

A Balanced Cluster Head Selection Based On k-Medoids to Enhance Wireless Sensor Network Life Time

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Abstract: *In this paper, a new clustering algorithm has been developed using k-medoids clustering algorithm for WSNs. The new algorithm is aimed to develop an algorithm, which perform better than the k-means and LEACH for WSNs. It is widely known that if cluster formation algorithm computes the cluster head according to the node density in a particular cluster. It is also known that the cluster head selection results are better in k-Medoids than k-Means. It has been already proved that k-Means performs better than LEACH. So our aim was to develop a clustering and cluster head selection algorithm based on k-Medoids which performs better than k-Means. In this paper, we have published the results of our new clustering and cluster head selection algorithm based on k-Medoids. This algorithm has improved the network lifetime than the k-Means algorithm by using the balanced cluster head selection based on the network density weight.*

Keywords: WSN clustering, k-Medoids, cluster head selection, Network Lifetime

1. Introduction

Wireless sensors networks (WSNs) are used to sense or collect many environmental conditions or other physiological data like temperature, pressure, sound and location etc. WSNs are made up of hundreds and thousands of sensors so that they can be used in various fields like healthcare, monitoring systems, military, etc. With the increasing and effective advancement of wireless system of communication and technology, sensors are used for sensing, computations of numeric data and communications capabilities are spreadly used in various fields. Wireless sensors networks contain nodes and these sensors nodes based on networks of tiny batteries. These batteries are used to collect and store information from one other sensor which is at equidistance from cluster-head (CH). After collecting information from sensors, these informations are transferred forwarded through base station (BS) to the system which is connected to the sensors nodes networks.

In latest research of WSNs, there are many limitations which are found and overcome by WSNs such as limited energy resources, varying energy consumption, high cost of transmission, limited energy resources, varying energy consumption. All these characteristics of wireless sensors are quite different from their wired networks because energy consumption is not an issue, transmission cost is relatively cheap, and network nodes have various of processing capabilities. Routing process which is well known for communication between two systems or networks from long periods will not suffer for this new generation of networks. Before maximizing the lifetime of the sensor nodes, the energy dissipated throughout the wireless sensor network in order to minimize maintenance and maximize overall system performance. Any communication protocol which contains set of rules to provide communications between two networks which involves synchronizations between end to end nodes find and removes some overhead of setting up the communication. Clustering protocols determine whether the benefits of more complex routing algorithms overshadow

the extra control messages each node needs to communicate. In networks each node can make a successful and informed decisions regarding communication if the network nodes are containing complete knowledge about the topology and the power levels. Hence it proves to yield the best performance if the synchronization messages are not taken into account. Usually the working topology of networks are considered to have many network nodes dispersed throughout a specific physical area. Wireless sensor networks are considered to be ad hoc networks, therefore they do not contain any specific no specific architecture or hierarchy in place. Regarding the limited power supply of wireless sensor nodes, spatial reuse of wireless bandwidth it is ideal concept to send information in several smaller hops rather than one transmission for long communications. In this research, we propose a new clustering method for the wireless sensor nodes which will be better than the existing clustering algorithms. We propose the use of k-medoids algorithm for the wireless sensor network clustering. K-medoids is effective algorithm than k-means, as it find the more accurate centers of the clusters, which can results as better communication between sensor nodes, less energy consumption and lower packet delay. This leads to better maintainability of the system, such as replacing the batteries all at once rather than one by one, and maximizing the overall system performance by allowing the network to function at its best capacity throughout most of its lifetime instead of having a steadily decreasing node population.

2. Literature Review

Geon Yong Park and associates have developed an efficient cluster head selection algorithm based on K-means clustering to enhance the network lifetime. The results of their experiments have proved that their proposed algorithm performs better than the LEACH and HEED clustering protocols when compared on the basis of WSN lifetime. Sonam Palden has developed an energy efficient routing protocol. The proposed protocol belongs to the hierarchical and cluster based WSN protocol category. In another

research, Sonam Palden and associates have developed a WSN routing protocol based to enhance the energy efficiency. The proposed protocol performs the cluster head selection computations on the base station of the wireless sensor network. The cluster head selection procedure completes in two stages. The first stage perform computations on all of the candidate nodes to elect the cluster head, on the basis of performance parameters of relative distance and remaining energy level. Sajal Sarkar et. al. have developed trust Based Protocol for Energy-Efficient Routing in Self-Organized MANETs. Geon Yong Park developed the cluster head selection algorithm for WSN using k-means clustering algorithm. The issue of the energy efficiency has been addressed under this research. K-means clustering algorithm is used in this experiment to improve the energy consumption of the WSN. The cluster head selected in this research has been used to increase the lifetime of the network. The cluster head minimizing process uses the Euclidean distance formula to compute the distance between the two nodes.

3. Existing Algorithm

Conditions:

1. Each node has an ID number.
2. All nodes are fixed or pseudo-static.
3. All nodes are able to send the data to the BS.
4. All nodes are able to control their energy consumption.
5. The initial energy of all the nodes are same.
6. The CHs are aware of their remaining energy.
7. The sensor nodes are randomly distributed in the target area.

