An energy efficient approach for data aggregation in wireless sensor networks based on sink mobility

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ABSTRACT

A network that does not include any central controller and allows nodes to enter or leave the network at any time is known as a wireless sensor network. There are very small sized nodes deployed in these networks in large areas. The energy consumption of the nodes in these networks is a major concern since it directly affects the lifetime of the network. These dead node cause several problems. To enhance the network lifetime mobile sink is introduced which improve network performance. But mobile also leads to another challenge such as mobile sink scheduling and (re)routing. The complete network is divided into fixed size clusters and based on the energy and distance, cluster heads are chosen from the clusters. The remaining nodes of the cluster are considered to be individual. Several clustering algorithms have been designed by researchers which can be broadly categorized based on the manner in which clusters are formed and the kinds of parameters included during the selection of cluster heads. This research focuses on aggregating the data from cluster heads by deploying multiple mobile sinks. The bee colony algorithm is used to make the base station mobile. The simulation of the proposed technique is performed in MATLAB and results are analyzed in terms of various parameters.

Keywords— WSN, Mobile sink, Energy efficient

1. INTRODUCTION

Wireless sensor network (WSN) and its applications are widely used in several environments. The main objective of WSN is to monitoring a large area. WSN is an organised structure of small size communication devices called nodes. With the help of these nodes, WSN gathers information from a particular region. Sensor node collects, transmit and aggregate data with help of some protocols. It continuously monitors and collect information from the network, then transmits that information to sink (base station). A hybrid WSN is another kind that consists of a mobile sink that travels to different locations to collect data sensed by normal static nodes. All sensor nodes have the same energy but they play different roles. This node can be normal nodes or special nodes such as aggregate nodes and gateway nodes. To enhance the network lifetime mobile sink is introduced which improve network performance. The primary objective of a mobile sensor network is to improve coverage. The mobile node moves to different locations in order to monitor the network in an effective way.

The recent enhancements which were made in the technology involving wireless sensor networks has provided great innovations and improvement within the applications that involve it such as the mechanical monitoring, traffic monitoring, cropping, etc. advance creative and productive thoughts are to be generated within this area such that their usage can be more helpful [1]. In the data routing, compression as well as network aggregation, various analyzed methods using different mechanisms have been introduced in recent years. The size of the sensor nodes is very small due to which their battery size is also limited. Further, it is impossible for humans to reach the locations where nodes are deployed since they are harsh and hostile. Thus, the utilization of battery is very considered as a very important factor as the overall lifetime of the network relies on the lifetime of nodes [2]. These networks include certain constraints like the size of memory storage, size of battery, processors and so on mainly because they are small in overall size [3]. Due to the usage of several optimization algorithms, advanced energy consumption is needed in these networks. The data collected and routed across the networks include several time constraints. Before any alterations, the information can be utilized by the network. For communicating the information across the network, the energy consumed is more as compared to the other executions. Thus, it is very important to address the energy conservation issue in the WSNs. Any efficient clustering mechanism can be applied to save the energy of sensor nodes [4].

Small clusters are generated when the nodes are divided into small groups using a productive network organization. A cluster head is present within every individual cluster and apart from that cluster, the remaining nodes are separated. Considering cluster heads as the higher level and the remaining nodes as a lower level, a two-level order of clustering is formed. The nodes are grouped into clusters through clustering and a periodic selection of cluster heads is performed to ensure that the collected data can be forwarded to the base station. The higher amount of energy is consumed by a cluster head in comparison to a normal node since it has various other tasks to perform also. For reducing the amount of energy consumed by the nodes, a clustering mechanism is performed [5]. The packet collision and channel contention are minimized using clustering mechanism and due to the increase of load, the throughput of the network also increases. The lifetime of WSNs is improved through clustering. For providing efficient execution of WSNs, it is important to ensure that their life is the highest one. All the conditions that are important for clustering are fulfilled by the clustering algorithms before generating a cluster. Higher details can be given for cluster formation by considering a few important parameters. In comparison to plane multi-hop routing and static routing, certain problems have been overcome in LEACH protocol due to which the lifetime of the network can be increased. There is a random selection of the cluster head is implemented [6]. It does not ensure the distribution of cluster heads. It is ensured that the node that has higher energy is selected as a cluster head in the case when the nodes have a similar priority. Since the nodes with less energy will die first, they might not be chosen as cluster heads. Automatic identification expertise which includes radio frequency is provided through RFID (Radio Frequency Identification) [7]. Active RFID and passive RFID are the two different types of RFID amongst which passive RFID is more beneficial in terms of cost and battery management factors. However, the sensing rate, sensing distance and sensing nature of active RFID are known to be better. For improving the nature of the framework, RFID is generated such that it can be possible to store and detect the physical information for longer time duration.

