A Hybrid Clustering based on Overlapping and Dual Path Routing Technique for Improving Life time of Wireless Sensor Networks

R.K.Krishna, B.Seetha Ramanjaneyulu

ABSTRACT--- It is known that Clustering and Routing along with appropriate Node placement substantially improves the overall lifetime of wireless sensor network. Optimized clustering and routing technique along with intelligent node placement is a good technique for reducing energy consumption and prolonging the lifetime. In this paper combination of different techniques have been used for setting an up a model that substantially prolongs the lifetime in Wireless Sensor Networks. In this model clustering is implemented using the overlapping concept and routing is done by selecting the two best paths based on the calculation of the reluctance and distance. Data is transmitted using both the paths. Simulation results indicate that the results obtained by the proposed method are better in comparison with the existing techniques

Keywords— Optimized Clustering, Routing, Intelligent Node Placement, Energy Consumption, Lifetime, Wireless Sensor Networks, Overlapping Concept, Reluctance.

I. INTRODUCTION

It is widely known that wireless sensor networks consist of many numbers of sensors whose purpose is to sense the events and transmit data to the sink. As the sensors are generally distributed in hostile regions randomly over unpopulated regions and they cannot be recharged it so happens that the network dies down even when 90% of battery is exhausted and further data cannot be transferred.Thefore a major issue of concern is to prolong the lifetime of wireless sensor networks by reducing energy consumption and balancing the networks. This can be done by appropriate node placement, selection of a proper cluster head, increasing the life of the cluster heads, and suitable techniques of data transmission.

In the existing techniques, as proposed by Bo-Chao Cheng in [1] the node that has higher energy in a cluster is chosen as the cluster head. This helps in prolonging the lifetime of wireless sensor networks. But the disadvantage of this system is that once the energy of the cluster head is exhausted the network tends to breakdown. Rotation of Cluster heads randomly has also some drawbacks. If a weak node becomes a Cluster head then also the network is weakened when the energy of this cluster head is exhausted. As is known the nodes are distributed randomly throughout the network.

Usually the nodes that are closer to the sink consume more energy as compared to the nodes that are at a distance from the base station. The reason for this is that the nodes nearer to the sink are more frequently used either as relay nodes or as Cluster heads for collecting the data in comparison to nodes that are away from the sink as in [4]. Moreover it is also preferable to have sensors nearer to the sink spread out densely as compared to nodes which are away from the sink which can be sparse as energy requirements for faraway nodes are less. These considerations are not always being taken care of in existing techniques.

Also nowadays the researchers are attracted towards optimization techniques which mimic the animal behavior. These methods include Particle Swarm optimization (PSO), Ant colony optimization (ACO), and BEES optimization Algorithm (BOA) etc. as in [5]. But the problem with the behavior of the animals is their predictability and difficulty in adapting to new problems that arise from time to time.

It is also most important to consider the POI (Point of Interest) where it is necessary that every POI should be taken care of and monitored [6]. Also due to the diversity of applications and complexity of sensor deployment all the requirements are not satisfied by one deployment technique. Complete coverage of all POIs in practice is very difficult to attain. It is also known that cluster heads generally consume more energy. This is because they not only have to collect the data from the other nodes but they also require sending the data to the base station through relay nodes. Therefore node density, residual energy, reluctance of the path, distance and location are all important criteria to be considered while designing the model. In most of the clustering techniques where clusters are formed in circles, the nodes which are outside the circles, there exists some ambiguity about the nodes which are outside the circles regarding the clusters they should join and to which cluster head it should transfer the data. This ambiguity is overcome in our technique.

In our proposed hybrid technique we have tried to overcome all these problems by including all the salient features of existing techniques and make our system a robust model that will be able to give us optimum results in terms of lifetime and efficiency as compared to the existing

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conventional and bio inspired techniques. In the technique we have considered optimum node placement by fixing the sink and distributing the nodes around the sink in such a way that the nodes which are closer to the sink have higher energy in comparison with the nodes which are away from the base station.

This increases the lifetime of the network. For Clustering we have used a new overlapping concept where clustering is done by using overlapping circles so that all the points are covered and the nodes that are overlapping are able to send the data to the nearest cluster head. Also sometimes these nodes can also act as Cluster heads and they collect data from both the regions and then transmit the data to the base station.

For the routing purpose we consider both the reluctance of the path and shortest distance path to send the data to the sink. We compute two paths one main path and another alternative path from the source to sink and both the paths are used simultaneously as shown in fig.1.This results in not only the improvement of lifetime of the network but also shows a marked improvement in the efficiency of the system.

