Connectivity Restoration and Relay Node Placement in Partitioned Wireless Sensor Networks

Manpreet Kaur[1], Manwinder Singh[2]

[1]M.Tech Scholar, [2]Associate Professor

Rayat Institute of Engineering and Information Technology, Ropar, India

Abstract - The main motive of WSN node is utilized to sense and gather the information from specific domain and then it sends to sink where application lies. Though, it set up the direct link between a sensor and the sink may force nodes to transfer their messages with such a high power that their resources could be quickly depleted. In this paper, an approach for optimum relay node placement is proposed. Also, this approach updates the value of objective function after each round of communication. And an objective function is estimated depending on the values of energy, number of packets lost in a node, distance between the source and the base station. The proposed approach and their results have been compared with the existing approaches. The result also verifies that the proposed approach outperforms the proposed approach in terms of various performance parameters like end to end delay, packet delivery ratio and throughput.

Keywords - WSN, Partitioning, Routing

I. INTRODUCTION

Wireless Sensor Network is the most growing industries for research nowadays. With the betterment in technology and growth of industries, many consider WSN as the basic requirement for setting up the industries. A sensing element node has been restricted sensing and computation capacities, communication performance and power, an outsized variety of sensing element devices square measure distributed over a part of interest for aggregation info wetness, temperature, motion detection, etc. The sensors setup in the network is either the same type of sensors or of different kind relies on the application [3]. In the various applications for military and police investigation Wireless sensor networks can be used. Various developments within the hardware minimize the less-cost production or development in wireless communications technologies that have created probably various applications with the high numbers of sensors. In some another cases, the main purpose of the access space must be checked and thus a result to be Set up the sensor to locate then from craft network. When the positions are not located, the only way to contribute enough target coverage by sensors in order to use multiple sensors than the fastened variety. [4] After the placement of the sensors in the network the second and the most important part is clustering. Clustering of the sensors in the network is either which is fixed and usually depends on the geographical location of the network or it is dynamic means the nodes in each cluster are dynamically distributed and there is some algorithm for the selection of the nodes in the cluster.

The planning and implementation of WSNs square measure forced by three sorts of resources: a) energy; b) memory; and c) process. It is forced by the restricted device nodes, physical size have restricted battery energy provide. At an equivalent time, their reminiscences square measure restricted and has restricted process capabilities. In industrial environments, the topology and property of the network could vary as a result of link and sensor-node failures. Moreover, sensors may additionally be subject to high humidness levels, vibrations, dirt and mud, or alternative conditions that challenge performance. These harsh environmental conditions and dynamic network topologies could cause some of commercial device nodes to malfunction. The big variety of applications envisaged on WSNs can have completely different QoS requirements and specifications. The QoS provided by WSNs refers to the accuracy between the information reported to the sink node and what's truly occurring within the industrial setting. In addition, since device knowledge square measure generally time-sensitive, e.g., alarm notifications for the economic facilities, it's vital to receive the information at the sink during a timely manner.

Attributable to the high density within the network topology, device observations square measure extremely related with the area domain. In addition, the character of the natural phenomenon constitutes the temporal correlation between every consecutive observation of the device node. Compared to wired networks, in WSNs, the come-at-able capability of every wireless link depends on the interference level perceived at the receiver, and high bit error rates square measure determined in communication. In addition, wireless links exhibit wide variable characteristics over time and area as a result of obstructions and yelling setting. Thus, capability and delay come at able at every link square measure location-dependent and vary ceaselessly, creating QoS provisioning a difficult task. Security ought to be a necessary feature within the style of WSNs to create the communication safe from external denial-of-service attacks and intrusion. WSNs have special characteristics that alter new ways in which of security attacks. Passive attacks square measure meted out by eavesdropping on transmissions as well as traffic analysis or

revelation of message contents. Active attacks encompass modification, fabrication, and interruption that in IWSN cases could embrace node capturing, routing attacks, or flooding. Most WSNs contain an oversized range of device nodes which could be unfold extensively over the preparation field. Thus, WSNs are used to determine connections and maintain network property autonomously. It is necessary for the development of sensing network to supply several services which give access to retrieve any information at any time and thus it may be integrated with the net protocol design. This sensor-network platforms use gateways for integration between WSNs and therefore the web. Wireless sensor network has wide range of application like in industrial application, medical application, agriculture application and many more. Few of them are following-

Area observation- Area observation could be a common application of WSNs. In space observation, the WSN is deployed over a region wherever some development needs to be addressed.