This research focuses on aggregating the data from cluster heads by deploying multiple mobile sinks. The bee colony algorithm, a bio-inspired technique is used to make the base station mobile. The simulation of the proposed technique is performed in MATLAB and results are analyzed in terms of various parameters.

2. LITERATURE SURVEY
Chae-Seok Lee et al. [8], proposed a novel approach for removing the overhearing issue which was named as Reservation Aloha for No Overhearing. Any kind of viable communication in the network is informed to the tag. Since overhearing is higher than the amount of communication performed, it is possible to minimize excessive energy. There are excessive time and duration of communication which is also known in the tag as the node can be sent to sleep mode and back to active mode as per the requirement during the period of transmission. In comparison to other protocol, 60 times higher amount of energy is saved by implementing RANO protocol.

LI Jian-qi et al. [9] proposed an improvement in the calculation of improved clustering routing that focused on energy efficiency of the network. The nodes compete with each other randomly as per the remaining energy for generating the cluster head initially. Further, the snugness coefficient of each cluster is calculated dynamically for determining the internal structure of clusters.

Towards the end, enhanced multi-objective PSO is calculated to upgrade the transmission path which exists in between cluster heads.

Yu Wang et al. [10] proposed a novel mechanism through which the energy produced and delay tolerant cooperative transmission can be calculated. Simulations are performed and results are achieved which show that the proposed EDTCT algorithm provides better results in comparison to other approaches. Even though the E2E sleep dormancy and energy consumption are found here, the performance of this algorithm is better. In complex networks, this approach provided better results and within the low-obligation cycled WSNs, it provided highly effective results.

Degan Zhang et al. [11] proposed a novel technique named as forwarding aware component (FAF-EBRM) which used forward energy thickness and link weight as the two parameters based on which the hop node could be chosen. Comparisons were made against LEACH and EEUC and the proposed approach. The energy is minimized and lifetime is improved by adjusting the proposed technique along with providing a better quality of services. Further, the progressive node breakdown provided by it is also minimized.

Nicolas Gouvy et al. [12] proposed a novel approach to calculate the routing performance of mobile nodes which was named as Path Merging Algorithm (PAMAL). A routing protocol is proposed initially and for reducing the traffic of the network, the paths included in it are utilized such that the topology can be adapted. Thus, the energy efficiency is improved here. The protocol moves far away from the destination by making intersection and then gets closer to the sources. This results in aggregating higher amount of data and saving energy. In comparison to the existing protocols, the lifetime of the network is improved up to 37%.

Peyman Neamatollahi et al. [13] proposed a clustering mechanism which aimed to minimize energy consumption. The initiation of an upcoming round is informed by informing each of the nodes indirectly and customizing the clustering mechanism. As per the demand, clustering is performed. As a base, the HEED protocol is proposed such that the efficiency of this method can be improved. It is seen that around 30% of improvement in lifetime of the network is achieved in comparison to other protocols.