In this paper we have compared the proposed work with the existing AODV routing protocol. Ad-hoc on demand distance vector (AODV) routing protocol is a reactive protocol. In this protocol routes are created only on demand. In this protocol Query and reply cycles are used to discover the required routes. And as is known the information regarding these routes is in all nodes in between the source and destination in the form of route table entries. There are four control messages that are generally used for searching of routes or paths. The first one is the Route Request (RREQ) message, the second one is the Route reply (RREP) message, the third being the Route Error (RERR) message, and the fourth one is the Hello message. During the initialization phase when route has to be discovered the source node transmits the RREQ message to all its neigbors.Of all the neighbors if any neighboring node has the capability to transmit the message to the destination it replies with a RREP message. Another function of the AODV protocol is to monitor the operation of the route that is being used. When a link is broken the process for the search of rotes is reinitiated and the source node will then transmit a RERR message to the other nodes .This RERR message contains list of destination nodes that cannot be reached due to loss of connectivity and it removes all such routes.

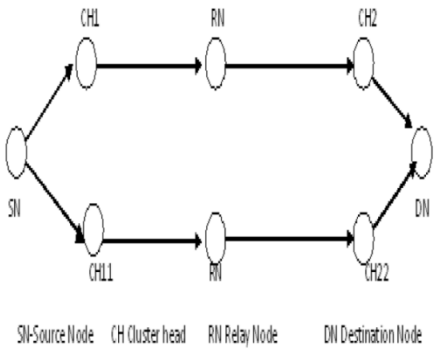

Fig.1.Data transmission through two paths

II. RELATED WORK

As is known, Clustering of sensors into groups is one of the most popular ways to improve the lifetime of the network. In [1], Cheng et al. propose the technique called High Energy First (HEF) clustering algorithm. According to the authors this method has proved to be an optimal clustering policy which can be adopted under certain ideal condition and is found to yield very good results. The core idea in this technique is that the node that has maximum energy is chosen to act as the Cluster head. The HEF technique is called a centralized cluster selection algorithm and is used in a distributed way to create a network centric energy view using the synchronization technique.

According to Delaney et al. [2] a stable route for transfer a data from source to destination is an important factor to be considered while designing of routes in wsns. They propose tree based routing structures for WSNs. The basic concept in this technique is to combine sensors current routing metric with its neighbors which can indicate the routing options available in case the current route becomes unavailable. This information is obtained from the new combined metric and helps in sensors in selecting good quality routes.

In [3] Sarma et al.propose a new routing protocol which has been found to be consuming lesser energy and having an extended lifetime. This technique offers some alternative routes for data transmission in the case of failure of existing routes. The intention is to send the data or packets using multiple hops which could minimize the the transmission energy at the sender node. Also some of the nodes which are not being used for transmission at a particular time are placed in a sleep mode. Later on these nodes may be used for data transmission. After the nodes are placed as per requirement, the base station creates clusters which are grouping of nodes. Each cluster may contain a few nodes. The base station selects three nodes with highest energies for them to act as a panel of nodes which shall act as Cluster heads. When one Cluster head dies the next Cluster head takes over and when the second one dies the third Cluster head takes over .The remaining nodes will participate in data transmission.

In [4] Saivoshi et al. propose a clustering protocol that may be applied to adhoc wireless sensor networks. They propose a geographical multilayered clustering protocol. In the proposed protocol the authors propose variable size of clusters .According to them the size of the clusters which are nearer to the sink should be smaller in comparison to the clusters that are located at a distance from the sink. The reason for this is that the nodes nearer to the sink have heavier load as compared to the nodes away from it. This method is both distributed and decentralized. This method not only helps in improving the efficiency of the network in terms of energy in intercluster as well as intra cluster communications but also is able to overcome problems arising due to energy holes. This also results in increase in the lifetime of the network.

Tsai et al. in [5] discuss the lifetime problems in wireless sensor networks and how metaheuristic methods are being

used for finding better solutions so that these problems may be overcome. According to the authors the problems concerning lifetime in WSNs are complex because they are composed of sensors, systems and software and therefore a number of factors have to be considered and improved so that the overall lifetime of wireless sensor networks is increased. Lifetime enhancement has been discussed based on different perspectives. The first problem discussed was the alive nodes problem. The second problem that has been discussed is the Clustering problem. The third problem that requires an optimum solution is election of a suitable cluster head. The other important problems in sensor networks such as deployment coverage problem, set cover problem and data routing problem have also been analyzed in detail. According to the authors metaheuristic algorithms such as SA, TS, PSO, ACO and GA can be used for providing promising solutions considering the above factors.

