International Journal of
Sensor Networks and Data Communications

Nayak et al., Int J Sens Netw Data Commun 2017, 6:1
DOI: 10.4172/2090-4886.1000151

Research Article OMICS International

Improving the Network Life Time of Wireless Sensor Network using EEEMR Protocol with Clustering Algorithm

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Abstract

Energy efficient routing is a one of the major trusted area in Wireless Sensor Networks (WSNs). The wireless sensor network composed of a large number of sensor nodes which has limited energy resource. The sensor nodes are working through the battery, energy saving becomes more vital issue in WSNs. The routing algorithms assure the concept of energy saving without affecting the Quality of Service (QoS) Parameters like Throughput, End to End Delay, Overhead and Packet Delivery Ratio. In the existing system the Enhanced Energy Efficient Multipath Routing (EEEMR) Protocol is implemented. The EEEMR Protocol is modification of AOMDV Protocol. In this paper, we are implementing Clustering algorithm in EEEMR Protocol. The development of cluster based sensor networks have recently shown to decrease the system delay, overhead and increase the system throughput and packet delivery ratio. Simulation is performed using NS2 and results shows that the proposed system is better than the existing system. The proposed system energy consumption is decreased by 13% compared to the existing system.

Keywords: Wireless Sensor Networks (WSNs); Quality of Service (QoS); Energy Efficient Multipath Routing (EEEMR); Clustering algorithm

Introduction

The progression of wireless sensor networks is initially motivated by military applications. Wireless sensor networks are used in numerous civilian application areas like detecting, monitoring the movement of enemies, chemical, and biological, radiological, tracking, and automation, nuclear and health care applications. The Wireless sensor network consists of hundreds or thousands of low powered sensor nodes that have ability to communicate either directly to the base station or among each other. These nodes are integrated with micro sensing, computing wireless communication capabilities. Which are capable of detecting various events related to its surrounding environment such as speed, temperature, pressure, light etc., the WSN nodes are operate in ad-hoc manner, limited hardware and limited energy resource because it's small size. The energy source of sensor nodes in wireless sensor networks is usually powered by battery. This is insufferable, even impossible to be recharged or replaced. The energy efficiency and maximizing the life time of the network are major challenges in wireless sensor network. In wireless sensor networks the sensor nodes are grouped into individual disjoint sets called a cluster. Clustering is considered as one of the method to reduce energy consumption. The clustering is used in WSNs; it provides network scalability and energy saving attributes. Clustering schemes offer reduced communication overheads, decreases the overall energy consumption and reducing the interferences among sensor nodes.

Related Work

In Raj and Sumathi; Singh and Sharma; Dave and Dala; Aliouat and Harous; and Tian et al. [1-5], the authors proposed a new Enhanced Energy Efficient Multipath Routing (EEEMR) protocol and compares the EEEMR Protocol with Flat routing protocols such as DSDV, DSR and AODV. The EEEMR Protocol is a modification of existing AOMDV protocol with the Bio inspired Cuckoo Search Algorithm (CSA). The AOMDV routing protocol is an extension of Flat routing protocol AODV. The EEEMR Protocol is slightly improves the QoS Parameters like throughput, delay, overhead and packet delivery ratio when compared to DSDV, DSR and AODV.

In Younis and Fahmy; Mallapur and Terdal [6,7], the authors presented an energy-efficient distributed clustering approach for ad-hoc sensor networks. The approach is hybrid: Cluster heads are randomly selected based on their residual energy and nodes join clusters such that communication cost is minimized.

In Ahmadi et al.; Maisra [8,9], the authors presented a new method which using the parameters of distance and remaining energy of each node in the process of cluster head selection, using the algorithm to find the shortest path between cluster head and base station.

In Al-Karaki and Kamal [10], the authors presented a new method is proposed, which is using K-means algorithm to forming the clusters and genetic algorithm to select the cluster head in each cluster.

