from cluster head node chosen in one communication cycle. Then once the non-CH messages are received the selection of nearer cluster to merge is done continuously until there are nil existing nodes. The data transmission stage is the other name for working stage. The CDMA data stream is transmitted from CH to start the action of acquisition of data so that the node members will be notified.

Once the procedure of digital communication is finalized, the formation of a novel cluster is formed which is done by commence of algorithm into the next CH election repetition. A broadcast is sent to the member nodes from the CH indicating the collection of data is started in working stage. Then the particulars which are received by the member of cluster are forwarded to the recognized CHs during this activity. When the complete details are received, the noise in the signal is reduced by integrating the CHs. Grouping of customers who resemble obtaining patterns present in alike cluster is known as the approach of clustering. The clustering process reveals the pattern organization into sensible groups, which allows us to find similarities and differences, as well as to derive the fruitful conclusions about them.

This idea is applicable in various fields of life, medical sciences and engineering. The problem of clustering is about dividing the given set of data into various categories, such that data points in the
clusters are more resemblant to each other than points in contrasting clusters. Clustering reduces the data transmission among the different nodes. It increases the efficiency of packet delivery ratio and the conservation of power in processing and transmission of data. Based on the high residual energy cluster head nodes are elected. When it retains the energy after the data transmission then it is said to have high residual energy. Such nodes are said to be cluster head.

The cluster head is chosen among the neighbouring nodes based on the residual energy. The cluster head collects the data from its ancillary nodes and transmits the data to the destination node via the base station. The data transmission from the individual nodes causes high energy depletion. The cluster head transmits data to the corresponding destination cluster head such that it reduces the energy and time utilization.

4 Performance Metrics
The network parameters considered are energy consumption, throughput, delay and network lifetime.

4.1 Network lifetime (Number of nodes Vs Lifetime)
Failure time of the first sensor node. It can also be referred as the clump of sensor nodes available in the network drain out of energy. The graph depicts the number of nodes versus its lifetime
4.2 Throughput (Number of nodes Vs Data transmission)
Rate of production or the rate at which something is processed is meant to be throughput. The graph depicts the number of nodes versus its amount data transmission.

4.3 End to end delay (Data transmission Vs Time consumption (ms))
Time taken to transmit the packet from source node to destination node across the network is said to be end to end delay. The graph depicts the amount of data transmission versus time consumption.
Figure 6 End to end delay (data transmission vs time consumption in ms)

4.4 Energy Consumption (Number of nodes Vs Energy consumption (mJ))

Energy is referred as the capability to do something. Figure 7 depicts the number of nodes versus and its energy consumption.

Figure 7 Energy consumption (number of nodes vs energy consumption in $10^{-3}$.)

The output can be viewed in the NAM (Network animator) window. The NAM is used for tracing real world packet and network simulation. It is a TCL based tool for animation. It supports layout topology, animation on packet level and inspection tools of various data. An OTCL file is a configuration file in NS2 which is known as TCL simulation script. This window helps to view the animation of sending of data from one cluster head to other cluster head which is the destination head node. The data are passed among the cluster head via the base station. The animator clearly depicts that the cluster head is chosen among the sensor nodes. Each sensor nodes sends its data to the cluster.
head node. The cluster head node collects and gathers all data and transmits to the destination cluster head node. If each node sends data to their corresponding nodes, it results in large energy consumption and reduces the throughput. The ratio of packets sent from the source node to the received packets in destination node is known to be the packet delivery ratio. In order to increase the energy efficiency, cluster heads are chosen for the data transmission.

5. Conclusion
The proposed method increases the lifetime of network, improves the throughput, reduces the power utilization, end to end delay and increased packet delivery ratio. The wireless sensor network is effectively applied with the cluster head selection protocol. The problem faced in the selection of cluster head has been solved in the proposed system. The energy depletion model with the wide system is established. The minimum power consumption is determined by the optimal number of systems. The cluster head nodes are selected on the basis of the maximum cluster head coverage. The replacement of cluster heads in the next cycle of communication is done due to occurrence of higher energy conservation. The persisting nodes of each cluster unite with its nearest cluster and transfers its data to the cluster head node. The single communication iteration is completed when the cluster head node sends data to the access point after fusing the data of every individual node. In order to ensure load balancing among the sensor nodes, energy consumption is balanced by changing the cluster head node periodically. This technique achieves the scalability and effective communication. By grouping the network into clusters, the unwanted power consumption in delivering data to the base station is reduced by the clustering algorithm.

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