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Research Article

An Energy Threshold based WSN Clustering Schema using PAM Algorithm

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Abstract

Wireless sensor network consists of number of sensor nodes clustered together to collect various environmental or other physiological data like temperature, pressure, seismic graph, sound, location, etc. WSNs are used in various fields like healthcare, monitoring systems, military, etc. Sensor nodes run on battery without direct power supply. Hence, energy efficiency becomes the major issue in WSNs to make WSNs run for longer. Because these wireless sensor nodes run on batteries and they carry a limited battery life. Routing process and Sensing process consumes the battery power. Sensing process is the primary process of sensor nodes, hence, cannot make changes in this process. Routing process is the secondary process of the nodes, and is having a great possibility of improvements. In the existing approach, k-mean was used for the clustering algorithm for the cluster head selection. In this paper, we have proposed an effective and efficient cluster head selection method using k-Medoids to solve the stated problem, especially for large WSNs consisting of thousands or millions of nodes. k-Medoids is more efficient and correct than k-Means for large clusters. Both of K-Means and k-Medoids utilize expectation maximization (EM) strategy to converge to a minimum error condition. While k-Medoids require the cluster centers to be centroids, in k-Means the centers could be anywhere in the sample space. k-Medoid is more robust to outliners than k-Means therefore results in more quality clustering. It is also computationally more complex. Computer simulation will be performed in the NS2 environment and the proposed approach will be compared with LEAH and HEED.

Keywords: *WSN, PAM etc.*

Introduction

These sensors are used to monitor many physical and environmental conditions such as Temperature, sound, Pressure etc. Earlier the development of wireless sensor networks was initiated by military applications such as battlefield surveillance & Border securities etc. But Nowadays wireless sensor networks are also used in other sectors for example Monitoring Earth quake prone Regions, Volcanoes , Patients health etc. typically a WSN is a collection of small-scale, micro-electro-mechanical devices. These tiny devices have three components sensors, a sensing subsystem, a processing subsystem for local data processing, wireless receiver and transmitter technology and in addition to this a power supply battery which provide power supply to all nodes . WSNs communicate directly with a centralized controller. In a single WSN the no of node might be vary from a few to several thousands and A sensor node might vary in size from that of a Tip of pen to the size of a football. In this paper we will discuss about the technique to enhance energy efficiency because wireless sensor nodes are totally dependent upon battery for power consumption. Hence energy efficiency is most vital part of WSN to apply it in real life based applications. In some critical regions there might be a problem to replace battery from time to time due to hazardous conditions such as war, critical temperature etc .Power consumption of a wireless sensor node depends upon various factors such as routing, clustering schemes on WSN, Number of sensor nodes and size of the network nodes etc.

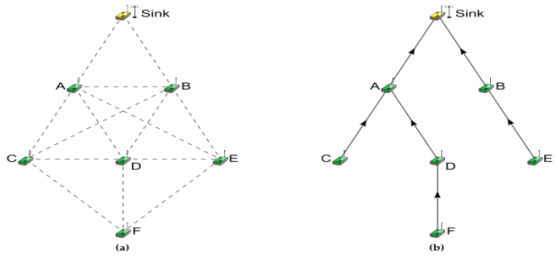

Figure 1: WSN routing

The applications of wireless sensor networks comprise a wide variety of scenarios. In most of them the

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network comprises of a large number of nodes. These nodes transmit data via other nearby nodes to the central device. Though WSNs are restricted by storage capacity and power consumption. Hence there is a need to route data from a sensor node to receiver via proper path which can save energy and increase battery life. This can be done by an energy efficient routing protocol.

Due to reduced battery resources of wireless networks sensors, routing protocols are expected to fulfill many requirement such as –There must be a good Data delivery model to overcome the problem of fault tolerance . The system should be scalable. Sometimes if a node stops working due to some reason (environment problem or battery consumption sensors error) . Then this problem is overcome by finding the alternate path. The cost of each sensor node should be kept low. Power consumption rate of each node must be maintained at low. Sensor network can be setup inside large machinery, at the base of the ocean, in a biologically or chemically contaminated field, in the battle field behind enemy line, in big building or warehouse etc. In WSN there are three main categories of routing are:

Flat-based routing: In flat based routing all nodes have equal roles and perform equal functions.
Location-based routing: In Location based routing all nodes have their roles to route data according to their locations.
Hierarchical-based routing: In this, all nodes have their own roles different from others.