R. Bhatti et al. [14] proposed enhancement in VGDBA algorithm in which network consists of logical grids of k cells where each cell has a header. Only cell headers are participated in data transmission with sink. Other nodes communicate with a header only. Sink move across the network in a periodic way. The shortest route is considered among multihop communication and this algorithm reduces distance for routing in the mobile network. The results show that if routing distance minimized then the overall energy consumption also reduce.

3. EXPERIMENTAL DESIGN
An energy efficient data aggregation approach using mobile sink is proposed to reduce the energy consumption of the wireless sensor network. And, the sink movement methodology is based on bio-inspired technique.

The diagrammatic representation of the proposed methodology is shown below and the steps involved explained above.
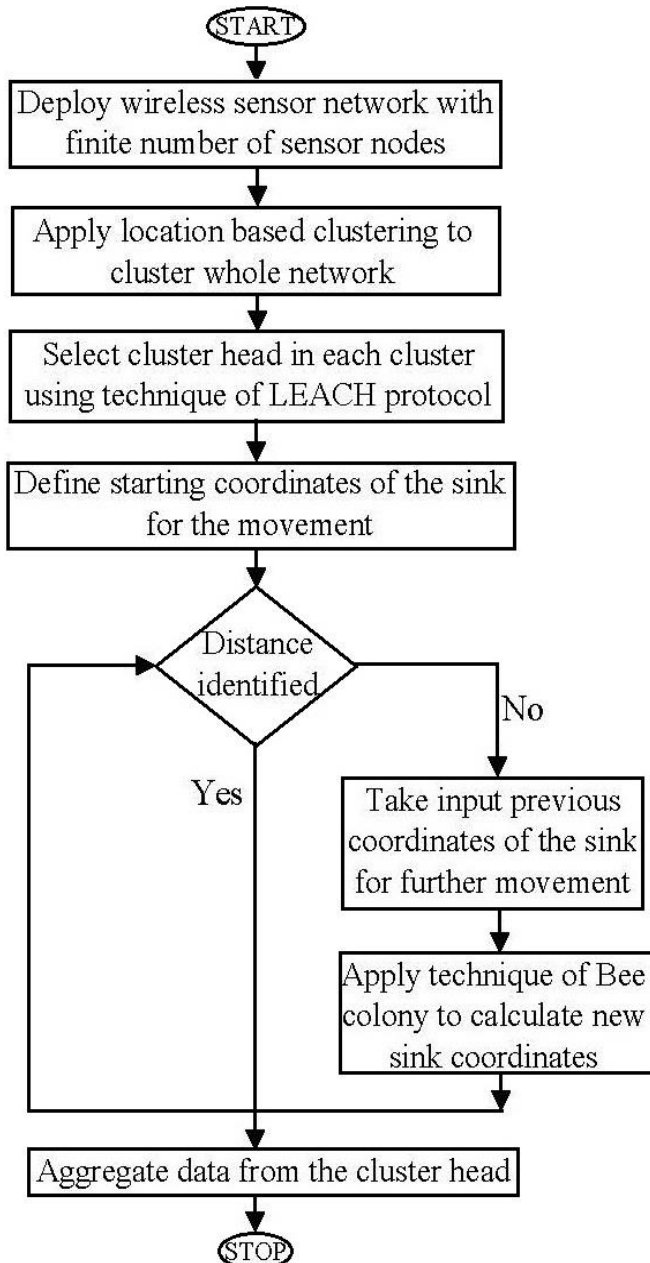
Fig. 1: Flowchart of proposed work

Fig. 2: Energy consumption

Figure 2 represents the comparison of base paper and proposed technique. It results that the proposed protocol has a minimum amount of energy consumption in comparison to the existing technique.

Fig. 3: Number of a dead node comparison

Figure 3 demonstrates the comparison of base paper and proposed technique in terms of the dead nodes. The proposed technique has fewer amounts of dead nodes in the given amount of rounds.

Fig. 4: No of Packets Transmitted

Figure 4 shows the comparison between the number of a packet transmitted to the base station, proposed technique and base paper. The proposed technique transmits a large number of the packet in comparison to the existing technique.