Proposed Work

In this paper, we are implementing Clustering algorithm in Enhanced Energy Efficient Multipath Routing (EEEMR) Protocol. In our existing work we have implemented the EEEMR Protocol. EEEMR Protocol is extension of AOMDV routing protocol with the Bio inspired Cuckoo Search Algorithm. The EEEMR Protocol uses the distance vector concept and hop-by-hop routing approach. The EEEMR Protocol also uses a route request broadcasted between source to destination and route discovery process to find the on demand routes. It also offers intermediate nodes with alternate paths, which are reducing the route discovery rate. Clustering is a good method in wireless sensor networks for effective data communication and towards energy efficiency. Cluster based operations consists of rounds. These involve cluster heads selection, cluster formation and transmission

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Received June 15, 2017; **Accepted** June 22, 2017; **Published** June 28, 2017

Citation: Nayak JA, Rambabu CH, Prasad VVKDV (2017) Improving the Network Life Time of Wireless Sensor Network using EEEMR Protocol with Clustering Algorithm. Int J Sens Netw Data Commun 6: 151. doi: 10.4172/2090-4886.1000151

of data to the base station. The Figure 1 shows that the cluster based wireless sensor network.

Proposed algorithm

The clustering algorithm proposed for energy efficient technique for WSNs consists of fixed number of sensor nodes that improve the Cluster Head selection approach to prolong the lifetime of networks. The Cluster Head selection in WSNs is based on the decision taken from the residual energy and certain threshold value of the respective nodes. The threshold value is:

$$T[n]=\begin{cases}\left(\left(\frac{P}{1-P*\left(r \bmod\left(\frac{1}{P}\right)\right)}\right)\frac{E_{residual}}{E_{initial}}*K_{optimal}, & n\in G\\ 0 & otherwise\end{cases}$$

Where P is the desired percentage of cluster head, r is the current round number and G is the set of nodes that have not been selected as cluster heads in last 1/P rounds. Using this threshold, each node will be moderately selected as cluster head at some point within 1/P rounds of the cluster head selection process.

Where $K_{optimal}$ is the optimal number of cluster head during the state of cluster formation. It is defined as follows:

$$K_{optimal}=\sqrt{\frac{N}{2\pi}}*\sqrt{\frac{E_{fs}}{E_{amp}}}*\sqrt{\frac{M}{d^2_{to\ BS}}}$$

Where N is the number of nodes and M is the network area and Efs and Eamp are the amplification power losses and d is the distance between the selected cluster head to the base station. The desired percentage of cluster heads depends upon different networks parameters like average distance between the sensor nodes to the base station, number of the sensor nodes deployed by the field and area of the field. The desired percentage varies at each round of cluster head selection [11].

After this each node that is selected as a cluster head will send a broadcast advertisement message to the all the nodes in the wireless sensor network. The each non-cluster head node decides the cluster to which it will belong for its round depending on the signal strength or distance. The node will send a message to the cluster head informing that it will be a member of that cluster. We will choose the nearest cluster head. The cluster head receives all the messages from nodes that would like to be in its cluster. Once the cluster head know the number of members in cluster it can create a TDMA schedule for data transmission purpose. Here each node in the cluster send their sensed data to the cluster head in one hop transmission and the cluster head send data to the base station by multi-hop transmission.

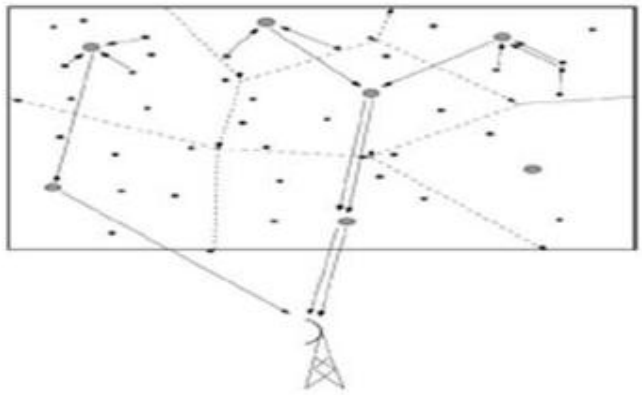

Figure 1: Cluster based WSN.

1. The algorithm takes into following assumptions:
2. The base station is far away from the sensor nodes.
3. The cluster head selection, cluster formation and transmission of data to the base station via cluster heads.
4. The selection of cluster head depends on the residual energy and certain threshold value, calculated by cluster head instead of calculating it by base station to reduce overhead and energy consumption at base station.
5. The cluster member nodes transmit their sensed data to their cluster head in one-hop transmission and cluster head to base station in multi-hop transmission.
6. The sensor nodes in the network infrastructure are forbid from being involved in the cluster head selection process to increase the stability in the network.