Nowadays wireless sensor network is widely used in many sectors. As we know all nodes are completely dependent upon a battery for power. In most Applications the sensors nodes are distributed in very hazardous conditions such as very high temperature, war, volcanoes etc. In these fields changing the power battery is not easy cup of tea. Due to this reason sensor nodes must be power efficient. Another thing is to be considered in this paper is data transmission in WSN between sensor nodes and the base station. Data can be transmitted through Wi-Fi network or it may be Radio transmission. The range of Wi-Fi network may vary from a few meters to hundred meters and range of radio network may be in few kilometers from base station. If a sensor node is placed far from transmission range of base station then it can't communicate directly with the base station.

This problem can be resolved by routing and clustering. Though routing provides a proper path to transmit data between sensor nodes. In a case where number of sensor nodes is very high then transmission of data from far away device to base station through only routing can consume more energy which makes the WSN difficult to apply in real life. Hence there is a strong need of clustering .Clustering of sensor nodes is an effective method to use the node energy optimally and prolong the lifetime of energy constrained wireless sensor network.

Clustering is a technique in which large scale wireless sensor network is divided into small manageable units, called clusters. Each node in a cluster will communicate with a central node within same cluster this central node known as Cluster head which further communicate with base station in this way data is transmitted from each node to the base station through cluster head.

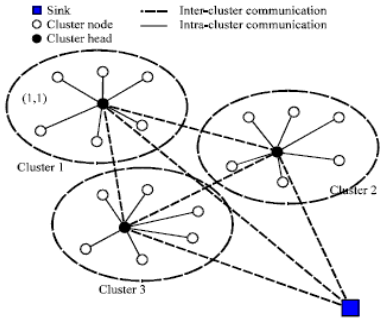

Figure 2: WSN Clustering

Generally a cluster head is a central node in a WSN cluster which is connected to all other nodes with the cluster as well as Base station. so it provides the communication interface between all nodes of the cluster and the base station .There is no need to connect each node with base station ,only cluster head node is to be connected with base station , this scheme makes WSN more energy efficient and wide network because a faraway which is not in range of the base station, can communicates with base station via cluster head. The node which is to be selected as cluster head should be situated in center of the cluster in such a way that all nodes within the cluster can easily communicate with the cluster head. In this paper we will discuss the more energy efficient scheme by selecting a cluster head of a cluster in a region where density of nodes is higher. It is not necessary to select cluster head node from center of cluster but the selection of cluster head should be depend upon nodes density. If cluster head will be located in most dense area then data transmission from nodes to cluster head will consume less energy so we can save battery life which is most essential component in a WSN.

Related Work

Geon Yong Park, Heeseong Kim and Hwi Woon Jeong have proposed WSN clustering application. The new cluster head selection method is based on k-means clustering algorithm. The k-means technique is used to create the small sized groups of the nodes called clustering. The authors have aimed this research to reduce the energy consumed by the network nodes in order to increase the lifetime of the WSN cluster. The authors have reported the performance of the proposed model. They have proved that the proposed model is effective then LEACH and HEED clustering protocols. Sajal Sarkar and Raja Datta have worked on secure trust based energy efficient protocol to protect

against various routing attacks. The proposed trust based protocol is designed to lower the routing overhead and PDR (packet delivery ratio) to reduce the energy efficiency of the WSN clusters. The proposed scheme has been designed using the wireless protocols of AODV and DSR. Sonam Palden et. al. have proposed a routing protocol based on clustering technology for the WSNs. The proposed routing protocol has been developed for the TDMA based routing environments. The distance between the two nodes is calculated using relative distance formula. Each cluster head follows two major tasks under the proposed routing protocols: sleep and transmit (TDMA based). The experimental results have shown that the proposed routing protocol has outperformed the LEACH protocol in the terms of clustering performance and energy efficiency.

Xu Jiu-Qiang et. al. has published their study on topology division WSNs and their network lifetime. The authors have analyzed the working of the algorithm and have conducted an in-depth analysis on the algorithm principles and theory. The authors have derived the idea to enhance the topology of WSN connectivity using additional nodes in the cluster. Also the authors have studied the path finding and planning capability of the various WSNs in detail. Abdellah Ezzati has proposed a new routing protocol for WSNs. The proposed routing protocol is based on adaptive balanced energy consumption for the heterogeneous networks. The heterogeneous networks are those containing nodes of different configurations in one cluster. The proposed protocol is named as Hierarchical adaptive balanced energy efficient routing protocol or HABRP. The aim to develop a new protocol is to enhance the network lifetime by reducing the node failures. The protocol identifies the nodes higher configuration and larger battery, and uses them as gateway nodes in the WSN cluster in order to improve the network lifetime of the WSN under the proposed model. Raymond Wagner have worked upon an analysis and processing for the distributed multiscale data in the sensor networks. The proposed analysis has been completed on the basis of two major factors: irregularly shaped typical WSN data and communication overhead for the data under observation. The authors have described new methods for the multi-resolution data to handle the shortcoming earlier addressed as the factor.