Health care observation- The medical applications are often of two types: implanted and wearable. Wearable devices area unit used on the body surface of an individual. There are a several alternative applications too e.g. body position activity and site of the person, overall observation of sick patients in hospitals and at homes. Body-area networks will gather information regarding a person's health, FITNESS, and energy expenditure.

Environmental or Earth sensing- There are a unit several applications in observation environmental parameters, samples of that area unit given below. They share the additional challenges of harsh environments and reduced power offer.

Air pollution observation- Wireless sensing element networks are deployed in many cities to observe concentration of dangerous gases for voters. These will make the most of the impromptu wireless links instead of wired installations that additionally build them a lot of mobile for testing readings in numerous areas.

Forest fire detection- sensing element nodes are put in a forest in order to detect whether fire has started or not. The first detection is important for victorious action of fire fighters; because of Wireless sensing element Networks, the fire brigade are ready to apprehend once a fireplace is started.

Landslide detection- A landslide observation system makes use of a wireless sensing element network to detect the changes in numerous parameters that will occur before or throughout a landslide. Through the information gathered it should be potential to understand the prevalence of landslides long before it really happens.

Water quality observation- Water quality observation involves analyzing water properties in dams, rivers, lakes & oceans, likewise as underground water reserves. the utilization of the many wireless distributed sensors allows the creation of a lot of correct map of the water standing, and permits the permanent readying of observation stations in locations of inauspicious access, while not the requirement of manual knowledge retrieval.

Natural disaster- Wireless sensing element networks will effectively act to stop the implications of natural disasters. Wireless nodes have with success been deployed in rivers wherever changes of the water levels ought to be monitored in real time.

Machine health observation- Wireless sensing element networks are developed for machinery condition-based maintenance as they provide vital price savings and change new practicality. Wireless sensors are often placed in locations troublesome or not possible to achieve with a wired system, like rotating machinery and unbound vehicles.

Data logging- Data work Wireless sensing element networks also are used for the collecting the environmental information. The advantage of WSNs over standard loggers is that the "live" knowledge feed that's potential.

Water Waste or water observation- This observation of water includes several activities like checking the standard of underground or surface water and guaranteeing a country's water infrastructure for the advantage of each human and animal. It may be accustomed defend the wastage of water.

Structural Health observation- in Structural health observation, Wireless sensing element networks are often accustomed monitor the condition of civil infrastructure and connected geo-physical processes near real time and over long periods through knowledge work, victimization suitably interfaced sensors.

II. LITERATURE SURVEY

Kumar, N. (1999) [1], proposed an effective way to increase the network lifetime of WSN. The clustering algorithms basically utilize two techniques, first one is the selection of cluster head by more residual energy, second one is the rotation of cluster heads on probability basis periodically, for same distribution of energy consumption with sensor nodes in cluster and increase the lifetime of WSN. To forward the data packets to base station, cluster heads make cooperation with cluster heads, on the probability the cluster heads are selected and large residual energy node cannot be opted as cluster head or low residual energy node can be selected as cluster head.

Cardei, Mihaelaet al.(2005) [2] proposed that SDP relaxation technique for the location estimation problem in WSNs. The problem of optimization is set up so as to decrease the error in

the sensor positions to distance measures. Observable persons are developed to clarify the quality of point estimation of sensors and to track erroneous sensors. The performance of this method is largely satisfactory comparing to other methods. Few nodes are needed to correctly estimate the location of all the unspecified nodes in network. Also the estimated errors are minimums when the anchor nodes are not compatibly placed within network or distance measurements are noisy.

Mao, Guoqian et al. (2007) [3] in this work, some techniques has been studied for wireless sensor network localization .The presented technique gives an method of the measurement in sensor network localization or one-hop localization algorithms technique rely on measurements

Ngo Hung (2007) [4] proposed a distributed clustering protocol technique for sensor networks, which is called Energy-Efficient Cluster Formation protocol. Suppose that any sensor may either a regular sensor or Cluster Head that regular sensor has to be connected to a Cluster Head, i.e., it has at least one CH in fixed transmission range. CHs can route data. In EECF, the set of Cluster Heads is elected following a 3-way message exchange between one-hop neighbours and every sensor. CH election is based on the sensors' respective residual degrees and energies. Run a flat network, protocol ends up on a clustered sensor configuration that increases network lifetime, during ensuring, under a specific condition, the connectivity of overlay network composed of CHs.