In [6] Xuxun Liu describe node placement as one of the important and crucial issue that is instrumental in increasing the lifetime of the network. Here the author proposes deployment strategy for multiple types of requirements. He discusses three different types of deployment types. The goal of these deployment techniques is to achieve optimum coverage and connectivity. The purpose of this deployment is not only to reduce transmission and deployment cost but also to improve lifetime of the network. It is up to the user to select the type of deployment depending upon the user's requirement. Different approaches are used for coverage and connections. Here coverage is implemented using the probabilistic way whereas connection is implemented using the deterministic manner. The three deployment strategies use the same coverage method but connection mechanism is different. The first deployment called cost based deployment algorithm. This method after complete coverage adopts a deterministic search mechanism and does not use the random search manner which is generally used .This method not only helps in achieving full connectivity but also results in substantial decrease in length of deployment path, deployment cost and transmission delay. This method also improves the traffic load balancing. This is because nodes in different groups are connected by the shortest paths.

The second method called delay based deployment algorithm uses the notion of counterflow.In this technique deployment cost and transmission delay loss are calculated. This method also takes into account transmission directions. This helps in controlling and guiding the connection directions. This also reduces the length of the routes used for transmission and delay in transmission is also reduced substantially.

The third deployment technique called Life based deployment Algorithm .In this technique the load at each and every node is computed for the purpose of load balancing. In this technique the node distribution is based he actual load levels. Extra nodes need to be employed only when they are necessary.

In [7], Hari Prabhat Gupta et al propose a routing protocol which provides coverage based on demand and also preserves connectivity. In this technique coverage and connectivity are provided with separate mechanisms. The sensing range should be able to cover all FOI. Whether the communication radios in sensors should be turned on or off is dependent on maintenance of connections. The network lifetime is also divided into rounds. Every round is divided into decision phase and working phase. Initially all sensors are said to be in active mode. This will make them eligible to participate in the decision phase of the next round. The next step is the transfer of the data in the sensors to the base station. In the decision phase a new sensing range for the sensors is then set up. The decision phase consists of sensors being set to a new sensing range. The result is that all sensors will take part in connectivity maintenance phase. Backbone and relay sensors are turned on and the other sensors are turned off so as to conserve energy.

In[8] Jia et al. propose a method in which cluster head is selected dynamically for a Wireless sensor network which can overcome the problem of overlapping arising because of coverage overlapping and also if energy consumption is not balanced. In this method first the area to be monitored is divided into number of regions using the voronnoi diagram. Every region will form one cluster and cluster head will be selected from each region and this area must have the maximum number of redundant nodes. Thus the small cluster can maintain for long amounts of time by changing the cluster heads in the same region. The authors have proposed perception probabilistic model. The attenuation probabilistic model selects the nodes that are redundant. In this method if one cluster head dies, one of the redundant cluster head takes over as the cluster head. If a normal node dies then also a redundant node replaces the dead node. Thus the life of the network is increased.

In [9] Yuhan Hu et al. proposes an adaptive overlapping clustering technique which is efficient and saves a lot of energy. This method is applicable whenever wsns are required to be monitored continuously. In this technique called EEAOC sensors adjacent to each other are generally allowed to be grouped in the same cluster for the purpose of data fusion. This method helps in Cluster migration operation to take place which is done without disturbing the overlapping structure of the clusters. This process of cluster formation called two logical overlapping cluster formations is operated in three time intervals. In the first time interval clusters are formed. These clusters are non-overlapping. Each node is connected to the nearest cluster head. In the second time interval in these clusters overlapping regions are allowed to be formed. The count of the boundary nodes in each area that is overlapping is found out from the corresponding cluster heads. Also the boundary nodes are used for connecting the adjacent cluster heads. Finally in the third interval overlapping regions that are equal in size are allowed to be formed. Nodes that are in the overlapping regions are made to join one of the clusters. Finally communication between cluster heads is done using TDMA scheduling and every cluster uses different channels for communication. The data or information collected by the Cluster head is sent to the base station directly. This technique not only reduces interference among clusters but also reduces overhead.

In [10] the authors have implemented the AODV protocol using AWN that is Algebra for wireless networks. AWN is a newly developed process based on algebra and is specifically modeled for design of wireless mesh network protocols. In this paper the authors have chosen the modeling language AWN. This language has been uses a very easily readable pseudo code for defining the protocols. It also offers primitives such as broadcast. The advantage of this language is that it is implementation independent. This language is a variant of standard process algebras and the advantage of this process is that it allows error handling in case of communications that fail. It is possible to abstract link layer implementations of communication handling and incorporating data structures with assignments .