The major steps of the protocol are follows:

1. The algorithm is basically divided into the number of rounds.
2. For the first round the nodes with the highest energy node are selected as cluster head randomly for that particular cluster and data transmission is performed.
3. At the start of the second round the cluster head aggregates the residual energy of the particular members and calculates the threshold at that cluster head.
4. All the cluster heads do the same with their cluster members and effective clustering is performed to reach the base station by selecting optimal cluster head.
5. Every node has calculated the threshold value. If the threshold value of a node is greater than threshold value, the node will be candidate for the cluster head of that cluster for the next round.
6. If the cluster head threshold value is below the threshold value of network the cluster head is removed and again the cluster head selection process is performed in that cluster.
7. If the cluster head is below the threshold value in that time the cluster members are send their sensed data to the nearest cluster head. This process is continuous until the new cluster head is selected in that cluster.
8. The optimal cluster head at each round will transmit the information to the base station and do not involve base station to select cluster head at each round and to reduce energy consumption at each round.

Simulation Setup

In this paper, we proposed and implemented EEEMR Protocol with adding the clustering algorithm, by the altering AOMDV in NS-2.34 simulator. The implemented EEEMR Protocol can be evaluated by the number of qualitative metrics such as Packet Delivery Ratio, Overhead, Delay, Throughput and Energy. Finally the simulated results are compared. Table 1 shows the simulation parameters.

Performance metrics: The EEEMR Protocol by using clustering

algorithm should address the following performance metrics such as increase the Packet Delivery Ratio and also Throughput, Minimization of Delay and also overhead, decrease the energy consumption of the wireless sensor network.

1. Throughput: It is the rate of successfully delivered data packets per second in the network between sources to destination.
2. End to end delay: It is the time taken by the data packets for the transmission between sources to destination across a wireless sensor network. This duration is caused by buffering, queuing and also the transmission delay at MAC.
3. Packet delivery ratio: It is the ratio between the received packets by the destination to the generated packets by the sources.
4. Overhead: It is calculated by the ratio of the total number of control packets sent by the sources to the number of data packets delivered to destination successfully.
5. Energy: It is calculated by the [Final Energy=Initial energy–Consumed energy].

Simulation Results

We have done our research analysis in wireless sensor networks by using NS2. Comparative analysis done between proposed system and existing system.

The Overhead comparison is shown in Figure 2. Overhead is decreases when compared to the existing system. In first 20 s the existing system is better than the proposed system. If the simulation time is increase the proposed system is better than the existing system.

The Delay comparison is shown in Figure 3. Delay is decreases when compared to the existing system. In first 20 s the existing system is better than the proposed system. If the simulation time is increase the proposed system is better than the existing system.

The Throughput comparison is shown in Figure 4. Throughput is increase when compared to the existing system. In first 20 s the existing system is better than the proposed system. If the simulation time is increase the proposed system is better than the existing system.

The PDR comparison is shown in Figure 5. PDR is increase when compared to the existing system. In first 20 s the existing system is better than the proposed system. If the simulation time is increase the proposed system is better than the existing system.

The Energy usage comparison is shown in Figure 6. Energy usage is decrease when compared to the existing system.

Parameter	Value
Routing Protocols	EEEMR Protocol
Algorithm	Clustering Algorithm
MAC Layer	802.11
Terrain Size	840 × 840
Number of nodes	100
Channel Type	Wireless Channel
Antenna Model	Omni Antenna
Radio Propagation Model	Two Ray Ground
Interface Queue Length	50
Interface Queue Type	Drop Tail/Pri Queue
Simulation Time	100 s
Network Simulation	NS-2.34

Table 1: Simulation parameters.