Guan Xin, Wu Hua Yang et al. (2008) [5] proposed an energy efficient hierarchical clustering algorithm (EEHCA). This algorithm uses a new method for the selection of cluster head and uses the multi-hop communication and clusters is of equal size. It minimizes the energy and balance the load over every node. Simulation results show that proposed algorithm increases the network lifetime compared with LEACH and HEED.

Yick, Jennifer et al. (2008) [6] proposed that wireless sensor network has vital applications like as remote environmental target tracking and monitoring. This has enabled by availability, specifically in later years, of sensors which are cheaper, smaller, and intelligent. Sensors are equipped with interfaces with those they can communicate with another to form a network. The design of wireless sensor network depends significantly on application, and it has considered various factors such as the environment, the application's design hardware, objectives, cost, and system constraints. The main goal of this method is to display a comprehensive review of recently updated information since the publication of the survey on sensor networks, IEEE Communications Magazine.

Sam danis (2009) [7] proposed an individual sensor node with several additional challenges to communication protocols of energy consumption. WSN communication protocols are mainly tailored to give high energy efficiency. Sensor nodes carried the limited power sources. Thus, traditional networks are designed to enhance the performance metrics like as throughput and delay, wireless sensor networks protocols focus primarily on power conservation. The placement of wireless sensor networks is a factor that is considered in developing wireless sensor networks protocols. The position of the sensor nodes require not be engineered or predetermined. It allows random placement in inaccessible terrains or disaster relief operations. On the other side, this random deployment needs the placement of self-organizing protocols for communication protocol stack.

DuanCuiq (2009) [8] proposed in local processing multi-hop communication, wireless sensor networks need some more functions that are efficiently carried out by low-end platforms. High-level tasks like as network management need larger processing power and memory compare to capabilities of platforms. More so, the integration of wireless sensor networks with included networking infrastructure needs several communication techniques to be integrated via gateway modules. Moreover, in networks processing storage hubs are integrated with the sensor nodes, huge capacity nodes are required.

PengZhiyong (2010) [9] proposed the distance constraint condition and residual energy of nodes between cluster heads are completely consideration. This makes nodes with residual energy in network has higher probability to become the cluster heads, and make cluster heads distribute in the actual limited regions uniformly, therefore avoid unrequited energy loss causing by short distance between the CHs. In the data transmission stage, the mode of single-hop communication is located with cluster member nodes and cluster head and sink node. Long distance communication mode is used at the cost of a specific survival time that avoids effectively "hot area" issues by multi-hop communication mode.

Bakr Bilal (2011) [10] proposed the EDL protocol. In the EDL protocol, in practical application of limited area, take phenomena of heterogeneous and isomorphic networks into consideration. That is to say, in isomorphic network, initial energy of all nodes are same; in the heterogeneous network, energy for the randomly setting a specific proportion of nodes is large, and energy for other nodes is relatively low. At the initial stage, cluster head is elected and the TDMA time slots are distributed to the ordinary member nodes with the cluster head. Within time slot, ordinary member nodes have joined an appropriate cluster. In stable working stage, the cluster head transmits data directly within a single-hop of communication mode to sink node after merging data. After round of the data collection, a new cluster head has been elected, therefore repeating work of two stages. In order to the lower cost at initial stage, time for stable working stage should be higher than that for starting stage.

III. PROPOSED METHODLOGY

Wireless Sensor Networks consists of n number of sensor nodes out of which m number of cluster heads and a base

station. Nodes are grouped into a number of clusters. Every cluster has one cluster head upon all other nodes, which act as normal and gateway nodes. Cluster head plays an important role for communication amongst the nodes in same cluster whereas a gateway node plays an intermediate node amongst the nodes belonging to different clusters for the purpose of communication. There are two type of messages in any cluster i.e. inter and intra-cluster message. Since Normal nodes only communicate with their cluster head, which in turn, aggregates the collected information and sends it to the MSS. In this scheme, cluster head failures are critical. When it fails, re-election process is invoked within the cluster.

The communications links connecting these nodes are assumed to be FIFO. Clocks are not synchronized and memory is not shared. Finite and arbitrary amount of time is taken by messages during transmission. Figure 1 shows the system model with cluster head and sensor nodes and base station.