III. PROPOSED WORK.

The proposed work is a hybrid technique that utilizes all the salient features of some existing works with the purpose of building a model that not only improves the efficiency of the wireless sensor network but also improves the lifetime of the network. In this technique about 100 nodes are randomly spread in the region around a sink. As the nodes nearer to the base station have heavier load in comparison to the nodes that are away from it, the nodes in proximity of the base station given more energy in comparison nodes which are at a distance from the base station. That is as one moves away from the base station energy given to nodes reduces. This provides for good energy balancing of the network and helps in improving the network lifetime. Once the nodes are settled down then the next step is clustering. As is known Clustering is one of the techniques that helps the wireless sensor network to improve the efficiency by reducing the energy consumption. Here we are using a new concept of overlapping for clustering. Here circles are formed overlapping each other and clusters are formed and the nodes get fixed into the area of the circle in which the circles fall.

The advantage of overlapping is that all the points are covered and no point in the region is left uncovered. This also results in the nodes falling in the overlapping region resulting in the nodes becoming a part of both clusters. The nodes which are in the non-overlapping regions are aligned to the Cluster head of that region whereas the nodes falling in the overlapping region gets attached to the cluster head that is nearer the node. Sometimes if the energy of the node in the overlapping region is high it may itself become the cluster head transmitting data through the relay nodes to the sink. Once Clustering is done with the next step is selection of a Cluster head in each region. Here we propose a panel of three cluster heads that is nodes with three highest energies are selected as the first, second and third cluster heads. The purpose of three cluster heads is that if one of the cluster head dies the second cluster head takes over and if the second cluster head is exhausted the third cluster head takes over. But in our technique we are utilizing two cluster heads and two paths for transfer of data along these paths simultaneously from source to sink. The third cluster head is in the sleep mode and it can take over when energy of any one cluster head gets exhausted. This not only helps in prolonging the life of wireless sensor networks but also helps in transmitting a larger amount of data at the same time. Once Clustering is completed the next step routing that is to select the best route for sending data from source to base station. In the proposed technique the path that is followed for the transmitting of data is from the source to the Cluster head and from the cluster head the data is sent through the relay node to the sink. The two factors that have been considered for selection of the path are energy and distance. The energies of all the nodes between the source and sink are computed. Also distances of all the nodes to the destination are computed. Then for all nodes between source and sink, the node that has the highest energy and minimum distance to the destination is selected as relay node. For transmitting the data the first of the three Cluster heads is used. In the proposed technique a second or an alternative path is also established. The data is transmitted through the second path also using the second set of Cluster heads. The data can be transmitted simultaneously using both the paths so that maximum data is transmitted and also because both the paths are used the life of the wireless sensor network increases.

The steps in the proposed algorithm are as follows

1) All the 100 nodes are spread in a square area of the size 300m×300m randomly.
2) All the nodes are given energies with the nodes nearer to base station having larger energies.
3) The base station is fixed.
4) Overlapping circles are drawn with a fixed radius so as to cover all the regions and all the points.
5) Nodes in each round will form clusters with some of the nodes becoming part of both clusters as they fall in overlapping parts of two clusters.
6) Once clustering is done with calculate the energies of nodes in clusters.
7) Three nodes in each cluster with highest energies are found out. They will act as a panel of Cluster heads.
8) The next step is routing. For routing we find the source node and destination node.
9) Then we compute the energies of nodes between source and destination. Nodes with higher energies are selected.
10) Also we find the nodes with minimum distance between source and destination.
11) Then we find the (distance/energy) ratio for all nodes. The nodes with minimum distance and maximum energy nodes are chosen as relay nodes. These relay nodes are used for transferring of data from source node to sink.
12) That is the nodes with minimum distance/energy ratio are selected as relay nodes. That means nodes with minimum distance between source and sink and nodes with maximum energy are selected to be relay nodes.
13) Now the path is selected between sources and sinks using the first Cluster head and relay nodes.
14) An alternative second path is now selected. This path will be from the second cluster head via the relay nodes to the destination.

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15) Once the paths are selected, the data is sent through the two paths simultaneously. This not only transmits the data rapidly but also prolongs the lifetime as maximum numbers of nodes are utilized.

This scenario and methodology are simulated using NS2 simulator and the quantities of number of alive nodes and lifetime are recorded. The simulation parameters are as shown in Table1.