Experimental Design

The Existing Algorithm is based on the static node ID, fixed location (un-moveable position), individual node-BTS connectivity (short/long distance communication), equal node energy and controllable energy module. The cluster heads in the existing scenario should be aware about their remaining energy. The existing solution which is using k-means based clustering is compatible with the randomly distributed topologies only. The existing algorithm supports homogenous networks only and does not work with the heterogeneous networks. The existence of the homogeneous WSNs is very rare when compared to that of heterogeneous scenarios. In the case of heterogeneous WSNs, the nodes do not carry the batteries of the similar power which makes the existing system incompatible with the heterogeneous models. Whereas the proposed scheme is using only a few conditions out the ones defined in the existing algorithm. The proposed scheme is being developed to mitigate the shortcomings of the existing system. The proposed solution is aimed at its use with heterogeneous WSNs distributed in the various types of topologies.

Algorithm 1: Proposed Clustering Formation

Stage 1: Cluster Formation and Cluster Head Selection

- ***N*** *number of nodes are divided into* ***k*** *number of cluster*
- *Each cluster* ***k*** *have* ***n*** *number of nodes*
- *Select initial cluster head* ***CH*** *randomly by selecting the random Intial* ***Medoid*** *from* ***n*** *number of nodes in cluster* ***k***
- *Each normal node propagates its three dimensional coordinates* ***(X, Y, Z)*** *to cluster head* ***CH***
- ***CH*** *performs k-means distance computation in 3-D space*
- *Center cluster node according to existing* ***CH*** *is selected new* ***CH***
- *Repeat step 4 to 6 until the node in the real center is found.*

Experimental Results

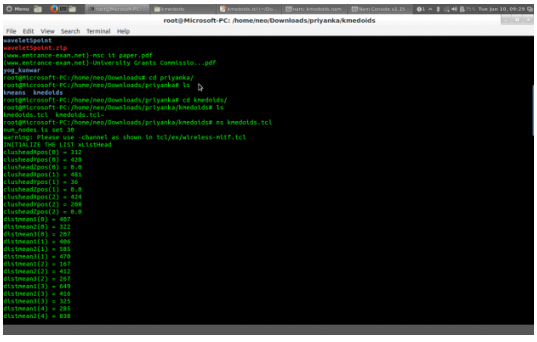

Figure 3: Command to run the simulation

The k-medoids algorithm for WSN clustering is developed using NS2 simulator on Ubuntu 12.04. The machine/computer used for this simulation is equipped with a Core i3 processor, 2 GB RAM, 4 MB L2 Cache and 2MB L3 Cache. The cluster formation is performed on wireless sensor network consisted of 30 nodes. The nodes have communicated to each other prior to the cluster formation process. The K-medoids algorithm has been used in this simulation for the purpose of WSN clustering. The simulation is programmed to create three clusters. The cluster formation process starts with the nodes exchanging information with each other about their physical

location by propagating X-axis and Y-axis. The algorithm forms the clusters on the basis of their location co-ordinates.

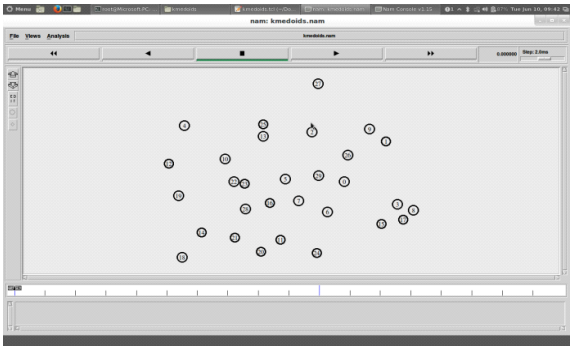

Figure 4: The black color of the nodes represents the switched off nodes in the simulation

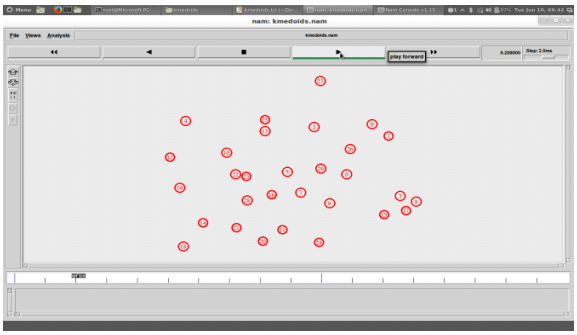

Figure 5: The red color of the nodes represents the node being switched on in the simulation