Following are the various steps to be followed in this research work:
- There is a finite number of sensor nodes deployed in WSNs and location-based routing is used to generate a fixed size of clusters.
- The cluster head is selected in each clustering using the technique of LEACH protocol in which node which has maximum energy and least distance to the other nodes is selected as the cluster head. The other remaining nodes within the cluster will aggregate its data to the cluster head and cluster head communicate with sink.
- The coordinates of the sink are defined as the initial population for the sinking movement. The sink will first check the signal strength and the change its location on the basis of the initial population and aggregate the data from where it gets maximum data.
- This step 3 is repeated until the required data get aggregated to the base station.

4. RESULT ANALYSIS
The proposed work is implemented in MATLAB and the results are evaluated by making comparisons against proposed and existing work in terms of several parameters.
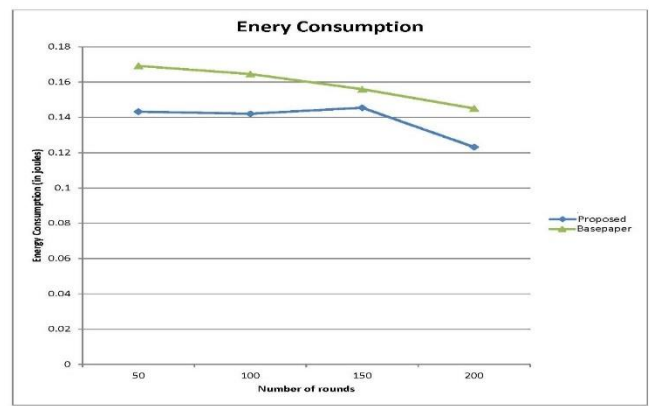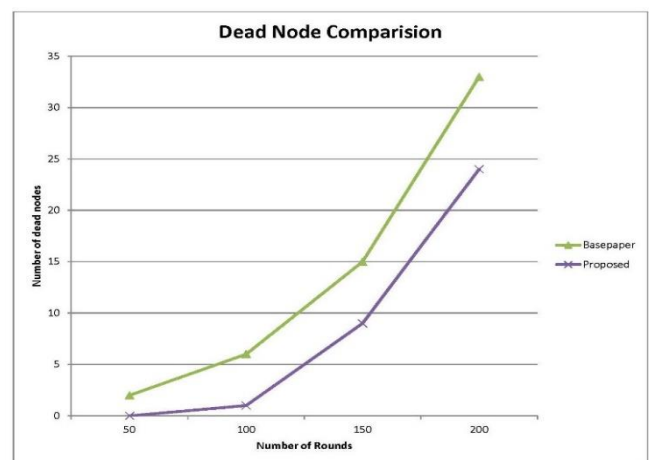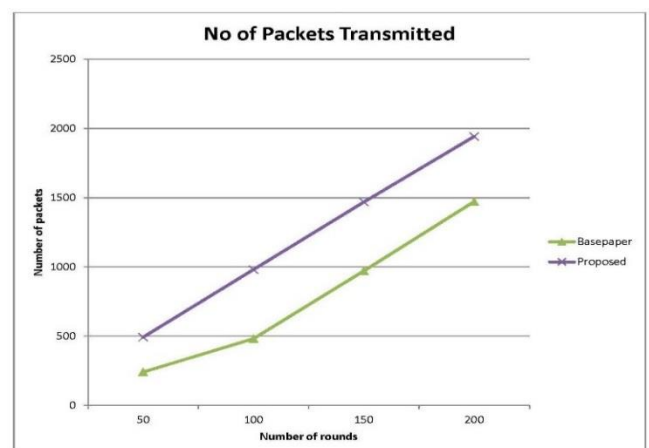
5. CONCLUSION
The aim of the thesis is to develop an energy efficient data aggregation approach to identify the performance of existing