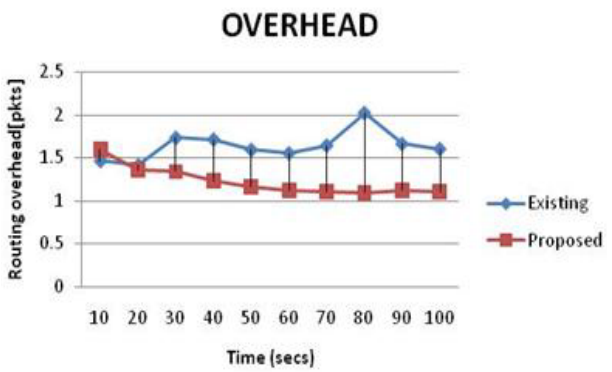

Figure 2: Comparison of overhead.

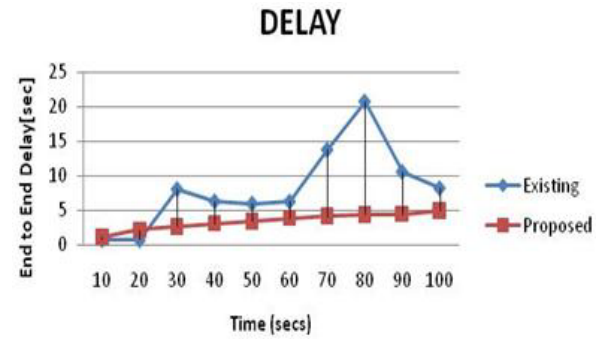

Figure 3: Comparison of delay.

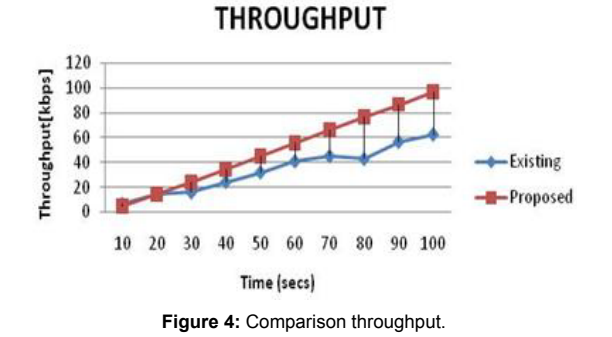

Figure 4: Comparison throughput.

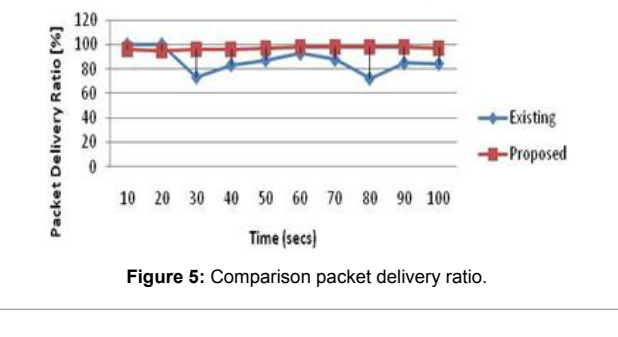

Figure 5: Comparison packet delivery ratio.

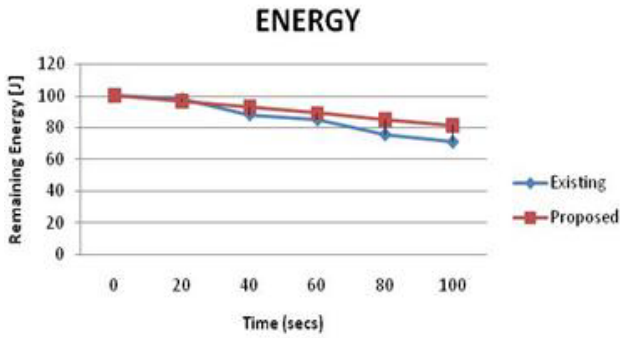

Figure 6: Comparison of energy usage.

Conclusion

In this paper, the EEEMR Protocol is implemented by using Clustering algorithm. By using this method we improve the quality of service parameters like Throughput, Packet Delivery Ratio, Delay, Overhead and Energy of wireless sensor networks. When compared to the existing system the Throughput is around 35% increase, Packet Delivery Ratio is around 13% increase, Delay is around 40% decrease, Overhead is around 40% decrease and Energy consumption is around 13% decreases. The network life time of wireless sensor network is increases based up on Quality of Service parameters.

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