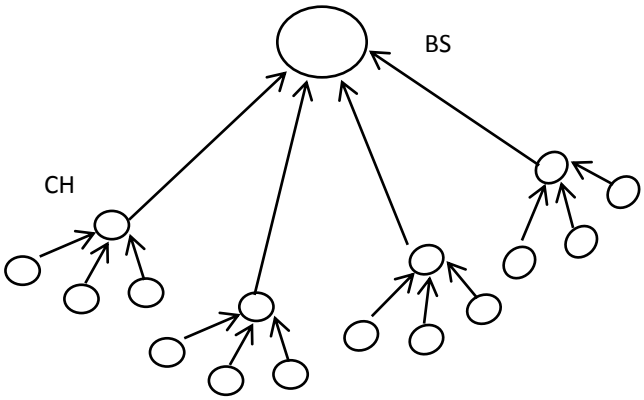

Fig: 1 System Model

The total numbers of nodes placed in the grid are 50. Wireless parameters like antenna type, channel type and propagation model are defined for each node. MAC layer is used for the extraction of energy from each node with standard following IEEE 802.11 and the radio model has been adopted. The performance parameters are:

Residual Energy- Residual energy is defined as the energy remained at the node after the communication cycle. The residual energy is an important measure of the performance of the system as more residual energy means the improved energy efficiency of the network.
End to End Delay is given by:

$$\text{Delay} = (\text{Packet received by receiver time} - \text{generated time})$$

This parameter shows that if the loss of packets in the network reduces the average end to end delay in the network also decreases. Number of Hops: Number of hops in the network means the number of nodes present in the path from source to destination. The number of hops after placing the relay node at the optimize location should be reduced.

IV. RESULT

Figure 2 shows the residual energy plotted against simulation time. Residual energy is the energy remaining at the node after the communication cycle. Figure 2 shows that the energy remaining at the node in the proposed approach is more than the basic approach.

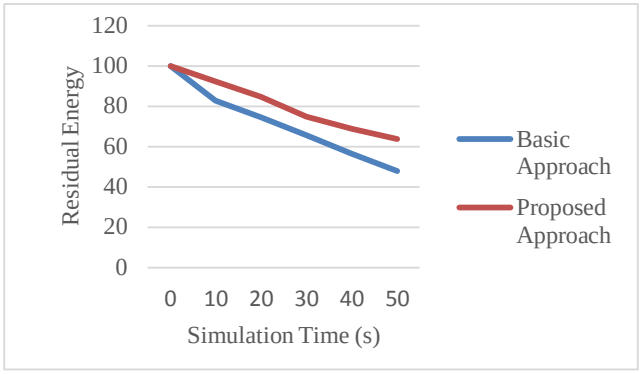

Fig: 2 Residual Energy vs Simulation Time

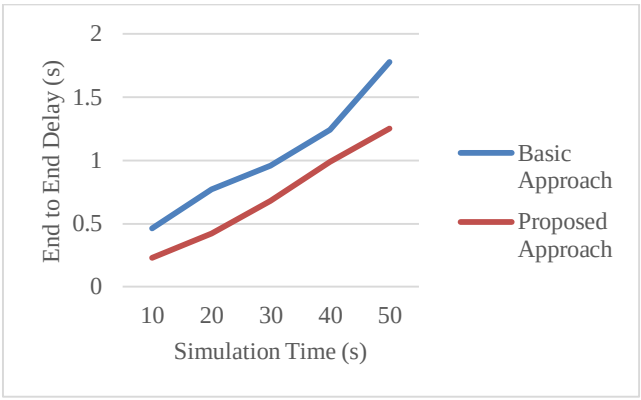

Fig 3: End to End Delay vs Simulation Time

Figure 3 shows the graph between end to end delay and the simulation time. As the number of packets lost in the network decreases, the end to end delay in the network also decreases as number of retransmissions decreases. Figure 3 shows the end to end delay of the proposed approach is less than the basic approach. Figure 4 shows the number of hops in the network.