single sink mobile technology to reduce energy. Also, to do mobile based multiple sinks technique of signal strength and bio-inspired technique to move sinks from one position to another. The main focus is to reduce the energy consumption of the wireless sensor network. Multiple sinks are deployed to improve the performance of a wireless sensor network. Depending upon the bee colony algorithm and signal strength the mobility of sinks is presented. There is an increment in the performance by implementing the proposed technique. Bee colony helps in deciding the mobility of sinks as well as enable the better solution. Several energy parameters are analyzed when the bee colony is applied and comparisons are made against previously existing and improved protocol. There is an improvement in throughput and data aggregation by implementing the proposed technique.

6. REFERENCES

[1] Akyildiz, I. F., Su, W., Sankarasubramaniam, Y., & Cayirci, E., "Wireless sensor networks: a survey", 2002, Computer Networks, 38(4), 393-422.

[2] Mendes, L. D., Rodrigues, J. J., Vasilakos, A. V., & Zhou, L., "Lifetime analysis of a slotted ALOHA-based wireless sensor network using a cross-layer frame rate adaptation scheme", 2011, Communications (ICC), 2011 IEEE International Conference on (pp. 1-5). IEEE

[3] Rai, M., K., D., "Dynamic Clustering in Wireless Sensor Network using Neural Network", 2013, International Journal for Advanced Research in Engineering and Technology Vol. 1, Issue II, ISSN 2320-6802.

[4] Nikodem, M., & Wojciechowski, B., "Upper Bounds on Network Lifetime for Clustered Wireless Sensor Networks", 2011, New Technologies, Mobility and Security (NTMS), 2011 4th IFIP International Conference on (pp. 1-6). IEEE

[5] Ying Miao, "Application of sensor networks", a seminar on self-organization networks, Faculty of Engineering Science, Delivered on Monday 02-05-2005

[6] Pant, S., Chauhan, N., & Kumar, P., "Effective cache based policies in wireless sensor networks: A survey", 2010, International Journal of Computer Applications (0975–8887) Volume, 11, 17-21.

[7] Kaur, K., & Kumari, N. Evaluation and Analysis of Active RFID Protocol in Wireless Sensor Networks, 2014, International Journal of Innovative Technology and Exploring Engineering (IJITEE)

[8] Chae-Seok, L., Jong-Deok, K., & Dong-Hyun K., "An Energy Efficient Active RFID Protocol to Avoid Overhearing Problem", IEEE, vol.14, no.1, pp 15-24, Jan,2014.Jiang, L., Bing Fang, & Li. (May 2013) Energy-optimized approach based on clustering routing protocol for wireless sensor networks. CCD Conference. IEEE

[9] Wang, Y., & Guo, S., "Optimized energy-latency cooperative transmission in duty-cycled wireless sensor networks", 2013, Mechatronics and Automation (ICMA), 2013 IEEE International Conference on (pp. 185-190).

[10] Zhang, D., Li, G., Zheng, K., Ming, X., & Pan, Z. H., "An Energy-Balanced Routing Method Based on Forward-Aware Factor for Wireless Sensor Networks. Industrial Informatics", 2014, IEEE Transactions on, 10(1), 766-773.

[11] Gouvy, N., Hamouda, E., Mitton, N., & Zorbas, D., "Energy efficient multi-flow routing in Mobile Sensor Networks", 2013, In Wireless Communications and Networking Conference (WCNC), 2013 IEEE (pp. 1968-1973).

[12] Neamatollahi, P., Taheri, H., Naghibzadeh, M., & Yaghmaee, M., "A hybrid clustering approach for prolonging lifetime in wireless sensor networks", 2011, In Computer Networks and Distributed Systems (CNDS), 2011 International Symposium on (pp. 170-174).

[13] R. Bhatti, & G. Kaur, "Virtual Grid Based Energy Efficient Mobile sink Routing Algorithm for WSN",2017, 11th International Conference on Intelligent Systems and Control (ISCO)