Table1. Values of simulation Parameters.

Sr.No	*Simulation Parameters*	*Values*
1	Channel Type	Wireless
2	Simulation Area	300m × 300m
3	Number of Nodes	100
4	Transmitting power	2mw
5	Receiving power	1 mw
6	Packet size	1000bits
7	Performance parameters	Number of Alive Nodes and lifetime.

IV. RESULTS

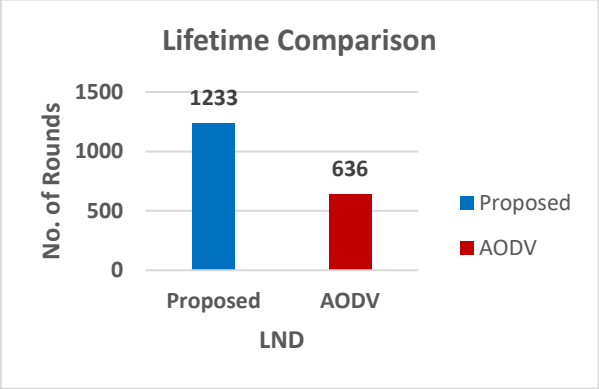

Fig. 2. Lifetime comparison of proposed hybrid technique with the existing AODV technique (Last Node Death).

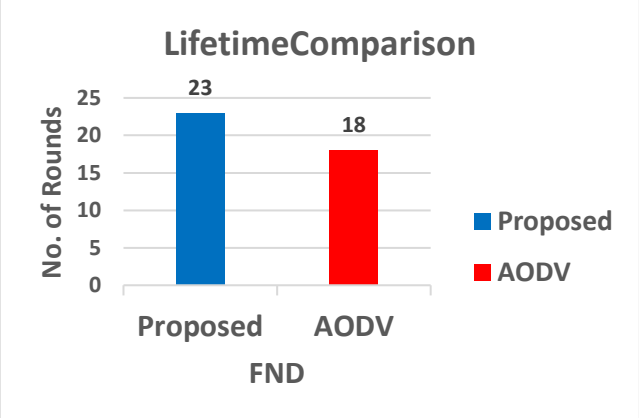

Fig.3. Lifetime comparison of proposed hybrid technique with the existing AODV technique (First Node Death).

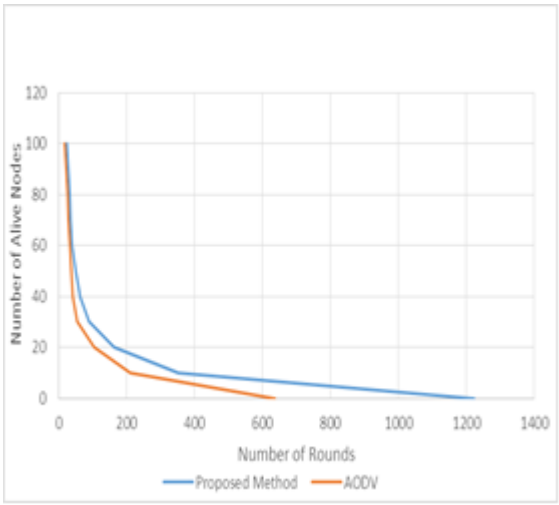

Fig. 4. Comparison of alive nodes for the proposed Method with the existing AODV technique

Comparison of simulation results of the proposed technique with AODV technique is shown.

Fig.2. shows the comparison of lifetime of the proposed technique with the existing AODV technique. It is observed that the proposed technique gives a lifetime of 1233 rounds in comparison to the AODV technique with 636 rounds.

Fig.3. compares the proposed technique with the existing AODV technique in terms of first node death. It can be seen that the first node dies after 23 rounds in the proposed technique as compared to the AODV technique whereas the first node dies after 18 rounds.

Fig.4. shows a comparison of alive nodes for the proposed method with the AODV technique. It can be seen from the graph that the nodes in the AODV technique die earlier as compared to the proposed technique for all the rounds.

V. CONCLUSIONS

In this paper we have proposed a hybrid technique where clustering is done using the overlapping concept and routing is done by selecting the path considering the nodes with highest energy and minimum distance to the sink. Another alternative path is also selected and data transmission takes place through both the paths resulting in rapid data transmission and utilization of all the nodes resulting in increase in overall lifetime of the wireless sensor network. On comparison with the AODV technique it can be seen that the proposed technique has the higher lifetime Also the first node in the proposed technique dies later as compared to the AODV technique.

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