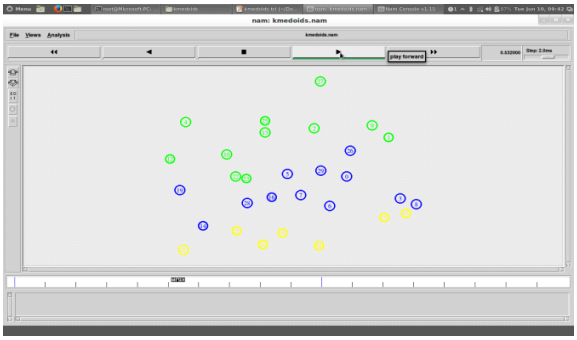

Figure 6: The different colored nodes represent the clustered node in the simulation

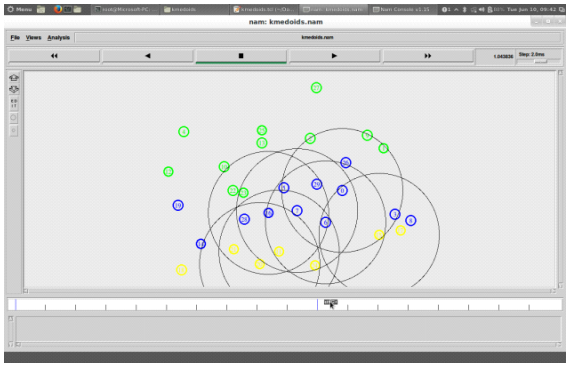

Figure 7: The nodes in the different cluster undergoing communication in the simulation

After the completion of the process of cluster formation, the process of cluster head selection begins. The cluster head is selected by comparing the area of the cluster with the location of the node. The node found very near to the centre of the cluster is selected as cluster head. The simulation contains 30 nodes in an area of 600 by 800 meters. Each node has a 250 meters of communication radius under this simulation. The simulation is running on the AODV protocol.

Table 1: Nodes Elected in Cluster 1

Node Number	X-axis	Y-axis
9	574	534
12	549	532
14	687	540
19	531	382
20	521	271
29	462	258

Table 2: Nodes Elected in Cluster 2

Node Number	X-axis	Y-axis
0	235	107
1	101	128
2	261	489
3	91	555
4	56	74
6	292	384
7	75	486
8	59	111
11	155	480
13	88	373
15	312	171
17	271	297
18	394	325
21	308	450
26	349	43
27	61	412
28	310	279

Table 3: Nodes Elected in Cluster 3

Node Number	X-axis	Y-axis
5	504	8
10	794	152
16	596	7
22	385	158
23	724	149
24	531	62
25	705	357

Conclusion

In this research, a new clustering algorithm for WSNs has been developed using K-Medoids algorithm. The inspiration for the proposed project has been derived from an earlier implemented clustering algorithm based on K-Means data clustering algorithm. The major objectives behind the development of the new algorithm were to enhance the WSN network lifetime and for the balanced centroid selection in the cluster.

Balanced Centroid is the centroid in the cluster on a central location on the basis of density of the nodes irrespective to the cluster area centre point. The N numbers of nodes are initially evaluated for the cluster formation. The distance between the nodes is calculated using Euclidean distance. The nodes are divided into K number of clusters. For each cluster K, its N number of nodes are evaluated using distance formula again to find the centroid by initializing the first stage of centroid election with random co-ordinates. Then the balanced CH (cluster head) is elected by the algorithm for a cluster K with N number of nodes. The proposed solution is based on the cluster algorithm K-medoids, in which centroid is selected on the basis of medoids technique of statistics. K-medoids is an algorithm uses portioning around medoids which in real select the centroids around the actual center of the clusters which is given by X-center (Xc) and Y-center (Yc) respectively. The proposed algorithm for the WSN clustering has performed well with the WSN simulations in NS2. It has formed the clusters in the actual transmission range specifications in real time, it means the nodes out of the coverage or near to the outer circle from one point if is inside the strong transmission range of the other, then will be selected the other cluster only. It may perform in that cluster better than the earlier circle, whereas K-means generally make those mistakes. Euclidean distance is used to compute the distance between the two nodes under this simulation. The cluster on which the results were tested contained 30 no. of nodes. The number of nodes can vary in the simulation. Overall recorded results have proved that k-medoids have performed better than k-means clustering over WSNs. K-Medoids have outperformed K-Means algorithm for clustering proposed in the base paper. Hence it is also proved that the proposed algorithm has also outperformed LEACH and other protocols compared in the base paper with K-Means.

Future Work

In the future, this research can lead to several other developments. The algorithm can undergo time analysis for the development of a fast WSN clustering algorithm based on the existing algorithm. The Individual nodes, Cluster Heads, Base stations, Network Governors or Wireless Sensor Network Monitoring applications used in WSNs can also use k-medoids algorithm for the network data clustering and analysis for the detection of several network attacks.

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