Algorithm 1: Existing Clustering Formation

Stage 1: Cluster Formation and Cluster Head Selection

1. N number of nodes are divided into k number of cluster
2. Each cluster k have n number of nodes
3. Select initial cluster head **CH** randomly from n number of nodes.
4. Each node propagates its two dimensional coordinates (X, Y) initially to the base station.
5. A virtual center cluster node **VCH** is selected in the real cluster center.
6. If node n found on **VCH** coordinates it is declared the cluster head

Stage 2: Reselection of Cluster Head

1. Input on Base Station: the nodes with **ID number**
 2. If Energy of cluster head $<$ Energy of threshold
 3. then
 4. All nodes \leftarrow **CheckID()**
 5. Current cluster head = **ChangeHeader()**
 6. All nodes \leftarrow **InformMsg()**
 7. Send the data to the **BS**
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Drawbacks of the Existing algorithm

The existing algorithm works with homogenous wireless sensor networks only, which are used very rarely because of several technical reasons. The existing algorithm requires all of the nodes to have same initial energy, which is an

impossible scenario, because sometimes nodes lose their energy before being the part of the network because of uplink or booting delays caused by several landing, environmental or physiological factors. The existing algorithm performs all of the cluster formation or cluster head selection computation on the base station node. In case a base station is not available and existing cluster head is malfunctioning or gone off, the wireless sensor network will stuck sending its data to the base station with receiving no response, which will lead to the network unavailability.

4. Proposed Research Model

4.1 Conditions

1. All nodes are fixed or pseudo-static.
2. The nodes are aware of their remaining energy.
3. The nodes are aware of their 3-D location coordinates i.e. X, Y and Z

4.2 Proposed Scheme Improvements:

- 1) Solution is adaptable to heterogeneous wireless sensor networks with different configuration and different initial energy levels.
- 2) No need of connection with Base Station for all nodes.
- 3) The cluster head will be in the very center than the existing clustering scheme based on k-means.
- 4) Also adaptable of WSNs without data propagation to BS.
- 5) Node movement can also be captured and evaluated in 2-D space in initial & reselection.
- 6) Solution is adaptable for random or even distribution of sensor nodes.

Algorithm 2: Proposed Clustering Formation

Stage 1: Cluster Formation and Cluster Head Selection

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

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 an Core i3 processor, 2 GB RAM, 4 MB L2 Cache and 2MB L3 Cache.

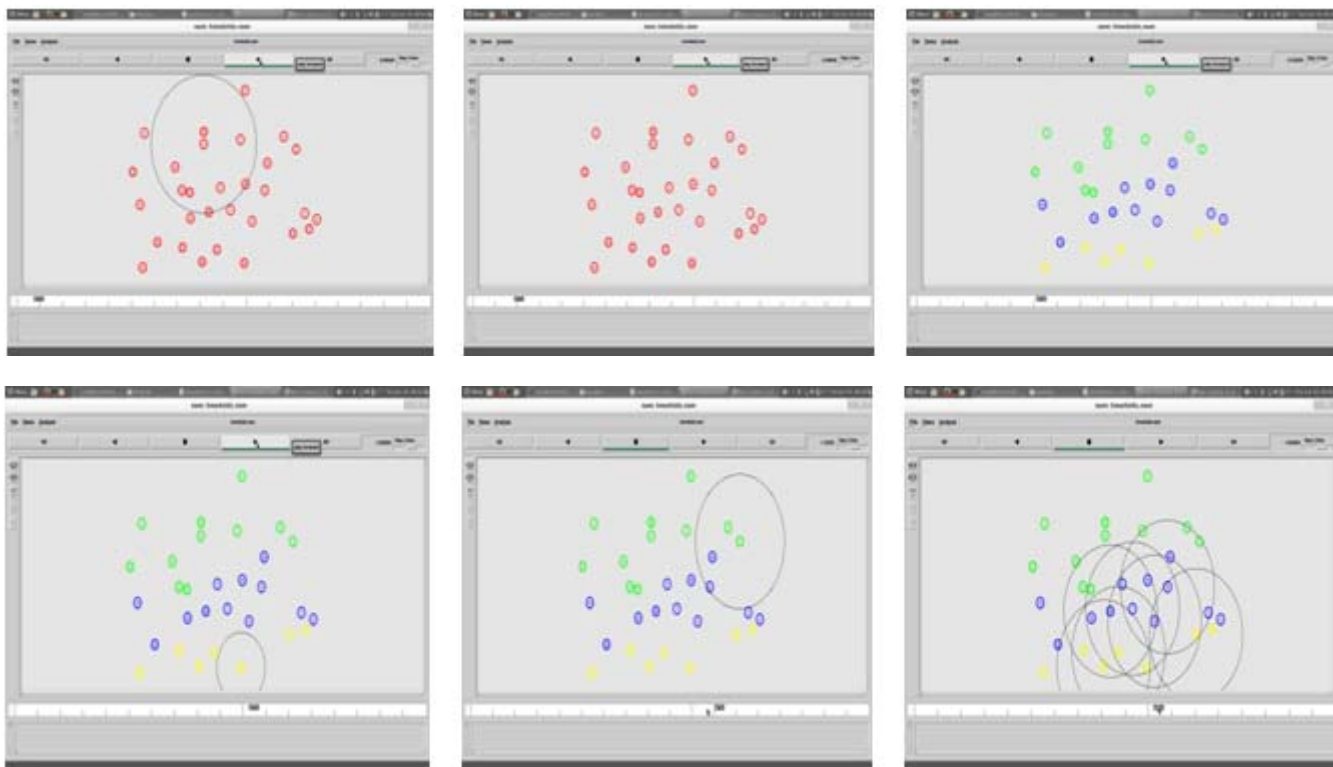


Figure 1: Graphical visualization of the simulation in NAM simulator (a) WSN before clustering. (b) Beginning of the clustering. (c) Cluster Formation. (d,e,f) Inter-Communication between Nodes after clustering

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. 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 center of the cluster is selected as cluster head.

The simulation contains 30 nodes in an area of 600 by 800 meters. Each node have 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	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

6. Conclusion

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 (X_c) and Y-center (Y_c) 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 it 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.

7. 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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