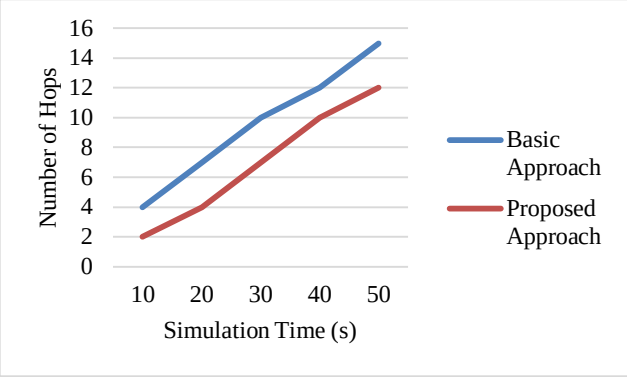

Fig 4: Number of Hops vs Simulation Time

Figure 4 shows the code which represents the creation of the neighborhood table for the hopping in the network. It is evident from the graph that number of hops in the network increases as the simulation time increases. This is due to the fact that more and more nodes are trying to transmit the data and more number of new paths are calculated. The relay nodes are placed near the nodes whose energy is more consumed as compared to other nodes in the network. Graph shows the proposed approach uses less number of hops as compared to the basic approach and requires less number of relay nodes.

V. CONCLUSION

Residual energy of the node is the energy left at the node after the communication cycle and must be considered as it gives an important idea about the adjustment of location of the node. The objective function value is calculated for each node in the network and a decision is taken for placing the relay node at the most frequently used route in the network. These approaches are implemented and compared with the existing techniques and an analysis is performed on the basis of their merits and demerits. In the present work for placing the relay node in the network firstly the location for the placement is defined. For the location calculation an objective function is designed which is based on the values of the number of packets lost, residual energy of nodes in the network and distance between the nodes. Several other statistical approaches must also be used like Bayesian Filters, Kalman Filters and Extended Kalman Filters to improve the non linearity of the problem so as to improve the acceptance of results. The results also show that the proposed approach outperforms the basic approach on the basis of various performance parameters like residual energy, end to end delay and the number of hops required in the network from source to destination. In the future various other machine learning and meta heuristic algorithms must be implemented on the objective function to further improve the accuracy of the results.

REFERENCES

[1]. Kumar N, Deborah, Ramesh Govindan, John Heidemann, and Satish Kumar. "Next century challenges: Scalable coordination in sensor networks." InProceedings of the 5th annual ACM/IEEE international conference on Mobile computing and networking, pp. 263-270. ACM, 1999.

[2]. Cardei, Mihaela, and Ding-Zhu Du. "Improving wireless sensor network lifetime through power aware organization." Wireless Networks 11.3 (2005): 333-340.

[3]. Mao, Guoqiang, BarışFidan, and Brian DO Anderson. "Wireless sensor network localization techniques." IEEE Conference on Computer networks 51.10 (2007): 2529-2553

[4]. Ngo Hung Quoc,LeeYoung-Koo,LeeSungyoung. "MEPA: a new protocol for energy-efficient, distributed clustering in wireless sensor networks" .In: Pro-ceedings the ISWCS2007;17–19October2007.p.40.44.

[5]. Xin, Guan, Wu Hua Yang, and Bi DeGang. "EEHCA: An energy-efficient hierarchical clustering algorithm for wireless sensor networks." Information Technology Journal 7, no. 2 (2008): 245-252.

[6]. Yick, Jennifer, Biswanath Mukherjee, and Dipak Ghosal. "Wireless sensor network survey." Computer networks 52.12 (2008): 2292-2330.

[7]. Sam Danis Konstantinos, Friderikos Vasilis, HamidAghvami A "Auto no michier- archical reconfiguration for wireless access networks", Journal of Network and Computer Applications2009;32(3):630–41.

[8]. Duan Cuiqin, SunJingjing, ZhouDuan, Zhang Jianxian. "An energy efficient regional partitioned clustering routing algorithm for wireless sensor networks". In: Second international conference on intelligent networks and intelligent systems(ICINIS-2009).IEEE;2009.p.205–8.

[9]. Bakr Bilal Abu, LilienLeszek, "Extending wireless sensor network lifetime in the LEACH-SM protocol byspare selection". In:Fifth international conference on innovative mobile and internet services in ubiquitous computing. IEEE Computer Society, IEEE;2011.p.277–82.

[10]. Peng Zhiyong, LIXiaojuan. "The improvement andsimulati on of leach protocol for WSNs" . Journal of Computer Networks, pp. 321- 344, IEEE2010.